Research Report

water

Water Sector

FCM | Green Municipal Fund
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RESEARCH REPORT: WATER SECTOR

–Final Report –

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Prepared for:

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EXECUTIVE SUMMARY

The Federation of Canadian Municipalities (FCM) Green Municipal Fund (GMF) engaged the services of Marbek Resource Consultants to review the issues and trends related to sustainable Water Sector practices in municipalities and to document typical and best practices, as well emerging technologies.

The Water Sector activities addressed by this report are municipal water services, including potable water, wastewater, stormwater and related planning and management activities such as watershed management and water demand management. For purposes of this project, the scope of the Water Sector does not include flood control practices other than municipal stormwater practices (flood diversion infrastructure is excluded, for example) or habitat management or restoration practices (such as wetland conservation, for example).

Sustainable water management is defined in this report as an approach that examines why we use water as well as how it is used, and to account for ecosystem needs. Planning for future use ideally includes goals of reduced consumption, no increase in supply, and to returned used water in a state that supports a healthy environment and future reuse. Sustainable water services also include planned operations and maintenance to meet environment and health requirements, and sufficient resourcing to manage and fund the built system for current and future community use.

Issues

The key issues affecting sustainable Water Sector are shown in the following Exhibit and described in the Report.

Exhibit E.1
Sustainable Water Sector Issues

Environmental	Economic	Regulatory	Governance	Technological	Social and Other
• Water Quantity • Water Quality • Emerging Contaminants • Energy Use / GHG Emissions	• Infrastructure Deficit • Revenue Collection and Rate Structures • Economic Barriers to Water Re-use	• Changing Regulatory Requirements • Water Allocation and Management • Potable, waste and storm water Requirements • Planning Requirements • Municipal Powers • Building Codes and Insurance • Regulatory Barriers to Water re-use	• Multiple Players • “Political Will”	• Treatment Technologies • Collection and Distribution Technologies • Energy Use Reduction	• Demographics • Perceptions of Water • Immediacy of Water Use • Liability Issues

Practices

Three aspects of municipal decision making are examined for best practices: planning approaches; governance and management; and, operational practices and technology. Best practices for strategic planning approaches include managing municipal water services within a watershed-based approach, demand management and infrastructure master planning. Best practices for governance and management for water servicing include decision support tools, financial instruments, staffing practices, monitoring and reporting, communications and engagement and regulatory instruments and their compliance promotion and enforcement. Best practices for operations and technologies include efficient technologies for water use (including reuse and matching quality to use), advanced treatment technologies and system efficiency measures (including alternative levels of service).

Financial Implications of Moving to Sustainability

The financial impact of sustainability is discussed from three perspectives. Firstly, using conventional cost-benefit calculations, sustainable solutions typically require higher up-front costs for innovative measures, as well as for changes to policies and planning tools, capacity-building, public consultation, and inclusive decision-making processes. Secondly, from the perspective of the long-term financial savings of holistic approaches, it is difficult to demonstrate savings due to the number of potentially changing variables in the future, including the effects of climate change on water supply and quality, demographics, increased regulatory requirements, etc. Future financial savings may not be a relevant question in any case; the choice regarding whether to act or not should not be based on future savings but rather future costs and risks of inaction. Finally, from the perspective of holistic approaches, understanding of the financial impacts of sustainability is nascent in Canada. Using Okotoks Alberta as an example, a summation of costs of the approach was not obtained due to the fact that it has affected virtually all aspects of community development and water resource management, including policy, planning, zoning, development processes, public education and other capacity-building requirements. In theory, the long-term benefits of these holistic practices should be reduced costs however this has yet to be demonstrated in Okotoks. As mentioned above, instead of thinking in terms of cost savings, the more important question may become "What are the reduced risks of adopting sustainable practices?"

Opportunities and Threats

Key trends and considerations for a discussion of the opportunities and threats with respect to the municipal water sector include:

- A continuing perception of water abundance and apparently low public valuation of water leading to a lack of rigorous approaches to water resource management;
- Growing domestic demands for water can be expected to continue, fuelled by pricing that is below cost; however certain provinces are taking steps to ensure communities plan for full cost recovery and this trend can be expected to increase water rates in those jurisdictions;
- Increasing regulatory controls in the area of wastewater and potable water quality;
- Climate change leading to physical changes in the water cycle/ availability regionally; public concern for action on climate change appears to be increasing and will eventually lead to more active government attention to mitigation and adaptation.

Key issues in moving towards sustainable water resource management and servicing include:

- *Measurement*: To effectively manage an issue, it is important to develop measurements of performance. Water metering is a cornerstone of good water management because it begins to address water quantity as well as public awareness issues. Installing meters is a necessary condition for financial management, demand side management, public awareness and education.

- *Full cost*: Similar to water metering, full cost accounting will not necessarily result in sustainable water resource use because of the inherently inefficient and wasteful nature of conventional water infrastructure design and use. However, full cost accounting and pricing is necessary to begin the sustainable journey.
- *Integrated land use decision-making for water environment protection and pollution prevention*: All land use decisions are water decisions. To protect the quality of water and the environment, land use decisions made by municipalities must incorporate watershed/ sub-watershed factors.
- *Basin Capacity:* The assumption that more water supply will always be available from somewhere in proximity to the community is well-entrenched in community planning and engineering approaches. Communities at the leading edge in terms of working within their water basin limits are those with no choice: these leaders have no alternate sources of water. Given Canadian's water consumption habits and the opportunities offered through more holistic approaches, alternative technologies and standards, there are numerous opportunities for improvement in this area.
- *Demand Side Management*: Municipalities willing to implement demand-side management measures in its broadest application are needed to overcome the inertia against changing to more efficient use of high quality drinking water. Measures include those that move beyond efficiency to conservation and alternative approaches that may not require water to meet service needs. Innovative water use schemes can also address stormwater, energy efficiency, wastewater volumes, and other interconnected issues.
- *Utility Reform*: In many cases structural changes in internal management are required in order to move from a conventional focus on infrastructure management for water supply and wastewater treatment to adoption of a concept of utilities as water service agencies, with emphasis on demand management and water cycle protection as well as supply-side issues.
- *Managing for Challenges of the Future*: One common theme that emerges in discussing the concept of sustainable water resources is a need for adaptive management; that is, a need for organizations to respond nimbly to challenges as they arise and adapt systems and practices to meet the challenge. Municipalities need performance measures and corresponding information about where they are with respect to their measures. Measures could include any number of factors, from physical to social to economic, management and others.
- *Climate Change*: The science and technological implications of climate change on water resource management and water service delivery are just beginning to emerge. There are many opportunities to support integrated measures for water and energy use reductions as well as community development of approaches to adapt to altered precipitation, storage and drainage patterns and to apply integrated 'green' measures in a changing climate.

Table of Contents

Appendices:

Appendix A	Contact List
Appendix B	Resources
Appendix C	Exemplary Community Profiles

Glossary of Terms

Acronym	Term
CCME	Canadian Council of the Ministers of the Environment
CMHC	Canada Mortgage and Housing Corporation
CSA	Canadian Standards Association
CWS	Canada-wide Strategy for the Management of Municipal Wastewater Effluent
CWWA	Canadian Water and Wastewater Association
DSM	Demand side management
GCDWQ	Guidelines for Canadian Drinking Water Quality
GIS	Geographic information system
HVAC system	Heating ventilation and air conditioning system
ICI	Industrial, commercial and institutional sectors
I/I	Inflow and infiltration
IWM	Integrated watershed management
IWRM	Integrated water resource management
NPC	National Plumbing Code
NPS	National Performance Standards
OECD	Organization for Economic Cooperation and Development
QMRA	Quantitative microbial risk assessment
PCBs	Polychlorinated biphenyls
PVC	Polyvinyl chloride
SCADA systems	Supervisory Control and Data Acquisition systems
WEP	Water efficiency plan
WWFMP	Wet Weather Flow Master Plan

Term	Definition
Activated sludge	Product that results when primary effluent is mixed with bacteria-laden sludge and then agitated and aerated to promote biological treatment, speeding the breakdown of organic matter in raw sewage undergoing secondary waste treatment.
Ambient water	Water of the surrounding area or environment.
Anaerobic digester	A closed vessel where solids, or sludges, produced by other treatment processes are stabilized through a biological process which takes place in the absence of oxygen.
Belt thickening	A method for the mechanical dewatering of sludge. Conditioned sludge is placed on a belt to allow drainage of liquid from the sludge. This belt then meets a second belt sandwiching the sludge between them and compressing the sludge, releasing more liquids.
Benthic invertebrate	An invertebrate organism that feeds on the sediment at the bottom of a water body such as an ocean, lake, or river.
Biosolids	Usually used to describe the sludge separated from the wastewater during treatment. The term may also mean either treated wastewater sludge or the biological solids growing in a wastewater treatment process or the beneficial use of wastewater sludge.
Blackwater	Water that contains animal, human or food waste.
Bleeder valves	Bleeder valves are used in cold climates to maintain continuous water movement in buried pipes in order to prevent freezing. These valves usually drain directly into storm or sanitary sewers.
Cathodic protection	A technique to prevent corrosion of a metal surface by making it the cathode of an electrochemical cell.
Chemical flocculation	Process by which clumps of solids in water or sewage aggregate through chemical action so they can be separated from water or sewage.
Cistern	Small tank or storage facility used to store water for a home or farm; often used to store rain water.
Coagulation	Clumping of particles in wastewater to settle out impurities, often induced by chemicals such as lime, alum, and iron salts.
Combined sewer system	A sewer system that carries both sewage and storm-water runoff. Normally, its entire flow is delivered to a wastewater treatment plant, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and sewage into receiving waters. Storm-water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system.
Conservation easement	Easement restricting a landowner to land uses that that are compatible with long-term conservation and environmental values.
Conveyance loss	Water loss in pipes, channels, conduits, ditches by leakage or evaporation.
Cross-connection	Any actual or potential connection between a drinking water system and an unapproved water supply or other source of contamination.

Term	Definition
Cure-in-place pipe	Cure-in-place pipe or relining refers to a method of rehabilitation of damaged or worn sewer pipes which do not require trenching or exposing existing pipe. This is achieved by inserting a resin-coated sleeve or tube into a damaged pipe, and using heat to cure the resin once the tube is in place on the existing pipe walls.
DSM – Demand side management	An attempt by utilities to reduce customers' demand for water by encouraging efficiency.
Downspout	A pipe for draining water from roof gutters.
Embodied energy	The total life cycle energy used in the collection, manufacture, transportation, assembly, recycling and disposal of a given material or product.
Endocrine disrupting substance	Endocrine disruptors are exogenous substances that act like hormones in the endocrine system and disrupt the physiologic function of endogenous hormones. Studies have linked endocrine disruptors to adverse biological effects in animals, giving rise to concerns that low-level exposure might cause similar effects in human beings.
Extended aeration	In this process, wastewater is screened and aerated in a large capacity reactor, over a long period of time, before progressing to a separate final settlement tank, for completion of the process. This means that there is no production of primary sludge and considerable savings of cost and time can be made by not having to remove it. A low level of excess biomass is also produced.
Fecal coliform	Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.
Fold and form	Fold and Form is a method used to rehabilitate pipe between manholes. A PVC pipe-liner is heated, pulled into the desired position within the pipe, and re-formed using steam or hot air.
Gravity settling (for sludge handling)	The thickening of sludge by allowing the sludge to settle is common in the treatment of water and wastewater sludges. The thickening tank often has a stirrer which slowly rotates, helping the sludge to settle and thicken.
Green roof	A green roof is a roof of a building that is partially or completely covered with vegetation and soil, or a growing medium, planted over a waterproofing membrane.
Grey water	Domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.
Ground water	The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Term	Definition
Impervious surface	Those surfaces in the landscape that can not infiltrate rainfall, such as rooftops, pavement, sidewalks, driveways and compacted earth.
Membrane Filtration Technology (water or wastewater)	Technology to separate (i.e. to filter) particles from the liquid stream that uses a thin porous membrane. The membrane may be a flat sheet, fine hollow fibres or in tubular form. The nominal size of separation achieved depends on the pore size of the membrane and these may include microfiltration, ultrafiltration, nanofiltration, reverse osmosis, dialysis and electro-dialysis. Various methods may be used to drive the flow across the membrane, including hydraulic pressure.
Oxidation ditch	The oxidation ditch is a piece of equipment used for a long-term aeration. It consists of a long channel of an elliptical or circular shape equipped with aeration equipment called (rotor) for generating a water flow and stirring water in the channel to supply oxygen. Thought it requires a relatively large area, it has a simple structure and can be easily operated. It also is able to remove nitrogen easily. Thus, it has recently been widely used in relatively small wastewater treating plants.
Pipe-lining technology	A technology which allows the rehabilitation of old or damaged pipes without exposing the existing buried pipe. Numerous pipe-lining technologies exist, including epoxy coating, cure-in-place pipe, fold in form pipe and pipe-bursting, a method which pulls a new pipe section in to place behind a device used to burst old or damaged existing pipe.
Plume chemistry	The study of how pollutants in the ambient water body disperse and, in some cases, how they react in the water body. Dispersion models are used to estimate or to predict the downwind concentration of water pollutants emitted from sources such as industrial and water treatment plants.
Potable water	Water which is free from impurities that may cause disease or harmful physiological effects, such that the water is safe for human consumption.
Pressure management	Pressure management aims to adjust water pressure levels in the supply system to achieve more consistent pressure levels which will reduce the number of water main breaks, improve the reliability of the water supply system and conserve water.
Primary sedimentation	First steps in wastewater treatment; screens and sedimentation tanks are used to remove most materials that float or will settle.
Primary treatment	To prevent damage to pumps and clogging of pipes, raw wastewater passes through screens to remove large debris. Smaller inorganic material, such as sand and gravel, is removed by a grit removal system. The lighter organic solids remain suspended in the water and flow into large tanks, called primary clarifiers. Here, the heavier organic solids settle by gravity. These settled solids, called primary sludge, are removed along with floating scum and grease and pumped to anaerobic digesters for further treatment.
Retention pond or lagoon	A man-made pond where stormwater is directed and held.
Reverse osmosis system	A treatment process used in water systems by adding pressure to force water through a semi-permeable membrane. Reverse osmosis removes most drinking water contaminants. Also used in wastewater treatment. Large-scale reverse osmosis plants are being developed.

Term	Definition
Riparian	Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.
Robotic spot repair	Involves use of remotely controlled systems for structural repair or leak control of buried pipes. It is used in the repair of sewer and water lines where structural enhancement is required.
Rotating biological contractor	A form of wastewater treatment in which biomass is attached to disks (up to 3.5 m in diameter) which rotate at 1 to 3 rpm while immersed up to 40% in the wastewater. When exposed to air the attached biomass absorbs air and when immersed the microorganisms absorb the organic load. A biomass of 1-4 mm grows on the surface and its excess is torn off the disks by shearing forces and is separated from the liquid in the secondary settling tank. A small portion of the biomass remains suspended in the liquid within the basin and is also responsible in minor part for the organic load removal.
Sacrificial metal anodes	The sacrificial metal anodes are easily oxidised materials connected by a conductive solid to a material to be protected from oxidation. In the case of water infrastructure, they are connected to buried metallic pipes and fittings to increase life, as the anode is oxidised in place of the protected pipe or fitting.
Secondary treatment	Secondary treatment begins with the effluent treated during the primary stage. The wastewater is mixed with a controlled population of bacteria and an ample supply of oxygen. The micro-organisms digest the fine suspended and soluble organic materials, thereby removing them from the wastewater. The effluent is then transferred to secondary clarifiers, where the biological solids or sludges are settled by gravity. As with the primary clarifier, these sludges are pumped to anaerobic digesters, and the clear secondary effluent may flow directly to the receiving environment or to a disinfection facility prior to release.
Sentinel fish species	A fish species used as an indicator of overall environmental conditions, particularly contaminants.
Septic system	A facility used for the partial treatment and disposal of sanitary wastewater, generated by individual homes or small business, into the ground. Includes both a septic tank and a leaching facility.
Slip lining	Slip lining is a cost-effective rehabilitation method in which a pipe is inserted into an existing line by either pulling or pushing continuous or short-length pipes, frequently HDPE pipe. With traditional slip lining, a lead-in trench is excavated for installation and pipes are winched or jacked into the existing pipe.
Sluice gate	A sluice gate is traditionally a wooden or metal plate which slides in grooves in the sides of the channel. Sluice gates are commonly used to control water levels and flow rates in rivers and canals. They are also used in wastewater treatment plants.
Small bore wastewater collection systems	A small bore sewer system separates sewage into solid and liquid components in each home's clarifier unit. The effluent then travels as a result of gravity to a sewage treatment facility via the systems' pipelines. The remaining solid waste in the clarifier unit is then removed every 7-10 years.
Storm water	Stormwater discharges are generated by runoff from land and impervious areas such as paved streets, parking lots, and building rooftops during rainfall and snow events that often contain pollutants in quantities that could adversely affect water quality.

Term	Definition
Swale	A wide, shallow depression in the ground designed to channel drainage of rainwater.
Tertiary treatment	Tertiary treatment involves the additional treatment to remove suspended and dissolved substances remaining after secondary treatment. This may be accomplished using a variety of physical, chemical or biological treatment processes to remove the targeted pollutants.
Trickling filter	A coarse treatment system in which wastewater is trickled over a bed of stones or other material covered with bacteria that break down organic waste and produce clean water.
Triple pipe conveyance systems	A storm water system which allows the infiltration of runoff from minor storm events through two smaller pervious pipes, but conveys runoff from major storm events via a larger conventional sewer line.
Turbidity	A cloudy condition in water due to suspended solids (silt or organic matter).
Wastewater	The spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.
Water catchment area	The area determined by topographic features where falling rain will contribute to the runoff at a particular point.
Watershed	The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.
Wellhead protection areas	A designated surface and subsurface area surrounding a well or well field that supplies a public water supply and through which contaminants or pollutants are likely to pass and eventually reach the aquifer that supplies the well or well field. The purpose of designating the area is to provide protection from the potential of contamination of the water supply. These areas are designated in accordance with laws, regulations, and plans that protect public drinking water supplies.
Xeriscaping	Xeriscaping refers to landscaping in ways that do not require supplemental irrigation.

1. INTRODUCTION

1.1 BACKGROUND

The FCM Green Municipal Fund (GMF) supports communities to improve air, water and soil quality, and to address climate change. Municipal governments across Canada, from large urban centres to smaller rural and northern communities, may apply to GMF through three funding streams in five sectors of activity (brownfields, energy, transportation, waste and water): stream 1 – sustainable community planning (for sustainable community plans only); stream 2 – for feasibility studies and field tests in the five sectors; stream 3 – for capital projects in the five sectors. The Fund provides low-interest loans and grants, builds capacity, and shares knowledge to support municipal governments and their partners in developing communities that are more environmentally, socially and economically sustainable. Information sharing among municipal practitioners and technology transfer for best practices are important features of the GMF funding program in order to increase the capacity of communities to undertake leading practices in Canada.

The Federation of Canadian Municipalities (FCM) commissioned Marbek Resource Consultants to undertake research on current and best practices of Canadian municipalities in the water sector.

1.2 OBJECTIVES

The purposes of the Water Sector Research project are to:

- Identify issues, trends, technologies, best practices, and Canadian examples related to *municipal* progress in sustainable community development within the water sector.

- Provide current and comprehensive information that could serve as the basis for educational or outreach materials in the water sector, could to be used in capacity building and knowledge sharing activities, or could be used in its entirety as a reference.

1.3 SCOPE OF THE WATER SECTOR

GMF's water sector includes watershed management; water conservation; wastewater treatment; water distribution upgrades to reduce leakage; and storm water run-off management (wetlands, green roofs).[1] Important projects in the water sector include, but are not limited to, projects that improve the quality of drinking water or wastewater or which reduce water use intensity. Wastewater projects include sanitary system wastewater, stormwater systems and combined sewer systems. For purposes of this project, the scope of the Water Sector does not include flood control practices other than municipal stormwater practices (flood diversion infrastructure is excluded, for example) or habitat management or restoration practices (such as wetland conservation, for example). The management and technical practices by industrial or other sectors that rely on municipal water services are not included, although programs by municipalities to reduce poor water practices by these sectors may be identified in the best practices.

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[1] Federation of Canadian Municipalities – *Tools and Resources for Building Capacity: Water*, 2008 (http://www.sustainablecommunities.fcm.ca/Capacity_Building/Water/default.asp - date accessed: April 2008)

1.4 SUSTAINABLE WATER SECTOR PRACTICES

Ideal practices for the Water Sector are described in Sections 3 to 5 following. A synopsis of sustainable water practices is provided by the Water Soft Path approach. This approach:

> *...requires us, as a society, to examine not just how we use our water resources but why we use our water resources the way we do. It requires water management systems to account for ecosystem needs. The water soft path also requires planning around a future goal of reduced water use and commitment of no increased supply.*[2]

While a commitment to no increase in supply needs is an ideal goal, many economic and social pressures arise in growing communities. However since the ultimate quantity of fresh water available is finite, it is an imperative for sustainable water use that there is no degradation of water quality. Thus, the water used must be returned in a state such that it can support a healthy environment and be reused in the future. Other practices for sustainable water services include planned operations and maintenance to ensure the water products (waste or potable) meet environment and health requirements and that the resources required are planned and in place to manage and fund the built system for current and future community use.

1.5 ORGANIZATION OF THIS REPORT

In addition to this introductory section, this report contains the following sections:

- Section 2 identifies key issues facing the municipal water sector and provides information on current status, trends, barriers and drivers with respect to the issues identified;
- Section 3 describes municipal planning approaches to management of water sector services
- Section 4 describes governance and management aspects of water sector service provision
- Section 5 describes operational practices and technologies pertaining to water sector services
- Section 6 discusses the financial impact of sustainability and
- Section 7 discusses moving forward to promote sustainable practices for the municipal water sector.

[2] Walter and Duncan Gordon Foundation, *More for Less: Using the Soft Path to Meet Future Needs with Less Water*, 2005 (http://www.gordonfn.org/FW_obj1_project-12.cfm - date accessed: April 2008)

2. KEY ISSUES

This section provides an overview of key issues as they relate to sustainable community development. These key issues represent the drivers for decision-making and challenges facing municipal governments wishing to implement sustainable practices and projects now and in the future.

Section 2.9 provides a summary table of key issues discussed in this section and their applicability to Canadian municipalities.

2.1 ENVIRONMENTAL ISSUES

2.1.1 Introduction

Water is a fundamental aspect of life on earth. It has amazing properties that allow it to crystallize at zero degrees Celsius, evaporate, dissolve substances, and to be taken up by organisms for nutrient transport and other life support operations. The magnitude of the implications of water's ability to dissolve and carry substances is only beginning to dawn on scientists and municipal water service providers as unanticipated by-products of wastewater (such as pharmaceuticals) are identified in the environment and in potable water supplies in densely populated areas of the globe. The paradigm of thinking about water as a once-through resource that can be used and disposed of without thought is ending as the substance gradually reveals the full repercussions of a lack of respect for its cyclical nature.

A key issue facing municipal water practitioners is that the sustainable path for water services entails an assumption that water supply is finite and that the assimilative capacity of receiving waters is limited. This is a different approach than that taken for traditional water infrastructure design, which essentially assumes increased supply will be available for potable water sources and that the environment can effectively assimilate wastes.

The practice of transferring water from one basin to another for potable water supply, or for wastewater or stormwater disposal, is commonplace. Further, as indicated above, the concept that wastewater is a normal and expected by-product of modern life is not challenged in the traditional approach. Traditional stormwater design entails drainage of lands quickly which is facilitated by sloping hardened surfaces (roads and roofs) and concrete drainage conduits. The fundamental changes to the water cycle resulting from traditional stormwater design are far-reaching and pervasive. These changes include reduced infiltration and groundwater recharge. These reductions in groundwater levels lead to reduced baseflows (i.e. water available in watercourses during dry weather). The hardened surfaces of typical communities also result in significant changes to the amount of water running off the land during rainstorms; the mass of water discharged into receiving watercourses during precipitation and snowmelt results in increased erosion, increases in water temperature and changes in aquatic habitat.

These traditional practices present environmental challenges where water resources are compromised as a result of over-use, transfers, waste discharges and flow rate changes.

Changes in water resources can result in changes to habitat and the abundance and diversity of species able to occupy the resulting water ecosystem. A sustainable approach takes the ecosystem into consideration in terms of both water availability and wastewater assimilation; it also recognizes that all land use decisions are water decisions that affect the volume, quality and flow characteristics of watersheds.

2.1.2 Water Quantity

Canada's renewable water supply is about 6.5% of the world supply[3]. This puts us in a four-way tie for third place globally, with the U.S., Indonesia and China. Brazil and Russia have the world's most abundant renewable water supplies. However, Canada is home to 20% of the global fresh water reserves, including the non-renewable water stored within the Great Lakes[4] and other ecosystems. This quantity of stored and renewable water has created a misconception of water abundance[5] on the part of Canadians (also discussed briefly in section 2.5 following).

In fact, in Canada there are large regional differences in the distribution of water[6]. On the prairies and in the B.C. interior (particularly the Okanagan Valley), available water is limited[7]. In the most populated and industrial regions of the country (the Windsor–Quebec corridor and parts of the Pacific and Atlantic coastal ecozones), water is plentiful[8]. In the north and other less populated regions of the country, the primary issue is not quantity so much as threats to water quality[9], although there is anecdotal evidence in Whitehorse Yukon that the water table is dropping[10].

Potable Water Supplies

In 2004, municipal uses represented 11% of Canada's total freshwater consumption, about half of which was attributable to residential consumption.[11] Between 1994 and 1999, about 26% of Canadian municipalities reported water shortages as a result of increased consumption, drought or infrastructure problems.[12] Potable water quantity challenges were faced most frequently by communities on groundwater supply.[13]

[3] John Sprague, *Great Wet North? in* Eau Canada: The Future of Canada's Water, Karen Bakker (editor), UBC Press, Vancouver, 2007

[4] ibid

[5] ibid

[6] Environment Canada, *The State of Canada's Environment*, 1996 (http://www.ec.gc.ca/soer-ree/English/SOER/1996report/Doc/1-7-3-6-9-1.cfm- date accessed: April 2008)

[7] ibid

[8] ibid

[9] ibid

[10] Linda Nolan, *Buried Treasure: Groundwater Permitting and Pricing in Canada* for the Walter and Duncan Gordon Foundation, 2005

[11] Environment Canada, *Threats to Water Availability in Canada*, 2004 (http://www.nwri.ca/threats2full/ThreatsEN_03web.pdf - date accessed: April 2008)

[12] ibid

[13] ibid

Approximately 74% of Canadians rely on surface water supplies for potable water, whereas about 26% rely on groundwater.[14] Exhibit 2.1 following provides a jurisdictional breakdown of groundwater use.

Figure 2.1
Groundwater Use in Canada[15]

Jurisdiction	BC	AB	SK	MB	ON	QC	NB	NS	PEI	NL	YK	NWT
Population reliant on groundwater (%)	28.5	23.1	42.8	30.2	28.5	27.7	66.5	45.8	77.8	33.9	47.9	28.1

Information on groundwater is typically patchy and the interaction of ground with surface waters is poorly understood and not well studied in Canada.[16] This lack of understanding poses challenges in management of water withdrawls, and in providing adequate protection for aquatic ecosystems, such as maintaining stream baseflows, for example. Records in Canada on water use and withdrawls (by all economic sectors, including municipal) is not well documented in Canada (see 2.3 Regulatory Issues). Overall, the lack of accurate information on water availability and water use increase the risk that jurisdictional authorities may authorize levels of water use that are not sustainable.[17] In parts of Alberta, computer simulations have demonstrated that overall demand for water in the South Saskatchewan River Basin has already exceeded supply[18]. Similarly in B.C. a shortage trend in some regions is starting, with over 17% of surface water sources reaching or nearing their capacity to reliably supply water for extractive uses, including 25 groundwater aquifers nearing their reliable extractive water use capacity[19].

Wastewater and Stormwater Impacts on Quantity

Wastewater and stormwater infrastructure can change the water balance by transferring water (in the form of wastewater discharges) from ground to surface water bodies or transferring surface waters from one sub-watershed area to another. The science behind how much water needs to stay in-stream to maintain ecological integrity is only now emerging, so water-taking practices do not typically take into account the form and function of surface water flows or their interaction with groundwater levels. The importance of understanding ecological needs will increase as water demand increases by the municipal sector and other sectors of the economy.

[14] Ibid.

[15] Linda Nolan, *Buried Treasure: Groundwater Permitting and Pricing in Canada* for the Walter and Duncan Gordon Foundation, 2005

[16] Environment Canada, *Threats to Water Availability in Canada*, 2004 (http://www.nwri.ca/threats2full/ThreatsEN_03web.pdf - date accessed: April 2008)

[17] J. Kinkead Consulting, *An Analysis of Canadian and Other Water Conservation Practices and Initiatives*, prepared for the Canadian Council of Ministers of the Environment, 2006.

[18] Linda Nolan, *Buried Treasure: Groundwater Permitting and Pricing in Canada* for the Walter and Duncan Gordon Foundation, 2005

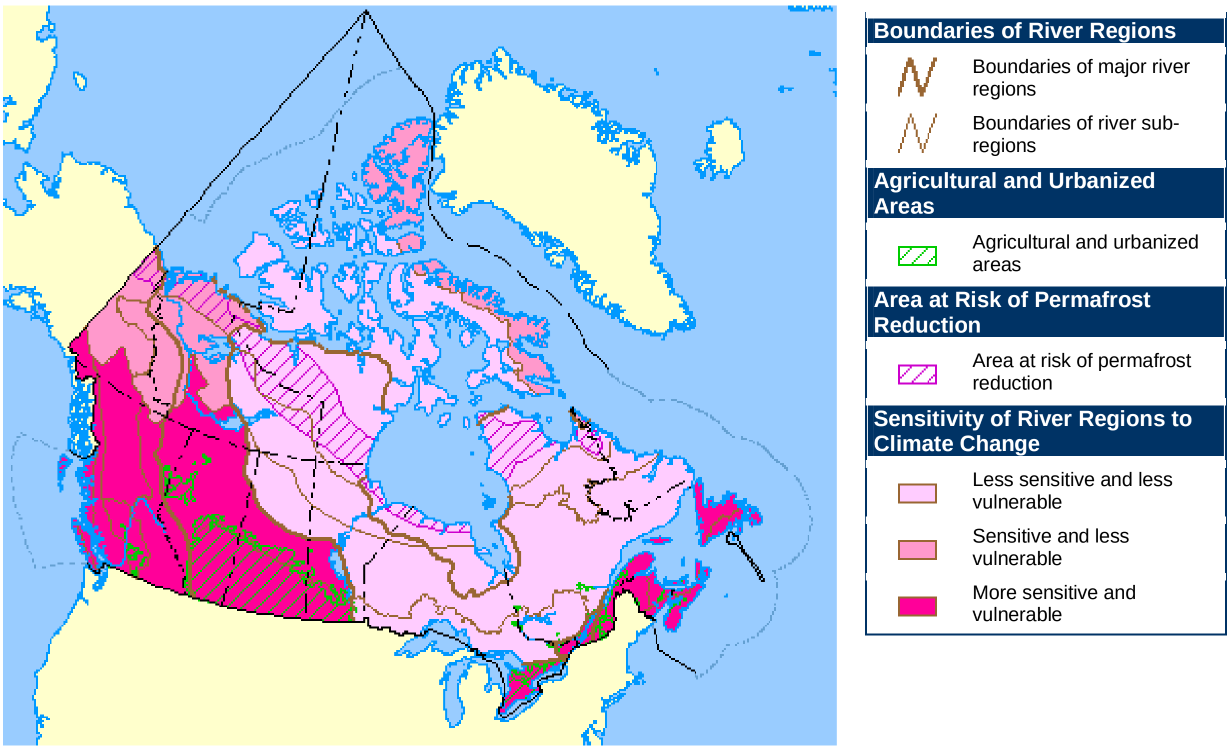
[19] Oliver Brandes and Keith Ferguson *for* The Polis Project on Ecological Governance, *The Future in Every Drop*, University of Victoria, 2004

Climate Change and Water Quantity

Climate change is expected to change the water balance on regional and national scales, with increased storm intensities and prolonged periods of drought. The following map, Figure 2.2 from Environment Canada[20], depicts regional river sensitivities in response to climate change for Canada's river regions. The most sensitive river regions include the Atlantic Coast, the Great Lakes-St. Lawrence Valley, the Prairies and the Rocky Mountains. While this land area is less than half of Canada's land mass, these areas are home to a majority of Canada's population.

The sensitivity projection for Canada's river regions in response to climate warming was derived based on an examination of the effects of projected precipitation changes on landscapes. Climate warming has the potential to cause substantial changes to flow in rivers. The most direct effects of projected climate change would be an increase in floods and river erosion[21].

Figure 2.2
Regional River Sensitivities Resulting from Climate Change[22]



[20] Natural Resources Canada – The Atlas of Canada, *Discover Canada Through National Maps and Facts, 2003* (http://atlas.nrcan.gc.ca/site/english/maps/climatechange/potentialimpacts/sensitivityriverregions - date accessed: April 2008)

[21] ibid

[22] Natural Resources Canada – The Atlas of Canada, *Discover Canada Through National Maps and Facts, 2003* http://atlas.nrcan.gc.ca/site/english/maps/climatechange/potentialimpacts/sensitivityriverregions

2.1.3 Water Quality

Water quality and water quantity are intrinsically linked because community water uses affect water quality. One implication of high water usage patterns in Canada is that investments for both the potable water and wastewater infrastructure and treatment are higher than need be and, in the case of dilution of wastewater, less efficient. Where septic systems are relied on for wastewater treatment, high usage can cause system failures resulting in poor groundwater quality and release of sewage into the environment. High usage can also stress existing water supplies, creating the need to extract less reliable, less accessible or more problematic drinking water sources that require more energy and/or treatment chemicals to access it and render it potable.

Wastewater Quality

Municipal waste water effluents are a complex mixture[23],[24] of human waste, suspended solids, debris and a variety of chemicals that come from residential, commercial and industrial activities; they also contain endocrine disrupting substances, pharmaceutical and personal care products[25]. About 200 chemicals[26] have been identified in municipal sanitary and stormwater discharges. In some communities, they may also contain by-products of nanotechnology, another emerging issue of more recent study and concern with respect to environmental and human health. The fate and effects of many of the contaminants in community waste streams are not well understood[27]. Further, conventional wastewater treatment processes are not designed to treat many of the constituents of concern; secondary treatment, for example, is a biological process that is primarily intended to remove solids, oxygen demand and some nutrients. In the case of most metals for example, the contaminants are largely removed from the water stream but transferred to the residual solids of the process (known as biosolids where secondary treatment is in place). Provincial jurisdictions specify limits for concentrations of contaminants in biosolids where these are land applied as a fertilizer so that they will not contaminate water sources, food or other sensitive receptors. The possible effects of

Text Box 2.1: Studying Biosolids

In a study undertaken by the Water Environment Association of Ontario, specific contaminants in sewage biosolids were divided into two groups: Group I contaminants, which have sufficient scientific information to assure the public that land application guidelines are adequate to protect the well beings of soils, crops, animals, human health, ground and surface water qualities; and, Group II contaminants, which do not have such scientific information[1]. Group II contaminants identified included some metals (silver and antimony, for example), pathogens (due to continued public skepticism of assurances that biosolids are safe), estrogenic hormones (a group of endocrine disrupters), pharmaceuticals, and radionuclides.

[23] Environment Canada, *Municipal Waste Water Effluents, 2002* (http://www.nwri.ca/threats/chapter09-e.html - date accessed: April 2008)

[24] Canadian Council of Ministers of the Environment, *Municipal Waste Water Effluent in Canada, December 2006* (http://www.ccme.ca/assets/pdf/mwwe_general_backgrounder_e.pdf - date accessed April 2008)

[25] ibid

[26] Environment Canada. 2003. *Environmental Signals: Canada's National Environmental Indicator Series 2003.*

[27] ibid

wastewater sludges or biosolids on local surface and groundwater quality and on other environmental factors are not fully understood[28] (see Text Box 2.1 adjacent).

Wastewater effluent quality varies with a community's use of the sewer system (in particular the industrial, commercial and institutional sector discharges) and technology in place to treat wastewater. The effects on the environment of wastewater effluents also vary, depending on receiving water characteristics and the quantities and types of contaminants released. In the case of smaller communities with septic systems, poor maintenance practices or poor land development decisions can create groundwater quality problems that affect drinking water supplies. Data for municipal wastewater treatment are incomplete but it is estimated that as of 2006, 19% of Canadians are served by primary treatment and 38% are served by secondary treatment[29]. Coastal communities are more likely to have primary treatment or no treatment whereas inland communities have a higher percentage of secondary or tertiary treatment[30]. (See 2.3 Regulatory Issues for more information on water quality requirements by jurisdiction.)

Potable Source Water Quality

Source water quality issues arise for potable water systems for a number of reasons, including storm and wastewater discharges, land use stressors (such as manure spreading in vicinity of well heads, for example), and other factors, such as naturally occurring conditions (arsenic, for example), drought and erosion. Potable water quality issues vary with location, infrastructure capability and the natural and altered characteristics of the land and water resources. (See 2.3 Regulatory Issues for information on potable water treatment requirements in Canada.)

Stormwater Quality

Stormwater has pervasive and far-reaching impacts on ambient water quality because of the release of poor quality water from both urban and rural community land areas. Urban stormwater contains substantial amounts of oil, grease, chlorides, toxic metals, organic chemicals, residues of fertilizers, insecticides and herbicides, debris, sand as well as settled air pollutants. In a 1995 stormwater study, 28 pollutants and pollutant groups with the potential to affect aquatic life and human health were identified[31], including solids, chloride, oxygen depleting substances, microorganisms, 12 heavy metals, and 9 organic chemicals. Many other studies have also identified metals including chromium, cadmium, copper, lead and nickel in stormwater runoff and in urban stormwater management facilities[32].

[28] National Biosolids Partnership, *Water Environment Association of Ontario Report on Biosolids Available for Downloading, 2001 (*URL:http://www.biosolids.org/news_weekly.asp?id=1276 – date accessed: April 2008)

[29] Canadian Council of Ministers of the Environment, *Municipal Waste Water Effluent in Canada, December 2006 (*http://www.ccme.ca/assets/pdf/mwwe_general_backgrounder_e.pdf - date accessed: April 2008

[30] ibid

[31] Makepeace *in* Environment Canada, *Threats to Sources Drinking Water and Aquatic Ecosystem Health in Canada*. National Water Research Institute, Burlington, Ontario

[32] See for example, Bruce Anderson et.al. *Accumulation of Trace Metals in Freshwater Invertebrates in Stormwater Management Facilities*, Water Qual. Res. J. Canada, 2004, Volume 39, No. 4, 362-373

Contamination of urban stormwater occurs when contaminant residues are swept off streets and yards during rainstorms. Rusting cars, gas and oil spills, brake pad linings, windshield washer fluid and lawn care are a few of the sources of contaminants. In 2005, 32% of households in Canada used fertilizers on lawns or gardens and 29% used pesticides; 52% of pesticide use was applied as part of a regular maintenance cycle (74% of households had lawns or gardens)[33]. The volume of water released during storms also degrades water quality because of its erosive effects and its increased ability to scour and carry pollutants. Stormwater also impairs surface water quality because it increases water temperatures, which can lead to faster oxygen depletion. Temperature increases are often exacerbated by the removal of riparian vegetative cover, exposing watercourses to increased sun and heat during critical periods in the life-cycle of aquatic species. Stormwater ecological damage is closely related to land use in urban areas (see Text Box 2.2[34] adjacent).

Text Box 2.2: The Stormwater – Urban Land Use Connection

According to the *Rapid Watershed Planning Handbook* the percentage of impervious surface (i.e. roads and roofs) within a watershed has a direct correlation with watercourse quality changes. With increasing imperviousness, certain elements are lost from stream systems with aquatic diversity, habitat quality and water quality being affected. With over 10% impervious cover, sensitive stream elements (such as sensitive invertebrates) are lost from the system. With 25–30% impervious cover, stream quality indicators can be expected to fall in the category of poor. These percent impervious cover thresholds have been used in the Handbook to identify three watercourse categories: sensitive (0–10% impervious), impacted (11–25% impervious), and non-supporting (greater than 25% impervious), each with unique characteristics. Sub-divisions are typically in the 40% impervious range; core urban areas can be over 90% impervious. Uban areas do not typically cover entire watershed areas; however, watersheds are nested, with size being a relative concept.

It should be noted that stormwater is essentially untreated, except where combined sewer systems carry flows to wastewater treatment facilities during non-peak flows and where newer subdivisions (since the mid-1980's) have been developed to drain to stormwater facilities. The degree of treatment in subdivision stormwater facilities varies widely and, in some cases, contributes to degradation of certain water properties (such as naturally cool water temperatures). The National Water Research Institute is developing a methodology for evaluating the impacts of stormwater discharges on receiving water ecosystems and preliminary results at a Toronto area stormwater management system indicate that chemical contamination of sediments contributes to some toxic effects on lower food web animals (especially benthic, or bottom-dwelling, invertebrates)[35]. The highly variable nature of discharges, weather conditions and infrastructure capacity and condition leads to highly variable contaminant releases from community to community and within communities spatially and temporally. Exhibit 2.3 following puts municipal sector releases of nutrients into perspective relative to other sources. As indicated in this Exhibit, municipal (and by extension, residential) sanitary discharges contribute relatively significant loadings of nutrients to surface waters.

33 Statistics Canada. 2006. *Households and the Environment Survey*

34 Centre for Watershed Protection, http://www.cwp.org/index.html

35 Sandra Kok, *Wet-Weather Flow Management in the Great Lakes Areas of Concern*, Water Qual. Res. J. Canada, 2004, Volume 39, No. 4, 319-330

Exhibit 2.3
Comparison of Nutrient Loadings to Surface Water and Groundwater from Various Sources in Canada, 1996[36]

Nutrient Source	Phosphorus (10^3 tonnes per year)	Nitrogen (10^3 tonnes per year)
Municipal		
Municipal Wastewater Treatment Plants	5.6	80.3
Sewers (stormwater and Combined Sewer Overflows)	2.3	11.8
Septic systems	1.9	15.3
Industry (value underestimated due to data limitations)	1.9	11.5
Agriculture (residual in the field after crop harvest)	55.0	293.0
Aquaculture	0.5	2.3
Atmospheric deposition	n/a	182.0 (NO_3^- and NH_4^+)

The magnitude of stormwater contributions is highly variable with weather and infrastructure from one location to another. However, as indicated above, stormwater is a significant source of water quality challenges. Exhibit 2.4 following provides a comparison of loadings of PCBs and mercury to two of the Great Lakes from three types of water infrastructure in comparison with industrial sources. Stormwater runoff is the most significant source of PCBs and is also a significant contributor of mercury by comparison with industry and other water infrastructure.

Exhibit 2.4
Estimated Loadings of PCBs and Mercury to Lakes Superior and Ontario, 1991–1992[37]

Loadings	PCB Loadings (kilograms/year)		Mercury Loadings (kilograms/year)	
	Lake Superior	***Lake Ontario***	***Lake Superior***	***Lake Ontario***
Industry	10	4	39	12
Stormwater runoff	18	83	40	29
Combined Sewer Overflows	2	4	3	2
Municipal Wastewater Treatment Plants	8	15	34	89
Spills			2	

Interconnectedness of Water Quality Issues

As mentioned previously, the connection between wastewater effluent quality, potable water quality and land use are starting to be recognized at the policy and regulatory levels in Canada. Some Canadian jurisdictions have developed source water protection requirements that include an assessment of risks to water contamination as a first step in protecting drinking water sources. The Canadian Council of Ministers of the Environment (CCME) is developing a National Strategy for Municipal Wastewater

[36] Environment Canada, The State of Municipal Wastewater Effluents in Canada, PWGSC, 2001

[37] Environment Canada, *Threats to Sources Drinking Water and Aquatic Ecosystem Health in Canada*. National Water Research Institute, Burlington, Ontario

Effluents (discussed in 2.3 Regulatory Issues). Stormwater management has more recently come to be called *rainwater management* to reflect the need to "control the generation of and entry of pollutants into, stormwater runoff... at source[38]". Some progressive municipal jurisdictions are tackling the enormous issue of stormwater pollution and prevention. However addressing stormwater quality impacts remains a significant gap in Canadian federal and provincial jurisdictional approaches (except when combined with sewage in older collection systems; many major cities in Canada have combined sewer systems serving portions of their collection area[39]).

2.1.4 Emerging Contaminants

Contaminants that are products of modern lifestyles are showing up in the water environment, including drinking water supplies and wastewater effluents. Trace amounts of pharmaceuticals, personal care products (e.g. shampoos, perfumes) and other substances (such as caffeine and illicit drugs) are found in watercourses, in particular those downstream of urban centres.

Studies have found effects[40] on the endocrine systems of fish, such as feminization of male fish for example, downstream of urban wastewater effluents. A study in Southern Ontario[41] found traces of nine drugs in finished drinking water of 20 water purification plants, evidence that some of these substances are not removed by wastewater treatment or water purification technologies presently in use. (Contaminants included ibuprofen, a common cholesterol-lowering medication and Prozac.) The environmental and human health effects of these substances are not currently known. As the science develops on emerging contaminants of concern, additional regulatory action may be needed to ensure pollution prevention and adequate treatment are in place to protect water quality for both human and environmental health.

A key reference manual for wastewater engineers, Metcalfe and Eddy's Wastewater Engineering: Treatment and Reuse, identifies a dramatic increase in the use of membrane filtration technologies (which remove contaminants more effectively than conventional systems) since about 2000, and speculates that "the use of conventional filtration technology may be a thing of the past within 10 to 15 years, especially in light of the need to remove resistant organic constituents of concern". Of course, this technology comes at a price, both economic and, in some cases, at the expense of increased water quantity requirements to keep the membranes from fouling (as in the case of reverse osmosis systems) and increased energy use to maintain the required pressure gradient across the membrane for treatment to occur.

2.1.5 Energy Use and Greenhouse Gas (GHG) Emissions

[38] Marsalek (2001) in Editorial, *Managing Urban Wet-Weather Flows: On the Road to Sustainability*, Water Quality Research Journal of Canada, Volume 39, No. 4, 2004

[39] CCME, *Canada-wide Strategy for the Management of Municipal Wastewater Effluent Draft*, September 2007

[40] Stapes, Sarah, *Prozac and Painkillers Found in Tap Water*, The Waterhole, 2004 (http://www.thewaterhole.ca/press/news/20041113.htm - date accessed: April 2008)

[41] The study was conducted by the National Water Resource Institute, results reported by The Vancouver Sun, 2004, Sarah Staples CanWest News Service

Water and wastewater services in urban areas are energy intensive, accounting for an estimated 4% of national energy demand in the U.S. An American Water Works Association Research Foundation (AwwaRF) benchmarking study showed that energy costs comprise, on average, about 11% of potable water operating budgets. The significant energy demands of water services presents challenges to communities committed to reducing GHG emissions.

Conversely, the wastewater treatment process produces waste gases that can be captured to produce useful energy as part of a combined heat and power system. The US Environmental Protection Agency estimates that an average wastewater treatment plant that uses an anaerobic digester can produce approximately 2.2 watts of power per person served per day and approximately 600 Btu of heat per person per day by using the digester gas[42] (i.e. methane) collected from the anaerobic digester process[43]. Biosolids produced during wastewater treatment can also be used to produce electricity and useful heat. This is usually accomplished by combusting biosolids to produce steam or hot gases, which power a turbine generator set. Biosolids can be combusted in the form that they are produced, dried and combusted, co-fired with another fuel, or gasified before combustion. The use of biosolids or biogas to produce electricity or useful heat is generally considered carbon-neutral, as no fossil fuels need to be burned in the power production processes.

As indicated in the discussion above on water quality (Section 2.1.3), treatment requirements for potable, waste and stormwater can be anticipated to increase as more is learned about both conventional and emerging contaminants. However increased treatment levels typically require increased energy requirements, thus necessitating trade-off decisions between potable water or wastewater effluent quality and the climate change imperative to reduce carbon use. Similarly, desalination technologies present an option for coastal regions to satisfy increased potable water demands through seawater treatment. This option comes with a concomitant requirement for energy use that would conflict with carbon reduction goals where fossil fuels provide the energy source.

2.2 ECONOMIC ISSUES

2.2.1 Infrastructure Deficit

A key economic issue facing municipalities in instituting sustainable practices is the infrastructure funding needed to properly maintain and replace aging infrastructure. The gap between current or projected revenues and system maintenance and replacement costs has become known as the infrastructure deficit. This deficit is projected to increase as the infrastructure systems age. An AWWA study[44] on 20 U.S. systems found that

[42] Anaerobic digester gas is 50% to 80% methane, depending on sources of wastewater, process management and other factors; reference: USEPA Energy Efficiency website, URL: http://www.eere.energy.gov/consumer/your_workplace/farms_ranches/index.cfm/mytopic=30003; date accessed April 2008

[43] USEPA: Combined Heat and Power Partnership; URL: http://www.epa.gov/chp/markets/wastewater_fs.html, date accessed April 2008

[44] Reinvesting in Drinking Water Infrastructure, Dawn of the Replacement Era: An Analysis of Twenty Utilities' Needs for Repair and Replacement of Drinking Water Infrastructure, A Study Sponsored by The AWWA Water Industry Technical Action Fund, May 2001

water infrastructure repair and replacement requires additional revenues ranging from about $550 per household to almost $2,300 per household over a 30 year period, not including increased compliance costs for meeting more stringent standards. This study also found that household impacts can be expected to be two to three times higher in smaller water systems ($1,100 to $6,900 per household over 30 years) due to disadvantages of smaller scales and the tendency for replacement needs to be less spread out over time. Wasteful water consumption patterns exacerbate the deficit where additional infrastructure is built to meet increasing demand rather than development of water demand management programs to defer construction of hard assets.

Governments in Canada have been making efforts to address the infrastructure deficit. A recent study by Statistics Canada[45] reveals the average age of water supplies, including pumping stations and filtration systems, went down from 16.9 years in 2001 to 14.8 in 2007; this trend was driven by strong urban growth in British Columbia, Ontario and Alberta. The average age of this infrastructure actually increased in Quebec and Newfoundland and Labrador. The report estimates that by 2007, Canada's water supply systems had reached 40% of its useful life (which is 36.8 years on average). The gross stock of water supply infrastructure increased by 5.1% a year on average (10 times faster than the rate for roads and bridges). Caution in interpretation of the decrease in average age is needed since the addition of new infrastructure in high growth areas is driving the decline; the need for investments to renew stock in older neighbourhoods and communities will still be needed.

Wastewater assets show a different trend in the same Statistics Canada report: the average age increased slightly between 2001 and 2007 (from 17.4 to 17.8 years), primarily due to aging infrastructure in Quebec, PEI and British Columbia. Wastewater assets surpassed 60% of their useful life in 2007. The value of wastewater stock is estimated to have decreased slightly during the period due to aging of significant investments made in the 1980s which have become older than their average useful life. This declining value indicates a need for reinvestment; reinvestment will be required to meet the national strategy for municipal wastewater effluents under development (see Section 2.3 following). Despite a long term increasing trend in the age of wastewater infrastructure[46], the quality of wastewater treatment is gradually improving in Canada from primary to secondary treatment; this results in improved removal of suspended solids, oxygen demand and nutrients.

The national average age of sanitary and storm sewers increased to 17.9 years, despite system growth of about 1% per year since 2001. The average age of sewers increased in all provinces except Ontario, Manitoba, Saskatchewan and Alberta. In 2007, storm and sanitary sewers passed 53% of their useful life.

2.2.2 Revenue Collection and Rate Structures

[45] Mychele Gagnon, Valerie Gaudreault and Donald Overton, *Age of Public Infrastructure: A Provincial Perspective*, Statistics Canada, 2008

[46] ibid

The price of water in Canada is one of lowest in the developed world[47]. Rate structures in Canadian municipalities do not typically recover sufficient revenues for capital, operating and maintenance activities, nor do they recover revenues necessary to mitigate environmental impacts (such as investment in greenhouse gas mitigation measures or process waste treatment).

The need for life-cycle costing of assets has been identified as a key issue in achieving sustainable municipal infrastructure approaches. Life-cycle or full price costing includes all capital and operating costs and the costs of replacing and upgrading infrastructure[48]; in progressive communities, it also includes costs of mitigating environmental damage such as greenhouse gas emission reductions, water demand management, wetland protection, and other initiatives. Similarly, development fee structures in Canadian municipalities do not fully recover the incremental cost of the added infrastructure creating a situation where an already under-priced commodity supplied to existing customers is subsidizing water services to new growth areas.

Wastewater revenues are typically collected as a percentage of potable water revenues and, similar to potable water, the rates established are not sufficient to address the infrastructure deficit problem.

Water metering is an essential aspect of revenue collection for water and wastewater servicing in Canada. The fact that many Canadian municipalities are not fully metered for potable water consumption (37% of residential customers and 17% of businesses receive un-metered water supply[49]), and use flat rate structures, makes revenue recovery on a user-pay basis impossible. The percentage of metered households served by municipal water systems increased only slightly during the 1990s, from 52% in 1991 to 56% in 1999, but jumped to 61% in 2001[50].

With or without metering, communities will face significant political challenges in collecting revenues that are sufficient to recover the increased costs of technologies required to comply with increasingly stringent potable and wastewater treatment requirements (as discussed in Section 2.3).

In Canada, stormwater management is most often funded through a property tax or as a part of the wastewater charge. The concept of a stormwater utility and rates that take into account impervious features of lots is well established in the United States but rare in Canada. The stormwater utility concept assists in generating revenue to deal with stormwater mitigation, collection and treatment challenges.

2.2.3 Economic Barriers to On-Site Water Reuse

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[47] Klas Ringskog in Infrastructure Canada Research Note, *The Importance of Water Metering and its Uses in Canada* (http://www.infrastructure.gc.ca/research-recherche/result/alt_formats/pdf/rn06_e.pdf - date accessed: April 2008)

[48] ibid

[49] Environment Canada (2007). *2007 Municipal Water use Report*.

[50] Environment Canada, “2004 Municipal Water Use Report: Municipal Water Use 2001 Statistics.” 2004. http://www.ec.gc.ca/water/en/info/pubs/sss/e_mun2001.htm

Water reuse is a particularly important issue for sustainable water resource management and service delivery since once-through use of highly treated potable water for toilets and lawn watering, among other activities, is highly inefficient and wasteful. Regulatory barriers are discussed in the section following. There are also economic issues requiring resolution as identified in a CMHC report[51] on regulatory barriers. The cost of using new, external, water versus the cost of capturing and reusing water does not warrant investment in the required infrastructure for on-site use. In other words, potable water is too inexpensive to provide incentive for reuse. This barrier is a derivative of the issue discussed above: “new” water (i.e. water from the municipal system) is under-priced.

2.3 REGULATORY ISSUES

2.3.1 Introduction

Due to the direct linkages between human health and potable water quality, water has historically been subject of regulations and on-going regulatory reviews to a degree that is not reflected in other sectors, such as transportation and energy. As the science on the environmental impacts of wastewater releases is better understood and as the linkages between wastewater effluents and drinking source water protection are made explicit, continued, and likely increased, regulatory action can be anticipated in the water sector.

Compliance programs that build capacity to meet regulatory requirements, and enforcement programs that ensure requirements are met, are important factors in achieving the outcomes envisioned by governments in enacting regulations. Like other levels of government, municipalities face challenges in adequately resourcing compliance and enforcement programs, such as sewer use bylaws, for example. Resources are required for communications, outreach, monitoring to assess compliance, and, at times, negotiations, ticketing and court appearances. The success of enforcement activities relies on the availability of staff that is trained, authorized and available to carry out enforcement duties. As regulated entities, municipalities must also build capacity to comply with regulatory requirements of senior levels of government.

2.3.2 Changing Regulatory Requirements

The ability to detect substances at very low levels in water is increasing and scientific understanding of the effects of water contaminants on human and environmental health is continuously developing. These two factors have spurred governments to manage specific substances and processes to better control known risks. For example, the federal government, under the Canadian Environmental Protection Act 1999 (CEPA), has identified ammonia and chlorine residuals in wastewater as toxic substances and have required specific management measures by municipalities to mitigate the environmental impacts. Similarly, the health effects of chlorine disinfection by-products in drinking water (such as trihalomethanes, or THMs) have prompted provincial governments to require process changes in potable water treatment plants.

[51] CMHC, Research Highlights, *Regulatory Barriers to On-Site Water Reuse,* Technical Series 98-101

Implications for Municipalities

The capacity to implement these regulatory requirements is a challenge for many municipalities in terms of both cost and operator training. Future contaminants can be expected to come under regulatory scrutiny for both drinking water and wastewater services as the issue of many known substances (lead, for example) and emerging substances (endocrine disrupting substances and pharmaceuticals) are studied further. Numerous wastewater systems will require investments to come into compliance with the National Strategy for Municipal Wastewater Effluents, as discussed following. Also, the Canadian Guidelines for Drinking Water Quality (GCDWQ) set out the concentration limits for various constituents in drinking water, including microbiological, chemical and radiological contaminants[52] and these are subject of continuous review in terms of parameters and limits established for drinking water quality. Changes in the GCDWQ often have implications for capital and operational expenses. For example, recommended reduction of the current acceptable arsenic limits can be expected to have cost and staff training ramifications for municipal systems, in particular groundwater systems with arsenic. Similarly, a proposed limit for haloacetic acids (HAAs), a sub-set of disinfection by-products, will have cost implications for process and monitoring activities where chlorine is used to disinfect potable water supplies[53].

2.3.3 Water Allocation and Management

Water allocation is managed through provincial jurisdiction (or, in Northern Canada, through Water Boards). Text Box 2.3[54] (adjacent) describes different approaches of Canadian regions to water allocation.

The precedence in Canada of applying historic water rights (i.e. 'prior appropriation' in the west and 'riparian rights' in the east) for water allocations can prove problematic where demands on the water resources exceed sustainable withdrawls[55] because established rights of access do not necessarily consider long-term public interest.

2.3.4 Potable Water Requirements

In Canada, drinking water protection is regulated under provincial legislation. In the territories, the Federal government is responsible for source water protection while the governing act relating to drinking water is typically a territorial public health act. Potable water treatment requirements and quality standards are a provincial responsibility. However, development of the Guidelines for Canadian Drinking Water Quality (GCDWQ) is lead by Health Canada through the Federal- Provincial-Territorial Committee on Drinking Water. The GCDWQ have been adopted, in whole or in part,

[52] Health Canada, *Canadian Drinking Water Guidelines* (http://www.hc-sc.gc.ca/ewh-semt/water-eau/drink-potab/guide/index_e.html - date accessed: April 2008)

[53] A current list of substances under review is maintained by Health Canada at URL: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/consultation/index_e.html, along with associated scientific rationale for the changes.

[54] Primary source: J. Kinkead Consulting, *An Analysis of Canadian and Other Water Conservation Practices and Initiatives*, prepared for the Canadian Council of Ministers of the Environment, 2006.

[55] ibid

into the legislation of many provinces. The approaches taken across the provinces and territories vary in their maturity and complexity. An overview of Canadian potable water requirements is given in Exhibit 2.5. References to applicable legislation and regulations are included as endnotes at the end of this document.

The approach to potable water servicing in most provinces of Canada, and particularly in Ontario, changed dramatically with the findings of the inquiry into the deaths of seven people and the illness of another 2,300 as a result of contamination of the Ontario town of Walkerton's water supply in 2000. A chain of events was identified as contributing to the tragedy, including well contamination from land application of manure, improperly functioning equipment, poorly trained and irresponsible operators, and, poor record-keeping. The key lesson learned from the incident was the need for a multi-barrier approach; this is an approach that includes physical measures (i.e. treatment and disinfection) as well as procedural methods, training, laboratory testing, inspections, enforcement and other components to ensure drinking water is safe for public consumption. Source water protection planning is a key feature of Ontario's approach.

Exhibit 2.5
Potable Water Requirements in Canada[i]

Region	Water Treatment (WT) Requirements	Water Quality (WQ) Standards	Applicable Provincial Legislation
British Columbia	Disinfection of surface water required, groundwater disinfection discretionary.	Case-by-case. All water must meet a coliform standard. GCDWQ not adopted	Water Treatment (WT) & Water Quality (WQ): B.C. Reg 200/2003 (Drinking Water Protection Regulation)[ii]
Alberta	Disinfection required for ground and surface water. Additional filtration required for surface water. Specified reduction in pathogens required.	Must meet Guidelines for Canadian Drinking Water Quality (GCDWQ) for microbiological, chemical and radiological characteristics.	WT&WQ: Alberta Ministry of Environment, *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems* (January 2006)[iii] WQ: Alta. Reg. 277/2003 (*Potable Water Regulation*), s. 6(1)(a).[iv]
Saskatchewan	Chlorination or other approved disinfection is required	Mandated bacteriological, radiological and pesticide standards. Turbidity standards in some instances.	WT & WQ: R.R.S. c. E-10.21 Reg. 1 (*The Water Regulations*) 2002[v]
Manitoba	Disinfection of surface and ground water is required (chlorination or other approved method). Specified bacteriological and microbial standards.	Must meet microbiological standard. GCDWQ not adopted.	WT: *Man. Reg. 330/88 (Water Supply Regulation), ss. 8; 10*[vi] WQ: *The Water Supply Commissions Act* C.C.S.M.c. W100, s. 10(7)[vii]; Manitoba Water Stewardship, *Guidelines for Public Water Systems98-02* (August 1998)

Region	Water Treatment (WT) Requirements	Water Quality (WQ) Standards	Applicable Provincial Legislation
Ontario	Surface water and groundwater must meet specific disinfection standards. Treatment must achieve specific reductions in pathogens.	GCDWQ adopted, additional standards to ensure treatment effectiveness	WT: Ontario Ministry of the Environment, *Procedure For Disinfection Of Drinking Water In Ontario* (As adopted by reference by O. Reg. 170/03)[viii] WQ: O. Reg. 170/03 (*Drinking Water Systems)*[ix]
Quebec	Surface water and ground water under surface water influence must undergo continuous filtration and disinfection treatment. Treatment must achieve specific reductions in pathogens.	Mandated levels for microbiological, inorganic, organic and radioactive substances, as well as in-system turbidity levels.	WT & WQ: R.R.Q. 2001, c. Q-2, r. 18.1.1 (*Regulation Respecting the Quality of Drinking Water*)[x]
New Brunswick	Chlorination is required, other treatment may be required through approval process for municipal systems	Discretionary standards	WT: N.B. Reg. 1988-200 (*Health Act*, R.S.N.B. 1973, c. H-2), ss. 225(2); 223.[xi]
Nova Scotia	Filtration and disinfection required for surface water, disinfection required for groundwater.	GCDWQ adopted	WT: Nova Scotia Environment; *Treatment Standard for Municipal Surface Source Water Treatment Facilities* [xii] and *Groundwater Treatment Standards*[xiii] WQ: N.S. Reg. 186/2005 (*Water and Wastewater Facilities and Public Drinking Water Supplies Regulations*), c.1 s. 35.[xiv]
PEI	No treatment required, but may be imposed on a case-by-case basis. Utilities that do not chlorinate must meet heightened sampling requirement	No binding standards. Testing required for microbiological and chemical analysis.	WT&WQ: P.E.I. Reg. EC2004-710 (*Drinking Water and Wastewater Facility Operation Regulation*)[xv]
Newfoundland	Continuous disinfection required for all public systems	GCDWQ adopted as binding for bacteriological standards, non-binding for chemical and physical monitoring standards	WT&WQ: Newfoundland Ministry of Environment, *Standards for Bacteriological Quality of Drinking Water* [xvi] WQ: Newfoundland Ministry of Environment, *Standards for Chemical and Physical Monitoring of Drinking Water*[xvii]

Region	Water Treatment (WT) Requirements	Water Quality (WQ) Standards	Applicable Provincial Legislation
Nunavut	Chlorination for surface water is required. Groundwater may require chlorination or other disinfection if at risk of contamination	Microbiological, physical, chemical and radiological characteristics addressed in territorial public water supply legislation	WT&WQ: R.R.N.W.T. 1990, c. P-23 (*Public Water Supply Regulations*)[xviii]
Northwest Territories	Chlorination for surface water is required. Groundwater may require chlorination or other disinfection if at risk of contamination.	Microbiological, physical, chemical and radiological characteristics addressed in territorial public water supply legislation	WT&WQ: R.R.N.W.T. 1990, c. P-23 (*Public Water Supply Regulations*)[xix]
Yukon	No treatment required, proposal to require disinfection for all sources and filtration for surface water.	Standards for coliform, chlorine residuals and some physical characteristics. Proposal to adopt GCDWQ.	WT & WQ: *Drinking Water Regulation, Enabled under the Public Health and Safety Act.*[xx] WQ: Y.O.I.C. 1999/82 (*Sewage Disposal Systems Regulation*)[xxi]

In summary, most provinces and territories require some form of disinfection for surface waters; groundwater requirements are much less consistent due to the lower risk of contamination posed by groundwater sources that are at low risk of anthropogenic contamination. Examples of jurisdictions with variations on the typical approach include:

- B.C., the Northwest Territories and Nunavut require disinfection for surface water only, and have discretionary requirements for ground water disinfection.
- P.E.I and the Yukon have no specific treatment requirements for ground or surface water. In the case of P.E.I., treatment may be imposed on a case-by-case basis. In the Yukon, proposed legislation will require disinfection for all sources and filtration for surface water.
- Research on small municipal systems in Quebec identified one community supplied by surface water that had no disinfection[56]. Although Quebec has a requirement for disinfection, it is not clear to what degree compliance is achieved. This situation contrasts with that in Ontario, for example, which has instituted strict inspection and enforcement of all legislative requirements pertaining to drinking water provision for all municipal systems of all sizes.

Similarly, most provinces and territories require water quality to meet standards for some or all of the characteristics regulated under the GCDWQ. In some cases, this has been done by adopting all or part of the GCDWQ into provincial or territorial legislation. Exceptions include:

- New Brunswick, where water quality standards are discretionary
- P.E.I., where testing is required, but there are no binding water quality standards.

56 Housseine Coulibaly and Manuel Rodriguez, University of Laval, *Portrait of Drinking Water Quality in Small Quebec Municipal Utilities*, Water Qual. Res. J. Canada, 2003, Volume 38, No. 1, 49-76

Provincial and territorial requirements also vary widely with respect to treatment, testing and system design and construction standards.

2.3.5 Wastewater Requirements

Wastewater effluent discharge is presently regulated under a number of pieces of provincial and territorial legislation, several pieces of federal legislation and a number of municipal sewer-use bylaws. The Canadian Council of Ministers of the Environment (CCME) is presently in the final stages of completing its Canada-wide Strategy for the Management of Municipal Wastewater Effluent (CWS)[57]. The strategy will provide a consistent regulatory framework across Canada, establish baseline National Performance Standards (NPS) and create a mechanism to move municipalities toward compliance with these standards on an established timeline.

The proposed NPS establishes a minimum wastewater treatment level equivalent to secondary treatment. In addition, the strategy requires site-specific and/or watershed based risk assessments to identify additional treatment or other requirements to protect each receiving environment. Municipalities are expected to implement pollution source control measures within their communities, including sewer use bylaws. The NPS also requires control of combined sewer overflows, prohibits construction of new combined sewers and requires no net increase in combined sewer overflow volumes even with growth or intensification in affected urban centres.

Facilities will be required to comply with the NPS on a timeline based on a risk assessment, with high risk facilities required to meet the NPS within 10 years, and low risk facilities within 30 years. Based on the assumption that the CWS are adopted, all municipalities will be required to achieve the equivalent of secondary treatment (and any other additional requirements) within 30 years. Throughout the development of the CWS, delegations and stakeholders submitting comments noted a lack of capacity of municipalities, in particular small and remote or northern communities, to develop risk assessment studies and to comply with the anticipated requirements

The national instrument for implementation of the CWS requirements will be a Regulation under the Federal Fisheries Act. As with all CWS initiatives, the provincial jurisdictions agree to implement measures to come into compliance with the requirements; it is most likely that provinces will implement requirements through wastewater permits and regulations under their water and/or environment protection legislation.

Some provinces already have general combined sewer overflow objectives[58]. Ontario, for example, requires capture and treatment of all dry weather flow plus 90% of the volume

[57] The *Canada-wide Strategy for the Management of Municipal Wastewater Effluent* was endorsed by the Council of Ministers on February 17, 2009 (following the completion of this report). Readers can access the text of the strategy and background studies at: http://www.ccme.ca/ourwork/water.html?category_id=81

[58] Marbek Resource Consultants, *Review of Existing Municipal Wastewater Effluent Regulatory Structures in Canada*, 2005, prepared for CCME (http://www.ccme.ca/assets/pdf/mwwe_cnsltn_hrf_conrpt_e.pdf - date accessed: April 2008)

of wet weather flows (above the dry weather flow volumes) during a seven month period starting in April.[59] B.C. specifies that no combined sewage overflow should occur during smaller storm and snowmelt events (those likely to happen every 5 years).[60] Quebec does not allow combined sewer overflows in proximity of drinking water intakes, shellfish harvesting sites, fish spawning sites and limits the number of overflows where human (water) activities occur[61].

Exhibit 2.6, below, summarizes existing provincial legislation related to wastewater. In all cases, the applicable Provincial (or Territorial) legislation sets out requirements for construction and operation of sewage treatment facilities, including specific effluent quality standards. Additional requirements are noted in the far right column. References to applicable legislation and regulations are included as endnotes at the end of this document.

Exhibit 2.6
Wastewater Legislation and Requirements in Canada

Region	Applicable Wastewater Legislation	Wastewater Treatment and Effluent Release Requirements - Highlights
Federal	The main Federal legislation applicable to wastewater treatment and effluent releases is the *Fisheries Act*[xxii].	A new Canada-wide Strategy for Management of Municipal Wastewater Effluent is expected to be implemented under the *Fisheries Act*. This standard is expected to supersede provincial legislation listed below.
British Columbia	Environmental Management Act[xxiii] B.C. Reg. 129/99 *Municipal Sewage Regulation*[xxiv]	
Alberta	Alberta Regulation 119/93, *Wastewater and Storm Drainage Regulation*[xxv] Alberta Ministry of Environment, *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems* (January 2006)[xxvi]	Secondary treatment is universally required.
Saskatchewan	*Environmental Management and Protection Act*[xxvii] R.R.S. c. E-10.21 Reg. 1 (*The Water Regulations*) 2002[xxviii] Saskatchewan Ministry of Environment *Guidelines for Sewage works Design*[xxix]	
Manitoba	*Environment Act*[xxx] *Man. Reg. 331/88 (Waterworks Sewerage and*	

59 Government of Ontario, *Procedure F-5-5: Determination of Treatment Requirements for Municipal and Private Combined and Partially Separated Sewer Systems*

60 Marbek Resource Consultants for CCME, op.cit.

61 Marbek Resource Consultants for CCME, op.cit.

Region	Applicable Wastewater Legislation	Wastewater Treatment and Effluent Release Requirements - Highlights
	Sewage Disposal Regulations)[xxxi]	
Ontario	*Environmental Protection Act*[xxxii] *Ontario Water Resources Act*[xxxiii]	
Quebec	*Loi Sur la Qualité de L'Environnement (Environmental Quality Act)*[xxxiv]	A moratorium is in place on the use of chlorine for disinfection. Discharge limits are determined on a site-by-site basis, taking into account performance of available technology.
New Brunswick	*Clean Environment Act*[xxxv] *Water Quality Regulation*[xxxvi] *Clean Water Act*[xxxvii]	
Nova Scotia	*Environment Act*[xxxviii] *Activities Designation Regulation*[xxxix] N.S. Reg. 186/2005 (*Water and Wastewater Facilities and Public Drinking Water supplies Regulations*), c.1 s. 35.[xl]	
PEI	Environmental Protection Act[xli] Water and Sewerage Act[xlii] The Island Regulatory and Appeals Commission: *PEI Municipal Water & Sewerage Utilities General Rules*[xliii]*(*established under the *Water and Sewerage Act)* P.E.I. Reg. EC2004-710 (*Drinking Water and Wastewater Facility Operation Regulation*)[xliv]	Secondary treatment with disinfection is minimum standard. Utilities located in Summerside, Charlottetown, Cornwall and Stratford are exempt from *General Rules*.
Newfoundland	Environmental Protection Act[xlv] Water Resources Act[xlvi] Environmental Control Water and Sewage[xlvii] Regulations	
Nunavut	Federal Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments (1976)[xlviii] Environmental Protection Act[xlix]	The federal government has not devolved responsibility for water to the territory. Wastewater treatment is regulated under federal guidelines in Nunavut, although releases are governed under territorial law.
Northwest Territories	Public Health Act[l] Public Sewerage System Regulations[li]	The federal government has not devolved responsibility for water to the territory, although territorial law regulates effluent treatment and release.
Yukon	Environment Act[lii] Waters Act[liii]	Yukon Territory was delegated authority for water management in 2002.

In summary, all provinces and territories have specific effluent quality standards under provincial or territorial legislation, although these standards are variable. Common standards are expected as part of the upcoming CCME National Strategy for Municipal Wastewater Effluents.

2.3.6 Stormwater Requirements

As indicated in Section 2.1, Environmental Issues, stormwater management represents a significant environmental issue but has not been comprehensively addressed through provincial or federal government regulations. By way of contrast, the United States, through its federal Clean Water Act, has been aggressively pursuing stormwater control and non-point source pollution since the late 1980's when the science indicated that control of point source pollution alone would not achieve desired ambient water quality objectives.

In Canada, stormwater has essentially been left to the discretion of municipal governments to manage under general provisions for land use planning. Municipalities implement stormwater management requirements through site plan approvals, often on a piecemeal basis as land development applications are received. There are a few exceptions in Canada where stormwater is specifically addressed by Provincial governments, as described following:

- In British Colombia stormwater management is legislated under the municipal waste management provision of the Environmental Management Act[62]. Under the act, Municipalities or Regional Districts have the option of developing "liquid waste management plans" (LWMP) or administering a permitting regime. In practice, LWMPs are widely adopted, as they are generally more economical and effective than waste discharge permits. LWMPs must estimate current and future stormwater runoff quantities, take into account stormwater management options (including source control and treatment), and explore site locations for stormwater treatment facilities and/or discharges.
- Ontario has not legislated stormwater management, but provides guidelines in the form of a Stormwater Management Planning and Design Manual[63]. In addition, in Ontario under the source protection provisions, watersheds draining to the Great Lakes may have contaminant loading limits imposed (which, by implication, would include non-point sources of pollution carried via stormwater). This provision is very recent and no limits have been identified as of 2008.
- Under Nova Scotia's Environment Act[64], areas surrounding current or future sources of drinking water may be designated as "protected water areas". These areas may be required to have stormwater control plans under provincial law[65].
- Alberta requires approval for all stormwater collection and treatment facilities under the Wastewater and Storm Drainage Regulation.[66] This requirement includes a

62 Government of British Columbia, *Environmental Management Act* (http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm - date accessed: April 2008)

63 Ontario Ministry of the Environment, *Stormwater Management Planning and Design Manual 2003* (http://www.ene.gov.on.ca/envision/gp/4329eindex.htm - date accessed: April 2008)

64 Canadian Legal Information Institute, *Environment Act* (http://www.canlii.org/ns/laws/sta/1994-95c.1/20080314/whole.html - date accessed: April 2008)

65 This has been done in several cases, for example, see section 12 of the McGee Lake Watershed Protected Water Area Regulations (http://www.canlii.org/ns/laws/regu/2005r.209/20080314/whole.html - date accessed: April 2008)

description of pre and post development stormwater flow, immediate and ultimate discharge points.

In other instances where stormwater is regulated, it is done so under municipal sewer use bylaws as maximum concentrations of certain constituents or in terms of provisions to ensure materials storage is adequate to prevent contamination of stormwater draining from commercial or industrial sites.

2.3.7 Planning Requirements

Although water planning and watershed management is not often required in legislation, activity is underway in many provinces. In addition to provincial initiatives, policies and legislation, the federal government provides incentives to complete IWMPs in some cases. For example:

- Since 2003, municipalities applying for water and wastewater funding under Infrastructure Canada's Canada Strategic Infrastructure Fund (CSIF) are required to commit to developing an integrated watershed management plan that addresses metering and pricing where appropriate. For Municipal-Rural Infrastructure Fund (MRIF) projects, applicants are encouraged to have a water and wastewater management strategy that demonstrates long-term sustainability and appropriate metering and volumetric pricing[67].
- Some of the federal-provincial gas tax fund transfer agreements specify broad based water management activities as qualifying projects. These funds are transferred from the federal to provincial/territorial governments with stipulations on the types of projects on which the funds are to be spent. Provinces then disburse funds to municipalities. Provincial-federal agreements which provide for broad-based water management projects include[68]:
    - The Canada-New Brunswick Gas Tax Agreement includes "Water Resource Management" as an eligible capacity building activity
    - The Canada-British Colombia-Union of British Colombia Municipalities agreement includes liquid waste management plans and water conservation/demand management plans as eligible activities in all areas outside of Metro Vancouver.
    - The Newfoundland and Labrador, PEI, and Saskatchewan agreements identify water supply system planning, wastewater system planning, and watershed planning as examples of "integrated" capacity building activities eligible for gas tax funds.
    - Several other federal-provincial agreements may fund broad-based water management activities, but do not explicitly identify such activities as eligible for funding.

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66 Canadian Legal Information Institute, *Wastewater and Storm Drainage Regulation, Alta. Reg. 119/1993* (http://www.canlii.org/ab/laws/regu/1993r.119/index.html - date accessed: April 2008)

67 Infrastructure Canada (ND). Research Note: Integrated Water Resource Management (http://www.infrastructure.gc.ca/research-recherche/result/notes/rn08_e.shtml#wm1 - date accessed May 2008)

68 Text of all federal-provincial agreements for the transfer of federal gas tax funds area available online at: (http://www.infrastructure.gc.ca/ip-pi/gas-essence_tax/index_e.shtml - date accessed May 2008)

Exhibit 2.7, following, summarizes requirements and current activities related to Integrated Watershed Management Planning (IWMP) as well as associated provincial legislation or policies. References to applicable legislation and regulations are included as endnotes at the end of this document.

Exhibit 2.7: Integrated Watershed Management Planning Requirements and Activity in Canada[liv]

Region	IWMP Requirements or Activities	Applicable Legislation/Policy Documents
British Columbia	IWM planning is not required; however, water plans completed under the *BC Water Act* and drinking water plans completed under the *BC Drinking Water Protection Act* could result in a source protection plan or IWMP depending on the circumstances of the plan.	*Water Act*[lv] *Drinking Water Protection Act*[lvi]
Alberta	Under Alberta's Water for Life Strategy, the province plans to complete water management plans for 11 watersheds by 2013/2014. These plans must include a summary of issues; a description of the area; a summary of the information assembled as part of the planning process; the relationship of the Water Management Plan to regional strategies or other planning initiatives; the recommended options and strategies to address the issues; and a list of performance monitoring requirements. The terms of reference for a plan include more specific requirements such as an overview of current conditions and an initial description of issues; a geographic description of the planning area; the intended objectives of the planning process; and the roles, responsibilities and accountability of those who will be involved.	*Water For Life Strategy*[lvii] Alberta Environment *Framework for Water Management Planning*[lviii]
Saskatchewan	The Saskatchewan Watershed Authority is responsible for watershed planning under the *Saskatchewan Watershed Authority Act*, although there is no specific legislation requiring watershed management planning. Emphasis is currently on source water protection.	*Saskatchewan Watershed Authority Act*[lix]
Manitoba	Under Manitoba's *Water Protection Act*, watershed management plans may be required in some cases. These plans are overseen by conservation districts, which are made up of neighbouring groups of rural municipalities, and approximate watersheds of major rivers. There are currently 18 conservation districts in Manitoba[lx], each of which is in the process of completing a watershed management plan. The province plans to complete a total of approximately 30 watershed management plans.	*Water Protection Act*[lxi]
Ontario	IWMP is not required in Ontario, although drinking water source protection plans are required under the Clean Water Act. Protection of municipal water sources is required within designated "source protection regions", and is overseen by conservation authorities (whose borders coincide with watershed boundaries).	*Clean Water Act*[lxii]

Region	IWMP Requirements or Activities	Applicable Legislation/Policy Documents
Quebec	The Quebec Water Policy outlines the requirement for the development of a Master Plan for Water (MPW) for watersheds. These are integrated watershed-based management plans. A Master Plan for Water (MPW) is defined as "a document that compiles the information needed to understand the hydrological and environmental problems of the watershed, as well as the proposed intervention strategies, especially in connection with the protection, restoration, and development of water resources." According to the Quebec Water Policy, a MPW will contain: 1) a description of the watershed, including a diagnosis of its environmental problems; 2) a list of wetlands and aquatic environments of ecological significance within the watershed; 3) a statement and prioritization of the relevant issues and results to be achieved; and 4) an action plan that includes an implementation schedule. Voluntary "Watershed Organizations" are responsible for implementing the action plan that results from the MPW, but municipalities and others are expected to be active participants in implementing those actions.	Quebec Water Policy[lxiii]
New Brunswick	Does not require IWMP for drinking water supplies. For bodies of water that are not drinking water supplies, a water classification and a watershed management plan (called an action plan) is required under the *Water Classification Regulation*. Community and watershed groups are encouraged to undertake planning for their watershed in order to help determine steps that should be taken to protect water quality.	*Water Classification Regulation*[lxiv]
Nova Scotia	Nova Scotia's focus is on source protection planning. Under the province's Drinking Water Strategy for Nova Scotia, the province has worked with municipalities to develop source protection plans. Source protection plans are required by the province as a condition for approval for the operation of the construction and operation of water treatment and distribution facilities[lxv]. Specific watershed protection measures may also be required in "protected water areas" as designated under Nova Scotia's Environment Act. These areas may require several prescriptive watershed management measures, such as restrictions on agricultural uses, pesticide use, landfill sites and specific sewage disposal regulations[lxvi].	*Drinking Water Strategy for Nova Scotia*[lxvii] *Environment Act*[lxviii]
PEI	In January 2007 the province released *A Guide to Watershed Planning on Prince Edward Island* for community watershed groups. The *PEI Drinking Water Strategy* that discusses the multi-barrier approach to protect drinking water (source protection). The province does not require source water protection planning; instead, it develops comprehensive IWM plans that include source protection issues such as well field protection.	*A Guide to Watershed Management on Prince Edward Island*[lxix] *PEI Drinking Water Strategy* [lxx]
Newfoundland and Labrador	There is no provincial requirement (or framework) for watershed management, but the Province does establish watershed management committees and assists communities with the development of watershed management plans on an as-needed basis. These plans focus on drinking water supply protection. The province's Multi-barrier Strategic Action Plan also includes source protection.	*Multi-barrier Strategic Action Plan*[lxxi]

Region	IWMP Requirements or Activities	Applicable Legislation/Policy Documents
Nunavut, Northwest Territories and Yukon	Neither the Yukon nor Nunavut have implemented IWMP or source water protection planning. The Northwest Territories produced a safe drinking water framework and strategy in 2005. The strategy indicates that the territory is in the process of identifying watershed areas for all public drinking water sources in the NWT and intends to implement watershed protection measures for public drinking water sources and develop watershed management strategies. The federal government, through Water Boards, plays a role in watershed management in the Territories.	*Managing Drinking Water Quality in the Northwest Territories: A Preventative Framework Strategy* [lxxii]

In summary, all provinces are undertaking some form of watershed planning or source protection. Municipalities are implicated in all cases, although their role is not always explicitly defined.

2.3.8 Municipal Powers

Of the three orders of government — federal, provincial, and municipal — municipalities have the most limited powers and resources[69]. Municipalities must rely on legal powers devolved to them by provincial governments, on appropriate provincial policies and programs, and on effective cooperation between the two orders of government[70]. With respect to water specifically, municipalities have power to set rates for water and sewer services and for development charges. The challenge of exercising these powers to collect sufficient revenues is political rather than one of regulatory limitations.

Municipalities also have the authority to enact Sewer Use Bylaws. These bylaws can control the use of sewer systems, including discharge of hazardous materials, substances that cannot be treated, or substances that will harm the infrastructure or treatment process. The bylaws can also stipulate pollution prevention practices or codes of practice by industrial, commercial or institutional dischargers. However, developing comprehensive bylaws requires capacity and implementing the bylaw, including compliance promotion, monitoring and enforcement, is costly. Smaller municipalities in particular face challenges in developing and implementing sewer use bylaws[71].

Another tool available to municipalities is the “general welfare provision”, a legal tool included in the legislation which empowers municipalities in most provinces and territories in Canada. This type of provision has been used by municipalities to create bylaws regulating water use, water quantity and water quality when no specific provincial or territorial legislation exists. General welfare provisions have also been used by

69 Environment Canada, The State of Canada’s Environment, 1996

70 ibid

71 The Canadian Council of Ministers of Environment is developing a Model Sewer Use Bylaw to assist municipalities in developing a comprehensive bylaw.

Canadian municipalities to pass watershed protection bylaws concerning pesticide use or intensive farming operations.[72]

2.3.9 Building Industry Codes and Insurance

Plumbing codes and building codes are designed to reduce risk to public health and safety. These codes can present challenges to water service providers interested in approaches or technologies that do not conform to conventional designs, such as grey water use in dwellings, low pressure water supplies or small bore wastewater collection systems. In the case of water re-use, adaptation of the National Plumbing Code of Canada (NPC) in the provinces has been identified as a barrier to the uptake of greywater re-use (see below). However, in the case of fixtures, plumbing codes can be a driver for water efficiency. For example, Ontario's plumbing code requires that all new toilet installations require no more than 6L per flush.

Urban water infrastructure services for fire suppression and flood protection are considered by insurance companies in establishing the level of risk for various events in communities. Alteration of the design standards used or levels of service can have dramatic impacts on insurance premiums paid in the community. The impact and limitations imposed on innovative municipal infrastructure designs resulting from the requirements for fire suppression are pervasive and difficult to over-estimate. Codes and standards are essential to protect the safety of people and properties but it must be noted that they also contribute to a continued focus on centralized engineering solutions. Centralized engineering solutions have been identified as one of the significant barriers to incorporation of broader demand-side management approaches into water resource management in Canadian communities[73].

2.3.10 Regulatory Barriers to On-site Water Reuse

As indicated above, water reuse is a particularly important issue for sustainable water resource management and service delivery. Similarly, use of rainwater as a resource is an essential practice for sustainable water supplies. Although there is no outright prohibition of on-site water reuse, a CMHC study found several barriers[74] to institution of this practice in Canada. At a national level, the Guidelines for Canadian Drinking Water Quality, the Guidelines for Canadian Recreational Water Quality and the NPC are three regulatory instruments that could affect implementation. In particular, the NPC provides for alternative systems but also calls for every water distribution system to be connected to a potable water supply. It also prohibits the discharge of non-potable water through outlets such as faucets and toilets[75]. Most provinces have either adopted the NPC in

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[72] See Sierra Legal *The Municipal Powers Report* (2007) for a detailed discussion of the use of general welfare provisions for water-related bylaw creation in Canada (http://www.ecojustice.ca/publications/reports/the-municipal-powers-report/ - date accessed May 2008)

[73] Oliver Brandes and Keith Ferguson *for* The Polis Project on Ecological Governance, *The Future in Every Drop*, University of Victoria, 2004

[74] CMHC, Research Highlights, Regulatory Barriers to On-Site Water Reuse, Technical Series 98-101

[75] ibid

whole, or with additions or slight modifications. The provinces of British Columbia, Alberta, Ontario and Quebec publish their own pluming codes based on the NPC.

To address this barrier, the CMHC and the Canadian Water and Wastewater Association have been working with the Canadian Standards Association (CSA) to develop a code for alternate water sources. The CSA has introduced guidelines[76] for grey water reuse systems. The guidelines entail a two-pipe standard for a non-potable water system in the home. More significantly, Health Canada has recently published the Canadian Guidelines for Household Reclaimed Water for Use in Toilet and Urinal Flushing, which were "developed as an option to reduce water consumption, in response to the growing interest for water conservation in Canada[77]". This standard can be accessed from the Health Canada website[78].

2.4 GOVERNANCE ISSUES

2.4.1 Multiple Players

Because water services are essential for public health and safety, it is understandable that all levels of government play a role in regulating or providing the services. Nevertheless, the number of players presents challenges to municipalities in terms of ensuring compliance with all current requirements and staying ahead of future requirements. Municipal and provincial levels are sometimes not able to coordinate their activities, such as in the case of building code changes to mandate water efficient fixtures[79]. In addition, the dual tier system of municipal governments in parts of Canada also leads to inherent inefficiencies[80] when water service infrastructure has fragmented management (such as, for example, lower tiers managing local buried infrastructure and upper tier managing central facilities).

2.4.2 Political Will

The fact that many communities are still not fully metered (see discussion above) is a governance issue, as well as an economic and a social perception issue. Similarly, the low number of stormwater utilities in Canada reflects a lack of understanding of the cost and impacts of stormwater; this is also a governance issue since insufficient funds and effort are applied to managing and reducing the impacts. The low political will at the municipal level to establish full cost accounting rates for all water services is a governance issue as well as a social (cultural) issue. Some provincial governments are responding to the need for full cost accounting. Ontario's Sustainable Water and Sewage Systems Act, 2002 (which is not yet proclaimed pending regulations required to implement the Act) makes it mandatory for municipalities to assess the costs of providing water and sewage services,

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[76] Canadian Standards Association, Sustainable Building (http://www.csa.ca/sustainablebuilding/Default.asp?language=english - date accessed May 2008)

[77] Health Canada, Canadian Guidelines for Household Reclaimed Water for Use in Toilet and Urinal Flushing, 2007

[78] See URL: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/consultation/reclaim-recycle/index_e.html

[79] Oliver Brandes and Keith Ferguson *for* The Polis Project on Ecological Governance, *The Future in Every Drop*, University of Victoria, 2004

[80] ibid

and to recover the amount of money needed to operate and maintain them[81]. Nova Scotia requires full cost accounting[82] and Quebec has guidelines on the practice[83].

2.5 SOCIAL ISSUES

2.5.1 Demographics

Accommodating population growth is a challenge for many urban communities. In particular, over next 20 years, 90% of Canada's population increase is expected to occur in four urban areas: Metro Vancouver, the Calgary-Edmonton corridor, Toronto and Montreal[84]. The northern community of Iqaluit has also been experiencing explosive growth as have many smaller communities in Alberta such as Fort McMurray and Grande Prairie. Conversely, many municipalities are also faced with declining populations, particularly in parts of Atlantic Canada and Saskatchewan. The populations of Newfoundland & Labrador, New Brunswick and Saskatchewan have all declined during the past ten years.[85] Both the expansion of infrastructure to meet population growth and the on-going challenge of providing water services with a reduced population base present economic challenges for water service providers. Aging populations present potential water quality challenges in terms of increased pharmaceutical use and related environmental releases.

2.5.2 Perceptions of Water

Canadians have a perception that water is abundant, cheap and reliable. This social issue underpins one of the key economic challenges in that public awareness is low regarding the financial and environmental costs of water services; willingness to pay increased rates for the 'hidden' services presents a challenge for most Canadian municipalities. The lack of universal metering in many communities contributes to the social challenge of water valuation and willingness to pay for the full cost of water services.

2.5.3 Immediacy of Water Costs

In urban areas, a potentially significant portion of the population does not pay for its own water bill since utility costs are included within rental unit rates. This disconnect can exist for residential units as well as commercial, institutional and industrial water users. Thus these water users do not know what their water consumption is and further, they do not review the costs of water use as an individual household or business expense because

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81 Ontario Government, *Resources for the Environment and the Law Catalogue* (http://www.ecolawinfo.org/WaterFAQ-WaterFinancing.aspx#watfin04 – date accessed: May 2008)

82 The Nova Scotia Utility and Review Board is empowered to require full cost of service billing for water utilities under Nova Scotia's Public Utilities Act (http://www.canlii.org/ns/laws/sta/r1989c.380/index.html – date accessed: May 2008)

83 J. Kinkead Consulting, *An Analysis of Canadian and Other Water Conservation Practices and Initiatives*, prepared for the Canadian Council of Ministers of the Environment, 2006.

84 Marbek Resource Consultants in association with Athena Sustainable Materials Institute and Jane Thompson Architect *for* CMHC, *Life-cycle Environmental Impacts of the Canadian Residential Sector*, 2007

85 Statistics Canada. 2007. *Census trends for Census subdivisions* (table). 2006 Census. Statistics Canada Catalogue no. 92-596-XWE. Ottawa. Released December 4, 2007 (http://www12.statcan.ca/english/census06/data/trends/Index.cfm - date accessed: December 5, 2007).

it is part of a larger rental cost. This disconnect creates an additional barrier for social marketing schemes to reduce water consumption because economic incentives to reduce water use are not realized by the parties with the capacity to directly reduce water use. In other words, the economic incentives (such as cost reduction) are not seen by the tenants, who have the direct capacity to act to reduce water consumption.

2.6 TECHNOLOGY ISSUES

2.6.1 Treatment Technologies

Adoption of new technologies occurs relatively slowly in water services due to several factors including: affordability; capacity to understand, design and implement new approaches (given other demands on staff and resources); conservative approach to ensure potable water is delivered through well-tested methods; and, the large capital investment in existing methods and technologies. In the last 10 to 15 years, membrane technologies have been deployed to remove specific contaminants from drinking water supplies (such as arsenic for example). Ultra-violet disinfection of wastewaters (as well as some potable waters and stormwaters) has been deployed as a substitute for chlorine. Conventional infrastructure design does not prevent release of, or fully treat, many emerging contaminants (see discussion above); this shortfall may spur research and deployment of technologies to attempt to remove these substances. Nanotechnology is one emerging area that may provide technologies for treatment but can also be expected to present new contaminants of potential concern.

New technologies often require a trade-off decision. In addition to the adoption challenge described above, additional water or energy resources may be required, or additional pollutants may be released. For example, some membrane technologies require more water resources for flushing to keep the membrane clean and operable than conventional systems. Similarly, additional treatment components or alterative technologies can require additional energy which, as discussed in Section 2.1.5 above (Energy Use and Greenhouse Gas Emissions), works against the climate change mitigation imperative to reduce carbon use where fossil fuels provide the energy source. Coagulants or other additives to remove salts, metals and other pollutants end up in the waste products (solid and/or liquid) of treatment processes, thus contributing to pollutant loads. Assessment of the trade-off is very difficult since it often involves disparate issues (health risk reduction versus carbon release increase, for example) and can also change depending on the scale chosen for the evaluation (local, regional, national or global).

Understanding and adopting new technologies is not only a challenge for municipalities. As the permitting agent, provincial governments and territorial water boards must also be able to respond to applications by progressive utilities and consulting engineers with designs that employ the most up-to-date and appropriate treatment technologies.

2.6.2 Collection and Distribution Technologies

In the case of stormwater collection systems, new technologies have a “back to the future” nature: rainbarrels, green roofs, swales and grassed areas to reduce runoff are promoted as stormwater best practices. These approaches do not conform with the cultural norm for subdivision design however and therefore present implementation challenges. They are also insufficient to prevent flooding during large storm events and so do not fully replace the need for stormwater infrastructure.

Street sweeping is a key ‘technology’ for surface water protection in urban areas, as swept streets lead to lower levels of suspended solids at outfalls, and consequently in waterways. Despite this benefit, street sweeping is typically not undertaken with this outcome as a goal[86]. Similarly, greywater systems to reduce water use and the use of rainwater for non-potable uses do not conform with conventional infrastructure design and are problematic for typical building / plumbing codes. Composting toilets have been implemented in sites in Canada with particular water or wastewater challenges. Demonstration sites for “off-grid” buildings, that is buildings that do not rely on central facilities for water services, exist in a handful of urban centres to pilot technologies but are still considered novelty installations. Researchers in Germany are piloting a fundamental re-design of a wastewater system, from toilet configuration to the disposal system for residuals, in response to the concern for endocrine disrupting chemicals and pharmaceuticals in wastewater effluents[87].

Technologies to reduce the cost of pipe maintenance or replacement have been well-established in recent years, including in-situ lining of watermains or sewers, remote viewing of sewer condition and leak detection for watermains; challenges of implementing these technologies are being reduced as more communities adopt them.

2.6.3 Energy Use Reduction Technologies

The inter-relationship of water and energy use has prompted interest in technologies and approaches to reduce the need for water services, to conserve water, and to use latent heat from wastewater. Challenges to implementing these measures include capacity to implement, sufficient budgetary allocations, and the relatively low priority of greenhouse gas emission reductions in municipal decision-making processes.

2.7 LIABILITY ISSUES

Provision of potable water presents inherent liabilities for municipalities as the responsible agents to ensure safe drinking water for the population. The implications of failure in this area were seen in the handful of outbreaks in North America in the past decade or so (e.g. Walkerton, Ontario). As mentioned above, fire suppression services and the insurance industry have significant influence on levels of service and operation of potable water systems, posing potential liability issues for municipalities contemplating a change in level of service, technology or approach that could potentially impact delivery of water for fire-fighting. Similarly, flood protection presents challenges in terms of maintaining urban infrastructure design standards.

[86] For example, the City of Ottawa states that its streets are presently swept for aesthetic purposes, with possible future services aimed at reducing airborne particulate matter. City of Ottawa (ND), *Ottawa 20/20* (http://ottawa.ca/city_services/planningzoning/2020 – date accessed: May 2008)

[87] Policy Research Initiative, Freshwater for the Future Conference, 2006; presentation on technologies

Climate change is expected to present challenges for stormwater system design and may create additional liability issues for municipalities in the area of flooding and related property damage. Liability of wastewater facilities to ensure acceptable effluent quality can be expected to increase under the proposed Fisheries Act Regulation, which may specify allowable toxicity limits. Wastewater effluent quality reflects the quality of waste materials discharged by community members, putting pressure on municipalities to develop and enforce Sewer Use Bylaws. Similarly, biosolids quality is determined by community discharges and municipalities are responsible for safe disposal or reuse of these materials.

2.8 IMPLEMENTATION CHALLENGES

Implementation challenges for best practice approaches or technologies have been discussed within the subsections above, but key issues are summarized as follows:

- Public and cultural perception of water abundance and low cost
- Political leadership or will to institute full metering and full cost service rates
- Municipal capacity to develop and implement different approaches while also addressing increasingly stringent regulatory requirements
- Inertia resulting from large, expensive and historically centralized infrastructure systems
- Barriers to innovation or change posed by building or plumbing codes and insurance companies.

2.9 SUMMARY TABLE

Exhibit 2.8 summarizes information in Section 2 with respect to the applicability of issues identified to community size, region or province, and geographic location.

Exhibit 2.8
Overview of Key Issues for Sustainable Community Development – Water Sector

Category	Issue	Sub-Issue	Applicability (Region/Province) (S,M,L) (Rural, Urban) (Remote/Northern)
Environmental	Water Quantity	Acknowledging finite supply	All
		Uneven regional distribution of fresh water	All, especially municipalities in Western provinces and on groundwater supply
		Anthropogenic alteration of water balance between ground and surface water	All
		Effects of climate change	All, especially those municipalities with limited water resources and in most vulnerable areas for climate change
	Water Quality	Wastewater effluent quality	All, especially inland municipalities discharging to smaller rivers and to lakes
		Source water quality	All
		Effects of land use	All; Rural for agricultural use in particular and Urban for development uses in particular

Category	Issue	Sub-Issue	Applicability (Region/Province) (S,M,L) (Rural, Urban) (Remote/Northern)
		Effects of urban stormwater	Urban
		Potable water quality	All
	Emerging Contaminants	Pharmaceuticals, other drugs, personal care products,	All, especially larger municipalities and those downstream of urban sewage plant outfalls or intensive agricultural operations
	Energy Use / GHG Emissions	Energy demand associated with water and wastewater services	All
Economic	Infrastructure Deficit	Gap between revenues and maintenance cost for potable water, wastewater and stormwater infrastructure.	All, possibly less of a factor where services are provided by a utility or where a municipality funds/ operates as equivalent to a utility
	Revenue Collection and Rate Structures	Inadequate rate structure and revenue collection for capital, operating, maintenance and environmental damage mitigation costs (including GHG emission reduction)	All
		Life-cycle costing	All
		Un-metered potable water service	All, more prevalent in small municipalities but not exclusively
	Economic Barriers to Water Re-use	Under-pricing of water and water services often renders re-use economically unattractive	All, barriers are lower in regions with high cost of service, (e.g. Northern communities)
Regulatory	Changing Regulatory Requirements	Regulations for emerging contaminants	All
		Capacity to implement incoming national guidelines	All
	Water Allocation and Management	Balancing demand/withdrawals with sustainability concerns	All, various applicability in different regions (See box 2.3, pp 14)
	Potable Water Requirements	Federal, provincial and municipal legislation, regulations and guidelines	All
	Waste Water Requirements	Federal, provincial and municipal legislation, regulations and guidelines	All, especially municipalities with primary treatment or less
	Storm Water Requirements	Federal, provincial and municipal legislation, regulations and guidelines	All (not a significant issue at this time due to limited regulatory requirements)
	Planning Requirements	Watershed and sub-watershed planning; source water protection and mitigation of effluent impacts	All, with variation from one jurisdiction to another (i.e. source protection in Ontario & N.S.; wastewater effluent plans in B.C.); regulatory requirements are evolving (especially in Alberta)
	Municipal Powers	Limited powers and resources	All
	Building Codes and Insurance	Relationship to new or innovative technologies	All

Category	Issue	Sub-Issue	Applicability (Region/Province) (S,M,L) (Rural, Urban) (Remote/Northern)
		Relationship between infrastructure design and fire suppression requirements.	All, especially municipalities considering alternate levels of service
	Regulatory Barriers to Water re-use	Relationship to federal codes and guidelines, and provincial regulations.	All
Governance	Multiple Players	Ensuring compliance with regulations at all levels of government	All
		Dual tier municipal governments	M,L
	"Political Will"	Metering for potable service	All unmetered municipalities
		Stormwater utility creation	Urban; M,L
		Implementation of full cost accounting	All
		Short term planning horizon	All
Technological	Treatment Technologies	Potable water	All
		Wastewater	All
		Stormwater	All, especially urban
	Collection and Distribution Technologies	Stormwater collection	All, especially urban
		Greywater re-use	All
		On-site treatment	All, especially S and rural municipalities, and those with diffuse suburban areas or developments located far from existing services.
		In-situ lining for rehabilitation and maintenance	All
		Remote viewing for maintenance	All
	Energy Use Reduction	Demand reduction for water services	All
		Wastewater heat recovery	M,L
		Cogeneration	M,L
Social	Demographics	Effect of population growth or population decline on infrastructure and affordability (tax base)	All
		Aging population and relationship to pharmaceutical contamination	All
	Perceptions of Water	Low public awareness of financial and environmental costs of water services	All
	Immediacy of Water Use	Low awareness of populations in rental units of water consumption and costs Disconnect between economic incentives and capacity to act to reduce water	Urban centers, especially those with higher proportion of apartment/ rental unit occupants
Other	Liability Issues	Health protection	All

Category	Issue	Sub-Issue	Applicability (Region/Province) (S,M,L) (Rural, Urban) (Remote/Northern)
		Fire suppression requirements and expectations	All
		Stormwater systems and implications for flood risk	Urban
		Liability arising from releases of toxic wastewater effluent and accumulation of toxics in biosolids	All

3. MUNICIPAL PLANNING APPROACHES

Municipal planning approaches are the methods and techniques used by municipal staff to identify what actions will be taken over a future time interval. In the context of this report, planning approaches pertain to strategic level resource use decisions (land, energy, water, existing infrastructure, staff and community human resources, economic resources). Strategic planning approaches establish what the functionality and layout of the community will be in the future, including municipal infrastructure and levels of service. Municipal planning approaches also influence the rates and charges established to provide community services. Examples of planning approaches include development of official plans, community energy plans, transportation plans, watershed plans, level of service and cost analyses, etc.

This section discusses municipal planning approaches with respect to water resources. These approaches include the strategic level planning and management of watersheds and/or water infrastructure systems. Examples of such approaches include managing municipal water services within a watershed-based approach, demand management and infrastructure master planning.

3.1 IDEAL PRACTICE

An ideal practice for a systems approach to municipal water services includes recognition of the water cycle and that potable water, wastewater and stormwater services are inter-related at a watershed level. In addition, an ideal practice recognizes that all land use decisions have potential implications for water quantity and quality as described following:

- The ideal approach focuses on the services provided by water, rather than the infrastructure itself, for community design decisions. This approach opens up the possibility that water is not required to meet the service need. For example, where cooling is needed other options are explored, such as building orientation and the design of heating, ventilation and air conditioning (HVAC) systems[88]. In areas with water challenges, waterless urinals and toilets may be considered. In the case of stormwater, the ideal approach is to minimize the need for infrastructure by designing land imperviousness to keep post-development runoff equal to pre-development flows.

- The quantity of water used takes into consideration the ecological capacity of the water resources in the area. Surface water withdrawls leave a quantity of water in-stream that is sufficient to meet the on-going ecological needs of watershed flora and fauna. Groundwater withdrawls are made within the capacity of the aquifer to recharge and do not impair baseflows of surface waters within the groundwater zone.

- The quality of water used matches the service need so that the most highly treated water matches this use (i.e. drinking, bathing, washing), whereas water of non-potable quality is used as appropriate for other services, such as rainwater for lawn watering or grey water for toilets. In industrial operations, process water is reused.

[88] There may be energy–water tradeoffs to consider resulting in decisions on greenhouse gas emissions

- The watershed approach incorporates a multi-barrier approach to ensuring safe potable water as well as risk reduction for releases of water (wastewater and stormwater) to the environment.

- Water services for new populations are met through intensified use of existing infrastructure.

- Pumping energy use is minimized through system design that reduces, to the extent possible, pipeline length for potable and wastewater services through use of local water sources and local wastewater treatment and release.

3.2 CURRENT PRACTICE

3.2.1 Watershed Management

Provincial governments promote watershed management and some, such as Ontario[89], have done so for decades. (See Section 2.3.7 and Exhibit 2.7 for an overview of watershed planning requirements of Canadian jurisdictions.) However, what constitutes watershed management has not been consistently defined; municipal implementation of watershed management varies considerably in terms of scope and intent, from subdivision-level drainage reviews for development approvals to municipality-wide consideration of the watershed capacity (as in the case of Okotoks, Alberta). The federal government has recently promoted integrated watershed management (IWM) as part of its infrastructure funding programs and gas tax sharing. It defines IWM as "a *process* of managing human activities in an area defined by watershed boundaries in order to protect and rehabilitate land and water, and associated aquatic and terrestrial resources, while recognizing the benefits of orderly growth and development."[90] This broad definition encompasses many types of water and land projects and activities.

In implementing watershed management, municipalities face numerous challenges, including: identifying clear goals; difficulty and high cost of obtaining required data from existing sources and field research; engaging stakeholders and forming committees; implementing recommendations. In addition, municipal boundaries are not defined based on watershed boundaries so cross-boundary co-operation is required. When properly developed and implemented, watershed management has the potential to influence land use decisions as well as water services, including water consumption, within the area.

Municipalities also face significant challenges from the development community and other stakeholders in implementing watershed measures that impact developable land. For example, the Ontario government stepped in to protect the Oak Ridges Moraine[91] from development hazards with the *Oak Ridges Moraine Conservation Act, 2001*, which

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89 Ontario enacted the *Conservation Authorities Act* in 1946 as part of a long-term intention to manage water resources on a watershed basis; Conservation Authorities are established for the southern and eastern watershed areas of the province.

90 Infrastructure Canada, *What is Integrated Watershed Management Planning (IWMP)?* (http://www.infrastructure.gc.ca/research-recherche/result/notes/rn08_e.shtml#wm3 – date accessed December 2007)

91 The Oak Ridges Moraine (ORM) is a ridge of sandy hills covering an area of 190 000 hectares located in Southern Ontario. It contains the headwaters of 65 waterways, 35 of which are in the in the Greater Toronto Area. Sixty five percent of the area of the moraine is located within the Greater Toronto Area.

sets aside a small portion of the moraine area (8%) for development, while placing varying degrees of development restrictions on the remaining area. In another example of the limited success of land use approaches, using a 1989 wetland inventory as a baseline, two Environment Canada researchers demonstrated that urbanization and other human land uses continue to encroach on the wetlands of the Vancouver area. Although agriculture was shown to be the largest single use for converted wetlands, increases in urban land uses (housing and industrial building) and related land uses (i.e. landfills, golf courses) are significant factors, accounting for over 500 hectares of lost wetlands from 1989-1999. The study found that wetland loss has been the cumulative result of many decisions to convert seemingly insignificant wetland areas.

One trend in the current practice is to implement source protection measures as part of a multi-barrier approach to protecting drinking water supplies. This approach does not necessarily consider the watershed level and is less effective for overall watershed health than watershed management. Ontario is in the process of implementing source protection for drinking water on a watershed basis; there is potential in the Great Lakes Region to establish targets for contaminant loadings. The Capital Regional District (Victoria, B.C.) recently completed a land transaction to acquire almost 9,700 hectares of forest intended to protect the region's drinking water supply[92] (see Section 3.5 following). Nova Scotia enables municipalities to make land use decisions within designated water catchment areas.

The focus on source water protection can be a first step towards broader watershed decision-making. Eventually it may be used with other decision-making tools to optimize infrastructure requirements and pollution controls. Specifically, a tool under development by Health Canada, known as Quantitative Microbial Risk Assessment (QMRA), proactively examines the overall health risks to a population with respect to various levels of treatment for the community's source water quality; this analysis can be applied to establish appropriate treatment requirements as well as upstream watershed management decisions to reduce risks of contaminants that may increase risks to the population.

A non-Canadian example of examining risk and applying watershed protection measures in lieu of treatment can be found in New York City; the City does not treat its drinking water through technological solutions but rather has extensive land use controls, land acquisitions and education programs in the Catskills catchment area of the reservoir feeding the City. It should be noted that Metro Vancouver has a similar water supply reservoir arrangement and historically only chlorinated its water without filtration; in 2001 it was experiencing turbidity issues that lead to the design and construction of $600M[93] supply tunnels and filtration plant which, when commissioned, will be the largest in Canada. The overall watershed approach adopted throughout the United States to address water quality impairment entails the requirement for stakeholders in watersheds responsible for all discharges, both point source and non-point source (such

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[92] Capital Regional District, *Media Release* (http://www.crd.bc.ca/media/2007/07-12-21_leechriverfinalizationhtm.htm – date accessed: May 2008)

[93] Metro Vancouver, *The Sustainable Region Initiative-Water* (http://www.gvrd.bc.ca/sustainability/water.htm – date accessed: May 2008)

as agricultural runoff for example), to develop limits for all contaminants exceeding the quality objectives for impaired waterbodies (known as Total Maximum Daily Load for each contaminant).

3.2.2 Demand Management

Potable Water

Demand management for potable water systems is typically undertaken by municipalities facing a crisis in supply or infrastructure capacity. Demand management is most commonly applied to reduce peak water demand (usually through restriction of outdoor water use in the summer), or to reduce base flows (through toilet replacements, industrial water use programs and/or rate increases). Demand management may include restrictions on outdoor water use, customer meter testing and replacement programs, and public education; less frequently, watermain leak detection programs and district metering (to identify unusual water demand in parts of the distribution system) may be included.

Wastewater

Wastewater demand management is most typically managed through a Sewer Use Bylaw to control waste strength and to limit the amount of ‘clean’ water entering the collection system (from weeping tiles, for example). Demand management may also include programs to reduce inflow (from catchbasin covers, for example) and infiltration (i.e. groundwater leaking into failed sewers).

Stormwater

Current practices to limit stormwater demand in established neigbourhoods are rare although gaining profile, particularly in British Columbia. Stormwater demand management generally occurs at the design stage for new subdivisions and entails land drainage design, measures to limit water run-off during smaller, more frequent storms and typically, a stormwater pond or other type of facility. Measures to reduce runoff volumes from developed areas may include grass swales, engineered ‘ponding’ of water near curbs on streets, or even more innovative approaches such as green roofs. Advances in this area are slow however due to lack of capacity and interest within the development community to undertake innovative drainage designs and, likely, capacity limitations within municipalities to review and approve such designs.

3.2.3 Infrastructure Master Planning

Many municipalities of all sizes undertake coordinated water and wastewater infrastructure master plans. Significant savings can be realized through coordination with major road rehabilitation projects. Another key benefit of coordination is reduction of public inconvenience. In urban areas facing significant growth, these plans identify infrastructure extensions to meet demands of new development areas. Some communities use integrated asset management software.

3.3 TRENDS

This sub-section describes trends observed among Canadian municipalities moving toward more sustainable practices and projects within the water sector. This section specifically emphasizes municipal planning and integrated systems approaches and describes trends towards more sustainable practices, versus general trends in the current or historic practices.

Three trends of interest are associated with watershed management. Firstly, watershed management is gaining attention, in part through a focus on source protection but also due to the federal government request for Integrated Watershed Management Planning as part of funding requirements through gas tax funding agreements with the provinces. The increasing experience and involvement of many stakeholders in watershed decision-making in Canada bodes well for continued and increased refinement of protocols and tools to implement this approach. Secondly, the implementation of watershed level management also represents, in the Ontario example, the decentralization of decision-making through multi-stakeholder committees. Alberta has implemented similar processes for air quality management and this trend is also one to watch for environmental resource management in general. Thirdly, provincial governments, in particular Alberta and Ontario, are increasingly interested in assessment of cumulative impacts of environment decisions. Questions of cumulative impacts naturally arise when making watershed level decisions since all sources of pollutants are considered in a comprehensive approach. This trend can be expected to increase the depth and sophistication of questions posed in developing watershed approaches over the coming decade.

The trend for demand management approaches for potable water systems is that it continues to be primarily implemented in communities facing water supply shortages or significant infrastructure investments to increase treatment or storage capability. The attitudinal barriers (as discussed in Section 2 above) to water metering, water pricing and water conservation are significant in Canada and tend to dampen community interest in aggressive demand management programs. However, some of the communities that are undertaking measures are recognized in North America for their techniques (such as the Halifax Regional Water Commission for water system loss controls). Also, the Canadian Water and Wastewater Association (CWWA) actively supports development of standards for water efficiency measures such as low flow toilets and water reuse. (The CWWA however has tempered support for universal metering, as evidenced in their comments on the National Strategy for Municipal Wastewater Effluents[94]). Demand management on the wastewater side is not robust in Canada; an anticipated future trend is that flow reductions and source pollution controls will gain significant profile as a result of the expectation in the National Strategy for Municipal Wastewater Effluent that municipalities will implement comprehensive Sewer Use Bylaws.

As climate change adaptation plans and approaches emerge, it is possible that demand management will be recognized as an important component of an adaptive management approach since it can ameliorate the effects of disaster and shorten recovery periods[95].

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[94] CWWA letter to Environment Canada

(http://www.cwwa.ca/pdf_files/EC%20Regulatory%20Framework%20Comments%20-%202008-01-31.pdf – date accessed: May 2008)

[95] David B. Brooks, Ph.D., *Less is More: Approaching Water Security and Sustainability from the Demand Side,* Presentation to the NATO Advanced Studies Workshop at Yerevan State University in Yerevan, Armenia, September 2007

Infrastructure Master Planning is fairly well-established in Canada. A trend that can be expected to increase the sophistication of the planning process is the increasing expectation of provinces and the federal government that municipalities will plan and manage infrastructure using full cost accounting techniques and, by implication, full cost pricing for services.

3.4 LEADERS

This sub-section identifies Canadian municipalities at the forefront within the water sector in terms of the implementation of sustainable practices, programs, and projects, and describes how their approaches distinguish themselves from other communities. Short descriptions of exemplary communities are given in the appendices. This section specifically emphasizes municipal planning and integrated systems approaches.

Okotoks, Alberta and Chelsea, Quebec are two clear leaders in the area of systems approaches for water management. Halifax (the utility) is leading in the area of demand management for potable water, with a particular emphasis on infrastructure leakage control, and is developing an approach for sewer system demand management (as described in the Best Practices section following). Detailed profiles of these communities can be found in Appendix C, Exemplary Community Profiles.

As a brief overview:

- Okotoks has established its growth limits on the basis of the capacity of the Sheep River to supply water and assimilate wastes. In doing so, it has educated its own staff and population as well as provincial contacts and neighbouring communities who share the larger watershed. Severe restrictions on water availability are anticipated for the region which is also growing rapidly. This proactive approach has gained wide recognition in Canada since Okotoks was the first community to implement such an aggressive and (to date) successful watershed planning approach.

- Chelsea has established a comprehensive private well system monitoring program in recognition of its limitations for supply and potential risks to water quality. The program, run by a non-government organization in partnership with the municipality and a regional university, coordinates private citizens to collect water samples; the regional university provides data analysis and scientific advice. The success of the municipality's approach has lead to the adoption of the program at a regional municipal level that includes five area municipalities.

- Halifax's water utility has aggressively pursued full metering of water services, district metering of distribution system pressure zones to detect leaks, pressure management techniques to reduce system leakage where possible, and has implemented a water infrastructure replacement program. It has implemented all measures to reduce non-revenue water that are economically feasible given the cost of water in the community. The success of the utility in managing water services was recognized by the municipal council to the extent that the council asked the utility to take over operation of its wastewater infrastructure. The ability and willingness of the utility to set rates to recover full costs was cited as a key factor in the success of the utility in managing water services.

3.5 BEST PRACTICES

This sub-section identifies best practices exist within the water sector in terms of implementing sustainable practices, programs and projects. Specific emphasis is placed on municipal planning and integrated approaches.

Best practices outlined in this section are not intended to be an exhaustive list of potential practices that are applied by municipalities to manage municipal water services within a watershed-based approach, through demand management or for infrastructure master planning. Instead, this section highlights particular practices undertaken by municipalities to move towards sustainable water resource approaches at a systems level. For example, there are many best practices in the area of data management for infrastructure master planning; these are not addressed following because, while important, their use does not necessarily mean an effective or progressive systems approach is in place. The best practices should be considered a sample only and indicative of the desirable practices. In some cases, there will be other communities not identified that have implemented similar practices; again, this list is not intended to be exhaustive in terms of municipalities undertaking these or similar measures.

3.5.1 Watershed management

Planning for Ecosystem Services/Back-casting

Planning water use and treatment levels for the preservation or restoration of ecosystem services can take the form of limiting withdrawals to preserve waterway flows or groundwater levels, or limiting discharges of wastewater or stormwater effluent to the assimilative capacity of the accepting body of water. A pair of related concepts are back-casting and the Water Soft Path. The Water Soft Path promotes the practices of thinking in terms of services needed rather than infrastructure required, fitting water use within the ecological means of the watershed and matching quality to use. To maintain ecological integrity, the Water Soft Path employs a method of “back-casting” to look at the future state, based on population projections and other considerations, to establish current appropriate water uses and volumes for the present.

- **Okotoks** Alberta has capped growth in recognition of the carrying capacity of its watershed; specifically, based on the limited water supply and assimilative capacity of the Sheep River (capacity is estimated at 30,000 people). The decision was made to live within local limits versus extending those limits by bringing in water from beyond the watershed. Similarly, Okotoks will not provide water to other municipalities. Okotoks has been very successful in engaging the community in conservation and planning activities, as witnessed by an 82% approval rating for capping population at the watershed’s carrying capacity.
- **Halifax Regional Municipality**’s (HRM) Harbour Solutions Project is an example of infrastructure planning for the restoration of ecosystem services. Wastewater treatment plants being commissioned as part of the project have been designed to provide effluent that will restore water quality in the harbour to a level that will

support various levels of shellfish harvesting and consumption; improved aquatic habitat; and, human recreational uses.

- **The Town of Oliver,** British Columbia, a community in the Okanagan Basin facing significant growth, has recently had a Soft Path analysis[96] performed, including back-casting, to identify three potential paths: a Business as Usual scenario; an Enhanced Efficiency scenario (which applies common demand management techniques); and, a Conservation Commitment scenario that illustrates what a commitment to "no new water until 2050" would entail. Recommended actions from the study include establishing a foundation with staff, education, water audit programs, universal metering and conservation-based pricing; commit to "no new water" enabled by the use of technologies and landscaping, promotion of retrofits and urban re-vitalization with water-centric planning; pass by-laws that require all future housing developments to use the full suite of water conserving fixtures and appliances as well as outdoor best practices; develop a rebate program for retrofitting existing houses funded through new development fees; and, ensure all new developments have the infrastructure for rainwater harvesting.

Integrated Water Resource Management (IWRM)

IWRM definitions and processes are evolving in Canada and internationally. Infrastructure Canada has developed guidance and research on IWRM for municipalities. In its broadest application, IWRM entails a governance approach that is ecosystem-based, with a key consideration being the integrity and resilience of the ecosystem. The Polis Project on Ecological Governance describes four underlying concepts for this approach[97]: Precaution for the prevention of harm; ecosystem-based management with ecosystem integrity setting the context for management decisions; matching of authority to jurisdiction with "nested" jurisdictional powers; and, adaptive management so that plans and policies are continually modified to respond to ecological, economic and social feedback.

Integration of Stormwater and Climate Change Mitigation Techniques

Many "green infrastructure" installations, such as green roofs and tree cover are attractive both in terms of stormwater management and in terms of reducing energy use or otherwise mitigating climate change:

- The City of **Ottawa**[98], in partnership with the Tree Canada Foundation and the FCM, ran a pilot project to test the application of CITYgreen in the City of Ottawa. CITYgreen is a GIS based software package developed by American Forests designed to calculate the value of forest landscapes for a number of attributes including storm water retention, carbon sequestration and air pollution abatement. In the case of Ottawa, the City's inventory of trees has been valued at over $19 million

[96] Oliver Brandes, T. Maas, A Mjolsness, E. Reynolds, *A New Path to Water Sustainability for the Town of Oliver, BC*, 2007 (http://www.waterdsm.org/pdf/oliver_casestudy.pdf – date accessed: May 2008)

[97] Oliver M. Brandes et al. *At a Watershed: Ecological Governance and Sustainable Water Management in Canada*, Polis Project on Ecological Governance, 2005 (http://www.waterdsm.org/pdf/report4_full.pdf – date accessed: May 2008)

[98] Personal Communication, David Miller, City of Ottawa

in terms of avoided stormwater storage and conveyance infrastructure costs. The pilot project also identified several thousand kilograms of Carbon Monoxide, Nitrogen Dioxide, Ozone, Particulate Matter and Sulphur Dioxide removed, nearly 8000 annual tonnes of sequestered Carbon, and significant reductions in contaminant loading to local bodies of water were attributable to the City's trees.

- The City of **Toronto** has also taken energy and climate change effects into account as part of its Green Roof Strategy[99]. A 2005 report commissioned by the city found that green roofs have the potential to save over $160 million in storm water treatment and conveyance and combined sewer overflow costs, and would contribute nearly $70 million in avoided energy infrastructure and $21 million in yearly building energy savings[100]. This report provided the basis for Toronto to implement a green roof pilot program in 2006 in order to encourage the construction of green roofs within the city. In its present form, the program offers a financial incentive of $\$50/m^2$ to construct green roofs on industrial, commercial, and multi-family residential buildings and $\$20/m^2$ for single-family residential buildings. A more complete understanding and valuation of benefits may allow for preservation or creation of green infrastructure that may not be economically feasible from either a stormwater or climate change standpoint alone.

3.5.2 Land-Use Controls and By-Laws

Land use controls and bylaws can be used to influence development and preserve water resources at scales from watershed to subdivision, neighborhood and lot level. Key land use control tools include source protection and watershed management initiatives, as well as development, chemical storage and pesticide use bylaws. Although direct benefits of land use controls are difficult to estimate, they can result in significant avoided costs for water treatment and associated infrastructure.

Watershed Preservation Initiatives

At the broadest scale, source protection may take the form of large scale watershed preservation projects. Projects of this type may reduce water treatment requirements by taking advantage of natural ecosystem services to remove pathogens, excess nutrients and other pollutants, as well as avoiding pollutant loading to water supplies that may occur if the land was used for industrial, forestry or agricultural purposes. In other cases, they aim to protect ecological function of water. Examples of best practices are:

- In the case of B.C.'s **Capital Regional District**, watershed protection has taken the form of a major land purchase[101]. The entire watershed of the Leech River, a main tributary to the Region's Sooke Reservoir, was purchased by the region from a logging company, TimberWest in December 2007. This 9,700 hectare purchase was

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99 City of Toronto, *Green Roofs* (http://www.toronto.ca/greenroofs/index.htm – date accessed: May 2008)

100 Green roofs reduce stormwater demand and combined sewer overflows mainly by absorbing and sequestering rainfall. They reduce energy costs mainly by reducing summertime cooling requirements through improved insulative properties and increased evapotranspiration, and to a lesser extent reducing heating season energy costs through increased insulative properties.

101 Capital Regional District, *Media Release* (http://www.crd.bc.ca/media/2007/07-12-21_leechriverfinalizationhtm.htm – date accessed: May 2008)

made at a cost of nearly $65 million, but has allowed the CRD to avoid the construction of a new $150 million water treatment facility, and will be completely funded through a small increase in the wholesale water rate.

- Similar goals have been achieved through a different mechanism in **Wolfville** Nova Scotia. Wolfville partnered with the Nova Scotia Nature Trust (NSNT), a non-profit land trust, to create the Wolfville Watershed Nature Preserve[102]. This preserve protects the municipality’s back-up water supply by placing the 245 hectare watershed under a “conservation easement”, administered by the NSNT. Under the terms of this easement, the NSNT is given the power to enforce conservation restrictions, ensuring permanent protection from development. The estimated $150,000 required to mange the trust is being raised through donations by the NSNT.
- Although an estimated 90% of its pre-settlement wetlands have been lost, the **City of Calgary** has recognized the importance of remaining wetlands within city limits, and the threat posed to these wetlands by urban development, by drafting a Wetland Conservation Plan (WCP). The plan identifies 18 separate benefits in five categories, including; water quality, flood attenuation and erosion control, ecological value, climate amelioration, and socioeconomic value. Calgary Parks is now working to develop an implementation plan for the policy, including developing wetland mitigation and evaluation procedures as well as research and monitoring programs to ensure wetlands remain sustainable and healthy. Existing wetlands have been mapped; the data will be used to assist city staff in convincing developers to incorporate key wetlands into the design of subdivisions. Ducks Unlimited Canada has partnered with the City to advise on storm water management and wetland conservation.
- **Chelsea**, Quebec has implemented a wetlands protection bylaw. This Zoning By-law establishes setbacks and other standards governing any work performed in the vicinity of wetland areas to protect the biodiversity of the wetland areas and maintain their role as a natural filter and source of replenishment for the watershed. Refer to Appendix C for other watershed protection initiatives.
- The **City of Ottawa** has an environmental effects monitoring program to assess the impacts of municipal facilities on receiving watercourses. The protocol used is based on the federal requirements for Pulp and Paper facilities and relies on a weight-of-evidence approach to determine whether there is an adverse effect or not. Factors included in the assessment are benthic invertebrate organism population in a potentially affected zone, plume chemistry and dimensions, sentinel fish species and whole effluent toxicity. The technique has been applied to demonstrate the effectiveness of the secondary wastewater treatment process, to make cost-effective decisions on wastewater infrastructure investments and to assess the need for water purification wastestream treatment.

Wellhead / Groundwater Protection

For communities dependent on groundwater, wellhead protection is an essential source protection tool and is most effective on a sub-watershed (or groundwater catchment zone) scale. Wellhead protection involves providing buffer zones around wells where activities,

[102] See http://nsnt.ca/ourwork/campaigns/wolfville/ and www.town.wolfville.ns.ca/whatshappening/mayorsnewsletter.pdf for additional information.

such as use and storage of chemicals, fertilizers and manure application and road salt use, are restricted or monitored. The **Regional Municipality of Waterloo** (RMW), Ontario has taken an integrated approach to preserving groundwater quality[103]. One of the largest cities in Canada that is dependent primarily on groundwater, RMW administers numerous programs targeted at preserving the quality of groundwater resources, including:

- Wellhead Protection Areas (WHPAs) established based on the type of overburden present, and the resulting speed of infiltration. WHPA status and ranking are used to make zoning decisions for future non-residential buildings and to guide regulation of land use (*i.e.* placement of fuelling stations and road salt application levels).
- The Rural Water Quality Program works with rural landowners and farmers to avoid both ground and surface water contamination, offering grants of up to $25,000 per farm for projects such as those to reduce impacts of manure handling and storage; chemical, fertilizer and fuel handling and storage; and inadequately maintained and constructed wells; the program coordinates with Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) for completion of environmental farm plans.
- The Business Water Quality Program grant program (now discontinued) worked with businesses to promote procedural and capital best management practices as well as facility reviews and assessments.
- Numerous public education and awareness initiatives related to groundwater protection are administered by the region, including school curricula, and the provision of technical and financial support for "Groundwater Guardian" community groups.

Wellhead and groundwater protection can also be achieved through regulations for storage of potential pollutant chemicals. Although generally applied to industrial, commercial and institutional (ICI) sites, chemical storage restrictions may also be applied to residential dwellings for the purpose of groundwater protection. The town of **Wolfville** N.S. is in the process of developing a source water protection plan[104]. The plan is anticipated to contain some unique aspects, such as restrictions on residential fuel oil storage and chemical storage and use. These measures are necessary because Wolfville obtains its water from wells located within the town limits. These wells draw from an aquifer that extends to sand and gravel deposits directly below the town's main street.

Limited inter-basin transfers

The project team did not identify policy approaches by municipalities to place limits on inter-basin transfers except in cases where such transfers were not possible (as in Chelsea and Okotoks, for example). For example, the Region of Waterloo is a progressive municipality with aggressive water efficiency promotion. However, within its long term plan for water servicing, Waterloo has plans for a pipeline from a Great Lake (likely Lake Erie due to provincial restrictions on access to Lake Huron). This plan highlights the

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103 For information on RMWs source water and wellhead protection activities, see http://www.region.waterloo.on.ca/web/region.nsf/8ef02c0fded0c82a85256e590071a3ce/e2b89d28258b6d5385256c1300690f79!OpenDocument

104 Town of Wolfville, *Source Water Protection Plan* (http://www.town.wolfville.ns.ca/departments/waterutility/swpp.html - date accessed: April 2008)

challenges facing high growth municipalities in meeting projected water demands within their existing basins. (Waterloo also faces challenges in gaining consistent local government level actions to manage local water distribution networks, which are not under the authority of the Regional government.) When presented with the option, inter-basin transfers continue to be a standard approach of municipalities.

3.5.3 Demand Management

Water Efficiency Master Planning / Potable Water Demand Management

Several Canadian municipalities have water efficiency master plans with a goal of reducing water use and wastewater effluent. These plans generally include demand-side management strategies and programs, and can include various technology promotion, education, and infrastructure renewal and management strategies. One of the best examples is **Toronto** Ontario's *Water Efficiency Plan* (WEP)[105]. The WEP sets targets for reductions in daily water and wastewater use as well as peak water demand; examines and evaluates savings for candidate DSM measures; screens measures based on a cost benefit comparison using the marginal cost of supplying new water and wastewater services; estimates maximum economical incentive levels for measures aimed at residential or ICI customers; recommends programs to implement attractive measures (including an implementation schedule); and estimates total program costs. Quantitative success is easily measured against specific yearly targets for peak day water demand and daily wastewater flow which are projected into the future until 2011. The total potential savings after full plan implementation are estimated at $146 million (an estimated $220 million of avoided water and wastewater infrastructure costs and an estimated $74 million cost for full WEP implementation). The **Region of Durham** and the **Town of Barrie** Ontario are also well recognized for their successful water efficiency approaches.

Wastewater Demand Management

As potable and waste water systems are largely interdependent, potable water demand reduction implies a reduced demand for wastewater services in terms of volume. Wastewater volume can also be reduced through other specific initiatives, known as inflow and infiltration (I/I) reduction. I/I reduction practices can include specific initiatives such as the reduction or elimination of "bleeder" valves (used in Northern municipalities to prevent freezing) in favour of continuously circulating systems, disconnection of downspouts from combined sewer systems, more general rehabilitation of buried pipes, valves and connections to reduce of groundwater and rainwater-derived infiltration, or separation of combined sewers. One example of a coordinated approach is **Halifax Water's** I/I Reduction Program[106]. Halifax Water identifies problem areas and establishes priorities through field investigations by public works staff. It has also performed I/I studies for a number of the region's sewersheds and facilities. Field investigations and I/I studies help to set priorities for manhole maintenance, sewer line replacement, placement of sealed manhole covers and other remedial measures. HRM

[105] City of Toronto, *Toronto's Water Efficiency Plan* (http://www.toronto.ca/watereff/plan.htm - date accessed: April 2008)

[106] Regional Municipality of Halifax., *Infiltration/Inflow Reduction* (http://www.halifax.ca/pollutionprevention/infiltration-inflow.html - date accessed: April 2008)

also encourages residents to disconnect downspouts and sump pumps connected to sanitary sewers. Demand for wastewater treatment services can also be managed by controlling the quality of wastewater entering treatment plants. This is most often accomplished through sewer use bylaws, discussed in Section 4.6.

Stormwater Demand Management

Like wastewater demand management, stormwater demand management may attempt to reduce the quantity of stormwater entering storm sewers, or attempt to increase stormwater quality. The City of Toronto's *Wet Weather Flow Master Plan* (WWFMP) includes one of Canada's few comprehensive demand management plans for stormwater. The plan attempts to manage wet weather flow on a watershed scale, and has several qualitative objectives, including improvement of water quality in local water bodies, preservation of natural hydrogeological cycles, and reduction of erosion. Activities carried out under the plan include improvement to source control measures (*i.e.* green roof installation, tree planting and downspout disconnection), municipal activities to improve stormwater quality (*i.e.* street sweeping, and catch basin cleaning), and public education activities (*i.e.* advertising and engagement of community groups, mainly with the goal of improving stormwater quality). As part of the WWFMP, an exhaustive study of stormwater management and control opportunities and technologies was completed, including source, conveyance and end of pipe level controls, as well as potential management and operational activities.[107] British Columbia requires Liquid Waste Management Plans and therefore Metro Vancouver and the Capital Regional District also provide good examples of stormwater and combined sewer overflow management plans.

Prerequisites for Demand Management

Price and price structure are an important component of a demand management approach, as is a social marketing campaign to identify and address barriers to demand reduction. Potable water pricing in Canadian municipalities is typically based on a rate structure that charges the same amount for all consumption (i.e. a per cubic meter rate) with a flat rate component based on service pipe size for the property. There are strong indications that volumetric pricing is associated with lower water use but the relative effects of pricing, metering, and other policy tools are unknown[108]. A Canadian study by Reynaud and Renzetti (2004)[109] suggests that price structure has a greater effect on water use than the price level (i.e. once a threshold price is exceeded, demand is more elastic and pricing structure can reduce consumption - through increasing block rate, for example). Some authors suggest that prices during peak periods should be higher than prices during off-peak periods[110] since water savings are potentially higher with peak use charges than with basic use charges; consumers will reduce water use for discretionary and seasonal

[107] For more information on Toronto's stormwater demand management activities, and WWFMP, see http://www.toronto.ca/involved/projects/archived/wwfmmp_archive/resources.htm

[108] Policy Research Initiative, *Economic Instruments for Water Demand Management in an Integrated Water Resources Management Framework*, Synthesis Report (http://www.policyresearch.gc.ca/doclib/WaterSymposium_e.pdf, - date accessed February 2008)

[109] Reynaud and Renzetti *in* ibid

[110] ibid

outdoor water use faster than they will for base load uses. Alternatively, prices could be set according to the time or location of use (so customers located farther from the water supply or at higher elevations would pay more)[111].

Public education plays an important part in demand management success. A Denmark study on the effects of a tax on water consumption found that 40% of the decline in water consumption could be attributed to the tax and 60% to education[112].

3.6 INTEGRATED PROJECTS

Water management is inherently integrated with land use planning. Because sustainable water management requires recognition of the water cycle as a whole, all land use decisions must also be considered water decisions. Water is stored in soils, trees and vegetation and on land surfaces (from temporary puddles to lakes and rivers) and thus water supply and the degree of natural water treatment attained are products of land uses. An integrated water and planning project is one that results from long term land use plans that acknowledge water resource limitations, as described in 3.5 above.

Transportation services require paved land surfaces and therefore need to be considered as part of the integrated land use planning process. Stormwater volumes and quality are directly impacted by transportation infrastructure and, as described above, paved and hardened land surfaces reduce groundwater recharge and have other effects that reduce the ecological function of waterbodies and can impact potable water sources. In addition to the planning connection, integrated transportation-water projects would identify the consequences to water quality and quantity of proposed works and mitigate or, preferentially, re-design to eliminate, negative consequences of the transportation undertaking.

Energy-water interrelationships are discussed elsewhere in this report (see for example section 2.1.5). Integrated energy-water projects include those that take advantage of the energy potential in wastewater process products (e.g. methane or biosolids) to generate heat or power; or, that take advantage of the heat transfer potential from sewers or drain lines (such as encouraging heat exchangers on shower drain lines that is used to reduce energy needed to heat water in the hot water tank). Projects may also include those that reduce the energy use of water services in communities, for example: designs using more distributed systems (i.e. treatment provided relatively close to users thus requiring less pumping); and, designs proposing alternative standards (small bore pipes, combination lot-level and public systems).

3.7 SUMMARY TABLE

Exhibit 3.1 presents an overview of best practices presented in Section 3 in relation to issues identified in Section 2 and with respect to the applicability of issues identified to community size, region or province, and geographic location.

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[111] ibid

[112] ibid

Exhibit 3.1
Overview of Best Practices – Municipal Systems Approaches

Category	Best Practice	Issue(s) Addressed	Applicability	Community Examples	Additional Comments
Watershed Management	Planning for Ecosystem Services/Back-casting	Water quality, Water quantity, Water allocation and management, Political will	All	Okotoks, AB Halifax RM, NS Oliver, BC	Planning for ecosystem services and back-casting can be used as a means to improve water quality and to preserve water / reduce quantity requirements. Water allocation practices may drive this practice. This practice also constrains politicians in the sense that long term goals must be set and worked toward.
	Integrated Water Resource Management (IWRM)	Water quality, Water quantity	All	None Identified	IWRM entails an ecosystem based governance approach. This can include governing to maintain ecosystem integrity in terms of water quantity and water quality.
	Integration of Stormwater and Climate Change Mitigation Techniques	Water quality, Water quantity, Collection and distribution technologies, Energy use reduction	M,L Urban	Ottawa, ON Toronto, ON	The integration of stormwater and climate change mitigation technologies in the form of “green infrastructure” can potentially improve stormwater quality, reduce demand for stormwater infrastructure, and mitigate ecological impairment and protect infiltration. Technologies such as green roofs also have the co-benefit of reduced energy use for buildings and associated GHG reductions.
Land-Use Control and By-Laws	Watershed Preservation Initiatives	Water quality, Potable Water Requirements, Waste water requirements	All, especially areas with limited water sources or sensitive receiving waters	Capital Regional District (CRD) , BC Wolfville, NS Calgary, AB Chelsea, QC Ottawa, ON	Watershed preservation initiatives have many goals, one of which is to maintain or improve source water quality, thereby ensuring supply and reducing potable water treatment costs. A fully integrated approach recognizes the water cycle and therefore also addresses wastewater effluent and stormwater impacts. Bylaws for source protection or wastewater effluents may complement or require watershed preservation initiatives.
	Wellhead / Groundwater Protection	Water quality, Potable Water Requirements	All, especially S communities, which are more	Regional Municipality of Waterloo, ON	Wellhead / Groundwater protection initiatives aim to protect groundwater quality, thereby ensuring supply and reducing potable water treatment costs. Wellhead

Category	Best Practice	Issue(s) Addressed	Applicability	Community Examples	Additional Comments
			likely to be dependent on groundwater	Wolfville, NS	protection bylaws or regulations may complement or require wellhead / groundwater protection initiatives.
	Limited Inter-basin Transfers	Water quantity, Water allocation	Mainly M and L communities	None Identified	Inter-basin transfers impact local and regional water quantity, and have water allocation implications.
Demand Management	Water Efficiency Master Planning / Potable Water Demand Management	Water quantity, Energy use/GHG emissions, Infrastructure deficit, Water allocation	All	Toronto, ON Region of Durham, ON Barrie, ON	Water efficiency planning and potable demand management affect water quantity most fundamentally. Energy use and GHG emissions are reduced as a function of reduced demand for water services. Demand management initiatives may also prevent the need for additional infrastructure. Potable water demand management may be driven by water allocation and management concerns.
	Wastewater Demand Management	Water quality, Energy use/GHG emissions, Infrastructure deficit, Wastewater requirements, Changing regulatory requirements, Regulatory requirements, Liability issues	Mainly M and L communities	Halifax Regional Water Commission (HRWC) (Halifax, NS)	Wastewater demand management affects the quality of receiving waters, and in some cases source waters. Reducing demand for wastewater services leads to secondary benefits such as reduced energy use/GHG production, and reduced demand for additional infrastructure. Wastewater demand management may be driven by wastewater requirements at multiple government levels and will be affected by incoming national guidelines for wastewater effluents.
	Stormwater Demand Management	Water quality, Stormwater requirements, Collection and distribution technologies	Mainly M and L communities	Toronto, ON	Stormwater demand management affects the quality of receiving waters, and in some cases source waters. Stormwater demand management may be driven by stormwater requirements at multiple government levels and may be driven by advances or research in collection technology.

4. GOVERNANCE & MANAGEMENT

Municipal governance and management entails how municipalities make decisions (versus what those decisions are – See Section 3 above) and the methods and approaches used by municipalities to analyse problems and opportunities, identify goals, develop plans, and assess how close they are to achieving the goals established for the community. Governance and management therefore includes both human resource elements, such as leadership of key players (the Mayor, Council, key community leaders) and engagement of the public, as well as management elements, such as analytical tools and approaches, performance measures, reporting and budgeting.

4.1 IDEAL PRACTICE

In an ideal practice, strong leaders head up the water service management function, which is undertaken with an unwavering commitment to a comprehensive and holistic approach. Systems and tools are in place to establish desired outcomes, to assess the success of programs in meeting the outcomes and to adjust and adapt the approaches and programs as results of the effectiveness are available. The public is informed on water issues and engaged in strategic decision-making.

In an ideal practice:

- Existing infrastructure and the service provided are managed on the basis of performance indicators, including water quality standards (potable, wastewater, stormwater, ambient), operations and maintenance standards, management standards and public outreach and education practices.

- Water rate structures (and development fees, service charges and other revenue tools) capture the full cost of providing the service including operations, maintenance, administration, capital replacement, future growth, and externalities such as climate change mitigation (i.e. greenhouse gas emissions reductions). Operations budgets also include staff training, system monitoring and other best practices, such as leak detection and district meters for water distribution.

- The public is engaged and knowledgeable about water sources, its intrinsic value, efficient use, where water goes when it is drained from plumbing and properties, and water service substitution options. Public engagement is complemented by supportive and active political leaders at the municipal and senior government levels.

4.2 CURRENT PRACTICE

This sub-section describes current practice within Canadian municipal governments in addressing needs within the water sector. This section specifically emphasizes governance and management.

- Many Canadian municipalities, especially smaller ones, do not have an asset management program, and therefore have little information available to inform decisions regarding whether to repair, expand or upgrade infrastructure. A 2002 survey[113] found that 22% of municipalities relied on paper-based data storage and management for storm and wastewater systems. At the opposite end of the spectrum, 26% of municipalities surveyed (none of which had a population of less than 100,000 people) used some form of integrated asset management system.[114]

- A 1999 survey found that approximately 50% of municipal customers paid a flat rate for water services. This figure includes un-metered residences and those who were charged a volume-based rate that included a minimum charge for a volume of water greater than the normal range of residential use.[115] The Organization for Economic Cooperation and Development (OECD) estimates that Canadian water rates are "on average less than half those in most OECD countries and roughly cover half of the costs of supplying water and treating wastewater."[116]

- There is a continuing perception of water abundance and apparently low public valuation of water leading to a lack of rigorous approaches to water resource management by many communities

- Growing domestic demand for water continues, fuelled by pricing that is below cost.

4.3 TRENDS

This sub-section identifies trends observed among Canadian municipalities moving toward more sustainable practices and projects within the water sector. Specific emphasis is placed on governance and management.

As indicated by the current practice bullets, a majority of Canadian municipalities are struggling to implement leading practices in the area of information management and public engagement (as reflected in the low water rates). However a trend appears to be emerging for provincial governments to step in and require municipalities to engage in more progressive management. For example, Ontario and Nova Scotia are requiring full cost accounting, which will, by extension, require municipalities to develop asset management systems. Ontario has developed guidance on valuation of assets to assist municipalities in this task.

Ontario and Alberta have developed multi-stakeholder decision-making processes (Ontario for source water protection and Alberta for air quality protection) and this trend may expand to other regions. These types of processes build capacity and interest in the community on the resource issues. Decisions may be more robust as they have been made by stakeholder groups (although this has yet to be demonstrated for the case of source water protection in Ontario).

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[113] Allouche, E. and P. Freure (2002), *Management and Maintenance Practices of Storm and Sanitary Sewers in Canadian Municipalities*. ICLR Research Paper series – No. 18.

[114] These databases allow for the integration of proposed repairs to adjacent utilities and resurfacing operations. Other common features include risk analysis (i.e. probability of burst), and scheduling of inspection and flushing programs.

[115] Environment Canada (2001), *Municipal Water Pricing 1991-1999*.

[116] OECD (2004), *Environmental Performance Review of Canada.* In *At a Watershed: Ecological Governance and Sustainable Water Management in Canada*, O. Brandes *et al.*

4.4 LEADERS

Leaders continue to emerge in a wide variety of communities of all sizes and locations across Canada. There does not appear to be a predictable pattern except that a committed individual or group decide to tackle a water resources issue and perseveres in seeing it to resolution at a policy or program level. In Chelsea, for example, a non-governmental organization raised the issue of water quality and its suggestions were taken up by a very receptive Mayor and Council. In Okotoks, the town staff recognized a water shortage issue was looming and gained support of its local Council to establish a process to define development limits. The Town had to gradually educate provincial contacts, adjacent communities and its own residents on its approach. Halifax's water utility is supported by the province in setting rates and undertaking innovative practices for infrastructure maintenance.

Leading municipalities are using bylaws to protect water resources and to control undesirable behaviours. Toronto's sewer use bylaw, for example has been used as a model for municipal pollution prevention requirements. Similarly, Capital Regional District has developed a series of Codes of Practice for industrial and commercial dischargers. Chelsea has enacted several bylaws to protect its water resources and environment.

4.5 MANAGEMENT BEST PRACTICES

This sub-section describes best practices existent within the water sector in terms of implementing sustainable practices, programs and projects. Specific emphasis is placed on governance and management.

Best practices outlined in this and the next section are not intended to be an exhaustive list of potential practices that are applied by municipalities to lead change and govern for sustainability. As indicated in Section 3 above, the best practices highlight particular practices undertaken by municipalities to move towards sustainable water resource approaches, in this case for governance and management. The best practices should be considered a sample only and indicative of the desirable practices. In some cases, there will be other communities that are not identified that have implemented similar practices; again, this list is not intended to be exhaustive in terms of municipalities undertaking these or similar measures.

We have identified a number of categories of tools relevant to making and implementing decisions that support sustainable water practices. Municipalities hoping to implement sustainability at a broad (systems) level would need to make use of tools in most of these categories.

4.5.1 Decision-Support Tools

The basic requirements for good decision-making on policies, plans, programs and projects – assessment of current conditions, identification of options to address needs and goals, and assessment of options – are the same regardless of whether or not there is a sustainability focus. But there are particular approaches and tools municipalities can use to better reflect sustainability objectives. Examples include the use of sustainability criteria or checklists to help identify needs and opportunities when assessing current conditions; the use of environmental assessment tools when comparing options; and, the use of full cost accounting. Integrated Asset Management and Design Principals or Guidelines, as described following, are two best practices in the water sector that can assist in effective decision-making.

Integrated Asset Management

To manage water infrastructure efficiently, basic information, such as location age and condition, must be known. Many municipalities employ Geographical Information Systems (GIS) based asset management which allows metadata such as asset age, condition and maintenance history to be tracked as part of a series of map layers containing geographical information, such as asset location. Integration of asset management across municipal departments can increase resource use efficiency by allowing for coordination maintenance and repair operations for multiple municipal departments in time and space. Integration of GIS databases for water, wastewater, roads, and other infrastructure assets allows for automation and optimization of rehabilitation and reconstruction scheduling. Some software packages also incorporate risk assessment (*e.g.* probability of pipe bursts) and maintenance scheduling (*e.g.* main flushing). A 2002 study[117] found that, although such software is in use in many Canadian municipalities, use was virtually non-existent in municipalities with less than 100,000 people.

Municipal design principles/guidelines

The use of innovative design principles or guidelines assists in building staff capacity to implement the measures. British Columbia has issued such a guideline for stormwater management. In other provinces, individual municipalities have developed similar guidelines, including Vancouver (stormwater and drainage management)[118], and Calgary (stormwater and erosion management)[119].

4.5.2 Financial Instruments

Municipalities can adopt development charges, impose or remove user fees, special levies and licensing fees, and offer grants to favour sustainable water practices. They can also establish incentives such as accelerated review for approval of projects that meet established criteria. Offering partnership opportunities to the private sector can be a form of incentive to adopt innovative practices.

Full cost accounting and revenue generation

Most Canadian municipalities do not consider the full cost of providing water services to customers when setting rates. Recognizing this issue, two provinces (Ontario and Nova Scotia) have set expectations for municipalities to examine the costs of water and wastewater servicing and to set rates accordingly. Municipalities without full metering

[117] Allouche, E. and P. Freure (2002). *Op Cit.*

[118] Metro Vancouver, *Stormwater Best Management Practices Guide* (http://www.gvrd.bc.ca/sewerage/stormwater_reports.htm – date accessed: May 2008)

[119] City of Calgary Stormwater Management and Design Manual, Guidelines for Erosion and Sediment Control , and Field Manual for Effective Erosion and Sediment Control (http://www.urbanswm.ab.ca/sag-4.1.8.asp – date accessed: May 2008)

face a serious impediment to full cost accounting and to effective water conservation incentive programs. The **Halifax Regional Water Commission** (HRWC) provides a good example of full cost studies, which support implementation of cost-effective leak detection and watermain repair programs for its service area.

Life-cycle Analysis

Conventional life cycle analysis does not necessarily incorporate external factors, such as reduction of greenhouse gas emissions, into calculations. This analysis would be a best practice and is one that is being researched for water infrastructure internationally. In Canada, **Metro Vancouver** undertook a full life cycle analysis to compare use of chlorine versus ultraviolet disinfection at their wastewater treatment facilities; the study included embodied energy of chlorine production, transportation as well as energy and materials for ultraviolet light disinfection[120].

Rate Structure to encourage conservation

Municipalities have the authority to set rates, although exercising this authority can be politically difficult. As discussed in Section 6 following, **Halifax**'s water utility has established rates to recover costs of service including long term maintenance and replacement costs. Rates are generally flat or consumption-based at a fixed rate; the practice of increasing block rate could discourage high water use but is rare in Canada. Discussion of rates for an essential service such as water needs to include considerations of affordability for disadvantaged citizens.

Because wastewater rates are typically charged as a percent of water rates, low water rates contribute to insufficient sewer revenues also. Metering of wastewater flows is rare in Canada although this may change in some communities that must implement significant wastewater treatment improvements to comply with the risk assessment decisions arising from implementation of the National Strategy for Municipal Wastewater Effluents.

It is a best practice to establish a stormwater utility and set rates based on land drainage and imperviousness. This practice is well established in the United States. In Canada, the City of **Regina, SK** is leading in this area; Halifax's utility will be examining rates and charges for stormwater once this responsibility is handed over from the Halifax Regional Municipal government.

4.5.3 Staffing

Staffing aspects were not a subject of focus of this study but are mentioned here to indicate their importance as an aspect of management for municipalities. Human resource issues play a very significant role in municipal capacity to deliver on sustainable development directions. Thus training and recruitment programs are important aspects of an approach to ensure staff is fully aware of, and committed to, water management goals of the municipality. Best practices include hiring and performance evaluation policies and

[120] Personal Communication June 2006.

approaches and training programs to keep staff up to date on skills and knowledge needed for sustainability.

The issue of retiring baby boomers and training and retention of qualified water operators will be a significant issue for municipalities providing water services. At the same time that the experience of the baby boomers is being lost in the workplace, increasingly stringent standards for operator certification are being implemented. A shortage of qualified water operators can be expected to be a critical issue facing many municipalities over the next decade.

4.5.4 Monitoring and Reporting

Setting targets and performance measures, monitoring progress, and reporting to council and citizens are all important to ensure transparency and promote confidence, learning and improvement. Reviewing annual reports and details of performance measures were not a subject of focus of this study.

4.5.5 Communications, Engagement

Increasing emphasis is being given to the need to engage citizens through all phases of the planning and implementation of sustainability directions. Education is also often critical to engagement, and to necessary behaviour changes. (See section 3.5.3 above for a brief discussion of public education as a foundation for demand management.) Note that this could be a subject area of extensive study but was not a focus area for this report. Examples of practices in this area include:

- Public education programming in Durham, especially the "Water Efficient Durham" program & household guide to water efficiency[121].
- School programming and curricula development by Waterloo[122] and York[123].
- Grants to overcome barriers to public action in Waterloo for farm plans[124] and efficiency in ICI sector in BC's Capital Regional District[125], for example.
- Several Canadian communities are currently conducting public education campaigns around water and wastewater issues. Some examples include: the Yellow Fish Road

[121] See http://www.region.durham.on.ca/works.asp?nr=/departments/works/services/water/indexpg1.htm&setFooter=/includes/worksFooter.txt for an outline of the Water efficient Durham Program.

Hard copies of Durham Region's "Household Guide to Water Efficiency" are available free of charge through http://www.region.durham.on.ca/works.asp?nr=/departments/works/services/water/hhguide.htm&setFooter=/includes/worksFooter.txt

[122] The Region of Waterloo conducts water-efficiency educational activities within the schools and the larger community. An overview of educational programs, including school curricula, is available online at http://www.region.waterloo.on.ca/web/region.nsf/c56e308f49bfeb7885256abc0071ec9a/580572a44d97d2a985256b03005d6533!OpenDocument

[123] York Region also conducts wide ranging educational activities. An overview is available at http://www.waterfortomorrow.com/

[124] See http://www.region.waterloo.on.ca/web/region.nsf/8ef02c0fded0c82a85256e590071a3ce/410557a0e9d86ee785257344006ede23!OpenDocument for detailed information for information on the Region's rural water quality program.

[125] See http://www.crd.bc.ca/water/conservation/ici/grantsrebates.htm for an overview of programs offered.

program[126], which operates in dozens of Canadian cities and aims to educate the public about the impacts of pollution entering storm drains; the Alberta "water for life" sustainability strategy[127], which includes educational components and goals for both drinking water supply and aquatic ecosystems; and, the Saint John's Harbour Atlantic Coastal Action Program (ACAP)[128], which conducts ongoing initiatives aimed at increasing community knowledge of wise water resource use and watershed protection.

4.6 REGULATORY BEST PRACTICES

This sub-section discusses policies, guidelines, by-laws and regulations in terms of the implementation of sustainable practices, programs, and projects within Canadian municipalities.

Land-Use Controls and By-Laws

Municipalities have prime responsibility for land use planning and exercise this responsibility *via* official plans, zoning by-laws and review and approval of development applications. Beyond zoning, by-laws can address a very wide range of issues and situations, as long as they are not in conflict with provincial or federal laws. Within these powers there is considerable scope for influencing development patterns and behaviour in favour of sustainability. A few examples of water resource or servicing bylaws include:

- **Outdoor Use Bylaws** – many municipalities adopt bylaws for summer peak use reductions. Outdoor water use reductions are most often accomplished by limiting lawn watering. The Region of Waterloo has an especially ambitious bylaw in place, which imposes progressively more stringent limits on outdoor use when municipal reservoirs fall below certain levels[129].
- **Sewer Use Bylaws** – Toronto[130] and Capital Regional District (CRD)[131] lead currently. These two municipalities have set specific concentration limits on organic and inorganic contaminants released to sanitary sewers. Toronto's by-law also requires pollution prevention planning for individual customers in certain commercial or industrial sectors. Sewer use bylaws will be a requirement of the Canada-wide Strategy for the Management of Municipal Wastewater Effluent, and as such, CCME is developing a Model Sewer Use Bylaw for reference by municipalities.

[126] Yellowfish Road, *News* (http://www.yellowfishroad.org/ – date accessed: May 2008)

[127] Alberta Government, *Water for Life* (http://www.waterforlife.gov.ab.ca/ – date accessed: May 2008)

[128] The St. John's Harbour ACAP is an initiative of the larger Northeast Avalon ACAP. Information on the St. John's Harbour project is available at http://www.naacap.ca/html/projects.html, and information regarding the Northeast Avalon ACAP is available at http://www.naacap.ca/.

[129] The Regional Municipality of Waterloo's Outdoor Use Bylaw is available online at http://www.region.waterloo.on.ca/web/region.nsf/97dfc347666efede85256e590071a3d4/133F1C006428DB2485256FCD005D0C49/$file/Outdoor%20Water%20Use%20Consolidation.pdf?openelement

[130] For a brief description of Toronto's sewer use by-law, and a link to the by-law itself, see http://www.toronto.ca/water/protecting_quality/pollution_prevention/about.htm

[131] CRD's Sewer use by-law is available online at http://www.crd.bc.ca/bylaws/liquidwasteseptagese_/bl29229999/BL29229999.pdf

- **Cross connection control bylaws –** These bylaws are often part of Sewer Use bylaws, but may be separate as in the case of CRD[132]. These bylaws require measures designed to prevent cross contamination between potable water and sanitary sewer pipes, both inside buildings and with respect to buried infrastructure.
- **Final Grade Requirements** - Okotoks has instituted a development requirement for final grade of soils for water retention[133]. This requirement has been done in order to reduce peak period demand for stormwater infrastructure use, thereby reducing maintenance and capital costs.
- **Pesticide Bylaws** - Chelsea and a handful of other municipalities have pesticide use bylaws which, in part, prevent pesticide loading to surface water[134].

A gap in bylaw and regulatory practices concerns uniform requirements for low flow plumbing fixtures in provincial (and the federal) jurisdictions in Canada.

4.7 SUMMARY TABLE

Exhibit 4.1 presents an overview of best practices presented in Section 4 in relation to issues identified in Section 2 and with respect to the applicability of issues identified to community size, region or province, and geographic location.

[132] CRD's cross-connection control bylaw is available at http://www.crd.bc.ca/bylaws/water_/bl33370000/BL33370000.pdf

[133] Personal communication during interview with Okotoks contact, February 2008

[134] The University of California Statewide Integrated Pest Management Program provides a discussion of the effect of pesticides on water quality at http://www.ipm.ucdavis.edu/WATER/U/watqual.html.

Exhibit 4.1
Overview of Best Practices – Governance and Management

Category	Best Practice	Issue(s) Addressed	Applicability	Community Examples	Additional Comments
Decision Support Tools	Integrated Asset Management	Infrastructure Deficit	All	Numerous	Currently only some M and L municipalities have implemented systems (no municipalities under 100,000 population were found to have comprehensive systems in place)
	Municipal design principles/guidelines	Potable water requirements, Stormwater requirements, Wastewater requirements, Collection and distribution technologies	All	Metro Vancouver, BC Calgary, AB	Municipal design guidelines may be driven by water treatment requirements, and may drive the adaptation of more progressive treatment and collection technologies
Financial Instruments	Full cost accounting and revenue generation	Revenue Collection and Rate Structures, Political will	All	HRWC (Halifax, NS) and others	Full cost accounting often requires a significant amount of local political will, or decrees from higher levels of government.
	Life Cycle Analysis	Revenue Collection and Rate Structures	All	Metro Vancouver, BC	
	Rate Structure to encourage conservation	Revenue Collection and Rate Structures, Political will	All	HRWC (Halifax, NS) Regina, SK	
Staffing	No Specific Practices Identified			N/A	
Monitoring and Reporting	No Specific Practices Identified			N/A	
Communications and Engagement	Public Education	Perceptions of Water, Water quality, Water quantity, Emerging contaminants, Political will	All	Durham Region, ON and others	Public education can shape public perception of water (both in terms of quantity and quality), and assist in limiting the release of emerging contaminants. A knowledgeable public may also be a driver for increased political will to tackle water issues.

Category	Best Practice	Issue(s) Addressed	Applicability	Community Examples	Additional Comments
	School Programming/Curricula	Perceptions of Water, Water quality, Water quantity, Emerging contaminants, Political will	All, especially L and M communities	RM Waterloo, ON York Region, ON	School programming and public education fill similar niches
	Grants to Overcome Barriers to Public Action	Water quality, Water quantity	M and L communities	RM Waterloo, ON	
Regulations, By-laws, Inspection and Enforcement	Outdoor Use By-laws	Water quantity	All	RM Waterloo, ON	
	Sewer Use By-laws	Water quality, Emerging contaminants, Wastewater requirements	All	Toronto, ON CRD, BC	Sewer use by-laws may be driven by concerns over wastewater effluent quality or by wastewater requirements. By-laws may be enacted in response to pollution by emerging contaminants, or may drive reductions in such pollution.
	Cross-connection Control By-laws	Water quality, Building codes and insurance, Regulatory Barriers to water re-use,	All	CRD, BC	Cross-connection control bylaws may potentially form a barrier to water re-use
	Lot grading By-laws	Water quality (stormwater), Stormwater requirements	M and L communities	Okotoks, AB	
	Pesticide Use By-laws	Water quality, Emerging contaminants, Wastewater requirements	All	Chelsea, QC	

5. OPERATIONAL PRACTICES AND TECHNOLOGY

Operational practices and technologies are applied by municipalities to implement and deliver community services. There are literally hundreds of potential such topics for each service delivered by municipalities; in the context of this report, our focus is on best operational practices to move communities forward in terms of sustainable community servicing. For the Water Sector, these practices and technologies include the various phases of service delivery, including treatment/ purification; collection/ distribution; operations and maintenance; and, replacement and rehabilitation.

5.1 IDEAL PRACTICE

In an ideal practice, water service delivery is undertaken in a planned and premeditated manner to avoid service interruptions and emergency repairs to the extent possible. Services provided reduce risks to the health of customers and contribute to the safety of people and property of the community. Practices and technologies are applied to ensure safe drinking water is delivered and risks posed by environmental releases are reduced.

In an ideal practice:

- Potable water production and distribution volumes are known. Potable water production is measured and correlated against other metrics, such as chemical demand, to verify production volumes. Master meters are in place and regularly calibrated and maintained. Water allocation within the distribution system is measured through the use of district meters so that water loss through system leaks, watermain breaks or unmetered consumption can be assessed and addressed in a timely and appropriate manner. A proactive leak detection program is in place to identify watermain failures and, where groundwater, soil conditions and watermain material warrant, a cathodic protection system is in place to protect buried water infrastructure from corrosion.

- Wastewater is treated to take into account site-specific conditions of the receiving environment and wastewater volumes are known. Wastewater conveyed to the treatment facility is measured and assessed for influences of rain and groundwater infiltration. A surveillance system is in place to identify collection system failures and a maintenance program is established to reduce infiltration and inflow into the collection system.

- Where water is used by customers, it is used very efficiently with comprehensive demand management programs in place. The municipality and codes support low use practices, such as dual flush or low flow toilets in the residential sector and efficient water use measures are in place in the industrial/ commercial/ institutional sector.

- Water use is metered for all connections. A testing and replacement program is in place for water meters.

- A sewer use bylaw is in place to control releases of wastewater to the collection system. Industrial wastes and other special wastes are treated on-site by the customer prior to release to the collection system. An industrial sewer use program to inspect, monitor, promote compliance and enforce the bylaw is in place.

- Stormwater volumes are mitigated through use of on-site and conveyance measures so that the release to surface waters matches natural system releases.

- The ideal practice may employ methods that eliminate the use of water for human waste and therefore significantly reduces the releases of related pollutants to watercourses (in particular, endocrine disruptors and pharmaceuticals). Methods such as waterless toilets and urinals, and experimental projects designed for source separation of urine from other waste streams, are considered and piloted where appropriate. Wastewater for industrial processes is reused to the extent possible and treated to stringent effluent criteria prior to release.

5.2 CURRENT PRACTICE & TECHNOLOGY

This sub-section identifies current practice within Canadian municipal governments in addressing needs within the water sector. Specific emphasis is placed on operational practices and technology.

Current practice is to consider water services along the lines of infrastructure. In other words, water is not considered in terms of its cycle but in terms of linear systems – potable water from watercourse to consumer; wastewater from consumer to treatment and watercourse (although the watercourse release does not have a high profile in the minds of consumers); and, stormwater is largely an inconvenience (as opposed to a resource) to be drained from properties as quickly as possible.

5.2.1 Potable Water

Treatment/Purification Systems

- 93% of the water served to municipal customers is treated in some way. Residents of small municipalities were more likely to receive untreated water than residents of large communities[135]

- In 2001, Environment Canada surveyed approximately 880 municipalities with more than 1000 residents each. This survey found that the three most widely used treatments applied to address water quality were coagulation/flocculation[136] (affecting 79% of the responding populations), granular filtration (74%) and sedimentation (72%). In other words, conventional water purification systems are in place and these entail coagulation, flocculation, sedimentation and filtration (in that order through the treatment train).

- Some recently constructed water treatment plants employ advanced methods. Examples include Kamloops B.C.'s River Street water treatment plant, the largest membrane filtration plant in North America, and a plant employing integrated

[135] Environment Canada (2007). *2007 Municipal Water use Report*.

[136] Coagulation and flocculation are conventional steps to purify water; these steps include the addition of a chemical that will clump together with particles in the water (coagulate) and create larger and larger particles (floc) that will settle out of the water (sedimentation).

biological filtration serving a small population in Yellow Quill First Nation Saskatchewan.

Distribution Systems

- Approximately 63% of residential clients and 83% of business clients receive metered water service. Homes in large municipalities are more likely to be equipped with water meters than those in smaller municipalities. Metering rates have risen throughout Canada in recent years. In 1991, slightly over 50% of residential clients received metered water service. [137]

- In a recent survey of 65 Canadian municipalities known to have undertaken water conservation initiatives, 55% had installed new or updated water meters[138]

Operation & Maintenance

- In a recent survey of 65 Canadian municipalities known to have undertaken water conservation initiatives, 66% had carried out leak detection and repair, 32% had installed or updated existing computerized water-use monitoring equipment and 15% had installed pressure reducing valves.[139]

- A 2006 study suggests that very few Canadian municipalities are performing active pressure management or active leakage control as a means of leakage loss reduction in potable water systems. Leakage management activities tend to be limited to repairing reported leaks and replacing mains.[140]

- Most Canadian municipalities employ Supervisory Control and Data Acquisition (SCADA) systems for data acquisition and remote and/or automated operational control of water and wastewater systems. SCADA systems allow for improved system performance and reduced operating costs by allowing monitoring and control to take place from a central location.

- Some Canadian water and wastewater treatment plants perform predictive maintenance such as vibration analysis and infrared imaging to protect critical equipment such as pumps. Predictive maintenance systems may also be integrated as part of a plant's SCADA system, to allow for remote operator observation or automated shutdown to prevent catastrophic failure.

[137] Environment Canada (2007), *Op.Cit.*

[138] Canada Mortgage and Housing Corporation (2001). *Research Highlights: Canadian Municipal Water Conservation Initiatives*.

[139] *Ibid.*

[140] Fantozzi et al. (2006). *Some International Experiences in Promoting the Recent Advances in Practical Leakage Management.* Water Practice and Technology vol. 1.

Replacement and Rehabilitation

- Several Canadian municipalities are employing “trenchless” or “pipe-lining” technologies for watermain rehabilitation and replacement. See below for a brief overview of these technologies as they relate to wastewater systems.

5.2.2 Wastewater

Treatment/Purification Systems

Wastewater treatment levels vary widely within Canada. The current state of wastewater treatment is described below, while Text Box 5.1 gives an overview of an idealized wastewater treatment process for reference.

- A 2004 Environment Canada survey reported that approximately 74% of Canada’s municipal population were served by secondary wastewater treatment or better. This includes populations served by waste stabilization ponds, secondary mechanical treatment, or tertiary/advanced treatment.[141] It should be noted that larger urban centres tend to have secondary treatment in place so this percentage cannot be applied to the portion of municipalities with secondary treatment (see following bullet).

- A 2001 survey of Canadian wastewater treatment plants performed by the Canadian Water and Wastewater Association (CWWA) found that only about 20% of plants had enhanced secondary wastewater treatment capability, while approximately 47% of plants had the capability to perform primary wastewater

Text Box 5.1: The Wastewater Treatment Process

Primary treatment
To prevent damage to pumps and clogging of pipes, raw wastewater passes through screens to remove large debris. Smaller inorganic material, such as sand and gravel, is removed by a grit removal system. The lighter organic solids remain suspended in the water and flow into large tanks, called primary clarifiers. Here, the heavier organic solids settle by gravity. These settled solids, called primary sludge, are removed along with floating scum and grease and pumped to anaerobic digesters for further treatment.

Secondary treatment
The primary effluent is then transferred to the biological or secondary stage. Here, the wastewater is mixed with a controlled population of bacteria and an ample supply of oxygen. The microorganisms digest the fine suspended and soluble organic materials, thereby removing them from the wastewater. The effluent is then transferred to secondary clarifiers, where the biological solids or sludges are settled by gravity. As with the primary clarifier, these sludges are pumped to anaerobic digesters, and the clear secondary effluent may flow directly to the receiving environment or to a disinfection facility prior to release.

Advanced treatment (tertiary treatment)
Advanced wastewater treatment is the term applied to additional treatment that is needed to remove suspended and dissolved substances remaining after conventional secondary treatment. This may be accomplished using a variety of physical, chemical, or biological treatment processes to remove the targeted pollutants. Advanced treatment may be used to remove such things as colour, metals, organic chemicals, and nutrients (phosphorus and nitrogen).

Disinfection
Before the final effluent is released into the receiving waters, it may be disinfected to reduce the disease-causing microorganisms that remain in it. The most common processes use chlorine gas or a chlorine-based disinfectant such as sodium hypochlorite. To avoid excess chlorine escaping to the environment, the effluent may be dechlorinated prior to discharge. Other disinfection options include ultraviolet light and ozone.

Adapted from: Environment Canada (2001). *The State of Municipal Wastewater Effluents in Canada*

[141] Environment Canada (2007), *Op.Cit.*

treatment capability or less.[142] Smaller facilities were more likely to have the capability to perform primary treatment or less. The CCME is in the process of identifying a 30 year program to upgrade Canadian municipal wastewater treatment to equivalent to secondary treatment as a minimum treatment level.

Other highlights of the 2001 CWWA survey:

- Disinfection methods reported included chlorination (25% of reporters) and UV treatment (12%). A small portion of treatment plants (3.5%) de-chlorinated prior to discharge. Large facilities (those serving over 25,000 residents) were approximately 2.5 times more likely to chlorinate and 6 times more likely to de-chlorinate than small facilities.

- Approximately 56% of facilities reported the use of one or more lagoons to treat wastewater. The majority of lagoons reported were anaerobic. Lagoons are more common at small facilities.

- The most common biological liquid effluent processes reported were activated sludge (25% of facilities), primary sedimentation (24%) and extended aeration (16%). Other biological liquid effluent processes reported include: chemical flocculation, oxidated ditch, rotating biological contractor and trickling filter. Large facilities employed an average of two processes, while small facilities employed an average of 0.8.

- Gravity settling was the most common sludge handling process reported (23% of facilities) followed by belt thickening (7%). Other methods reported include dissolved air flotation, co-thickening and centrifuge thickening.

- 26% of facilities reported some form of phosphorus removal process, 5% reported having a nitrogen removal process.

Collection Systems

- Many Canadians, especially those living in older parts of large municipalities are serviced by combined sanitary/storm sewers. One source estimated the number to be 6.7 million in 1969, with the present number being somewhat smaller due to inner-city population decline and limited sewer separation projects.[143] Combined sewers are subject to overflow during large rainfall events; some also experience overflows during more routine rainfall events or even dry weather flows where sewer system integrity is compromised.

- Concrete pipes account for 41% of pipes in use, while PVC pipes make up 22% of the stock. Plastics are more common for small diameter sewer pipes (<600 mm), while concrete is more often used for large diameter pipes. Three percent of Canada's storm and sanitary sewers are made of brick. These pipes are likely over 70 years old.[144]

142 Canadian Water and Wastewater Association (2001). *National Survey of Wastewater Treatment Plants*.

143 Environment Canada, (2001). *The State of Muicipal Wastewater Effluents in Canada.*

144 Allouche, E. and P. Freure (2002), *Op. Cit.*

- Some Canadian municipalities are employing real-time control in water and wastewater collection systems. Real-time control allows diversion of flows in order to protect against combined and sanitary sewer overflows and basement flooding. It also allows for optimal operation of sewer systems. A recent installation of this technology was completed in a trunk sanitary sewer in the City of Ottawa.[145]

Operation & Maintenance

- A 2002 survey of 26 Canadian municipalities found closed-circuit television (CCTV) scans to be standard practice for the inspection of storm and wastewater pipelines in surveyed Canadian municipalities, with 100% of respondents reporting the use of this practice. Over 50% of respondents used physical inspection methods (“man entry”) and smoke testing, a method of examining for cracks or improper connections. Methods of inspection using sonar and ground penetrating radar were reported by less than 25% of respondents.[146]

Replacement and Rehabilitation

- In 2001, Over 80% of surveyed Canadian municipalities reported the use of one or more “pipe lining” technology. This technology is used to repair sewer lines without the need to excavate the entire sewer. The most common technology reported was cure-in-place-pipe, followed by slip lining, fold and form, and robotic spot repair.[147]

5.2.3 Stormwater

Treatment/Purification Systems

- A 2003 survey by the Greater Vancouver Regional District found that 95% of surveyed North American municipalities release stormwater to a natural body of water, only 5% treated stormwater in man-made retention ponds or lagoons[148].

- Where stormwater quality is monitored in Canada, monitoring programs generally track standard water chemistry parameters (water temperature, pH, total suspended solids *etc.*); some municipalities also measure fecal coliforms. Conversely, chemical, physical and biological monitoring is common in the United States. Some American municipalities also perform toxicity testing, and many survey benthic macroinvertebrate communities as a proxy for water quality in bodies of water which accept stormwater discharges.[149]

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[145] Stantec (ND), *Real Time Flow Control for a Trunk Sanitary Sewer and Tunnel Relief System in the City of Ottawa* (www.stantec.com/StantecCom/CmtDocs/21.PDF – date accessed: May 2008)

[146] Allouche and Freure (2002) *Op. Cit.*

[147] Allouche and Freure (2002) *Op. Cit.*

[148] Greater Vancouver Regional District (2003). *Review of Stormwater Monitoring in North America*.

[149] *Ibid.*

Collection/Conveyance Systems

- A few communities in Canada are presently encouraging adoption of lot-level stormwater source controls such as the disconnection of downspouts from storm sewers (*e.g.* Toronto ON, Welland ON and Vancouver, BC). Other lot-level controls being adopted in Canada include rooftop water detention (*e.g*. Toronto's green roof incentive program) and reduced lot grades to slow runoff.

- A 2007 survey of 71 stormwater utilities in 22 U.S. states found that 58% of utilities had installed stormwater treatment systems within their stormwater conveyance system. The Canadian proportion with installed treatment systems can be expected to be much lower than this since stormwater requirements are much more strict in the U.S. than Canada.

- Many Canadian municipalities use methods of stormwater treatment such as oil and grit separators and various types of sediment traps. The most commonly used community scale stormwater management systems in Canada include 'end-of-pipe' systems, stormwater management ponds and constructed wetlands.[150] There are also some municipalities promoting conveyance controls, such as the construction of stormwater swales and reduction of impervious surfaces to aid stormwater infiltration.[151]

Operation & Maintenance

- A 2002 survey of 26 Canadian municipalities found an average return period for assessment of sanitary and storm sewers of 25-30 years (this approaches the design life in many cases)[152]. In a 1995/1996 survey of 167 Canadian municipalities, 53% noted that storm sewer infrastructure was in need of upgrading.[153]

Replacement and Rehabilitation

- A 2007 survey of 71 stormwater utilities in 22 U.S. states found that 46% of utilities had produced a stormwater plan or stormwater utilities plan since 2005. Again, this proportion will be much lower in Canada since stormwater is not a high-profile issue with Canadian regulators and there are few stormwater utilities in Canada (Regina SK was the only municipality in Canada identified with a stormwater utility approach).

[150] Environment Canada, (2001). *Op. Cit.*

[151] *i.e*. the City of Vancouver's "Sustainable Streets" project.

[152] Allouche, E. and P. Freure (2002) *Op. Cit.*

[153] FCM 1993 in Mirza, M and M. Haider (2003). *The state of Infrastructure in Canada: Implications for Future Infrastructure Planning and Policy*.

5.3 TRENDS

This sub-section identifies trends observed among Canadian municipalities moving toward more sustainable practices and projects within the water sector. Specific emphasis is placed on operational practices and technology.

Very innovative technologies, i.e. those that use alternative water sources (waste water or grey water) or that are off-grid for wastewater services are largely installed at a pilot stage in Canada. Innovative subdivision designs are starting to emerge to demonstrate multi-building applications of innovative water resources techniques. These sparse trends reflect the many barriers to unconventional approaches to infrastructure design discussed in Section 2.

There is a trend towards more advanced treatment technologies at both the water purification and wastewater treatment ends of water servicing. This trend reflects the concern among regulators for human health and environmental protection. It is also a reflection of emerging contaminants as discussed in Section 2.

There is also a trend towards source controls, in particular with respect to land use and activities in proximity to drinking water supplies and to sewer discharges that are controllable through Sewer Use Bylaws.

5.4 LEADERS

This sub-section identifies Canadian municipalities that are at the forefront within the water sector in terms of the implementation of sustainable practices, programs, and projects, and describes how do approaches distinguish themselves from other communities. Short descriptions of exemplary communities are given in the appendices. This section specifically emphasizes operational practices and technology.

The Canadian Housing and Mortgage Corporation is a leader in actively researching and/or promoting a significant number of the most innovative water sector technology installations in Canada. Larger innovative subdivision designs and projects appear to be largely driven by specialized developers and land owners rather than municipal councils.

The water research community, in partnership with many progressive municipalities are leading research on new technologies and methodologies to assess risk to appropriately match technologies to individual situations (such as appropriate drinking water treatment to address specific potential hazards within a given water supply area). The water research community in Canada includes water sector associations that work with members to research and develop technologies; the American Water Works Association (AWWA) and the Water Environment Federation (WEF) have numerous Canadian municipal members participating in studies to assess or refine technologies and processes. Canadian academic researchers are connected with practitioners through the Canadian Water Network, was created as one of Canada's Networks of Centres of Excellence to work in collaboration with universities, government and industry on scientific projects and initiatives that address key water-related issues. Municipalities that work in partnership with researchers in academe and associations tend to be large to medium sized urban centres, including Edmonton, Toronto, Guelph, Ottawa, and Halifax.

5.5 BEST PRACTICES AND PROGRESSIVE TECHNOLOGIES

Best practices outlined in this section are not intended to be an exhaustive list of potential practices applied by municipalities for sustainable operational management or technologies. As indicated in the best practices Sections 3 and 4 above, this section aims to highlight particular practices undertaken by municipalities that will assist in moving towards sustainable water practices.

In the area of technologies in particular, there are numerous applications and innovations to improve potable water quality production and distribution and to collect and treat wastewater. Use of any technology will not necessarily lead to sustainable water resource use because it is more a question of how the technologies are used within a broader context of planning, budgeting and leadership (or not). In addition there are some technologies, such as water meters and data acquisition tools, that are not considered best practices in the context of this section, but rather necessary components of a sustainable water system. The best practices outlined following should be considered a sample only and indicative of potentially desirable practices, assuming an appropriate context for sustainable water resource use has been established. In some cases, there will be other communities that are not identified that have implemented similar practices; again, this list is not intended to be exhaustive in terms of municipalities undertaking these or similar measures.

5.5.1 Efficient technologies for water use

Promotion of Efficient Potable Water Technologies and Practices – Residential Sector

In Canada, 56% of municipal water is used in the residential sector[154]. Within the residential sector, major end uses include toilet flushing, showers and baths, clothes washing and outdoor use. Several municipalities promote technologies and techniques which exist for more efficient water use in each of these areas:

- *Toilets:* Toilets manufactured before 1985 may use over 20 L of water per flush, while those manufactured between 1985 and 1995 generally use 13 L. Most modern toilets use 6 L of water per flush. Models which have a dual (*i.e.* 3 and 6 L) flush option are also available. A 2002 CMHC study found dual-flush toilets could save 26% more water than 6-L toilets. In comparison with existing toilets (14.7 L average), savings were much higher[155]. This technology has low market penetration in Canada but is well established in other regions, for example in Europe. Several Canadian municipalities offer rebates for the purchase of efficient toilets. B.C.'s **Sunshine Coast Regional District** administers a program unique to Canada, in which residents are not only provided with a free dual flush toilet (as well as faucet aerators and showerheads), but are also provided free installation and disposal / material recycling services for replaced toilets. This program allows residents to swap out up to 2 of their old 13+ litre toilets for a new dual flush toilet at no charge. The package also includes free installation of a low flow showerhead and a low flow faucet aerator. Many other examples of this type of rebate program can be found in Canada

[154] Environment Canada (2007), *Op.Cit.*

[155] Canada Mortgage and Housing Corporation (CMHC) (2002). *Dual-Flush Toilet Project.*

as more and more municipalities adopt the practice of promoting efficiency. The lack of progressive plumbing code standards in Canada necessitate keeping toilet efficiency on the list of best practices; in fact this is well established technology that faces political and attitudinal barriers.

- *Clothes Washing Machines:* Front-loading washing machines consume up to 40% less water (and up to 60% less energy) than conventional washing machines. A few municipalities offer subsidies or rebates for the purchase of water efficient washing machines, including the Cities of **Toronto**[156]**,** and **Guelph** ON[157], and B.C.'s **Capital Regional District**[158].

- *Faucet Aerators and Low Flow Shower Heads:* Many municipal water utilities, as well as several gas and electrical utilities promote, subsidize or provide low flow showerheads and faucet aerators. One municipality estimates that low flow showerheads result in a reduction in shower water consumption of up to 65%[159].

- *Outdoor Use:* Efficient outdoor water use is most often promoted through outdoor watering restrictions or bylaws (see section 4.6). There are, however, several techniques which can be employed by municipalities to encourage more efficient use of water outdoors. Municipalities such as B.C.'s **Sunshine Coast Regional District** promote xeriscaping by providing educational material such as a "water-wise" gardening guide, listings of native plants and demonstration gardens[160]. Ontario's **York Region** promotes similar water efficient gardening techniques, soil amendments and landscape design. The Region also offers free water efficient landscape audits to residents through its *Water for Tomorrow* program.[161]

Efficient Potable Water Technologies and Practices – ICI Sector

Many water efficient technologies that are applicable in the residential sector, such as efficient toilets and clothes washing machines, are equally applicable to the ICI sector. Several municipalities extend technology subsidies similar to those offered for residential customers to commercial or multi-residential buildings and sites. In addition, there are several measures that can be undertaken that are specific to ICI water users, many of which are specific to particular subsectors or business types. Four prominent examples of technologies and practices promoted by municipalities to the ICI sector are shown in Exhibit 5.1, below.

[156] City of Toronto, *Residential Washer Rebate* (http://www.toronto.ca/watereff/washer/index.htm - date accessed: April 2008)

[157] City of Guelph, *Smart Wash Pilot Rebate Program* (http://guelph.ca/living.cfm?itemid=74266&smocid=2338 – date accessed: April 2008)

[158] B.C. Capital Regional District, *SmartWash Rebate Program* (http://www.crd.bc.ca/water/conservation/rebates/smartwash.htm - date accessed: April 2008)

[159] Water Efficient Durham (2006). *Household guide to Water Efficiency.*

[160] Sunshine Coast Regional District, *Water-wise Planting and Xeriscaping* (Archived at http://web.archive.org/web/20070714032309/http://www.scrd.bc.ca/infrastructure_water.html#xeriscape – date accessed: February 2008)

[161] York Region, *Water for Tomorrow – Water Efficient Gardening* (http://www.water4tomorrow.com/grdn_hme.html - date accessed: April 2008)

Exhibit 5.1: Selected Efficient Water Technologies & Practices and Associated Canadian Program Examples -ICI Sector

Technology / Practice	Example Municipalities	Program Description	Estimated Cost and Savings (if available)
Efficient pre-rinse spray nozzles: A pre-rinse spray nozzle is a handheld device that uses a spray of water to remove food and grease from dishware, utensils, and pans before placing them in the dishwasher.	Region of Waterloo, ON[162] Toronto, ON[163] Welland, ON	Waterloo offers free equipment and installation as part of an ongoing pilot program Toronto and Welland offer free spray nozzle retrofits in partnership with Enbridge Gas	Paybacks can be as short as 3 months (independent of subsidy, considering both water and energy savings)
Elimination of "once through" cooling systems: Once-through cooling systems, or single-pass cooling systems, systems remove heat by transferring it to a supply of potable water and discharging it directly to the sewer. Equipment types may include air conditioners, refrigerators, coolers and ice machines.	Capital Regional District, B.C.[164]	CRD offers rebates for the replacement of once through condensers and icemakers on a per ton replaced basis.	Paybacks for small commercial systems are as short as 1.5 years (independent of subsidy, considering water savings only)
Efficient Irrigation Systems: Irrigation can be made more efficient by installing timers or rain sensors, or by using a method that reduces evaporation, such as drip irrigation	Capital Regional District, B.C[165]	CRD offers rebates for Automatic rain shut-off devices or Rain Sensors, and Irrigation Controllers with a 365-day calendar	n/a
Large Customer Water use Monitoring: Monitoring of large customers for abnormal water usage for the purpose of leak detection in private distribution systems.	Halifax Water, Halifax Regional Municipality, NS	Halifax Water offers a monitoring service for a monthly fee. Any action undertaken by the customer to remediate suspected leaks is done voluntary by the customer.	n/a
Site Water Auditing: Water audits attempt to find instances within buildings (or landscapes) where water is being used inefficiently or unnecessarily.	Capital Regional District, B.C	CRD offers free water use and efficiency audits to businesses in Greater Victoria and provides assistance with measurement and cost-benefit analysis of various measures to conserve water.	n/a

162 Region of Waterloo, *Restaurant Pre-Rinse Spray Valve Program* (http://www.region.waterloo.on.ca/web/region.nsf/0/02b9474f4ea5b2d485257037005215fe?OpenDocument – date accessed: April 2008)

163 City of Toronto, *Spray 'N' Save program for restaurants* (http://www.toronto.ca/watereff/spray_and_save/index.htm - date accessed: April 2008)

164 B.C. Capital Regional District, *Once-Through Cooling Systems Rebates* (http://www.crd.bc.ca/water/conservation/ici/coolingrebate.htm - date accessed: April 2008)

165 B.C. Capital Regional District, *Irrigation Rebate Program*, (http://www.crd.bc.ca/water/conservation/rebates/irrigation.htm - date accessed: April 2008)

Matching Quality to Use

Greywater reuse and effluent reuse can potentially reduce demand for both municipal water and wastewater services. Greywater reuse systems tend to treat greywater (wastewater from sinks, showers, washing machines) to an acceptable level before using it for a non-potable application, such as flushing toilets or watering lawns. These types of re-use systems may also incorporate black water (wastewater from toilets) reuse. There are several examples of grey and black water reuse at the house and neighborhood scale in Canada:

- In Victoria, B.C. a new mixed use development, **Dockside Green**, will re-use all grey and black water on site. Wastewater will be treated centrally on-site using an activated sludge process, as well as a membrane bioreactor before being reused, primarily for toilet flushing and irrigation.

- On a household scale, the City of **Yellowknife**, NT has installed five “Healthy House” systems, designed to treat all domestic wastewater on site to a quality suitable for non-potable applications such as clothes washing and toilet flushing. Five such systems were installed in public housing in Yellowknife in late 1998 and continue to be in operation.

- On a larger scale, the effluent re-use process is similar, but with a municipal wastewater stream as the starting stock. In **Vernon**, B.C., all municipal wastewater undergoes tertiary treatment before being pumped to a reservoir for use as irrigation water for agricultural areas, golf courses, and forestry areas[166]. This system was initially devised to reduce phosphorus loading into Lake Okanogan in the 1960’s, but has become an important tool to reduce demand for potable and wastewater services. As a method for further potable water conservation, Vernon has proposed an expansion of its reclaimed water system to include piped service to residents for irrigation use[167]. Effluent is also sometimes reused in industrial applications.

- The City of **Edmonton**’s Gold Bar Treatment Plant is presently providing a nearby refinery with effluent which has undergone tertiary treatment and membrane filtration.[168] This arrangement has been beneficial for both parties. Since the refinery funded the construction of the membrane filtration facility and a 5.5 km pipeline from the treatment plant, the City avoided approximately $26 million in capital costs. The project has saved the refinery the cost of building an on-site treatment facility. Instead, through its partnership with the City, the refinery receives a guaranteed water supply for which it is charged on a cost recovery basis.

[166] City of Vernon, *Water Reclamation & Spray Irrigation* (http://www.vernon.ca/services/utilities/reclamation/index.html - date accessed: April 2008)

[167] Coote, D.R., and L.J. Gregorich, (2000). The Health of our Water: Toward Sustainable Agriculture in Canada. (http://www.agr.gc.ca/nlwis-snite/pub/hw_se/pdf/intro_e.pdf - date accessed: April 2008)

[168] Environment Canada, *New Technologies or 'Clean' Technologies* (https://www.ec.gc.ca/pp/en/print.cfm?storyid=137 – date accessed: April 2008)

5.5.2 Treatment / Purification Systems

Advanced Sewage Treatment

Some Canadian municipalities are treating wastewater using methods beyond those described in Text Box 5.1. These advanced treatment methods include biosolids composting for beneficial reuse, and membrane filtration:

- In **Okotoks**, Alberta, biosolids resulting from treatment in the town's wastewater treatment plant is being disinfected and composted at an in-vessel composting facility into a high quality product which is being used by the municipality in landscaping applications. The Okotoks wastewater treatment plant employs several advanced technologies, including biological nutrient removal, fine particulate filtering, and ultraviolet disinfection. Under a public-private partnership EPCOR has assumed responsibility for a recent $11.2 million upgrade to the treatment plant, as well as ongoing responsibility for water and waste treatment system operations, and maintenance and enhancement of the composting process.[169]

- Other municipalities are using membrane filtration to produce high quality wastewater effluents. **Edmonton**'s Gold Bar Treatment plant and the **Victoria**'s Dockside Green[170] development (both mentioned above) are examples where this technology is in use. In the case of Dockside Green, the treatment process includes a bioreactor, where micro-organisms consume biodegradable waste, a series of ultra-filtration cassette membranes, which physically screen out suspended solids, bacteria and viruses, and ultraviolet units for additional disinfection.

- A number of non-traditional sewage treatment technologies exist which incorporate various forms of natural or semi-natural biological treatment. One such technology is *solar aquatics* systems, such as those constructed in **Bear River** and **Beaverbank** Nova Scotia[171]. These systems use a combination of bacteria, algae, macrophytic plants and animals housed partially within greenhouses to remove nutrients and other pollutants from wastewater. Because they are built and operated within a controlled environment (i.e. a greenhouse), these systems have the advantage that they can be managed as facilities rather than open systems. Another approach for non-conventional wastewater and stormwater treatment is to construct wetlands modelled on natural systems. Advantages of these types of systems include cost effectiveness, aesthetic attractiveness and, in some cases, habitat creation. Disadvantages include poor phosphorus removal, susceptibility of constituents to disease (and in the case of constructed wetlands, to predators and sub-optimal weather). In addition, constructed wetlands have a limited life expectancy due to silt accumulation, and often concentrate toxins in the environment, leading to the creation of toxic habitats. Unless

[169] See http://www.okotoks.ca/sustainable/Water/wastematters.asp for a description of Okotoks' treatment process, http://www.epcor.ca/Communities/Alberta/Operations/Water+Treatment+Plants/Okotoks/wtp.htm for a description of recent plant upgrades and Appendix A in this publication for an outline of Okotoks' relationship with EPCOR for wastewater services.

[170] See http://www.docksidegreen.com/sustainability/eco-friendly/onsite-reclaimed-water-treatment.html for a description of Dockside Green's wastewater treatment process.

[171] For a description of the Bear River N.S. system, see http://www.esemag.com/0904/bearriver.html

managed properly, maintenance of constructed wetlands can interfere with fish habitat, thereby violating federal fisheries law. These technologies are not necessarily considered best practices, but may be considered more sustainable than existing methods of treatment in some cases. Case-by-case assessment is needed to determine whether the advantages of constructed wetlands outweigh the disadvantages.

Advanced Water Treatment

Membrane filtration and biological treatment are also being employed for potable water treatment, especially when concerns over chemical use or unique water quality issues make traditional treatment methods unattractive:

- The potable water treatment plant in **Kamloops**, B.C. has undergone a recent upgrade which has made it the largest facility in North America to employ membrane filtration. Prior to the upgrade, water treatment was considered inadequate, and consisted of coarse (3mm) screening and chlorination. The upgraded plant process includes initial coagulation and flocculation, membrane ultra-filtration, in which water is drawn through a membrane with a pore size of 0.04 microns (4 x 10^{-5} mm), and disinfected with a hypochlorite solution. The plant also has the capability to add ultraviolet disinfection in the future. The plant upgrade cost a total of $48.5 million, or approximately $300 per m^3 of daily water treatment capacity. This compares well with the cost of more traditional plants. For example, the city of Penticton, B.C. recently completed an upgrade of its water treatment facility, moving from minimal treatment to a process which includes coagulation, flocculation, sedimentation, traditional filtration, and disinfection at a cost of approximately $330 per m^3 of daily capacity.

- Advanced treatment, including biological processes, can be necessary for treating water from a poor quality source. **Yellow Quill First Nation**, Saskatchewan uses groundwater from a naturally contaminated source, a common problem in the Canadian prairies. Contaminants include natural arsenic, nitrates and other chemical contamination, as well as high levels of organic material. The Yellow Quill treatment process involves biological filtration and reverse osmosis filtering. Biological filtration uses microbes that obtain energy by consuming unwanted chemical constituents within untreated water. In the case of Yellow Quill, contaminants, including iron, arsenic, ammonium and organic carbon are removed in a three-step biological filtration process. After the microbes have consumed these contaminants, they are filtered out of the water, in this case using a reverse osmosis filter[172]. This process was devised and piloted in Yellow Quill, and has since been exported to other small municipalities and First Nations with similar water quality problems. In addition to improved treatment quality, such systems have been found to be less

[172] Peterson H., R. Pratt, R. Neapetung, O. Sortehaug. 2006. *Integrated biological filtration and reverse osmosis treatment of a cold poor quality groundwater on the North American prairies*. In: Recent progress in slow sand and alternative bio-filtration processes, edited by R. Gimbel, N.J.D. Graham, and M.R. Collins

expensive to operate than conventional systems, due mostly to decreased need for chemical addition, fewer filter changes required and decreased maintenance.[173]

5.5.3 Distribution / Collection Systems

Sewage System Efficiency

One of the main methods of improving sewage system efficiency used by Canadian Municipalities is inflow and infiltration (I/I) reduction (see Section 3.5). Specific measures include downspout disconnection from combined storm sanitary sewers[174], and disconnection of basement sump pumps from combined storm and sanitary sewers. Both of these measures are also used to reduce inflow into storm sewers in areas with dedicated storm sewers. Automated surveillance and real time control are used by some municipalities to manage sewer system use on a larger scale. In **Ottawa**, ON sanitary sewer flow is regulated in major trunk sewers by means of sluice gates controlled by electric actuators[175]. This actuator receives instruction from an on-site computer, which computes flow and is, in turn, connected to the City's central computer control system. This system helps to prevent basement flooding and sewer overflows by maximising use of the main trunk sewers and minimizing use of diversions to a tunnel relief system. **Quebec City**, QC has also made a significant investment in the efficiency of its sewage system. Quebec's Global Optimal and Predictive Real Time Control (GO RTC) approach monitors the distribution of flow inside the entire sanitary sewer system, uses meteorological data and measurements to predict future flows, and employs in-system gates and actuators in order to manage flows. This method maximizes system storage capacity while and minimizing combined-sewer and sanitary sewer overflows during wet weather events. It is estimated that this approach has saved Quebec City $90,000,000 in avoided infrastructure costs.[176]

Potable System Efficiency

Improving potable water system efficiency generally means reducing system losses. Many municipalities have leakage management plans for their potable water systems. Common elements include source metering, which allows a utility to monitor input into the potable water system; district metering, which allows utilities to pinpoint areas with leaks; and pressure control, which can reduce lost volume from existing leaks. **Halifax** was the first Canadian utility to adopt the International Water Association / American Water and Wastewater Association (IWA/AWWA) water audit methodology for real loss reduction in its distribution systems. This methodology advocates tracking of all water

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[173] Peterson, H., R. Neapetung, R. Pratt, and A. Steinhauer (2007). *Development of Effective Drinking Water Treatment Processes for Small Communities with Extremely Poor Quality Water on the Canadian Prairie*. Canadian Society of Experimental Biologists, Volume 64, Number 1, Spring 2007

[174] For a program example, see http://www.toronto.ca/water/protecting_quality/downspout.htm (A recently completed program in Toronto). Programs are presently underway in the city of Welland, ON,

[175] For a full system description see Stantec (ND), *Real Time Flow Control for a Trunk Sanitary Sewer and Tunnel Relief System in the City of Ottawa* (www.stantec.com/StantecCom/CmtDocs/21.PDF – date accessed: May 2008)

[176] Colas, H., L. Robatille, A. Charron, C. Marcoux, M. Laverdiere, and D. Lessard (ND). *Application of Real Time Control for CSO and SSO Abatement: Lessons Learned form 6 Years of Operation in Quebec City*.

use, including leaks, and promotes leak detection and reduction using the methods mentioned above. Other methods of reducing system losses may include monitoring of large customer and private distribution system consumption for the purposes of leak detection and irrigation system monitoring (see Figure 5.1, above). One method of loss reduction specific to Northern communities is the water circulation “bleeder valves”. Bleeder valves are used in cold climates to maintain continuous water movement in buried pipes in order to prevent freezing. These valves usually drain directly into storm or sanitary sewers. In the case of **Yellowknife**, NT, bleeder valve discharge into the sanitary sewer system has contributed to significant water losses, as well as increased burden on the city’s wastewater treatment lagoon. Yellowknife is presently undergoing a program to switch from bleeder valves to dual pipe services, which allow for water circulation without losses[177]. **Whitehorse**, YK is reducing its system losses by installing thermostatically controlled bleeder valves in place of standard “always on” type valves[178].

Another aspect of potable water system design and operation is to ensure water quality is not degraded from the point of leaving treatment to arriving at the customer. Treatment methods (such as the addition of trace ammonia amounts to assist in preserving chlorination protection to the ends of the distribution system) and corrosion prevention methods (such as addition of lime softening to increase the pH of distributed water) are fairly standard practices. However, these practices do warrant on-going research and field applications to continue perfecting the methods. Another method of addressing water quality issues in the distribution system is to ensure there are no dead end water mains where water may stagnate; municipalities can address this problem by creating looped systems at the time of water system renewal or infill development.

Storm water system efficiency

Several technologies and techniques exist for improved stormwater system efficiency. These include the use of green roofs in Toronto, Waterloo and several communities in British Columbia. In addition, triple pipe conveyance systems (in **Ottawa**, for example), bioswales for conveyance and increased pervious surfaces (for example, the **City of Vancouver**’s “Sustainable Streets” initiative[179]) all assist in reducing volumes of runoff, improving quality and temperature and reducing ecological damage from stormwater runoff. Constructed infiltration beds, which allow the stormwater to pool on top and filter through sand or other granular material, have been successfully demonstrated to remove metals and other contaminants; however there are maintenance issues associated with removal and disposal of the upper layers of the infiltration bed over time.

Technologies to satisfy supply under infrastructure constraint

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177 See Appendix A for further detail.

178 J. Kinkead Consulting, *An Analysis of Canadian and Other Water Conservation Practices and Initiatives*, prepared for the Canadian Council of Ministers of the Environment, 2006.

179 City of Vancouver, *Environmentally Sustainable Options* (http://www.city.vancouver.bc.ca/engsvcs/streets/design/enviro.htm - date accessed: April 2008)

The pressure at which potable water must be delivered to properties determines design features and operating costs of the system, including the size of watermains and energy costs for pumping. High-pressure water delivery also results in higher water losses through leaks in watermains and seals. Therefore, operating the distribution system at lower pressure delivery during off-peak demand periods can reduce energy costs and reduce water losses. **Halifax Water** has been successful in reducing loss levels through pressure management, which is part of its integrated leak reduction strategy. A 2005 study by the American Water and Wastewater Association Research Foundation (AwwaRF) found that pressure reduction in Halifax's potable water system reduced losses by up to 169L/connection/day.[180] Pressure management activities have not caused a noticeable spike in main replacement, although main replacement has increased from a historical average of approximately 0.4%/yr, with a goal of 1.2%/yr, in order to keep pace with infrastructure reaching the end of its useful life.

Alternative levels of service

Small bore watermains with low pressure distribution and lot level storage (i.e. a cistern) and pressure pump in the basement are a design approach that can save capital and operating costs. Such a system, known a "trickle-feed" system, was installed in 1997 in **Carlsbad Springs**, Ontario where poor well water quality necessitated treated water but conventional approaches were prohibitively expensive. This system has also been successfully used in western Canada[181]. Perhaps the most significant level of service issue for the system is that it does not provide fire protection. In addition, part of the distribution system is on private property (i.e. the storage cistern), thus requiring maintenance by property owners.

Technologies to extend infrastructure life

Simple technologies exist to protect watermains from corrosion, for example through use of sacrificial metal anodes that corrode in preference to the watermain material (in use in **Beasejour** MB and **Ottawa** ON, for example). Also, in-situ lining techniques for replacing the interior surface of watermains and sewers are gaining usage. These and similar techniques are important for sustaining existing infrastructure and reducing rehabilitation costs and public inconvenience. A key advantage of this technique is that the linear pipe does not need to be excavated since the replacement liner can be inserted through strategically chosen manhole access points.

5.6 SUMMARY TABLE

Exhibit 5.2 presents an overview of best practices presented in Section 5 in relation to issues identified in Section 2 and with respect to the applicability of issues identified to community size, region or province, and geographic location.

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[180] AwwaRF (2007) *Leakage Management Technologies.*

[181] Krug, John. (1997). "*Minimizing Water Supply Costs In Rural Communities*". The Newsletter of the Municipal & Industrial Division of the Plastics Pipe Institute Volume 3 Number 3 Fall, 1997.

Exhibit 5.2
Overview of Best Practices – Operational Practices and Technology

Category	Best Practice	Issue(s) Addressed	Applicability	Community Examples	Additional Comments
Efficient Technologies for Water Use	Promotion of Efficient Potable Water Technologies and Practices – Residential Sector	Water quantity, Building codes and insurance	All	Sunshine Coast Regional District, BC Toronto, ON Guelph, ON CRD, BC	The uptake of efficient technologies can be driven by stringent building codes.
	Promotion of Efficient Potable Water Technologies and Practices – ICI Sector	Water quantity, Building codes and insurance	All	RM Waterloo, ON Toronto, ON Welland, ON CRD, BC HRWC (Halifax, NS)	The uptake of efficient technologies can be driven by stringent building codes.
	Matching Quality to Use	Water quantity, Economic barriers to water re-use, regulatory barriers to water re-use	All	Dockside Green (Victoria, BC) Yellowknife, NT Vernon, BC Edmonton, AB	Matching quantity to use conserves potable water. The practice is discouraged by under-pricing of potable water, and, in some cases, by regulations discouraging re-use practice for perceived health reasons.
Treatment / Purification	Advanced Sewage Treatment	Water quality, Wastewater requirements, Liability Issues	All	Okotoks, AB Edmonton, AB Dockside Green (Victoria, BC)	In many cases, source water quality is affected by sewage treatment levels and effluent releases. In some cases, municipalities may be held liable for the release of toxic or poorly treated effluents by those downstream.
	Advanced Water Treatment	Water quality, Potable water requirements	All	Kamloops, BC Yellow Quill First Nation, SK	In many cases, raw water of poor initial quality may be treated using advanced methods to meet drinking water standards
Distribution / Collection	Sewage System Efficiency	Collection and distribution technologies	All	Ottawa, ON Quebec City, QC	Collection systems that operate efficiently have the co-benefit of reduced energy use to convey the water and reduced chemical use (where applicable) to treat the water

	Potable System Efficiency	Collection and distribution technologies, Water quantity	All	HRWC (Halifax, NS) Yellowknife, NT Whitehorse, YK	Water quantity concerns can be addressed, in part, by improving potable system efficiency in the form of leak reduction initiatives.
	Stormwater System Efficiency	Collection and distribution technologies	All	Ottawa, ON Vancouver, BC	Stormwater system efficiency can have the co-benefit of protecting ecological function of waterbodies and improving system resilience in the event of natural disasters
	Technologies to satisfy supply under infrastructure constraint	Collection and distribution technologies, Infrastructure Deficit	All	HRWC (Halifax, NS)	Demand management techniques such as lower potable water system pressures and reduced system losses have co-benefits of reduced energy use and more efficient use of infrastructure
	Alternative levels of service	Collection and distribution technologies, Infrastructure Deficit	All, in particular may offer cost advantages for smaller systems and systems struggling with debt	Carlsbad Springs, ON	Alternative levels of service can have co-benefits for reduced energy consumption and more system resilience in the event of natural disasters
	Technologies to extend infrastructure life	Collection and distribution technologies, Infrastructure Deficit	All	Beausejour, MB Ottawa, ON	Timely application of technologies to repair infrastructure can assist in reducing the infrastructure deficit since repair is less costly than emergency repair or full scale replacement

6. FINANCIAL IMPLICATIONS

The financial impact of sustainability is discussed following from three perspectives:

- Approaches that generate savings using conventional cost-benefit calculations
- Management for long-term financial and operational viability
- Holistic approaches.

The benefits and costs considered in this discussion assume the long-term marginal cost is of primary interest since shorter-term analyses (i.e. payback and short-term marginal cost) cannot adequately incorporate environmental externalities (such as carbon release).

Approaches using conventional cost-benefit calculations

Water efficiency programs of leading municipalities present clearly defined savings and deferred costs. As indicated earlier in this report, these programs are undertaken where water supply is limited or infrastructure expansion is needed. Water efficiency programs are not sufficient on their own to guarantee sustainable water resource use, but they are necessary to build public awareness of consumption and to educate consumers about ways to reduce use. The context for these programs in municipalities currently is that they aim to reduce use of potable water; they do not incorporate alternate ‘sources’ of water, such as grey or rain water, although they may promote use of rainwater for landscaping purposes. The financial impact of water efficiency planning for the following two communities indicates the types of savings possible taking an infrastructure perspective:

- Toronto City Council approved a Water Efficiency Plan to meet the water and sewage treatment needs of a growing Toronto population. The Plan emphasizes efficiency measures such as toilet and clothes washer replacement programs to reduce peak demands for water, and flows of wastewater, by about 12 per cent by the year 2011. At a cost of $75 million, the implementation of the Plan will be about one-third of the equivalent expansion of water and wastewater infrastructure, estimated to cost $220 million. In addition, the Plan identifies anticipated deferral of operating costs, greenhouse gas emission reductions of about 100,000 tonnes of CO_2 during the planning period and an additional 14,000 tonnes yearly after 2011[182].

- Similarly York, which has been pursuing water efficiency through its Water for Tomorrow initiative for about a decade, in its ten year savings update, has estimated that an additional 23.4 million litres per average day of water savings can be achieved with a budget of close to $31M. The cost per litre saved is $1.31, significantly less than the current cost to build new infrastructure which on average is $8.10 per litre per average day[183].

Clearly the budgets for these water efficiency measures ($75M and $31M respectively) are significant. However, in comparison with continuing to provide conventional central engineering solutions, the savings associated with these costs justify the programs.

[182] City of Toronto, *Water Efficiency Plan* (http://www.toronto.ca/watereff/plan.htm – date accessed: May 2008)

[183] Regional Municipality of York, *Water Efficiency Master Plan Update*, April 2007

Management for long term financial and operational viability

In May 2007, the Halifax Regional Municipality (HRM) transferred responsibility of its wastewater and storm water assets, including buried infrastructure and treatment facilities, to the Halifax Regional Water Commission (HRWC). The HRWC is an autonomous, self-financed utility that was already responsible for a fully metered water utility providing drinking water and fire protection services to Halifax customers.

The transfer was unanimously approved by the HRWC Board. In announcing the transfer, Halifax Mayor Peter Kelly said[184], "As the first regulated water and wastewater utility in Canada, this new approach to wastewater and storm water services will provide the financial sustainability necessary to ensure the future integrity and safety of our water and wastewater infrastructure." In other words, the utility has the long term perspective and leadership required to set rates to recover costs of the services provided. In discussing the transfer with the media, HRWC General Manager, Carl Yates stated "The only major change from a public perspective is that rates for storm and waste water will also be set by the Board. This will allow the Commission to develop a long term strategy for environmental compliance, infrastructure maintenance and replacement plans for both [water and wastewater] systems.[185]" Mr. Yates anticipates it will take 10 or so years to build the capacity needed to properly maintain the wastewater system to the standard now delivered for water and to overcome the extended period of insufficient proactive maintenance of the sewer system. Significant resource and capacity building will also be needed as the municipality hands over newly commissioned wastewater treatment facilities. (Refer to Appendix C for a profile of HRWC.)

Similarly, the water utility in Windsor, Ontario is currently in the process of rolling out significant water rate increases to properly maintain and repair watermains. Recognizing that municipalities do not necessarily make these decisions on their own, Ontario has pending legislation that will require full cost accounting for water and wastewater servicing (see Section 2).

It is significant that HRM politicians recognized that they could not make the rate decisions necessary for the successful long term operation of the community's wastewater infrastructure. There is a financial impact of sustainability in terms of rates and cost recovery. However, the financial impact is closely tied to political impacts and thus, the barrier of short term decision-making will continue to hamper progress in this area.

Holistic Approaches and Integrated Decision-making

Understanding of the financial impacts of sustainability where holistic approaches are undertaken is nascent in Canada. The community of Okotoks is pursuing an integrated approach to land development and water use which has entailed significant capacity building among staff, local and provincial politicians, stakeholders (including the development community) and residents. In profiling the community (refer to Appendix C), a summation of costs of the

[184] Halifax Regional Municipality, *Media Release* (http://www.halifax.ca/mediaroom/pressrelease/pr2007/070530RegionalWaterCommissionHRMUtilitiesMerger.html – date accessed: May 2008)

[185] ibid

approach was not obtained due to the fact that it has affected virtually all aspects of community development and water resource management, including policy, planning, zoning, development processes, public education and other capacity-building requirements. It is possible to qualitatively indicate that, over the short term, the financial costs of developing this approach have been higher than the business-as-usual costs would have been. In theory, the long term benefits of these holistic practices should be reduced costs however this has yet to be demonstrated in Okotoks. In fact, demonstration of savings over time may not be relevant due to changing variables, including the quantity of water available due to climate change. Instead of thinking in terms of cost savings, the more important question may become “What are the reduced risks of adopting sustainable practices?”

A recent joint study by Friends of the Earth and the Polis Project on Ecological Governance examined potential water savings from adopting water soft path approaches. Key findings[186] indicate that applying the soft path to urban areas could result in savings of two-thirds of the water used. This finding implies that most communities could grow vigorously for the next 20 to 30 years but still require no new supplies of water. The study also examined Ontario as a region and estimates that water savings of 20% or more from current use can be achieved across all the major industrial sectors. In Nova Scotia’s Annapolis Valley, savings of 50% are estimated. The study purpose was to estimate potential savings rather than explore more detailed cost-benefits. Again, the question of financial impacts however is similar to the case of Okotoks: What is the risk of not undertaking more sustainable practices?

The Water Soft Path and other approaches promote integrated decision-making. For example, food choices and crop decisions have implications for water management on a regional level. One tool that looks at integrated benefits with respect to trees and water resources has been developed by American Forests. CITYgreen (see also Section 3.5) is used to assess the financial impact of trees on, among other things, stormwater infrastructure. A study of parking lots in Atlanta of the value of enforcing a tree ordinance indicated that a tree canopy over a 4 acre parking lot would provide equivalent to $16,000 in stormwater management benefits and $275 annual air pollution removal benefits. If all 122 acres of surface parking lots in the downtown Atlanta study area complied with the tree ordinance, the trees would provide almost half a million dollars worth of stormwater management benefits and over $7,500 annual air pollution removal benefits. This small study demonstrates the enormity of the task to identify the benefits of protecting environmental features, let alone ecological function.

Summation

Generically, management of sustainable solutions appears to typically require higher up-front costs to undertake measures that will save larger investments in the future as well as for changes to policies and planning tools, capacity-building, public consultation, and inclusive decision-making processes. Sustainable solutions that incorporate factors currently external to business-as-usual approaches, such as incorporation of greenhouse gas mitigation techniques, will also be higher over the short term. The public will also see higher rates and charges, although these may be mitigated by efficiency or progressive water conservation measures.

[186] Oliver Brandes and David Brooks, *The Soft Path for Water in a Nutshell*, Revised May 2007 (http://www.foecanada.org/WSP%20Lexicon/nutshell_revised_may07%20(2).pdf – date accessed: May 2008)

It will be difficult to demonstrate the long-term financial savings of holistic approaches due to the number of potentially changing variables in the future, including the effects of climate change on water supply and quality, demographics (e.g. increased wages to replace retiring baby boomers), increased regulatory requirements, etc. In fact, future financial savings may not be a relevant question in any case. Similar to the approach taken by Sir Nicolas Stern in his assessment of action on climate change when he concluded, "the benefits of strong and early action far outweigh the economic costs of not acting[187]", the choice regarding whether to act or not should not be based on future savings but rather future costs and risks of inaction. So the question of what the financial impacts of sustainability are needs to be broadened in the future to what are the financial and risk reductions of sustainability?

[187] N. Stern, Sir, *Stern Review: The Economics of Climate Change*, Summary of Conclusions, p.vi (http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm – date accessed: May 2008)

7. MOVING FORWARD

This section addresses the issue of “setting the bar for the future” by identifying current and possible future trends in the sector, and by outlining opportunities and threats to municipalities arising from these trends.

7.1 SUMMARY OF TRENDS

Trends have been identified throughout this report and will not be repeated in detail here. In summary, key trends which should be considered by municipalities moving forward include:

- A continuing perception of water abundance and apparently low public valuation of water leading to a lack of rigorous approaches to water resource management by many communities.
- Growing domestic demands for water can be expected to continue, fuelled by pricing that is below cost; however certain provinces are taking steps to ensure communities plan for full cost recovery and this trend can be expected to increase water rates in those jurisdictions.
- Increasing regulatory controls in the area of wastewater and potable water quality will lead to more sophisticated technologies and increased specialized training for water and wastewater operators.
- Climate change leading to physical changes in water cycle/ availability regionally; public concern for action on climate change appears to be increasing and will eventually lead to more active government attention to mitigation and adaptation.

7.2 OPPORTUNITIES AND THREATS

A summary of the key issues in moving towards sustainable water resource management and servicing:

- *Measurement*: To effectively manage an issue, it is important to develop measurements of performance. Water metering is a cornerstone of good water management because it begins to address water quantity as well as public awareness issues. Installing meters is not sufficient to achieve sustainable water practices, but it is a necessary condition for financial management, demand side management, public awareness and education. More sophisticated metering approaches, including those that assist in leak detection, are also indispensible for optimization of system operations and maintenance.
- *Full cost*: Similar to water metering, full cost accounting will not necessarily result in sustainable water resource use because of the inherently inefficient and wasteful nature of conventional water infrastructure design and use (such as the practices of using fully treated water for fire suppression and grass watering). However, full cost accounting and pricing is necessary to begin the sustainable journey. Innovative approaches in Canada would include inclining block rates to discourage high usage, creation of stormwater utilities to fully reflect costs of service and incorporation of greenhouse gas mitigation measures in rates.
- *Integrated land use decision-making for water environment protection and pollution prevention*: All land use decisions are water decisions. To protect the quality of water and the environment, land use decisions made by municipalities must incorporate watershed/

sub-watershed factors. Understanding the watershed capacity is scientifically difficult and fraught with politically sensitive issues. However, communities as different as Okotoks, Toronto and Chelsea have begun to realign their priorities to protect the water environment and their water resources on a holistic level. Although pollution prevention encompasses many issues other than land use decisions, the prevention of the pervasive pollution issues of stormwater quality and the ecosystem degradation from stormwater quantity needs to be incorporated at a fundamental level into subdivision designs and infill developments.

- *Basin Capacity:* The assumption that more water supply will always be available from somewhere in proximity to the community is well-entrenched in community planning and engineering approaches. Communities at the leading edge in terms of working within their water basin limits are those with no choice: these leaders have no alternate sources of water. Similar to the concept behind ecological footprint calculations[188], the ideal of working within the limits of one's watershed is part of a sustainable approach to resource use. Given Canadian's water consumption habits and the opportunities offered through more holistic approaches, alternative technologies and standards, there are numerous opportunities for improvement in this area.
- *Demand Side Management*: Municipalities that tackle demand-side management in its broadest application will be the leaders in Canada. Incorporation of Water Soft Path principles, for example, will lead to innovative studies, techniques and approaches. Municipalities willing to implement measures to match water quality to use, for example, are needed to overcome the inertia against changing to more efficient, indeed more sane, use of high quality drinking water. Measures include those that move beyond efficiency (such as low flow toilets) to conservation and alternative approaches that may not require water to meet service needs. Because they promote an integrated understanding of resource use (land, water, energy), innovative water use schemes can also address stormwater, energy efficiency, wastewater volumes, and other interconnected issues.
- *Utility Reform*: There are internal management requirements in order to move, organizationally, from a conventional frame of reference (i.e. a focus on infrastructure management for water supply and wastewater treatment) to adoption of a concept of utilities as water service agencies, with as much emphasis on demand management and water cycle protection as supply-side issues. Through various management methods, such as creating a vision, staff recruitment and training, and establishing a range of performance indicators and targets, with sustained leadership, the internal culture of utilities can be shifted to incorporate demand-side measures and larger ecological concerns arising from water cycle protection.
- *Managing for Challenges of the Future*: No one really knows precisely what sustainable water resources looks like in terms of technologies, governance instruments or planning approaches. However one common theme that emerges in discussing these is a need for adaptive management; that is, a need for organizations to respond nimbly to challenges as they arise and adapt systems and practices to meet the challenge. Municipalities need performance measures and corresponding information about where they are with respect to their measures. Measures could include any number of factors, from physical (e.g. quantity of water used per capita) to social (e.g. customer awareness of bylaw requirements) to economic, management and others. Performance measures for project applications should demonstrate that municipalities have considered a wide range of

[188] William Rees and Mathis Wackernagel, UBC, 1992

factors to monitor and manage the issue(s) the project is designed to address. Social factors to address attitudinal issues of the public towards water and environmental factors to try to assess cumulative or unexpected consequences of project implementation would be important (in addition to more conventional financial and management factors).

- *Climate Change*: The science and technological implications of climate change on water resource management and water service delivery are just beginning to emerge. Municipalities must understand and implement measures and techniques to mitigate greenhouse gas emissions and to adapt to changing climate conditions. There are many opportunities to support integrated measures for water and energy use reductions as well as community development of approaches to adapt to altered precipitation, storage and drainage patterns and to apply integrated 'green' measures in a changing climate (for example, trees and greenspace for their many ecological and social benefits).

7.3 CONCLUSION

The water sector is complex and is intrinsically integrated with land use and other resource uses. Key issues for monitoring and understanding progress among municipalities for sustainable water management include environmental, regulatory and attitudinal issues. There are Canadian leaders undertaking both holistic approaches and developing best practices for more sustainable water management. Evolution and dissemination of these approaches will take time given the wide range of conditions, experiences, capacity and issues in the various geographic locations and types of Canadian municipalities.

APPENDIX A

Contact list

Contact List

Name	Position & Organisation	Location & Contact Info	Related Websites
Study Contact			
Andrew Cowan	Senior Manager, Knowledge management Unit , FCM	acowan@fcm.ca (613) 907-6368	http://gmf.fcm.ca/Home/
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Peer Review Panel			
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Oliver Brandes	Associate Director and Water Sustainablility Project Leader, POLIS Project on Ecological Governance (University of Victoria)	omb@uvic.ca (250) 721-8193	http://www.waterdsm.org/
Robert Andrews	Professor of Civil Engineering, University of Toronto	andrews@civ.utoronto.ca (416)-978-5399	http://www.civil.engineering.utoronto.ca/infoabout/staff/professors/andrews.htm
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A. Robert Funke, P. Eng.	Town Engineer, Town of New Glasgow and FCM Green Funds Peer Reviewer	bfunke@newglasgow.ca (902) 755-8345	
Sustainable Community Contacts: Water			
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Nancy Kedousek	Director, Water Services Regional Municipality of Waterloo	konancy@region.waterloo.on.ca (519) 575-4426	http://www.region.waterloo.on.ca/web/region.nsf/DocID/37A888F08FD43A5C85256E430075588B?OpenDocument
Richard Quayle	Municipal Manager, Town of Okotoks, AB	municipalmanager@okotoks.ca (403) 938-8902	http://www.okotoks.ca/sustainable/overview.asp

Name	Position & Organisation	Location & Contact Info	Related Websites
Dave Robertson	Operations Manager, Town of Okotoks, AB	drobertson@okotoks.ca (403) 938-8922	http://www.okotoks.ca/sustainable/overview.asp
Bryan Shoji	General Manager, Infrastructure Services Sunshine Coast Regional District	(604) 885-6800	http://www.scrd.bc.ca/infrastructure_water.html
Dion Whyte	Manager, Sustainable Services Sunshine Coast Regional District	Dion.Whyte@scrd.bc.ca (604) 885-6800	http://www.scrd.bc.ca/infrastructure_water.html
Carl Yates	General Manager, Halifax Regional Water Commission	(902) 490-4840	http://www.halifax.ca/hrwc/
Scott Findlay	Director, Institute for the Environment, University of Ottawa; Scientific Advisor for H2O Chelsea	University of Ottawa (613) 562-5874	http://www.ie.uottawa.ca/English/welcome.html
Sustainable Neighbourhood contacts: Water			
Ms Lynn Strathdee	Dockside Green Coordinator, City of Victoria	lstrathdee@victoria.ca (250) 361-0536	http://www.victoria.ca/cityhall/currentprojects_dockside.shtml?zoom_highlight=Dockside+Green
Other			
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Hubert Colas	Vice President, BPR CSO (Author of several papers on combined sewer and sanitary sewer overflow prevention in Quebec City)	hubert.colas@bpr-cso.com (514) 257-2439	www.bpr-cso.com
Gregg Morrison	Director of Planning, Town of Wolfville, NS	gmorrison@town.wolfville.ns.ca (902) 542-3232	http://www.town.wolfville.ns.ca/departments/waterutility/swpp.html
Heidi Macintosh	Nova Scotia Utility and Review board	(902) 424-4448	http://www.nsuarb.ca/

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APPENDIX B

Resources

Jurisdictional Strategies, Guidelines and other Reference Documents

- Alberta Environment. *Framework for Water Management Planning.* . (http://environment.gov.ab.ca/info/library/6367.pdf - date accessed: April 2008)

- Alberta Government. *Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems.* January 2006. Date accessed: April 2008. (http://environment.gov.ab.ca/info/posting.asp?assetid=6979&subcategoryid=96 - date accessed: April 2008)

- Government of Alberta. January 30, 2008. *Water for Life: Alberta's Strategy for Sustainability*. (www.waterforlife.gov.ab.ca. - date accessed: April 2008)

- Government of Nova Scotia, Developing a Municipal Source Water Protection Plan (http://www.gov.ns.ca/nse/water/sourcewater.asp - date accessed May 2008)

- Government of Newfoundland and Labrador. *Standards for Chemical and Physical Monitoring of Drinking Water.* (http://www.env.gov.nl.ca/Env/env/waterres/Policies/WQ-Standard-PhysicalChemical.asp - date accessed: April 2008)

- Government of Newfoundland and Labrador. *Standards for Bacteriological Quality of Drinking Water*. (http://www.env.gov.nl.ca/env/Env/waterres/policies/wq-standards-microbiological.asp- date accessed: April 2008)

- Government of Prince Edward Island. 2001. *Clear from the Ground to the Glass 10 Points to Purity – What We'll Do and When We'll Do It.*. (http://www.gov.pe.ca/photos/original/10points2purity.pdf - date accessed: April 2008)

- Government of Prince Edward Island. *A Guide to Watershed Planning on Prince Edward Island*. (http://www.gov.pe.ca/photos/original/eef_waterguide.pdf - date accessed: April 2008)

- Ministère du Développement durable, de l'Environnement et des Parcs, Québec. *Water. Our Life. Our Future: Québec Water Policy. (*http://www.menv.gouv.qc.ca/eau/politique/policy.pdf - date accessed: April 2008)

- Nova Scotia Department of Environment and Labour. (Revised November 2004). *Treatment Standard for Municipal Surface Source Water Treatment Facilities.* (http://www.gov.ns.ca/nse/water/docs/MunicipalSurfaceSourceWaterStd.pdf - date accessed: April 2008)

- Nova Scotia Department of Environment and Labour. 2003. *Treatment Standard for Municipal Groundwater Source Water Facilities.* (http://www.gov.ns.ca/nse/water/docs/GroundwaterTreatment.pdf - date accessed: May 2008)

- Nova Scotia Department of Labour. *A Drinking Water Strategy for Nova Scotia*. (http://www.gov.ns.ca/nse/water/docs/NSWaterStrategy.pdf - date accessed: April 2008)

- Ontario Ministry of the Environment. *Procedure for Disinfection of Drinking Water in Ontario* (as adopted by reference by Ontario Regulation 170/03 under the Safe Drinking Water Act) Originally dated: April 16, 2003 First Revision: June 1, 2003 Second Revision: June 4, 2006 PIBS 4448e01. (http://www.ene.gov.on.ca/envision/gp/4448e01.pdf - date accessed: April 2008)

- Province of Manitoba, Planning and Co-ordination Branch. *Conservation Districts.* (http://www.gov.mb.ca/waterstewardship/agencies/cd/index.html - date accessed May 2008)

- Saskatchewan Ministry of Environment. January 2008. Guidelines for Sewage Works Design (EPB 203). (www.saskh20.ca/DWBinder/EPB203GuidelinesSewageWorksDesign.pdf - date accessed: April 2008)

- Whiteworks: Policy, Planning & Evaluation and Jennifer Luckay Creative Communications (May 2005). *Managing Drinking Water Quality in the Northwest Territories: A Preventative Framework and Strategy*. (http://www.pws.gov.nt.ca/pdf/WaterAndSanitation/WaterFramework.pdf - date accessed: April 2008)

- Newfoundland and Labrador outline of activities under the Multi-barrier Strategic Action Plan, http://www.env.gov.nl.ca/Env/env/waterres/Surfacewater/DWS-Report/2006/DWQ_Annual_Report_2006.pdf

- Health Canada, Canadian Guidelines for Household Reclaimed Water for Use in Toilet and Urinal Flushing http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/consultation/reclaim-recycle/index_e.html

- Health Canada, Quantitative Microbial Risk Assessment (QMRA), which proactively examines the overall health risks to a population with respect to various levels of treatment for the community's source water quality; this analysis can be applied to establish appropriate treatment requirements as well as upstream watershed management decisions to reduce risks of contaminants that may increase risks to the population.

Canadian Statutes and Regulations for Jurisdictions

A. Canadian Legal Information Institute (A sampling of the links accessed for this are provided following; researchers are advised to go to the canlii home page):

- Canadian Legal Information Institute. Manitoba Statutes and Regulations: *Water Supply Commissions Act, C.C.S.M. c. W100*. (http://www.canlii.org/mb/laws/sta/w-100/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. New Brunswick Statutes and Regulations: *Clean Water Act*, *S.N.B. 1989, c. C-6.1*. (http://www.canlii.org/nb/laws/sta/c-6.1/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Newfoundland and Labrador Statutes and Regulations: *Environmental Control Water and Sewage Regulations, 2003, N.L.R. 65/03*. (http://www.canlii.org/nl/laws/regu/c2003r.65/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. North West Territories Statutes and Regulations: *Public Sewerage Systems Regulations, R.R.N.W.T. 1990, c. P-22*. (http://www.canlii.org/nt/laws/regu/p-22/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Nova Scotia Statutes and Regulations: *Activities Designation Regulations, N.S. Reg. 47/95*. (http://www.canlii.org/ns/laws/regu/1995r.47/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Nunavut Statutes and Regulations: *Environmental Protection Act*, *R.S.N.W.T. 1988, c. E-7*. (http://www.canlii.org/nu/laws/sta/e-7/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Ontario Statutes and Regulations: *Ontario Water Resources Act*, *R.S.O. 1990, c. O.40*. (http://www.canlii.org/on/laws/sta/o-40/index.html (English version) - date accessed: April 2008)

- Canadian Legal Information Institute. Prince Edward Island Statutes and Regulations: *Drinking Water and Wastewater Facility Operating Regulations, P.E.I. Reg. EC710/04*. (http://www.canlii.org/pe/laws/regu/2004r.710/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Québec Statutes and Regulations: *Quality of drinking water, Regulation respecting the, R.Q. c. Q-2, r.18.1.1*. (http://www.canlii.org/qc/laws/regu/q-2r.18.1.1/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Saskatchewan Statutes and Regulations: *Water Regulations, 2002, R.R.S. c. E-10.21 Reg. 1*. (http://www.canlii.org/sk/laws/regu/e-10.21r.1/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Yukon Territory Statutes and Regulations: *Sewage Disposal Systems Regulation, Y.O.I.C. 1999/82*. (http://www.canlii.org/yk/laws/regu/1999r.82/index.html - date accessed: April 2008)

- Canadian Legal Information Institute. Alberta Statutes and Regulations: *Wastewater and Storm Drainage Regulation, Alta. Reg. 119/1993*. (http://www.canlii.org/ab/laws/regu/1993r.119/index.html- date accessed: April 2008)

- Canadian Legal Information Institute. Federal Statutes and Regulations: Consolidated Statutes of Canada. *Fisheries Act*, *R.S.C. 1985, c. F-14*. (http://www.canlii.org/ca/sta/f-14/ -- date accessed: April 2008)

- McGee Lake Watershed Protected Water Area Regulations, http://www.canlii.org/ns/laws/regu/2005r.209/20080314/whole.html

B. Other References for Canadian Jurisdictional Statutes and Regulations

- Government of British Columbia. *Drinking Water Protection Act [SBC 2001] Chapter 9.* (http://www.qp.gov.bc.ca/statreg/stat/D/01009_01.htm - date accessed: April 2008)

- Government of British Columbia. *Environmental Management Act [SBC 2003] Chapter 53*. (http://www.qp.gov.bc.ca/statreg/stat/E/03053_00.htm - date accessed: April 2008)

- Government of British Columbia. *Environmental Management Act: Municipal Sewage Regulation* [includes amendments up to B.C. Reg. 132/2006, May 18, 2006]
- (http://www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/129_99.htm - date accessed: April 2008)

- Government of British Columbia. *Water Act [RSBC 1996] Chapter 483. (*http://www.qp.gov.bc.ca/statreg/stat/W/96483_01.htm - date accessed: April 2008)

- Government of Prince Edward Island, Regulatory and Appeals Commission. April 6, 1993. Prince Edward Island Municipal Water & Sewerage Utilities General Rules & Regulations. (http://www.irac.pe.ca/utilities/document.asp?f=wsrandr.asp - date accessed: April 2008)

- Yukon regulation in effect as of September 2007, see news release: http://www.gov.yk.ca/news/2007/07-186.html

Associations and Organizations with Research and Other Material relevant to the Water Sector

- American Water Works Association, http://www.awwa.org/

- Canadian Water and Wastewater Association, http://www.cwwa.ca/

- Water Environment Federation, http://www.wef.org/Home

- American Water Works Research Foundation (AwwaRF), http://www.awwarf.org/

- CCME National Strategy for Municipal Wastewater Effluent, http://www.ccme.ca/ourwork/water.html?category_id=81

- Canadian Standards Association Guidelines for grey water reuse systems, Sustainable Building (http://www.csa.ca/sustainablebuilding/Default.asp?language=english - date accessed May 2008)
- Tree Canada, http://www.treecanada.ca/index_e.htm

Tools, Manuals and References from Non-Government Organizations

- Rapid Watershed Planning Handbook, Centre for Watershed Protection, http://www.cwp.org/
- CITYgreen by American Forests (tool for assessment of the ecological and economic benefits of trees), http://www.americanforests.org/productsandpubs/citygreen/
- Metcalfe and Eddy's Wastewater Engineering: Treatment and Reuse
- Bertrand, V., Integrated Watershed Management Planning (IWMP) and Infrastructure Investments in Canada, 2007, prepared for Infrastructure Canada and Environment Canada.
- Sierra Legal Defence Fund (2006) "Water Proof 2: Canada's Drinking Water Report Card"

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APPENDIX C

Exemplary Community Profiles

Okotoks, AB, Water Sector Profile	
Overview of Why This Community is Exemplary	Okotoks has capped growth in recognition of the carrying capacity of its watershed; specifically, the limited water supply and assimilative capacity of the Sheep River. The decision was made to live within local limits versus extending those limits by bringing in water from beyond the watershed. (Similarly, Okotoks will not provide water to other municipalities.) There is a strong commitment to sustainability in infrastructure planning/design/upgrades and in approaches to accommodating new development.
General Community Description	• Population size of municipality: **Close to 20,000 as of Dec ’07 (2006 census data is 17,145)** • Population dynamics: **Fast growing** – town will likely be fully built out to permitted maximum of 30,000 within 6 years, which is 3-4 years ahead of anticipated • Location (remote, rural, peri-urban, contiguous urban): **Urban** • Geographic setting: **Prairie (drought-prone)** • Primary economic base: Approximately 65% of workforce commutes to Calgary; local jobs are in service sector & light manufacturing
Jurisdictional Context	• The Alberta government (via the Water Act) sets allocations for withdrawal, and licensing conditions. It does not recognize quality/volume of return to basin in establishing withdrawal limits. • South Saskatchewan River Basin Management Plan prohibits further shallow wells or withdrawals from basin. (Relates to obligation to maintain minimum flow into SK.) • Okotoks participates in the Calgary Regional Council, Bow River Basin Council, and the Alberta Water Council on issues regarding watershed management and advocacy on behalf of small municipalities.
Description of Relevant Sectoral Conditions and Challenges	<u>Characteristics of Water Resources</u> • Drought-prone region with long low-flow period (e.g., 12 week period without rain in 2007) • Drinking water source is shallow aquifers (30 ft) adjacent to Sheep River • 100-year flow records show huge decrease in volume in Sheep R, so assimilative capacity is also severely constrained • Okotoks is downstream of 2 communities also dependent on Sheep R for water <u>General Characteristics of Existing Infrastructure</u> • 9 licenced wells with total current allocation of 608 million gal/yr; ap 850 million gal will be required to meet build-out target • Pumping capacity (from wells to reservoir) is 1522 gal/min • 7 storm sewer outfalls into Sheep River • Fully metered • Especially with impacts on revenues from lowered consumption levels (due to efficiency/conservation), Okotoks must manage carefully to ensure sufficient future revenues to support infrastructure life cycle costs.
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	• Municipal development plan caps growth at 30,000 based on available water supply. • Council has been consistently committed to population cap for over 10 years, through three elections – representatives and residents (whose input has been sought through extensive survey work) know that Sheep R can’t give more. • Target of 70 gal/pp/day

Okotoks, AB, Water Sector Profile	

Defining Features of Plan/Approach	**Okotoks Water Management Plan**
	• Water Management Plan (WMP) was completed by WM Task Team in 2002 and updated in 2004 and 2006, including status updates for specific goals.
	• WMP focuses on potable and wastewater, with no provision for storm water management.
	• WMP's eight major goals (each with specific strategies and actions) are:
	  • Ensuring reliable supply using existing infrastructure and scheduled expansion
	  • Operation of an efficient utility
	  • Life cycle maintenance and recapitalization
	  • Utility rate restructuring
	  • Municipal bylaws and wise use of water resources
	  • Provincial legislation and water use
	  • Public information and education
	  • Evaluation of goals and activities of the WMP.
	
	Other:
	Recognition that even with cap, growth could only be accommodated if wastewater treatment was improved.
	Municipality is taking water limitations into account in implementing its goal of boosting C&I from 13 to 22%: will only accept low water consumption industries with demonstrated water conservation approaches.

Implementation and Current Status	• Per capita daily water consumption has been reduced to 72 gallons (273 liters) per capita. The town is on track to meet established target of 70 gal, and is on track to meet its 30% per capita water use reduction target • The sewage treatment plant has been upgraded (e.g., enhanced secondary treatment with ammonia and phosphorus removal); UV disinfection has eliminated use of chlorine and its toxic by-products. 70 to 80% of water removed is returned to the river. Upgrades will accommodate the built-out population. • Prior upgrades included in-vessel sludge composting using activated sludge. The resulting compost meets CCME Class A requirements. • A low-flow fixture by-law applies to all new developments. • Other requirements for new developments include landscape standards to decrease run-off/increase recharge – e.g. scarification of soil, 8 inches of loam. • A watering by-law controls summer irrigation and allows the reservoir to replenish overnight. Consideration is being given to further constraints. • Water and energy savings initiatives have been undertaken in all municipal systems and facilities. City using Exact ET service to trigger irrigation based on weather conditions (soil moisture) versus simple timer • The public education program is funded by the utility at $65 to $70K per year, for staff to do direct householder education, resulting in a lot of cooperation and support e.g. for watering restrictions. • A leak identification and repair program has reduced potable water leakage loss to about 5% • Moving to true user-pay: 90% consumption-based (single block rate), 10% flat rate (rates are comparable to regional average)

Okotoks, AB, Water Sector Profile	
	• Municipality is beginning to explore options of allocation transfers from industries in area to meet increased volume required for build-out population, and this may lead to collaboration to increase industrial efficiency The municipality is looking into treatment and use of storm-water, and into grey water use. Okotoks is encouraging the provincial government to consider return-flow credits in its allocation process. The sewage treatment plant upgrade was a PPP, saving the municipality a huge amount in up-front capital costs ($11.2 versus $30 million). Plant is municipally-owned, but EPCOR has 20 year operating contract. Capital costs were covered by an acreage charge paid by developers, municipal funding from the provincial government, and the municipality itself. The City received an FCM grant for the in-vessel composting system (which cost in the order of $2.6 million). The vessel-composted sludge is taken to a privately-run composting site for curing/blending. Municipality buys back resulting compost wholesale for its own landscaping.
Specific Best Practices	*Planning for Ecosystem Services and holistic Decision Making* - Okotoks has capped growth in recognition of the carrying capacity of its watershed; specifically, the limited water supply and assimilative capacity of the Sheep River (capacity is estimated at 30,000 people). The decision was made to live within local limits versus extending those limits by bringing in water from beyond the watershed. Similarly, Okotoks will not provide water to other municipalities. Okotoks has been very successful in engaging the community in conservation and planning activities, as witnessed by an 82% approval rate for capping population at the watershed's carrying capacity. *Advanced Sewage Treatment* - Biosolids resulting from treatment in the town's integrated wastewater treatment plant is being disinfected and composted at in in-vessel composting facility into a high quality product which is being used by the municipality in landscaping applications. The Okotoks wastewater treatment plant employs several advanced technologies, including biological nutrient removal, fine particulate filtering, and ultraviolet disinfection. Under a public-private partnership EPCOR has assumed responsibility for a recent $11.2 million upgrade to the treatment plant, as well as ongoing responsibility for water and waste treatment system operations, and maintenance and enhancement of the composting process.[189]
Key Barriers and How They Have Been Addressed	The town undertook an extensive public survey to determine the criteria that should govern the growth of their community. The recommendation of the people was that growth should be limited by the carrying capacity of the Sheep River, their water supply. This decision has been challenged and has withstood three successive municipal

[189] See http://www.okotoks.ca/sustainable/Water/wastematters.asp for a description of Okotoks' treatment process, http://www.epcor.ca/Communities/Alberta/Operations/Water+Treatment+Plants/Okotoks/wtp.htm for a description of recent plant upgrades and Appendix A in this publication for an outline of Okotoks' relationship with EPCOR for wastewater services.

Okotoks, AB, Water Sector Profile	
	elections.
Lessons Learned	• Have the facts. Do an assessment and know where the water is going. • Deliver on direct responsibilities – e.g., reducing leakage from system. • Get community involved. Public education is key. It brought residents on side with population size cap, and with measures. • Keep provincial agencies (e.g., municipal affairs, environment) in the loop – be transparent.

Halifax Regional Municipality, NS, Water Sector Profile	
Overview of Why This Community is Exemplary	Halifax Regional Water Commission (HRWC) is working to reduce leakage from its potable water system, and has become the first utility in Canada to adopt the International Water Association/American Water Works Association (IWA/AWWA) methodology for loss reduction. Halifax Regional Municipality (HRM) has recently transferred responsibility for stormwater and wastewater to HRWC, forming the country's first combined water, wastewater and stormwater utility. HRM is taking action to improve water quality in the Halifax harbour under the Harbour Solutions Program. Finally, HRWC is taking progressive action with regard to the security of its potable water system.
General Community Description	• Population size of municipality: **372858 (2006 Census)** • Population density per km^2: **68** • Population dynamics: Fast-growing urban/suburban/rural: **Urban core, large suburban/rural outlying area.** • Geographic setting (e.g., coastal, arctic, mountain, arid, etc.): **Coastal** • Primary economic base (agricultural, resource-based, industrial, service-based, mixed): **Mixed** • Per capita income (above, below or around national average): **Average**
Jurisdictional Context	• HRM encompasses the former cities of Halifax and Dartmouth and the over 200 outlying towns and neighbourhoods within Halifax County. • Water services are provided by the HRWC. The HRWC is an autonomous, self-financed utility, and the first regulated water, wastewater and stormwater utility in Canada. • The Nova Scotia Utility and Review Board (NSURB) exercises general regulatory supervision over all water utilities operating as public utilities within the Province. Its jurisdiction includes setting or approving rate schedules, which must take into account all costs, including infrastructure, operations and maintenance costs. In the case of HWRC, NSURB also regulates wastewater stormwater rates.
Description of Relevant Sectoral Conditions and Challenges	HRM relies primarily on surface water, with treatment plants operating at two major lake sources to supply its urban area. HRWC also operates seven small systems in outlying towns, including four groundwater source systems. Relative to other Canadian municipalities Halifax is an old city, making ageing infrastructure more of a concern than average. Much effort has been expended on reducing leakage in the HRWC potable water system, resulting in a significant reduction in treatment plant output (>25% in some areas). The wastewater treatment system includes four large wastewater treatment plants and nine smaller community plants. Rural residents are on private wells and septic tanks. There are three additional wastewater treatment plants being planned as part of the Halifax Harbour Solutions Project. This project is a response to poor water quality in the Halifax Harbour resulting from over 180 million litres per day of untreated storm, sanitary and combined sewer effluent entering the harbour. Storm sewer outfalls and Combined Sewer Overflows into Halifax harbour make stormwater and wet weather flow

Halifax Regional Municipality, NS, Water Sector Profile	
	management a high priority in HRM. As part of the Harbour Solutions Project, combined sewers are being separated in older parts of the city. Also, HRWC is presently charging customers a stormwater surcharge on their water bills (based on water consumption). It is anticipated that rates will become based on runoff amount pending the results of a stormwater cost of service study.
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	<u>Vision</u> HRM is in the process of establishing a Water Resources Strategy as part of regional planning exercise. This strategy includes a Stormwater Management Strategy (lead by HRM), a Wastewater Master Strategy (lead by HRWC), and a Water Quality Master Plan (WQMP, lead by HRWC). The WQMP sets out goals and objectives for next 25 years, outside of what regulators require at present. This will allow HRWC to stay ahead of, or react quickly to future regulations, and will increase the likelihood that equipment installed in the near future, particularly in water treatment plants, will meet regulatory requirements to the end of its service life. For example, plants are currently being designed to meet a standard of 80 parts per billion (ppb) for trihalomethanes (the U.S. standard), rather than the less stringent Canadian standard of 100 ppb.
Defining Features of Plan/Approach	Because there is an abundance of water sources within HRM that are easy and inexpensive to access, HRWC is focusing on system efficiency (*i.e.* loss reduction and combined sewer separation) for potable and wastewater rather than more expensive conservation techniques such as fixture replacement or greywater reuse/recycling.
Specific Sustainability Best Practices	1) *Metered Districts / IWA/AWWA methodology for loss reduction* - Halifax Water was the first utility in North America to adopt the IWA/AWWA methodology for real loss reduction in its distribution systems. As of early 2006, HRWC had reduced leakage in the Dartmouth system by 16 million litres/day, with a corresponding plant output reduction from 59 to 43 million litres/day. HRWC used the same methodology to reduce system input by 18 million litres/day in the Halifax system. The total leakage reduction of 34 million litres/day represents annual savings of $550,000. In addition to direct savings, the customers see increased public health protection and reduced service disruption and property damage as leaks are now found in a proactive manner. The creation of district metered areas (DMAs) has resulted in the largest portion of savings. Although DMAs have sometimes required a large effort to set up, they have been found to be an invaluable tool, allowing staff to pinpoint areas with abnormal off-peak use, suggesting high losses. HRWC has adopted a holistic methodology for leakage reduction which includes fast, high quality repairs; asset management and pressure control in addition to leakage detection. Advanced pressure management and off-peak pressure reduction is HRWC's next target area. Pressure management activities have not caused a noticeable spike in main replacement, although main replacement has increased from a historical average of approximately 0.4%/yr, with a goal of 1.2%/yr, in order to keep pace with infrastructure reaching the end of its useful life.

Halifax Regional Municipality, NS, Water Sector Profile	
Specific Sustainability Best Practices (cntd.)	Research conducted through the American Water and Wastewater Association Research Foundation (AwwaRF)[190] has set an International Leakage Index (the ratio of total system losses to unavoidable losses) of 3.5 as an approximate economic level of leakage for the Halifax system. HRWC feels that there are some instances where the economics of reducing leakage below this level are attractive.This loss reduction methodology should be highly replicable, as the age of Halifax's infrastructure likely presents a larger challenge for loss reduction programs than might be experienced in municipalities with more recent infrastructure. 2) *Harbour Cleanup* – The Halifax Harbour Solutions project will address untreated storm, sanitary and combined sewage outfalls to the harbour. The project has been designed so that specific goals such as the swimming and shellfish consumption can be met for various areas of the harbour. Major capital projects undertaken involve the construction of a sewage collection system, three advanced primary treatment plants, and a biosolids processing facility. It is anticipated that the three new treatment plants may be required to upgrade to secondary treatment, and reduce overflows in order to meet anticipated Canada-wide Strategy for the Management of Municipal Wastewater Effluent and National Performance Standards. In light of the large assimilative capacity of the Halifax harbour and surrounding ocean, HRWC is presently concentrating on wet weather flow reduction, instead of upgrading to secondary treatment. The biosolids disposal/ processing plant will service the three new plants and existing plants. Processed biosolids will be land-applied. A sewer use regulation through NSURB helps ensure high-quality biosolids. Under this regulation (formerly a HRM bylaw) users who are unable comply with pollutant concentration standards (*i.e.* breweries) are assessed a surcharge based on concentration levels. The Harbour Solutions project is jointly funded to a total of $333 million dollars by federal, provincial and municipal governments, the latter by way of a pollution control levy on HRM resident's water bills. It is expected to be totally completed in 2009, although many components are completed at present. Assets will be transferred to the utility when upon completion. 3) *Combined Water Utilities / Financially Independent Water Utilities* – In 2007, the Halifax Regional Water Commission assumed responsibility for HRM's wastewater and stormwater assets. This merger is expected to increase system and resource use efficiency, provide increased financial stability, and will allow for integrated long term planning in areas such as infrastructure renewal and environmental compliance. This initiative was driven by a large local infrastructure deficit, (calculated at $600 million without considering future growth or regulations). Because HRWC had been successful in long term planning and asset management as an independent potable water utility (based partially on its freedom from the political responsibilities associated with election cycle timelines), HRM decided that stormwater and wastewater should be added to HRWC's responsibilities. The merger

[190] In particular, AwwaRF report #2928

Halifax Regional Municipality, NS, Water Sector Profile	
	also meant that stormwater and wastewater services in HRM became regulated by the NSURB, relieving council of the responsibility of approving rates for these services. NSURB ratemaking process is transparent and logical, with no discrimination for different customer classes (*i.e.* Commercial *vs.* Residential). Rates take into account cost causation principals and must be cost neutral including a specified level of return. In addition, the utility is not allowed to extend an existing system by increasing rates for existing customers, meaning that developments must pay for increased infrastructure.
Other Notable Practices and Approaches	• As a port city with a large military population, HWC has made system security a priority. A risk assessment was completed in 2002 for the potable water system using an AwwaRF methodology, and second assessment is scheduled for the system, along with a first assessment for the wastewater system. HRWC employs a full time safety and security coordinator. Although this is an established issue for HRWC, it is likely to be an emerging issue for other municipalities. • HRWC has constructed a pilot water treatment plant within the existing Pockwock treatment plant. Research will be conducted in this pilot plant as a component of the Water Quality Management Plan. A partnership with Dalhousie University to perform research at the plant through an NSERC research chair has been established, as has a relationship with the Canadian Water Network. • An internal corporate performance scorecard is used to measure performance. This is presently being done for the potable water system, but will be expanded to wastewater and stormwater. The scorecard consists of eight critical success factors with specific goals: o High quality drinking water – *i.e.* goals for bacteriological tests for coliforms and results of customer surveys (85% good or excellent water quality) o Environmental stewardship – *i.e.* number of businesses checked for compliance with regulations, customer survey results for pollution prevention compliance o Service excellence – service customer survey results, number of service outages (water and wastewater) o Responsible financial management – *i.e.* goals for expense/revenue ratio (Includes revenue from leveraging assets, land leasing, consulting work, and full time large customer monitoring) o Effective asset management – *i.e.* system ILI ratio& sanitary inflow/infiltration levels. o Regulatory compliance – *i.e.* number of environmental and public health infractions leading to written order, and number leading to convictions o Motivated and satisfied employees – *i.e.* average number of employee days absent, number of jobs filled from within, number of grievances o Safe and secure workplace – *i.e.* number of labour infractions leading to written warnings, number leading to convictions, number of lost time accidents.

Halifax Regional Municipality, NS, Water Sector Profile	
Barriers and Lessons Learned	Funding: underground infrastructure is not visible, and is therefore often not a high funding priority. HRWC has found that there must be dedicated funding for infrastructure, especially underground infrastructure. Achieving public buy-in: HRWC (and previously HRM) found it difficult to achieve buy-in buy in for costly, long term projects. HRWC has found that getting buy-in is easier for water (where something is physically received), than wastewater (where only the service of removal is received). Transparency and tools such as customer feedback surveys have helped build a trusting relationship between the utility and customer Political drivers for water services: The main barrier and identified by HRWC was political will to run water utilities in a financially sound manner, including a tendency to think within election-cycle timelines when making infrastructure management and rate decisions. Utility Integration and subsequent transferring of rate setting responsibility to the NSURB has addressed this in part.
Moving Forward and Upcoming Trends	• Stormwater: will likely move toward a user-pay system. HRM will continue to separate combined sewers in older areas. • Land use issues: CCME guideline will not allow increased Combined Sewer overflow (CSO) events, so increased housing/density will require action to reduce CSO and sanitary overflows. This may require gradual on-site stormwater discharge. • Loss reduction: Activity is generally stable for HRWC, but the trend will be toward increasing activity in other municipalities. • System Security: Activity is generally stable for HRWC, but the trend will be toward increasing activity in other municipalities. • Utility Integration:

Sunshine Coast Regional District, BC, Water Sector Profile	
Overview of Why This Community is Exemplary	The Sunshine Coast Regional district (SCRD) has shown leadership in water conservation through technological means (an aggressive bathroom fixture replacement/rebate program, including free installation and a bylaw requiring ultra low-flow toilets in all new construction), management methods (lawn watering regulations, the development of a universal metering master plan), operations and maintenance activities and community outreach (promotion of water efficiency self-audits, and a xeriscaping demonstration program). The SCRD also performs yearly long term planning exercises by updating its 10 year Water Master Plan. Demand management activities within the SCRD are driven by challenges in maintaining an adequate supply of water to residents throughout the year, and by a high marginal cost for new water supply.
General Community Description	• Population size of municipality: **27,759 (2006 Census)** • Population density per km^2: **7.3** • Population dynamics: Fast-growing urban/suburban/rural: **Largely rural with several small towns and settlement areas. 8.4% growth from 2001 – 2006.** • Geographic setting (e.g., coastal, arctic, mountain, arid, etc.): **Coastal, no road access** • Primary economic base (agricultural, resource-based, industrial, service-based, mixed): **Mixed** • Per capita income (above, below or around national average): **Slightly Below Average**
Jurisdictional Context	• The Sunshine Coast Regional District (SCRD) encompasses the Town of Gibsons (pop. 4182), the District Municipality of Sechelt (pop. 8454) as well as several settlement areas and The Sechelt Indian Government District (SIGD). SCRD does not have jurisdiction over the SIGD, although a representative of the SIGD does sit on the SCRD board. Due to its mountainous terrain, the SCRD is accessible only by airplane or ferry from the reset of Mainland B.C. • Water services are provided by the SCRD. The town of Gibsons administers its own drinking water and wastewater treatment, distribution and collection systems. Gibsons obtains the majority of its water independently and purchases additional bulk water from SCRD. Staff from Gibsons and the SCRD often collaborate in order to maximize resource use. Joint projects include xeriscaping demonstrations and educational material, and adopting of a common lawn watering bylaw. • Water and sewer rates are set by the SCRD board of directors.
Description of Relevant Sectoral Conditions and Challenges	SCRD relies primarily on surface water, with approximately 90% of drinking water coming from a single source, Chapman Creek. Historically, treatment of this source has been minimal, but due to seasonal quality concerns, as well as concern over the potential for waterborne diseases, the Chapman Creek Water Treatment Plant was constructed, and came into operation in 2004. The water treatment process consists of chemical injection and rapid mixing, coagulation and flocculation, clarifying by floatation, filtration and disinfection. Ultra violet light is used as the primary disinfection system followed by chlorine disinfection. Four smaller surface water sources and four small groundwater sources are also in use. Monthly bacteriological tests are conducted and made public. In addition to water resources managed by SCRD, there are numerous small private wells, a number of private high capacity industrial wells and a small number of volunteer run small water distribution systems located within the District. SCRD has recently taken

	over responsibility for two small distribution systems in light of ongoing water quality and management issues. The wastewater treatment system includes twelve wastewater treatment facilities of varying vintages and obtaining various treatment levels. New treatment plants are required to meet an effluent standard of 10 mg/L for both Biological Oxygen Demand and Total Suspended Solids for ocean outfalls[191] and are typically constructed and run by developers on a one year bond, at which point the asset is transferred to the District. A sewage use charge is levied against properties connected to treatment facilities (covering operation and maintenance costs) and a frontage charge is levied against properties within each service area in order to build a reserve fund for infrastructure replacement. Private septic systems are prevalent throughout the District. SCRD has a legacy of older buildings receiving un-metered water service. Despite seasonal water quantity concerns and significant conservation efforts, SCRD's water consumption remains near the Canadian average at approximately 600L/capita (from all sources)[192]. SCRD now requires metered service for all new residential construction, as well as all non-residential properties. Although the idea of moving to a fully metered system has encountered political resistance, a voluntary metering program is in the process of being developed and the region's water rate bylaw is being reformed in order to facilitate the transition to a fully metered system.
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	• SCRD has completed a 10 year Water Master Plan Framework, which was recently expanded to include one of its component areas, Regional District Electoral Area A. Area A had previously been serviced by small private systems, but a significant portion of water services are now provided by SCRD following transfer of two of the larger private systems to SCRD control. • SCRD also completed a Universal metering master plan in 2003. This plan includes lifecycle costing and a cost-benefit analysis for remote and mobile metering options. An update of the 10 year Water Plan, expected to be completed in 2008, will re-examine the metering issue. • SCRD staff cite water conservation programs as a major factor in fostering a conservation ethic among citizens. Public participation and response to these initiatives, especially the bathroom fixture replacement program, has been far beyond expectations.[193]
Defining Features of Plan/Approach	• SCRD's present conservation programs (see below) are much more aggressive than in the past, and are more proactive than other communities. This aggressive stance is justified by seasonal water quantity concerns and a high marginal cost for new water supply. An emphasis on conservation programs such as fixture replacement has been easier to accomplish than measures such as metering for political reasons.

[191] Meeting this standard generally requires tertiary treatment.

[192] According to Environment Canada's 2007 Municipal Water Use Report, the Canadian total average daily flow was 609 L/capita in 2004.

[193] The SCRD reports that 45-50% of eligible customers have participated in the bathroom fixture retrofit program.

Sunshine Coast Regional District, BC, Water Sector Profile	
Specific Sustainability Best Practices, and Key Tools for Sustainability	1) *Bathroom Fixture Retrofit Program* - Fixture replacement is central to SCRDs conservation efforts. SCRD's program not only provides free efficient bathroom fixtures, but also provides free installation and disposal/ material recycling service for replaced toilets. The program retrofitted 2100 bathrooms in 2006 and 1900 in 2007, realizing water consumption reductions of approximately 75 L/capita per day for retrofitted households. This program allows residents to swap out up to 2 of their old 13+ litre toilets for a new dual flush toilet at no charge. The package also includes free installation of a low flow showerhead and a low flow faucet aerator. These savings were achieved with minimal additional burden to staff, as a private partnership was established with Sustainable Solutions International to supply and install fixtures, share administrative duties, and perform basic marketing activities. SCRD estimates that the program has cost between \$1540 and \$2200 per cubic meter/day saved. This compares favourably with SCRD's estimated marginal cost for new water supply of \$1700 - \$4000 per cubic meter/day (net of operating costs). In addition to the fixture retrofit program, SCRD has passed a bylaw requiring ultra low-flow toilets in all new construction. 2) *ICI Water Efficiency Awards/Assessments* – SCRD has implemented a Water-Wise program to encourage water efficiency self-audits for Industrial, Commercial and Institutional customers. The program will be formerly launched in the spring of 2008, with a successful pilot program completed in spring 2006, and program development activities continuing through 2007. The program combines support for water efficiency self-audits with a four-tiered awards structure. Customers perform a self audit to determine if they qualify for, or would like to qualify for a bronze, silver, gold or platinum award. Once any necessary retrofits necessary to achieve award status are completed, an SCRD employee will perform a mini water audit to verify efficiency levels. 3) *Outdoor Use Reduction/efficiency Initiatives* - SCRD maintains two xeriscaping demonstration gardens, one of which is administered in partnership with the town of Gibsons and a local non-profit. Initiatives to promote reduced outdoor water use include providing educational information on xeriscaping and local drought-resistant plants. SCRD is also exploring the development of a water wise garden award, which would have a similar structure to the ICI water efficiency award. SCRD has also passed a bylaw restricting outdoor lawn watering, and is in the process of creating a bylaw that will require permitting and minimum efficiency standards for outdoor irrigation systems, with a goal of reducing peak water demand. **Other Notable Practices and Approaches** • Stormwater management activities: SCRD has initiated Integrated Stormwater management plans for three areas with specific stormwater management concerns: Robert's Creek, Elphinstone and West Howe Sound. These plans may be expanded to other areas dependent on results. This joint project is being undertaken by the planning & infrastructure departments of the SCDR and the B.C. Ministry of Transportation and will deal with stormwater management issues at the building permit and development sages. It will attempt to find engineering solutions for known stormwater management problems, and prevent future stormwater

Sunshine Coast Regional District, BC, Water Sector Profile	
	management issues by bridging the regulatory gap between building permitting and subdivision build-out stages. • Promotion of residential self-audits: SCRD provides a home self-audit checklist, and provides support to customers upon request.
Key Barriers and How They Have Been Addressed	Barriers for water conservation activities in SCRD include: • Lack of dedicated staff - file must be shared among individuals as time permits. Staff have requested additional conservation / education funding from the SCRD board. • Public perception of abundance & General lack of public understanding of system, infrastructure, and capacity issues – Public education initiatives have been undertaken. • Absence of political will to implement some efficiency measures (i.e. universal metering) – Staff have concentrated on other efficiency measures (i.e. fixture replacement), while also attempting to secure outside funding for metering initiatives. • Lack of reliable consumption data - monitoring progress has been difficult in a system that is not fully metered, specific evaluation procedures have been designed for projects where evaluation was necessary or of particular value.
Lessons Learned and Partnerships	Partners include: • The Town of Gibsons – Shared programming (*i.e.* xeriscaping demonstration garden) and policy development (*i.e.* lawn watering bylaw) • Sustainable Solutions International – Delivery of bathroom fixture replacement program • Evergreen (Vancouver) – Xeriscaping support General lessons for the delivery of efficiency programs include: • Programs should be as simple as possible. Participation for the bathroom retrofit program was approximately 470% higher than for a previous rebate program with a comparable financial incentive level. This improvement is attributable to the low level of customer responsibility for logistical coordination and paperwork. • Operations must be efficient for partnerships with private entities to remain profitable. In the case of the fixture retrofit program, this meant coordinating replacements geographically to maximize the number of replacements per installer per day. • As part of the roll out for programs engaging the public (especially those offering free goods or services), prepare for a spike in inquiries, and have additional staff or systems in place if possible. • Partnerships are important, especially for small municipalities with limited human and financial resources. These partners can include NGOs, community groups and corporations.
Moving Forward and	Future activities for SCRD include:

Sunshine Coast Regional District, BC, Water Sector Profile	
Upcoming Trends	• A move toward universal metering – this is seen by SCRD staff as the last “low hanging fruit” in terms of conservation. • Revisions to the water rates bylaw to allow for metered service (in progress). • Creation of a full Water Use Efficiency Plan and associated financial plan for delivery of services • Updated capital and financial planning • Expansion of the bathroom fixture program to ICI customers – preliminary data suggests that each ICI retrofit will save an amount of water equivalent to six residential retrofits. • Formal launching of the ICI efficiency awards program • Exploration and study of the predicted effects of climate change on the SCRD water system Applicability to other municipalities: • Similar water efficiency programming should be transferable to other communities with high marginal costs for water system expansion, but are not likely to have feasible economics in communities with inexpensive water from a plentiful source.

Region of Waterloo, ON, Water Water Sector Profile	
Overview of Why This Community is Exemplary	Regional Municipality of Waterloo Region (RMW) is a leader in protecting source water and implementing water efficiency measures. It faces unique challenges as one of the few large urban centres in Canada that is mainly dependent on groundwater.
General Community Description	• Population size of municipality: **478,121** • Population density per km^2: **349.3** • Population dynamics: Fast-growing urban/suburban/rural: **Mainly urban, with significant rural agricultural areas 9% growth from 2001 – 2006 (Canadian Average: 5.4%). RMW is an area targeted for high growth under Ontario's Places to Grow Act.** • Geographic setting (e.g., coastal, arctic, mountain, arid, etc.): • Primary economic base (agricultural, resource-based, industrial, service-based, mixed): **Mixed, including significant agricultural activity in rural areas.** • Per capita income (above, below or around national average): **Slightly above average (2001).**
Jurisdictional Context	• The Region of Waterloo provides water supply and wastewater treatment services to seven lower-tier municipalities including the cities of Waterloo, Kitchener and Cambridge and the townships of North Dumfries, Wellesley, Wilmot and Woolwich. These constituent municipalities work together on issues such as potable system distribution losses, but have different councils, and hence different priorities. • The Region is responsible for water supply and wastewater treatment plants. The Region is not responsible for stormwater management. Regional staff has the ability to provide consistent guidelines (*i.e.* standard design guidelines) for municipalities, but municipalities are ultimately responsible for their local water distribution and wastewater collection systems including operations and maintenance activities such as leak detection and prevention. • The province of Ontario now requires source water protection and full cost accounting for water and wastewater services under the Sustainable Water and Sewage Systems Act
Description of Relevant Sectoral Conditions and Challenges	Approximately 75% of the Region's municipal water supply is from groundwater. The system comprises a network of 113 supply wells operating in multiple aquifers throughout the region. Monitoring these wells for source protection purposes is a major challenge. The Grand River is the source for the remaining 25% of supply. The wastewater system includes 13 wastewater treatment plants and several wastewater pumping stations. Rural residents are on private wells and septic tanks. Source protection is a critical issue, in particular with respect to agricultural sector activities. Water supply capacity is also a critical issue. The Region's approach for growth involves increasing water supply by building a pipeline to Lake Ontario by 2035. Until a pipeline is built, the Region will emphasize conservation in order to allow population growth while utilizing existing sources. This approach has been successful thus far; consumption has remained stable in recent years despite significant population growth.
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	<u>Vision</u> The *Long Term Water Strategy* (LTWS) was initiated in 1991, adopted in 2000 and revised in 2005. The core objective of the strategy is to ensure the adequate supply of water to Waterloo Region until the year 2041. This strategy has been championed by regional staff and adopted by council. The LTWS incorporates other plans, such as the Water Resource Protection Strategy and the Water Efficiency Master Plan.

<table>
<tr><th colspan="2">Region of Waterloo, ON, Water
Water Sector Profile</th></tr>
<tr><td></td><td><u>Key Objectives of Plan/Approach</u>
The strategy aims to: make efficient use of existing water supply infrastructure; make best use of local water resources; defer the need for significant capital expenditures; and provide the flexibility to adapt to changing water demands in the future. The strategy works on a 10 year planning horizon, and annual updates are part of the Region’s normal operating process. Regional council has committed to fully updating these plans on a 5 year cycle.

Decisions have been made by examining high-level financial factors, as well as social and environmental costs and benefits. Full financial costing is done after examining financial, social and environmental costs and benefits at a high level.

There is also:
➢ A Water Resources Protection Strategy that includes planning policies to limit high-risk business development near municipal water supplies, and financial incentive programs for existing businesses and farmers to carry out appropriate actions; and
➢ A Water Efficiency Master Plan with a water reduction target of 8,200,000 L/Day by the year 2015

<u>Relationship to Other Major Municipal Policies/Plans</u>
The 2005 update of the LTWS addressed the new growth strategy as outlined in the Regional Growth Management Strategy (RGMS) Plan, and recent legislation and regulatory changes. The strategy includes aquifer storage, additional groundwater sources and a pipeline from either Lake Erie or Huron.</td></tr>
<tr><td>Defining Features of Plan/Approach</td><td>• Long term, comprehensive planning
• Emphasis on groundwater protection
• Extensive public education and school curricula initiatives[194]</td></tr>
<tr><td>Implementation and Current Status</td><td><u>Status of implementation</u>
• The LTWS has recently been updated.
• The aquifer storage system is constructed and in use.
• A variety of initiatives are in place to improve water efficiency/conservation (e.g., toilet replacement rebate program, outdoor water use by-law, rain barrel program), and protect water quality (e.g., a sewer use by-law, education for salt reduction).
<u>Steps taken to ensure any necessary behaviour-change/compliance</u>
• Bylaws control new well locations and planning tools can specify conditions for development
• Financial incentives are offered for the purchase of efficient technologies (residential and ICI), as well as for source protection (agricultural and business incentives).
• Educational and community programs emphasize water conservation and groundwater protection</td></tr>
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[194] See http://www.region.waterloo.on.ca/web/region.nsf/8ef02c0fded0c82a85256e590071a3ce/cb8a51755e81904b85256c140048e3d4!OpenDocument for details

Region of Waterloo, ON, Water Water Sector Profile	
	<u>Sources of funding</u> The majority of programming discussed below receives rate-based funding, although Regional Development Charges have been employed to recover costs when new developments give rise to the need for additional growth-related infrastructure.
Specific Sustainability Best Practices	1) *Aquifer Storage and Recovery*: The ASR system consists of a series of specially constructed wells that allow the injection of water treated at the Mannheim Water Treatment Plant (WTP) into the ground during periods of low water demand (fall, winter, early spring) and storage of this water in the deep aquifer for recovery during periods of higher water demands (summer). The ASR installation at the Mannheim WTP is the first use of aquifer storage and recovery technology in Canada. The first phase of the ASR facility consists of four injection/recovery wells and two recovery wells, (implemented 2004 and 2005) at an estimated total cost of $7 million. 2) *Municipal Rainbarrel program* - The purpose of the rainbarrel program is to increase water efficiency awareness along with reducing peak water demand. Rainbarrels were made available to residents for the subsidized cost of $20 each. Marketing was done via newsprint, radio, posters, home shows, Internet and mailings. Word of mouth was also a significant advertising tool. 3) *Smart about Salt* – Chloride levels in particular are rising in the Region's water; both chloride and sodium levels are rising in urban and rural municipal wells. The Region is working with local municipalities to reduce road salt, and has an education and outreach program for salt reduction by residents and businesses, in particular snow contractors. This program is administered in partnership with lower-tier municipalities. 4) *Groundwater Protection Initiatives* - The Rural Water Quality Program works with rural landowners and farmers to avoid both ground and surface water contamination, offering grants of up to $25,000 per farm for projects such as those to reduce impacts of manure handling and storage; chemical, fertilizer and fuel handling and storage; and inadequately maintained and constructed wells; the program coordinates with Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) for completion of environmental farm plans. The Business Water Quality Program grant program (now discontinued) worked with businesses to promote procedural and capital best management practices as well as facility reviews and assessments. 5) *Community Awareness and Educational Initiatives* – Highlights include curriculum material specific to water efficiency and groundwater quality preservation, and several prepared presentations on various efficiency and groundwater quality topics. There is also a new program for water audits of industrial facilities, run in partnership with municipalities and industrial clients.
Key Barriers and How They Have Been Addressed	• Resource Constraints: Not necessarily monetary, but rather constraints in terms of capacity to deal with projects that are broad in scope and increasingly complex. • Dealing with provincial government: difficulties in following processes lain out by the provincial Ministry of the Environment for initiatives such as aquifer storage (see above). These difficulties must be overcome by employing the best available scientific information and using industry experts as resources. The province has a role in addressing this barrier also in terms of its capacity to grant approvals or direction on emerging issues and technologies.

Region of Waterloo, ON, Water Water Sector Profile	
	• The Region has been identified by the province in its Places to Grow as a key center for population and employment growth. Accommodating provincial level planning targets within municipal resources has challenged the regional planning initiatives; targets for population have been met years ahead of original forecasts; this challenge has been met with an increased planning review frequency and discussions with the province. • Split jurisdiction between Regional and local municipal governments requires continuous management and will inevitably result in inefficiencies due to differing priorities among the various governments. (For example, some municipalities emphasize reduction of inflow and infiltration, others have no programs to address this issue; the Region must treat the wastestream it receives and has limited control over efficiency in terms of volumes of groundwater/ infiltrated water treated.
Lessons Learned	• Educational campaigns are a valuable tool. Using by-laws (such as the sewer use by-law) for context can help to show citizens what the impacts of their actions may be. • Social marketing tools have also been useful in changing public perception and actions, and in focusing educational campaigns.

Chelsea, QC, Water Sector Profile	
Overview of Why This Community is Exemplary	H2O Chelsea has an engaged community that participates in holistic measures to protect water and ecological functions. Community education is a key component of the approach. Ongoing water sampling and resident surveys are used to make policy decisions on water and land use. The municipality also provides resources to residents on treatment options should well sampling reveal any concerns. The goal is to help protect water sources and the ecological integrity of the municipal landscape.
General Community Description	• Province/Territory :Quebec • Population size of municipality: 6040[195] (2001); expected to be 7,081 by 2006, 7,544 by 2011, • and 8,009 by 2016. • Population dynamics (fast-growing, declining, stable) : stable with some growth (1.9% from 1996 to 2001); concern for aging population • Density: low density developments • Location (remote, rural, peri-urban, contiguous urban): peri-urban close to a national park site • First nations community? No • Primary economic base (agricultural, resource-based, industrial, service-based, mixed): mixed residential and agricultural with little industrial
Jurisdictional Context	Quebec municipalities are required to undertake or update a Master Plan every 5 years A Planning Act instrument in Quebec allows municipalities to zone blocks of land to conform with desired uses while meeting criteria developed by a municipality to ensure the development conforms with goals. Siting and Architectural Integration Plans[196] are a provision of Quebec's *Loi sur l'aménagement et l'urbanisme* (the provincial planning act). This approach provides quality control of projects using criteria developed for construction, development, and the integration of building projects into areas that are already developed. The Planning Act also allows Comprehensive Development Programmes (CDP)[197] (article 84). This planning tool can be used in the delimitation of development areas within the municipal territory; municipalities have the power to enact by-laws to protect and enable conformity with the desired development practices. A CDP allows municipal planners to assess each development request on a case-by-case basis in the areas covered by the CDP. Sensitive parts of the municipality may be developed subject to site-specific conditions without requiring overarching modification to town planning.
Description of Relevant Sectoral	General Characteristics of Water Resources and Existing Infrastructure: • Municipality is predominantly on private wells and septic systems • To remedy well water contamination due to defective private septic systems, overly small lots, and impermeable soil, the Municipality

195 All statistics for population and growth are sourced from the Chelsea Master Plan, available at URL: http://www.chelsea.ca/_files/635-05PU_Anglais.pdf

196 Description from CMHC report *Permitting Secondary Suites,* available at URL: http://72.14.205.104/search?q=cache:xl-j5mlK5wsJ:www.cmhc-schl.gc.ca/en/inpr/imhoaf/afhoid/pore/pesesu/pesesu_006.cfm+cmhc+Siting+and+Architectural+Integration+Plans+are+a+provision+of+Quebec%E2%80%99s+Loi+sur+l%E2%80%99am%C3%A9nagement+et+l%E2%80%99urbanisme&hl=en&ct=clnk&cd=1&gl=ca

197 For text of this Act, see URL: http://www.canlii.org/qc/laws/sta/a-19.1/20050211/whole.html

Chelsea, QC, Water Sector Profile	
Conditions and Challenges	built a wastewater collection and treatment system in one specific area (Mill Road sector) in 2003. • 100% reliant on groundwater; no alternative to groundwater • Uranium was discovered in the groundwater, affecting many private wells
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	• Chelsea's Master Plan identifies a vision for environmental protection and includes several protective By-laws • Chelsea's Mayor has an environmental outlook and strongly supports water resources protection • In addition, the community group ACRE - Action Chelsea for the Respect of the Environment – a local NGO, has a strong and dedicated volunteer network with a concern for water and environment protection. The University of Ottawa's Institute for Environment was also engaged from the beginning as a partner in delivering the H2O Chelsea program. The primary focus of the program is drinking water. • Monitoring and communication tools were designed and developed based on the *precautionary principle*: reduce groundwater consumption in order to avoid water shortages in the future, even in the absence of scientific data indicating that shortages are imminent.
Defining Features of Plan/Approach	• Due to the nature of the private system in Chelsea, there was a need for capacity building among the public to ensure water resource protection and to understand water.
Key Approaches/ Tools for Planning and Organizing for Sustainable Development:	*The Master Plan, By-laws and Other Tools* • Chelsea has developed a Site Planning and Architectural Integration Program by-law (SPAI) for a multipurpose centre with fairly generic criteria. These are expected to be applied to allow more dense development specifically to accommodate seniors' residential accommodation, something presently absent in Chelsea. • The development policy in the 2005-2010 Urban Plan sets a minimum lot size for housing development (4000sq.m) which allows for greater spacing between domestic wells and sceptic systems. Within the area for seniors housing, the minimum lot size is half this under the SPAI. • Chelsea has identified an Aquifer Protection Zone in response to hydrogeological information available • Within its Master Plan, Chelsea has instituted several land use restrictions and specific environmental protection measures to ensure the protection of people and goods as well as the environment, including: o Landslide Zones (this zoning by-law limits construction and establishes specific administrative and technical parameters for the granting of construction permits); o Flood Zones (to protect two categories of floodplains); o Waterfront Zones (to protect the ecological and biological components of the shorelines of lakes and waterways; this by-law mirrors the protective set-back provisions of the Quebec Ministry of Environment Policy Regarding Protection of Waterfront, Shores and Flood plains); o Wetlands (a Zoning By-law establishes which establishes setbacks and other standards governing any work performed in the vicinity of wetland areas to protect the biodiversity of the wetland areas and maintain their role as a natural filter and source of replenishment for the watershed). • A by-law has been developed to ensure that forested areas of the municipality are preserved. Clear cutting a property is illegal. Also, a wooded buffer zone of 4.5m must be preserved at the boundary of each lot if trees are present on the property before building begins. The municipality has the right to request that residents plant a buffer zone between properties.

Chelsea, QC, Water Sector Profile	
	• Chelsea has identified an Aquifer Protection Zone in response to hydrogeological information available • These and other by-laws work together to protect groundwater resources, in particular, a by-law concerning pesticides; the by-law to protect wetlands, and a regulation imposing new construction requirements for wells built in the municipality through permits and certifications • The Municipality has developed Comprehensive Development Programmes (CDP) to ensure that development or reconstruction occurring in the municipality will respect the cultural and ecological integrity (including groundwater) of the region. Chelsea's CDP was purposely written ambiguously so that municipal planners may establish unique requirements for a property that is to be developed, in order to achieve the intended environmental standards deemed important for the property in question. *H2O Chelsea* H2O Chelsea consists of two main components: ongoing water sampling and community education and outreach. It aims to maintain the area's high water quality by providing educational initiatives to residents. Wells are inspected and residents are surveyed to assess their water use. Results from the surveys are used to make policy decisions on water and land use. For example, results from a survey prompted Chelsea Council to require that developments on all parcels of land four hectares or larger must demonstrate that groundwater supply is sufficient to supply the proposed number of residences. Uranium in the water was discovered and scientific investigation into the extent and implications is on-going. The municipality provides resources to residents on treatment options should well sampling reveal any concerns. A communication and monitoring program and tools have been designed as alternatives to groundwater modeling (pump tests etc.), which are expensive. The monitoring tools and resources incur minimal costs to the municipality, yet are effective to increase public awareness of groundwater resources and the opportunities that exist for conservation. Monitoring of water quality takes place in creeks, lakes and homes. A static level program was in place for a short period of time to monitor aquifer level changes; the static level program was not as successful due to difficulties homeowners had in regularly accessing and exposing their well head areas and the high density of measurements needed to assess water level conditions in the highly fractured bedrock of the area.
Implementation and Current Status	• Since 2003, almost 1,000 wells have been inspected and more than 1,000 residents have been surveyed about their water use. • The H2O Chelsea program has been so successful and popular that Chelsea has identified a staff position to take the place of the volunteer coordinator. This was a condition of the volunteers at the outset of the program (i.e. that, if successful, the municipality would take over management of the volunteers). • Further, the regional municipality, which includes Chelsea and four other area municipalities has made a decision to adopt the program regionally. • Land use decisions have been affected. Requirements of developers have changed so that they must demonstrate that capacity for their proposed development is available. Another land use change resulted from creek monitoring results, which demonstrated the negative effects of cows in the water; the property owner (the National Capital Commission) subsequently prohibited cattle grazing on the field.
Key Barriers and How They Have Been Addressed	• An initial barrier was the knowledge gap of people in community with respect to awareness of water; conducted a survey to assess awareness. • Community members collect data; University of Ottawa assists in analysis of data; Council and community decision-making role. • The potential barrier of volunteer fatigue has been addressed by the municipality agreeing to identify a staff position to coordinate the program.

Chelsea, QC, Water Sector Profile	
	• Several surveys have been undertaken to assess public reaction and understanding of water-related issues. These were distributed in various ways: tax bill, newsletter, telephone interviews. Some surveys have had higher response rates than others; no clear pattern has been discernable in which surveys had high response rates and which did not (e.g. survey complexity does not appear to have been a factor in the success or not of a survey).
Lessons Learned and Partnerships	• Partners include: the municipality, the University of Ottawa and ACRE - Action Chelsea for the Respect of the Environment. The scientific capacity and third party review of data provided by the university was an important aspect of achieving residential buy-in since the university could provide scientific rationale for measures in a way that ACRE or the municipality could not. • The Mayor plays an active role in environmental stewardship and vision for the community; in addition, Chelsea has a high community capacity with respect to interest and concern for environmental issues • To date, H2O Chelsea has accrued more than $397,000 worth of funding, including $150,000 from the ***Fonds d'action québécois pour le développement durable*** (2004-2005), $40,000 from the ***North American Fund for Environmental Cooperation*** (2003-2004), $100,000 from the ***Municipality of Chelsea*** ($20,000 a year for 2003-2007), $70,000 from the ***CLD des Collines de l'Outaouais*** (2006-2007), $25,000 from the ***Walter and Duncan Gordon Foundation*** (2006) and $12,000 from Environment Canada's ***Ecological Monitoring and Assessment Network*** (2006). • Funding has been renewed and expanded by the municipality for 2008 • As mentioned above, the program will be rolled out regionally to four other local municipalities by the regional municipal government. • A program that runs on volunteers must respect the time taken and needed by the volunteers; for example, the static water level program was discontinued due to difficulties faced by homeowners in data collection.
Moving Forward and Upcoming Trends	• The municipality plans to require water meters in the planned higher density development in the centre village. Details have yet to be worked out with respect to meter reading and data management. • The H2O Chelsea approach has high potential for replicability; a grant from a non-government organization has been used by H2O Chelsea to develop generic materials for establishing and running similar programs.

Yellowknife, NWT, Water Sector Profile	
Overview	Yellowknife is taking steps to improve infrastructure to increase efficiency. It also faces challenges unique to cold climate conditions.
General Community Description	• Population size of municipality: **18,700** • Population density: **177.7/km^2** • Population dynamics: **13% growth between 2001 and 2006** • Location (remote, rural, peri-urban, contiguous urban): **Urban** • Geographic setting (e.g., coastal, arctic, mountain, arid, etc.): **Northern, extreme cold** • Per capita income (above, below or around national average): **Above national average, but with significantly higher living expenses.**
Jurisdictional Context	• NWT does not have full delegated authority from the federal government to manage water resources. • Water Boards play an important role in water allocation and wastewater permitting. The Mackenzie Valley Land and Water Board (MVLWB) provides water licences to the City of Yellowknife. • In addition, the territorial Department of Environment and Natural Resources is the competent authority for the reporting of spills.
Description of Challenges Specific to Cold Climate Conditions	• Dual water service lines: properties are serviced with two water lines – one that runs into the house to provide potable water and one that returns unused potable water back to the water distribution system. This design is needed to prevent freezing of water in the distribution system during the winter. Inside the buildings, each service has a bleeder valve to run the water to the drain when freezing does occur and the service line needs to be thawed (see following). • The water main system is looped for continuous flow at all times as a means of mitigating freezing frequencies. • Pipe Freezing: "Bleeder valves", which drain water from potable water pipes directly to sanitary sewers are often used during service thawing operations; these valves are located inside homes. When water services freeze, excavation is difficult and expensive and, in addition, access to inside the buildings to reconnect the service and discontinue the bleeder valve operation is often delayed for extended periods of time. • Water Heating: Potable water destined for the public distribution system is heated to approximately 10^{o}C using a boiler; this warmed water must be mixed with source water to avoid freezing within the system. • Sewage Treatment: The City's sewage treatment lagoon can only be discharged over a short period in the fall due to cold conditions and retention time requirements. The use of bleeder valves (see above) causes the sewage treatment lagoon to overtop because of the large amounts of (potable) water flowing to the facility.
Description of Other Relevant Sectoral Conditions and Challenges	• The potable water source is surface water. Water is currently piped 8 km from an inlet in the Yellowknife River. • The cold climate impacts water infrastructure design and operation. Given temperature extremes and rocky geology, some areas are dependent on trucked water and sewer services. • The sewage lagoon generally operates at or in exceedance of its capacity. It was constructed in 1981 and raised to the current elevation in 1987. Sewage treatment is accomplished in the lagoon itself (approximately 10 months detention time) and in the downstream wetlands/watercourse, which is part of the treatment finishing process. Effluent leaving the lagoon flows through approximately 13 km of wetlands area before reaching Great Slave Lake. The entire contents of the lagoon are discharged to the downstream catchment over a 6-8 week period in the fall. Sewage lagoon capacity is filled, in part, by bleeder valves used to avoid pipe freezing in the winter months. It is estimated that 20% of municipal potable water usage is due to the use of

Yellowknife, NWT, Water Sector Profile	
	bleeder valves. • A portion of the sewer system is combined stormwater/sewer. • Construction costs have recently been rising at a rate of approximately 10%/year. In many cases, Yellowknife must compete with Alberta for the services of qualified tradespeople.
Vision, Scope, Objectives and Anticipated Benefits of Plan/Approach	Yellowknife is updating its infrastructure to reduce non-revenue water, and to reduce the burden on the city's wastewater treatment lagoon, which often operates at or above capacity. Leak detection activities have recently reduced water consumption despite significant growth.
Defining Features of Plan/Approach	Yellowknife is currently updating its buried infrastructure to operate in its extreme climate in a more reliable and efficient manner. Specific projects include: • Enabling remote pressure and temperature monitoring to avoid water freezing. • Reducing the number of "bleeders", which continually run water from potable pipes into the city's sanitary sewer system to maintain flow and avoid freezing. • Replacing aging water and sewer mains with insulated pipes. The city is installing computerized meters able to accommodate automated or wireless metering. Allocation of capital funds has been made to complete the project. The computerized metering is expected to reduce labour effort by one person-year. Yellowknife is also expanding the lagoon system. The city is exploring mechanical aeration, physical-chemical manipulation to remove phosphorus or a sewage treatment plant to reduce loading into local waterways.
Additional Information on Specific Best Practices	"Healthy House" pilot project: This involves greywater reuse in an attempt to reduce the need for trucked water services. The Healthy House system is designed to treat all domestic wastewater (grey and black) on-site to a quality suitable for non-potable applications, such as clothes washing and toilet flushing. Five such systems were installed in public housing in Yellowknife in late 1998 and continue to be in operation. Improvements to piped water and sewer infrastructure: As part of the city's water and energy conservation program piped water and sewer mains that require upgrading are being replaced with insulated pipe, thus reducing pipe failure and lowering water consumption by 30 per cent. The city also identified critical areas for potential freeze up and monitors the water main temperature at those points, enabling the city to heat the water only every second or third day and cutting energy consumption by 64 per cent.

Dockside Green, Victoria BC, Water Sector Profile	
General Community Description	• Location : **Victoria, British Columbia** • Population: **2500 Residents at build-out** • Population density per km^2: **Approximately 40,000 (at build-out)** • Water source: **Capital Regional District municipal water (Obtained from a surface water source)**
General Information	Dockside Green is a mixed-use residential development presently under construction on 15 acres of former brownfield in the city of Victoria. The development incorporates several sustainable features falling under the water, energy, transportation and planning sectors, and is targeting LEED Platinum certification for all eligible buildings built as part of the development. Two particularly progressive practices are profiled below
BP1: Integration of climate change technologies/Stormwater Management.	Dockside Green will feature a naturalized waterway that will be used to treat stormwater. This waterway will be combined with underground storage and the majority of components are being built to handle a 100 year return storm event. Existing municipal stormwater infrastructure will not be used. The development also includes green roofs, terraces and vertical green walls on several buildings and abundant green space for infiltration.
BP2: Greywater Reuse / Technologies for water efficiency	Dockside will treat all sewage on-site. Treated effluent will be of suitable quality to use for non-potable applications, and will be used on site for toilet flushing, irrigation, and decorative water features. The sewage treatment plant will employ an integrated membrane bioreactor system and may incorporate heat recovery for use in space heating applications. This system will allow the development to avoid paying sewerage fees to the city of Victoria. It is anticipated that greywater re-use, combined with efficient technologies and real-time in-suite water metering and display will lead to a 60-65% reduction in water use compared with similar developments. Water efficiency measures include low flow fixtures, dual flush toilets, waterless urinals, efficient washing machines and in-suite digital water meters allowing residents to monitor use in real-time.
Contacts	Kimberly Stratford City of Victoria Planning & Housing Division Research Analyst Project Manager, Dockside Green (250) 361-0320 Jonathan Westeinde, Managing Partner Windmill Development Group Phone: (613) 820.5600 x158 jonathan@windmilldevelopments.com

End Notes

[i] Primary Sources for Table: Sierra Legal Defence Fund (2006) "*Water Proof 2: Canada's Drinking Water Report Card*", and AMEC for Ontario Ministry of Environment (2007 - unpublished) *A Jurisdictional Review of Best Practices Related to Drinking Water Issues*.
[ii] http://www.qp.gov.bc.ca/statreg/stat/D/01009_01.htm
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[xiii] http://www.gov.ns.ca/nse/water/docs/GroundwaterTreatment.pdf
[xiv] http://www.canlii.org/ns/laws/regu/2005r.186/index.html
[xv] http://www.canlii.org/pe/laws/regu/2004r.710/index.html
[xvi] http://www.env.gov.nl.ca/env/Env/waterres/policies/wq-standards-microbiological.asp
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[xviii] http://www.canlii.org/nu/laws/regu/p-23/index.html
[xix] http://www.canlii.org/nt/laws/regu/p-23/index.html
[xx] Regulation in effect as of September 2007, see news release: http://www.gov.yk.ca/news/2007/07-186.html
[xxi] http://www.canlii.org/yk/laws/regu/1999r.82/index.html
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[xxv] http://www.canlii.org/ab/laws/regu/1993r.119/index.html
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[xxxiii] http://www.canlii.org/on/laws/sta/o-40/index.html
[xxxiv] http://www.canlii.org/on/laws/sta/o-40/index.html (English version)
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[lxv] Government of Nova Scotia, *Developing a Municipal Source Water Protection Plan* (http://www.gov.ns.ca/nse/water/sourcewater.asp - date accessed May 2008)
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[lxxi] For an outline of activities under the Multi-barrier Strategic Action Plan, see http://www.env.gov.nl.ca/Env/env/waterres/Surfacewater/DWS-Report/2006/DWQ_Annual_Report_2006.pdf
[lxxii] http://www.pws.gov.nt.ca/pdf/WaterAndSanitation/WaterFramework.pdf