

# **Considerations for Source Water Protection in Ontario**

by

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## Abstract

Source water protection under the Ontario Clean Water Act (2006) emerged after the fatal *E. coli* outbreak in Walkerton, Ontario in 2000. It is the protection of raw drinking water at its source, and it is carried out at a local watershed and municipal level primarily through land use planning tools and stewardship in Ontario. The scope of source water protection is limited to anthropocentric considerations, and therefore it misses the opportunity to protect watersheds for the sake of ecosystem integrity and to conserve the many critical ecosystem services provided by watersheds. There are numerous threats to watersheds and other considerations that are not currently addressed by the regulation that undermine effective source water protection, such as groundwater quantity, urban growth, and existing contaminated lands. In addition, a jurisdictional gap has led to a water crisis in many First Nations communities, for whom contaminated source water is a primary concern. However, source water protection in First Nations communities is made difficult by external and internal threats, and as a tool, it is neither holistic nor aligned with traditional water management practices. Management of watersheds and water sources requires complex solutions and strong governance and institutions. Global freshwater resources are under unprecedented strain, and the lessons from Ontario can be emulated and expanded upon to achieve sustainability and ecosystem integrity.

## Foreword

I have always felt very connected to water, and have been interested in water issues for as long as I can remember. Perhaps my interest is rooted in my visceral connections to the Great Lakes and the cherished time I spent growing up with two of the Great Lakes in my backyard; Georgian Bay in the summer, Lake Ontario in the winter. The successive development and changes to the lakes have left me curious to understand more about what the impacts are to the ecosystem. This led me to study environmental policy for my undergraduate degree. I also majored in International Development, which stemmed from my curiosity for how the rest of the world lives, and how we interact through mechanisms of globalization. How people are left out of the benefits of globalization, and the continued fight to bring justice, fairness, and peace to the people of the world. For four years, I worked for an international youth-run organization, which gave me opportunities to work and travel abroad, while developing solutions to global problems with youth, businesses and NGOs alike. These experiences have all brought me to the MES program, where my interests remain at the intersection of environment and development. Particularly, my interactions with people around the world; law, policy and economics professors/literature; and visiting rapidly urbanizing settings, have left me curious about the management and planning processes of the world's resources.

During my undergraduate degree, I studied transboundary water issues at the Rothberg International School in Jerusalem, where I closely examined water management tools in the Jordan Basin in the context of complex historic, geographic, hydrologic, and political considerations. During my Master's degree, I had the opportunity to study water and

indigenous law at the Universidad de Concepción in Chile. These experiences provided me with a unique perspective of water management, and an innate understanding of the need for responsible source protection and planning. From witnessing worst-case practices—to learning about best-case practices, I have been left with a sense of urgency to protect our freshwater resources.

I wanted to bring my experiences home, and into a cumulative report that encompasses my interests and knowledge gained from these experiences. I decided to research watershed protection and source water protection policy tools, as it is exemplary of a proactive approach to environmental management – a welcomed change from the status quo of reactive policies. It encompasses land use planning, environmental policy, and resource management. Furthermore, we have development challenges of our own in Canada. Many of our First Nations peoples are living in what some have called “third world” conditions, and water degradation is a driver of this.

This final major research paper satisfies all three of my learning components in my Plan of Study: resource and environmental management, environmental law and policy, and land use and environmental planning

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*“Water management issues, often embedded in seemingly endless ecological, social and political interactions across temporal and spatial scales, are context-dependent, socially constructed and technically uncertain”*

- Ferreyra et al, 2008

## Introduction

On February 14<sup>th</sup> 1990, Voyager 1 took a photo that captured Earth from six billion kilometers away. The photo shows a cosmic array, with Earth making up just one tiny pixel of the photograph -- a tiny dot in vast space. The image inspired the name for Carl Sagan's seminal book, *Pale Blue Dot*. This portrait of our world and Sagan's reflection of our place in the universe is certainly awe-inspiring. The interconnectedness of our planet and our experiences had never been made so clear. Moreover, we are but a blue dot. Blue, because seventy-seven percent of Earth's surface is water. The salty oceans make up 97 percent of all water on our planet, while the fresh, life-sustaining water accounts for just three percent of Earth's water; most of which is frozen in glaciers (Perlman, 2016).

In a world where private for-profit companies own and control municipal water supplies<sup>1</sup>, where human activity and industry have left once-vast lakes to dry<sup>2</sup>, where rivers are disappearing<sup>3</sup>, where millions of people contract water-borne diseases each year<sup>4</sup>, and where violent conflicts wage over water<sup>5</sup>, the need to manage our water resources has never been more pressing. Ontario

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<sup>1</sup> All water is privatized in Chile. The Ontario Teacher's Pension Fund is the owner of several for-profit municipal drinking water systems.

<sup>2</sup> Lake Urmia, Iran and the Aral Sea, Kazakhstan are two large lakes that have been considerably reduced in size over a fifty year period.

<sup>3</sup> The Colorado River, USA no longer reaches the Gulf of Mexico.

<sup>4</sup> Water-related diseases affect more than 1.5 billion people every year (World Health Organization and UNICEF Joint Monitoring Programme (JMP). (2015) Progress on Drinking Water and Sanitation, 2015 Update and MDG Assessment.); According to the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, at least 1.8 billion people worldwide are estimated to drink water that is contaminated with raw sewage

<sup>5</sup> According to UNESCO, the current interstate water conflicts include: disputes stemming from the Euphrates and Tigris Rivers among Turkey, Syria, and Iraq; and the Jordan River conflict among Israel, Lebanon, Jordan and the State of Palestine; Nile River-related conflicts among Egypt, Ethiopia, and Sudan; and the Aral Sea conflict among

is a beacon of light when it comes to water management with numerous environmental statutes playing a part in protecting water sources. Moreover, with 250,000 lakes and over 100,000 kilometers of rivers, the province of Ontario has water resources that are the world's envy (Government of Ontario, 2016). But, like anything, there is always room for improvement.

A multi-barrier approach (MBA) to drinking water safety was introduced to Ontario's drinking water management following the fatal water contamination in the town of Walkerton in May of 2000 (Appendix 1). The MBA is predicated on a source-to-tap approach to ensure drinking water safety. It includes the protection of sensitive source water areas, water treatment, distribution, monitoring, and response to adverse conditions (FitzGibbon & Plummer, 2004; Dyck et al, 2015). In many ways the policies that came about following these events represent a "next generation" environmental policy, which Kettl describes as policies that address complex challenges of diffuse or non-point sources of pollution, unclear boundaries, and intensified political pressures (Kettl, 2002). They earn their name as they are a shift from "first generation" policies that came about in the years following the first wave of the environmental movement that typically focused on point-source pollution. As Plummer et al describe, these next generation environmental policies tend to arise out of a crisis. Prompted by the Walkerton crisis, the MBA and the successive Clean Water Act and Safe Drinking Water Act represented a radical shift from the former norm of local ad hoc water protection initiatives (Plummer et al, 2010).

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Kazakhstan, Uzbekistan, Turkmenistan, Tajikistan and Kyrgyzstan (Kameri-Mbote, Patricia (January 2007). "Water, Conflict, and Cooperation: Lessons from the Nile River Basin" (PDF). Navigating Peace. Woodrow Wilson International Center for Scholars) ("Water Conflict Chronology". Pacific Institute. Retrieved April 14, 2014.)

The Safe Drinking Water Act was passed in 2002 and stipulated controls and regulations for drinking water systems and drinking water testing. It addresses the latter stages of the MBA process. The Clean Water Act was passed in 2006 and is the legislation that enables source water protection, which is the first stage of the MBA, and is an approach that protects the quality and quantity of sources of municipal drinking water, such as lakes, rivers, and groundwater.

Protecting water at its source is a logical first step in ensuring drinking water safety. The World Health Organization has claimed that source water protection “is almost invariably the best method of ensuring safe drinking water and is to be preferred to treating a contaminated water supply to render it suitable for consumption” (WHO, 1993). Moreover, proactive protection of water at its source is significantly more cost effective than extensive water treatment of (Kenny, 2006). Source water protection is now being implemented in municipalities across southern Ontario.

This paper examines source water protection, and reviews the critical role municipalities play in the protection of drinking water sources. Moreover, this paper makes a case for the need to expand the scope of source water protection to protect watersheds for the sake of ecosystem integrity. There are numerous threats to watersheds and other considerations that are not currently addressed by the regulation that undermine effective source water protection, which this paper will address. The province of Ontario serves as a case study, and details are provided about the province’s source water protection under the Clean Water Act. Specific analytical emphasis is placed on the Greater Toronto Area. This paper provides a broad overview of what source water protection is, why it is important, what is missing from the formal program, and some possible considerations on how source water protection can be improved and expanded.

As a cumulative report, this paper will discuss themes of environmental planning, resource management, and policy. The aim of the research is to provide a synthesis of the legislated drinking water and planning regimes and how they intersect in practice. The research is focused on the intersection between watershed planning and municipal land use planning. Additionally, the research will also focus on how First Nations communities are and can be included in source water protection in Ontario. The principal research methodology is a review of primary legal documents and case law, a secondary literature review, a review of case studies, conference attendance, government documents, media reports, and an application of legal and analytical methods. Where possible, reference will be made to the scholarship of ecosystem services.

This paper opens with a brief history of water and water management in Ontario. Second, is a review of the Clean Water Act and an overview of the various provisions that can be implemented through the Planning Act. Third, the jurisdictional gaps and the threats to watershed protection are reviewed. Fourth, water management considerations and challenges facing First Nations communities are detailed. Finally, this paper concludes with insight into the current global water situation, and what can be learned from Ontario.

## **Background and History of Ontario Source Water Protection**

### **Background**

Source water is the raw water that supplies our wells and municipal drinking water systems. It can come from groundwater or surface water resources, such as aquifers, lakes, and rivers. Due to our vital dependence on water, humans have settled near water sources for millennia. For much of this time, our actions have profoundly degraded the water quality. As far back as ancient

Rome, for example, intricate networks of sewers transported human waste directly into the Tiber River. Unsurprisingly, this contamination was detrimental to public health. By 312 B.C.E., the river had become so polluted that the Romans had to construct their infamous aqueducts to transport water from a clean source dozens of kilometers away (Hodge, 2002). Anthropogenic water pollution continued to plague human settlements throughout the Industrial Revolution, especially in cities where industries were centred and urban populations grew at unprecedented rates. Industrial byproducts and wastes were dumped directly into rivers, and the causal relationship between pollutants like raw sewage and diseases like cholera did not have widespread acceptance.



*Figure 1: The single longest Roman aqueduct runs for 250km; and five are longer than 100km.*

Since the Industrial Revolution, our scientific understanding of the dynamics of the water cycle and public health has evolved. We can better quantify the health risks associated with contaminated drinking water now more than ever. Yet even in the modern era we continue to degrade our water resources through reckless industrial activity, in many ways through the failings of sustainable growth planning. For example, in the 1930s, Ohio's Cuyahoga River

caught fire as a result of oil slicks and other flammable industrial waste that had been dumped into the river. In the 1960s, Lake Erie was declared “dead” because of the extreme eutrophication and consequent lack of lake oxygen (Ludsin et al, 2001).

In Ontario, our relationship with water resources echoes the experiences elsewhere in the world since the time of European settlement. Industrial and sewage wastes have severely impacted our water quality, and they continue to pose significant threats to human and ecological health.

The first piped drinking water supply in Ontario was in Toronto in 1837, whereby a private operation pumped and delivered untreated water from Lake Ontario to private residences (Ontario Sewer and Watermain Construction Association, 2001). Similar private, communal supplies were subsequently constructed elsewhere in the province on an ad hoc basis. The primary reason for piped water supplies at this time was the need to combat fires.



*Figure 2: Water pipes on a wintery Huron St., south of College St., in Toronto 1925. City of Toronto Archives Series 372, Subseries 72, Item 991.*

Following the implementation of the *Baldwin Act* (today’s *Municipal Act*), municipalities began providing public piped water services. Later, the *Municipal Works Act* of 1882 facilitated the

creation of a number of municipal water pumping utilities. However, since the cost and debt of these capital projects was assumed by municipalities, few actually built such facilities. It was not until several towns and cities experienced outbreaks of cholera and typhoid fever that municipalities began to deliver drinking water. It was around the same time that the science community was beginning to understand water as a vector for diseases and pathogens, spurring increased formalization and regulation of drinking water, such as provisions in Ontario's *Public Health Act* (1884) (Ontario Sewer and Watermain Construction Association, 2001). However, in some cases, untreated sewage continued to be discharged into drinking water sources. For example, in Sarnia, the drinking water intake pipe in the St. Clair River was a mere 45 meters away from a raw sewage outfall pipe (Ontario Sewer and Watermain Construction Association, 2001). The prevailing attitude towards water quality at the turn on the twentieth century was "*dilution as a solution to pollution*" (Ontario Sewer and Watermain Construction Association, 2001).

The cumulative impacts of such practices remained unknown for several decades. Many sites of contamination in Ontario are due to "legacy" pollutants, which remain in the environment long after their initial release (Environment and Climate Change Canada, 2016). Common legacy pollutants include persistent organic pollutants (POPs), which as their name suggests, take a long period of time to degrade through chemical, biological, and photolytic processes. Many agricultural pesticides and insecticides, as well as industrial by-products contain POPs. Polychlorinated biphenyls, dichlorodiphenyltrichloroethane, dioxins, and polychlorinated dibenzofurans are common POPs. These compounds are known to bioaccumulate in fatty animal

tissue, and therefore pose significant threats to human and environmental health (Environment and Climate Change Canada, 2016).

For example, Randle Reef in the Hamilton Harbour, was the site of industrial waste discharge for much of the late nineteenth and twentieth centuries. A 695,000 cubic metre sediment mass of coal-tar, metals and other chemicals occupy 60 hectares below the water's surface (Government of Canada, 2016). It is one of the worst sites of contamination in the country, and much of the pollution dates back to the early 1900s (Environment and Climate Change Canada & United States Environmental Protection Agency, 2016; Environment and Climate Change Canada, 2015; Environment and Climate Change Canada, 2016).

In 1912, the International Joint Commission (IJC) declared the Great Lakes water unsafe to drink. The IJC was established by the United States and Canada under the Boundary Waters Treaty of 1909, and serves as an independent bi-national organization (Environment and Climate Change Canada, 2016). Excessive amounts of coliform bacteria from raw sewage was the trigger for their decision, which is used as an indicator of the likelihood of the presence of other pathogenic organisms. At this time, the IJC recommended the treatment of all drinking water and the installation of proper sewage facilities (Ontario Sewer and Watermain Construction Association, 2001). Chlorination was discovered as an effective drinking water treatment method in the late 1800s, and rolled out as a standard practice in municipalities across the globe in the early 1900s. Toronto began chlorinating its water supply in 1910, and within a short period of time, the number of typhoid-related deaths per 100,000 people dropped from 44.2 to 0.9 (Ontario Sewer and Watermain Construction Association, 2001).

In 1946, the Conservation Authorities were created under the Conservation Authority Act. Conservation Authorities are watershed management agencies tasked with providing services and programs that protect and manage water (and other natural resources) with government, landowners and other organizations (Conservation Ontario, 2016).

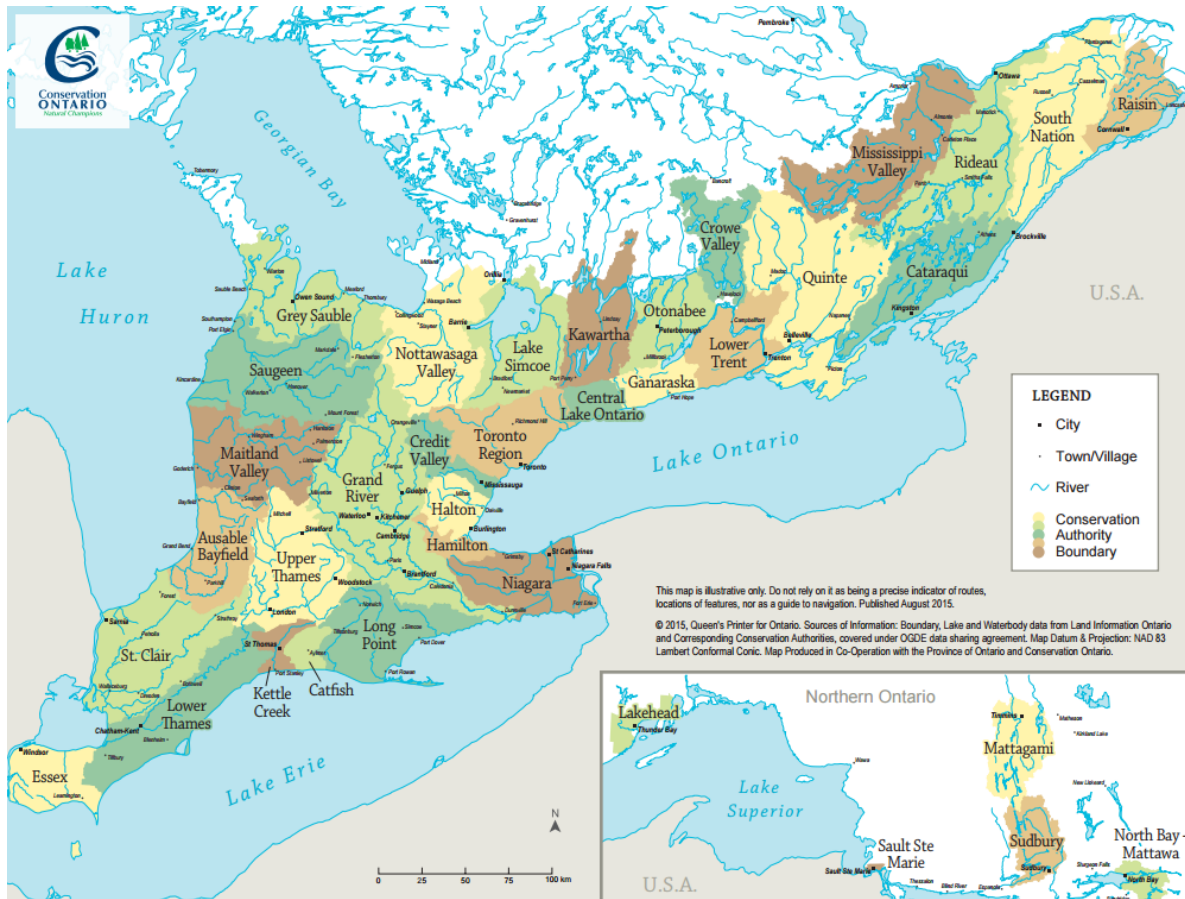


Figure 3: Map of the Conservation Authorities in Ontario. These boundaries now act as the Source Water Regions/Areas as prescribed in the Clean Water Act. From Conservation Ontario (2016).

For the first half of the twentieth century, the Ontario provincial government required municipalities to get approval for all water supply and sewage treatment systems from the Board of Health, which was given the authority to issue mandate orders for chlorination treatment and construction of filtration facilities. In 1956, the Ontario Water Resources Commission (OWRC)

was established with the mandate of financing, building and operating water treatment and sewage disposal systems; and supervising and controlling the use of the province's water resources. The OWRC was the first of its kind, worldwide, and was vested with the power to approve and inspect facilities and levy fines for water pollution (Ontario Sewer and Watermain Construction Association, 2001).

In 1972, the OWRC amalgamated with other agencies (including the Waste Management and Pesticides Control department of the Department of Health) and became the Ontario Ministry of the Environment. The work and mandate of the former OWRC was expanded to include the broader environment. New standards were created for the quality of potable water quality, industrial and sewage effluents, and ambient water quality in receiving water bodies, amongst others. In addition, the Minister was vested with the power to make environmental regulation; issue, suspend, and revoke operator's licenses; issue permits to take water.

A number of cities have taken bold initiatives to secure drinking water supplies through substantial watershed protection. In 1997, New York City purchased roughly 500 square kilometers of land in the foothills of the Catskills Mountains in Upstate New York. A labyrinth of reservoirs and aqueducts transports freshwater hundreds of kilometers to the almost 1 million buildings in New York City. This decision followed the implementation of the federal Safe Drinking Water Act, which mandated that all major surface-water systems filter their water or demonstrate their ability to protect the source watershed. Drinking water in New York City traditionally came from the surface waters of Delaware River. Accordingly, New York City would have had to filter this water by law, or protect its source. Conservative estimates put the

cost of a filtration plant large enough to clean the City's water supply at \$8-\$10 billion USD, plus an additional \$6 billion USD to build and another \$250 million USD annually to maintain. Instead, the City decided to preserve the watershed at a one-time cost of \$1.5 billion USD (Kenny, 2006). Hence, not only did the decision make economic sense, but it also means that a significant swath of land is protected from development, and continues to provide ecosystem services including water filtration and others such as carbon sequestration, nutrient cycling, and air purification.

*Table 1: US cities that have secured land to protect drinking water sources  
(adapted from Postel & Thompson, 2005)*

<b>Metropolitan Area</b>	<b>Population (approx.)</b>	<b>Costs Avoided (\$ USD)</b>
New York City	9,000,000	1.5 billion spent on watershed protection over 10 years to avoid at least 6 billion in capital costs and 300 million in annual operating costs.
Boston, Massachusetts	700,000	180 million (gross) avoided cost
Seattle, Washington	650,000	150–200 million (gross) avoided cost.
Syracuse, New York	150,000	10 million watershed plan is avoiding 45–60 million in capital costs

While no similar examples exist in Ontario, several provincial plans have aimed to address the preservation of important natural features by protecting and limiting development on select natural features<sup>6</sup>. For example, the Greenbelt Act enabled the creation of the Greenbelt Plan,

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<sup>6</sup> A natural feature is defined by the Provincial Policy Statement as a feature or area, including significant wetlands, significant coastal wetlands, other coastal wetlands (Ecoregions 5E, 6E and 7E), fish habitat, significant woodlands and significant valley lands (6E and 7E -- excluding islands in Lake Huron and the St. Marys River), habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which have important environmental and social values (see appendix for Ecoregion locations), (Provincial Policy Statement, 2014).

which protects nearly two million acres of sensitive environmental and agricultural land in the Golden Horseshoe (a dense, predominantly urban area that stretches from the western portion of Lake Ontario south to Lake Erie and north to Georgian Bay) (Ministry of Municipal Affairs and Housing, 2016). Protection is mostly from urban development and sprawl, which builds on the protection of nearly 800,000 acres of land that is within the Niagara Escarpment Plan and the Oak Ridges Moraine Conservation Plan. The Oak Ridges Moraine Conservation Plan is enabled through the Oak Ridges Moraine Conservation Act, 2001. The plan is environmental in scope, and is administered by the Ministry of Municipal Affairs and Housing. It provides land use and resource management direction for the 470,000 acres of land and water within the boundaries of the Oak Ridges Moraine (ORM)<sup>7</sup>.

### The *Walkerton* Inquiry

By 1995, Ontario's water and sewage infrastructure was estimated to be worth over 50 billion dollars (Ontario Sewer and Watermain Construction Association, 2001). Just five years after this assessment, Ontario experienced one of the most tragic public health events in our modern history, which crucially demonstrated that infrastructure only represents one part of drinking

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<sup>7</sup> A coordinated review of the Greenbelt Plan, Oak Ridges Moraine Conservation Plan, Niagara Escarpment Plan, and the Growth Plan for the Greater Golden Horseshoe began in February, 2015. An advisory panel made 87 recommendations to improve the four plans in December, 2015 (Ontario Ministry of Municipal Affairs and Housing, 2016). Recommendations included the identification of a natural heritage system, and a moratorium on municipal settlement expansion onto these systems, and required watershed planning throughout the Greater Golden Horseshoe (Ontario Ministry of Municipal Affairs and Housing; 2016; Kalinowski, 2016). The deadline for public feedback on the Review was October 31st, 2016. Positive changes could be ahead, however, challenges of existing land uses and activities and legacy contaminants will remain for time to come.

water management. In May 2000, seven people died in Walkerton, Ontario, after drinking local municipal water that was contaminated with *Escherichia coli* O157:H7 (*E. coli*). Hundreds more fell sick because of the contaminated water, and it was later revealed that the issue stemmed from agricultural runoff that flowed into a system input well. Multiple public utility and management failures, coupled with newly privatized water testing allowed the system to go unchecked as the community drank the contaminated water for several days (O' Connor, 2002).



Figure 4: Walkerton Ontario suffered an *E. coli* outbreak in 2000, resulting in seven deaths and hundreds of illnesses. (Brent Davis: Waterloo Region file photo)

At the time of the incident, three municipal wells were supplying water to the town's water treatment and distribution system. The *Walkerton Inquiry* confirmed the cause of the outbreak stemmed from manure that had been applied on a field near one of these wells. The well's groundwater was surrounded by fractured bedrock under a shallow overburden. A routine manure application in April was followed by significant rainfall, and the surface water and runoff became contaminated with *E. coli* and it eventually seeped into the well's groundwater (O'Connor, 2002). Since its construction in 1978, this particular well had been flagged as potentially dangerous by Ministry inspectors, but a lack of leadership failed to address the concerns outlined by the initial inspection.

In the aftermath of the tragic events, the town's utility managers were arrested and served time in jail and under house arrest. It was an event that shocked the entire country, and Ontarians quickly began to doubt the safety of their drinking water. In 2002, Justice O'Connor led an inquiry into the events at Walkerton, which produced a two-part report detailing the events, along with a series of recommendations to ensure the future safety of Ontario's municipal drinking water. At the same time, this event highlighted the realities of the water issues facing First Nations communities in the province and across the country (more discussion on this topic in a later chapter).

The inquiry revealed many failures that led to the events in Walkerton. But notably, a key recommendation from the inquiry was the provincial-wide implementation of a comprehensive multi-barrier approach to ensure safe drinking water. The steps of the multi-barrier approach include: source water protection, robust water treatment, secure water supply, monitoring programs, and response plans in case of adverse conditions (Walters et al, 2012). According to Justice O'Connor, source water protection refers to "the development and implementation of policies, plans and activities to prevent or minimize direct or indirect release of pollutants into surface or groundwater resources currently used or intended to be used in the future as sources of drinking water" (O'Connor, 2002). Justice O'Connor's recommendations related to treatment and distribution were addressed in the Safe Drinking Water Act. The Clean Water Act emerged out of Justice O'Connor's recommendations was passed in 2006, and calls for the protection of water at the source. The Walkerton events also had revealed the extent of the water problems facing First Nations communities within the province and across the country.

## Ontario's Watersheds

A watershed is an area of land that drains into a common water source. Watersheds can connect and encompass groundwater, land, freshwater, and coastal ecosystems, and they perform a wide variety of valuable services, including the supply and purification of freshwater (Postal & Thompson, 2005). Watersheds range in size -- from small ponds, to large swaths of land spanning national or provincial borders (Molnar et al, 2012). Moreover, watersheds are interconnected, and are affected by adjacent ecosystems and human activities outside of their boundaries (Molnar et al, 2012). Ontario's watersheds are outlined in the map below (primary, secondary, and tertiary).



Figure 5: Map of watersheds in Ontario, showing the Great Lakes-St Lawrence (yellow), Southwestern Hudson Bay (orange), and Nelson River (green) primary watersheds. Each primary watershed is further broken down into secondary and tertiary sub-watersheds

A watershed's net inputs and outputs can be described by its *water balance*. The water balance of a watershed should have inputs that are equal to its outputs to sustain its equilibrium. Inputs include precipitation, ground and surface water inflows, and anthropogenic inputs (such as waste effluent), while outputs include evapotranspiration, water supply removals, surface and groundwater outflows.

A water budget is a tool that uses a watershed's water balance to help decision-makers evaluate the incidence and movement of water through the natural environment. In Ontario, water budgets have been used since the 1960s, providing information regarding how much water is available at

any level of a watershed, what the flow paths are from recharge to discharge, and how the movement of groundwater and surface water interact.



*Figure 6: Georgian Bay is the primary drainage for seven watersheds in Ontario.*

Ontario's winter precipitation trend is strongly influenced by lake and topographic effects in the central and southern areas of the province – especially in the areas downwind from Lake Superior, Georgian Bay, and Lake Huron. Across the province, winter precipitation and snow accumulation is highly variable. Parts of Ontario in the south and east are highly influenced by low-pressure, moist air. Winds accompanying the low-pressure conditions gather moisture while moving across the Great Lakes, and drop precipitation along the colder landmasses. These areas include cities such as London, Collingwood, and Barrie, which are referred to as being part of the “snow belt”, named for the high amounts of winter snowfall (Baldwin, et al, 2004). Areas with higher elevation also tend to receive above average winter snowfall, such as the Algonquin Highlands (Huntsville, Dorset, Upper Ottawa Valley) (Baldwin et al, 2004).

Summer precipitation is more related to continental trends, as opposed to lake effects. The climate in western portions of the province is dominated by continental high pressure, which has the effect of reducing precipitation in early and middle summer. Unlike winter trends, summer precipitation is greatest away from lakes, where air masses and storm cells build over the land. This effect is greatest in the central portions of the province (Baldwin et al, 2004).

## Current Status of Source Water in Ontario

### Legislation Protecting Ontario's Watersheds

The Clean Water Act emerged out of the Walkerton inquiry, and it was passed in 2006 as part of a multi-barrier approach to drinking water safety (see Appendix for more on the multi-barrier approach). The aim of the Clean Water Act is to protect existing and future sources of drinking water in Ontario. To achieve the Act's stated goals, communities are required to identify potential threats to drinking water sources with a scientific, technical assessment of their watershed; and to develop and implement source protection plans that are designed to reduce or eliminate the identified threats.

The Clean Water Act designates watershed-based planning areas called "source protection areas" (or regions). The boundaries of these regions are more or less aligned with those of the province's Conservation Authorities. There are 19 source water protection areas and 22 approved plans in Ontario. The plans are comprehensive documents that include policies to achieve protection of the quality and quantity of drinking water sources. Several years of research, expert advice and public consultations are behind each source protection plan, which typically total a few hundred pages. Upon approval, the plans become effective immediately to all new threat

activities. In addition, timelines are included to bring all current threat activities into compliance with the source protection policies. Once approved by the MOECC, implementation of the plan typically becomes the responsibility of the municipality. The responsibility of the initial risk assessment and source protection planning is assigned to a local Source Protection Authority for each area, which in most cases is the local Conservation Authority. Much of the initial technical work is focused on identifying and assessing of the drinking water quality and quantity threats that affect four types of vulnerable areas (Credit Valley, Toronto and Region, and Central Lake Ontario Source Protection Region, 2016). The types of vulnerable areas are outlined in the table below.

*Table 2: Clean Water Act: Vulnerable areas  
(adapted from Credit Valley Source Protection Area Approved Source Protection Plan (2015))*

<b>Vulnerable Area Type</b>	<b>Description</b>
Wellhead Protection Areas (WHPA)	Areas on the land surrounding a municipal well -- the size of which is determined by how quickly water travels underground to the well, measured in years. The Clean Water Act requires a standard 100-metre protective radius around each municipal well (noted as WHPA-A); WHPA-B represents the 2-year time of travel; WHPA-C represents the 5-year time of travel; and WHPA-D represents the 25-year time of travel
Intake Protection Zones (IPZ)	The area on surface water and the land surrounding a municipal surface water intake. The size of each zone is determined by how quickly water flows to the intake, in hours. The time of the flow is determined in consideration of an emergency response. There are three IPZs, based on time.
Highly Vulnerable Aquifers (HVA)	An aquifer that is susceptible to contamination due to its location near the ground's surface or where the ground materials are highly permeable.
Significant Groundwater Recharge Areas	Areas with porous soils, such as sand or gravel, which allows water to seep easily into the ground and flow to an aquifer.
Wellhead Protection Area (Water Quantity)	Areas where drinking water stress has been identified.

Threats are prescribed by O. Reg. 287/07 under the Clean Water Act. Currently, a total of 21 types of threats are identified in the Act, and it is the responsibility of the Source Protection

Committee to develop policies where these threats could be significant. Local authorities can add additional threats which may be specific to that jurisdiction. The prescribed threats are:

1. *The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act [waste management].*
2. *The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.*
3. *The application of agricultural source material to land.*
4. *The storage of agricultural source material.*
5. *The management of agricultural source material.*
6. *The application of non-agricultural source material to land.*
7. *The handling and storage of non-agricultural source material.*
8. *The application of commercial fertilizer to land.*
9. *The handling and storage of commercial fertilizer.*
10. *The application of pesticide to land.*
11. *The handling and storage of pesticide.*
12. *The application of road salt.*
13. *The handling and storage of road salt.*
14. *The storage of snow.*
15. *The handling and storage of fuel.*
16. *The handling and storage of a dense non-aqueous phase liquid.*

17. *The handling and storage of an organic solvent.*
18. *The management of runoff that contains chemicals used in the de-icing of aircraft.*
19. *An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.*
20. *An activity that reduces the recharge of an aquifer.*
21. *The use of land as livestock grazing or pasturing land, an outdoor confinement area, or a farm animal yard.*

Vulnerable areas are assigned a risk score according to the MOECC's *Tables of Drinking Water Threats*. The risk score is calculated by multiplying the vulnerability score (1-10) by the hazard rating of the threat (1-10), details of which are found in the Tables. Scores less than 60 are assigned a low threat classification; scores between 60 and 80 are moderate; and scores between 80 and 100 are high (Credit Valley, Toronto and Region, and Central Lake Ontario Source Protection Region, 2016). Once a source water protection plan has been approved, decisions related to its policies cannot be appealed to the Ontario Municipal Board. Examples of delineated vulnerable area plans can be found in the Appendix.

### **Role of Planning Act in Implementing Source Water Protection**

Source water protection under the Clean Water Act provides a comprehensive formal mechanism for land and water integration at the watershed scale (Ivey et al, 2006). It helps overcome issues of technical knowledge shortages, capacity issues, and inconsistent land use planning. The Clean Water Act is an enabling legislation that relies on tools provided in other provincial statutes for implementation, notably the *Planning Act*. The Planning Act details the rules for land use planning in Ontario and describes how lands can be controlled.

Under the Planning Act, land uses are controlled with zoning bylaws. They state what types of buildings are permitted and how they may be used, lot size and dimensions, and other details such as parking requirements, building heights and setbacks from the street (Ministry of Municipal Affairs and Housing, 2016). According to James B. Milner, a zoning by-law typically does two things. First, it classifies and segregates the various uses of land and the permitted types of buildings, with all other uses being prohibited. Second, it regulates the permitted uses in varying degrees depending upon circumstances (Milner, 1962). The legitimacy of enforcing zoning bylaws on private lands was established in the United States, in the case of *Euclid v. Ambler Realty Co*, whereby a zoning ordinance restricting private property rights was upheld as valid in recognition of broader social and community values (*Euclid (Village) v. Ambler Realty Co*, 1926).

In Ontario, zoning bylaws are subordinate to provincial policy (Provincial Policy Statement and Provincial Plans) and official plans. They are an exercise of “legislative” power by municipalities, which has been delegated by the provinces and authorized by statute.

Historically, zoning bylaws have been premised on the separation of incompatible uses.

*§.34(1), Planning Act: Zoning by-law must conform with the official plan.*

*Despite any other general or special Act, where an official plan is in effect, no public work shall be undertaken and, except as provided in subsections (2) and (4), no by-law shall be passed for any purpose that does not conform therewith.*

Zoning bylaws are powerful tools for planners to control and implement source water protection. They can be used to prohibit certain land uses, buildings, and structures in vulnerable areas; impose setbacks from vulnerable areas; establish a vegetated buffer strip zone; prohibit accessory uses; or impose other restrictions that a municipality sees fit (Conservation Ontario, 2014).

Site plan control is another tool authorized by the Planning Act. Site plan control details site-specific matters regarding a particular piece of land and its impact on and relationship with the surrounding land uses. It can be imposed during the development or redevelopment of land (*Hi Rise Structures Inc. v. Scarborough (City)*, 1992). The authority to impose site plan control comes from Section 41 of Planning Act (for all municipalities except City of Toronto) and Section 114 of City of Toronto Act, 2006. An upper-tier municipality (i.e. Region, County or District) cannot exercise site plan control, but may impose conditions to a local municipality's site plan approval. To use site plan control, an Official Plan must include provisions that allow site plan control by-laws in the appropriate areas. Section 41 (1) of the Planning Act stipulates that site plans/ site drawings must be approved by council (or adjustment committee delegate), or OMB (on appeal) before undertaking any development or redevelopment in a site plan control area.

To protect source water, a municipality could require site plan control for all or certain classes of development in all or specific vulnerable areas described in the Assessment Reports. In situations where properties fall within or partially within a vulnerable area, a municipality can use site plan control to prohibit threat activities associated with structures (for as long as that activity remains a noted significant threat) (Conservation Ontario, 2014). Specific examples of how site plan

control can be used to minimize risk from prescribed threats are summarized in the Table 3 below. It should be noted that source protection plans do not allow for legal non-conforming uses. Hence, once a zoning designation has changed, all land must conform to the new classification. Policies may apply to future and/or existing activities and prohibit, regulate or otherwise restrict those activities.

Table 3: (Adapted from Conservation Ontario, 2014: Implementation Resource Guide: Land use Planning)

<b>Prescribed Threat (from Reg.)</b>	<b>Example</b>	<b>Examples of Site Plan Controls</b>
Storage of Snow	Snow disposal site	Lot grading; location of dedicated snow storage; stormwater management plan
Storage of agricultural storage material	Manure produced and stored on a farm	Building envelope for storage facility; capacity of storage facility
Storage of road salt	Storage of road salt at a contractor's yard	Lot grading; stormwater management plan
The use of livestock grazing of pasturing land, an outdoor confinement area, or a farm-animal yard.	Farm animal yard	Location of yard on property; lot grading

There are limits to what the tools in the Planning Act can do in terms of protecting source water. One key fact to note is that the Planning Act provides the legislative framework for municipalities to regulate land *uses* -- not the specific activities that occur within these uses -- while the Clean Water Act specifies restrictions on certain *activities*. To address the specific activities, prescribed threats (listed in O. Reg. 287/07), through land use planning, all uses within which these activities might occur would have to be restricted (Conservation Ontario, 2014). This approach can be extreme. For example, to prohibit the spreading of agricultural materials (as listed in O. Reg. 287/07), agriculture as a land use would have to be prohibited in the designated area. This would effectively prohibit a number of activities that do not pose any threat

to source water. This is inefficient in a place like southern Ontario, where there is intense competition for land, and some of the country's top-graded agricultural soil. Hence, there is an inconsistency between the goals and abilities of these two key acts. Therefore, it is the responsibility of land use planners to translate the source water protection policies into land use policies. As more municipalities update their Official Plan with source water protection policies, it will be critical to assess the implementation of source water protection. Furthermore, the province and municipalities should periodically review the source water plans, and it is worthwhile to expand the scope of source water protection, as this paper will demonstrate.

### **Planning for Water Protection – Beyond the Clean Water Act**

In addition to land use planning, municipalities have the authority over certain activities that have the potential to affect source water quality. The Municipal Act grants municipalities with the power to pass sewer use by-laws, which allow municipalities to regulate discharge of pollutants into the sewer system. Municipalities can state acceptable limits of certain pollutants and regulate discharges from local industries. Furthermore, municipalities themselves are some of the biggest threats to source water quality. Discharge of sewage water, stormwater, and runoff (even from municipal wastewater treatment facilities) into surface and ground waters pose significant risk to source water. Wastewater effluents and storm water runoff are two of the greatest threats to source water. Hence, municipalities are key players in source water protection.



*Figure 7: Wastewater effluent is one of the greatest threats to source water. (Stock photo)*

Ontario's Building Code and Building Code Act also have important considerations for planners and source water protection. For example, minimum standards for building and construction materials are outlined in the Building Code. Furthermore, the Building Act was amended in 2015 to include a mandatory and discretionary on-site sewage system maintenance inspection program, which includes private septic systems. Green roofs also represent an opportunity to contribute to source water and watershed protection through their ability to reduce runoff. Although not specified in the Building Code, a municipality can take it upon themselves to require green roofs through their municipal by-laws. For example, the City of Toronto has a green roof bylaw, whereby all new development must have a green roof, should their building area exceed a specified square footage (City of Toronto, 2016). Toronto was the first city in North America to implement such a by-law (City of Toronto, 2016).

Individual homeowners and businesses can also be educated and incentivized to increase the amount of permeable surface on their property, and consider landscaping options that will reduce water runoff. The government and the construction industry also have a role, as infrastructure

such as roads should be built, and replaced with permeable concrete lined with vegetated buffers. Furthermore, right-of-ways and parking lots can be reduced in size/ footprint, and use natural and similar materials as mentioned above.

Ontario's residential per capita water use is 225 litres per day. To put this into context, the United Nations estimate that humans require about two litres of drinking water per day. Further, average per capita consumption in France, India, and China is 106, 52, and 32 liters, respectively (World Business Council for Sustainable Development, 2009). This disparity suggests there is a considerable amount of room for water conservation in Ontario. Municipal pipe replacements, and low-flow household faucets and toilets have been a step in the right direction. However, as long as water is considerably undervalued, excessive amounts will be used. This is true for both households and industry, who pay just 3.41 CAD per million litres of water. Conservation initiatives should start with industry paying a fair share for the water they consume.

Source water protection under the Clean Water Act is arguably one of the most comprehensive water protection programs in Canada, and possibly in the world. But, from an environmental planning and ecological services perspective, its scope is narrow and there are gaps in what is protected, which will be addressed later on in this paper.

In the ten years since the implementation of the Clean Water Act, source water protection has received a lot of well-earned praise. According to federal and provincial water quality assessments, the quality of the Great Lakes and other surface waters have improved over the past several years (Environment and Climate Change Canada & the United States Environmental Protection Agency, 2016.). Of course, it is difficult to draw any correlations between these

reported findings and the contribution of the Clean Water Act since source water protection policies are only just being implemented at the municipal level. However, there is now heightened awareness around the consequences of poor water quality, and there have not been any major municipal water crises since Walkerton. Planners, developers, and citizens alike have been more aware of the importance of protecting source water quality – thanks to the policy and the associated stewardship, education, and awareness programs associated with source water protection. This is a very positive step forward for water protection.

While the successes of the Clean Water Act are undoubtedly commendable, there are certainly areas of improvement for water protection in Ontario. As mentioned, no major municipal water supply systems have been compromised due to source water since Walkerton. However, the same cannot be said for First Nations communities, whose source and drinking water has been subject to ongoing contamination and do not drink/ boil advisories for decades. In particular, jurisdictional gaps, and fragmented management makes source water protection difficult in First Nations communities, and in the protection of groundwater quantity is not adequately accounted for by legislation. Furthermore, there are additional opportunities for the protection of private wells, and communities outside of the boundaries of source protection areas.

### **Role of Governance and Institutions in Source Water Protection**

In Ontario, municipalities are responsible for land use planning within their jurisdiction. The province, however, determines the broad ranging provincial-wide interests, which are described in the *Provincial Policy Statement*. Local planning decisions must be consistent with the Provincial Policy Statement – regardless of whether the municipality’s Official Plan has been

updated to conform to it. In some outstanding cases, the province can administer local planning controls and grant approvals for certain developments. However, the local municipality holds the responsibility of making the planning decisions, and for determining the course for the future of its communities.

The Planning Act considers key provincial interests and it explicitly provides a local land use planning system led by provincial policy. An additional purpose for the Act is to integrate matters of provincial interest into planning decisions (Planning Act, sec. 1.1., b.c.). Section 2.2 of the Provincial Policy Statement explicitly addresses water, and the responsibility of planning authorities to protect, improve and restore the quantity and quality of water (Ontario Ministry of Municipal Affairs and Housing, 2014). The Planning Act fails to *explicitly* protect land to facilitate these goals, however, the methods stated in the Provincial Policy Statement to protect, improve, or restore watersheds include:

- a. using the watershed as the ecologically meaningful scale for integrated and long-term planning, which can be a foundation for considering cumulative impacts of development;*
- b. minimizing potential negative impacts, including cross-jurisdictional and cross-watershed impacts;*
- c. identifying water resource systems consisting of ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas, which are necessary for the ecological and hydrological integrity of the watershed;*
- d. maintaining linkages and related functions among ground water features, hydrologic functions, natural heritage features and areas, and surface water features including shoreline areas;*
- e. implementing necessary restrictions on development and site alteration to:*

- i. protect all municipal drinking water supplies and designated vulnerable areas;*
- ii. protect, improve or restore vulnerable surface and ground water, sensitive surface water features and sensitive ground water features, and their hydrologic functions;*
- f. planning for efficient and sustainable use of water resources, through practices for water conservation and sustaining water quality;*
- g. ensuring consideration of environmental lake capacity, where applicable;*
- h. ensuring stormwater management practices minimize stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces*

Implementing source water protection on a local scale can be achieved in part through land use planning. However, local authorities can be faced with numerous constraints when protecting watersheds above and beyond the source water plans (which protect drinking water *sources*, as opposed to all water).

For example, the local authority must also have sufficient capacity to understand, implement, and facilitate watershed protection. Technical knowledge concerning source water location and characteristics is a minimum requirement. Not all communities have professionals with this type of expertise working for the local government. Furthermore, not all communities have the resources to hire external consultants to support them with this expertise.

In addition, local governments cannot effectively protect source water and watersheds without the legal authority to protect sensitive or vulnerable areas from potentially unsafe land use practices (Ivey et al, 2006). This is especially true in cases where land use practices upstream impact water quality and quantity of downstream jurisdictions (Ivey et al, 2006). This situation is

underscored by First Nations communities, which can have the ability to regulate land uses on reserve, but are extremely limited in decision-making and control of activities off-reserve.

Therefore legal authority over land use decisions must have a transboundary element. When it comes to water, political boundaries are irrelevant, and the way humans manage the resource must recognize and internalize this fundamental nature of water movement. Furthermore, municipalities do not fit perfectly within a single watershed. Rather, a single municipality could be located within multiple watersheds and source protection areas, and similarly, multiple municipalities might be located within a single watershed.

Walkerton's fatal E. coli outbreak was an isolated incident of groundwater contamination caused by agricultural runoff. However, as revealed by the Walkerton Inquiry, the underlying cause was institutional and government failure. In the mid-1990s, an ultra-conservative reform swept the province of Ontario upon the election of Premier Mike Harris, which included the typical hallmarks of neoliberalism: fiscal austerity, administrative deregulation, and privatization (Prudham, 2004). Ontario's environmental governance capacity was undermined as regulatory agencies experienced significant deregulation -- environmental regulatory and resource management agencies in Ontario were especially hard hit with austerity (Prudham, 2004). Over 2000 jobs were eliminated at the Ministry of Natural Resources, and nearly one-third of the Ministry of Environment's staff was let go (Prudham, 2004). The neoliberal agenda undermined both the agricultural and water quality regulation, which together created the conditions for a perfect storm of public services failure and a public health outbreak. Justice O'Connor noted these institutional changes in the Report on the Walkerton inquiry, citing,

*“The reductions were initiated by the central agencies of the government rather than from within the MOE, and they were not based on an assessment of what was required to carry out the MOE’s statutory responsibilities,”*  
*(O’Connor, 2002, p. 34).*

The failure to carry out statutory responsibilities was due to a capacity issue, and the institutional arrangements and neoliberal reforms led to a failure in environmental management, which compromised the local water supply. This incident underscores the fragility of environmental management, and the thin barrier between human health, land use, and the environment. The inquiry revealed many failures that led to the events in Walkerton. One key recommendation was to implement a provincial-wide, comprehensive multi-barrier approach to ensure safe drinking water. The steps of the multi-barrier approach were to include: source water protection, robust water treatment, secure water supply, monitoring programs, and response plans in case of adverse conditions (Walters et al, 2012; O’Connor, 2002). According to Justice O’Connor, source water protection refers to

*“the development and implementation of policies, plans and activities to prevent or minimize direct or indirect release of pollutants into surface or groundwater resources currently used or intended to be used in the future as sources of drinking water”* (O’Connor, 2002).

The constraint caused by institutional arrangements to implement effective source water protection is especially true for municipalities and First Nations communities outside of the current source water protection areas/regions boundaries. In the Greater Toronto Area, many

have voiced concerns about the trend of favouring developers in land use decision-making. To achieve water protection, public health and environmental needs must come first. The public, experts, and NGOs alike must have a greater influence in decision-making. Meaningful public involvement is critical in any planning process.

Arnstein's *A Ladder of Citizen Participation* (1969) categorizes eight levels of participation, which are illustrated as rungs on a ladder. As one moves up the metaphorical ladder, the level and depth of participation improves. The eight levels in ascending order are: manipulation, therapy, informing, consultation, placation, partnership, delegated power, and citizen control. Arnstein argues that citizen participation is citizen power. Citizen participation leads to a redistribution of power, enabling the have-not citizens, who are traditionally excluded from political and economic decision-making to be deliberately included (Arnstein, 1969). Without a voice, it is difficult for the environment to advocate for itself, however, there are numerous NGOs, professionals, and individuals willing and capable to provide this voice when there are open and meaningful opportunities. Such opportunities can enhance the decisions made by local governments concerning watershed and source water protection. The Clean Water Act details minimum requirements for public consultation.

## Threats and Gaps in Ontario Source Water Protection Policy

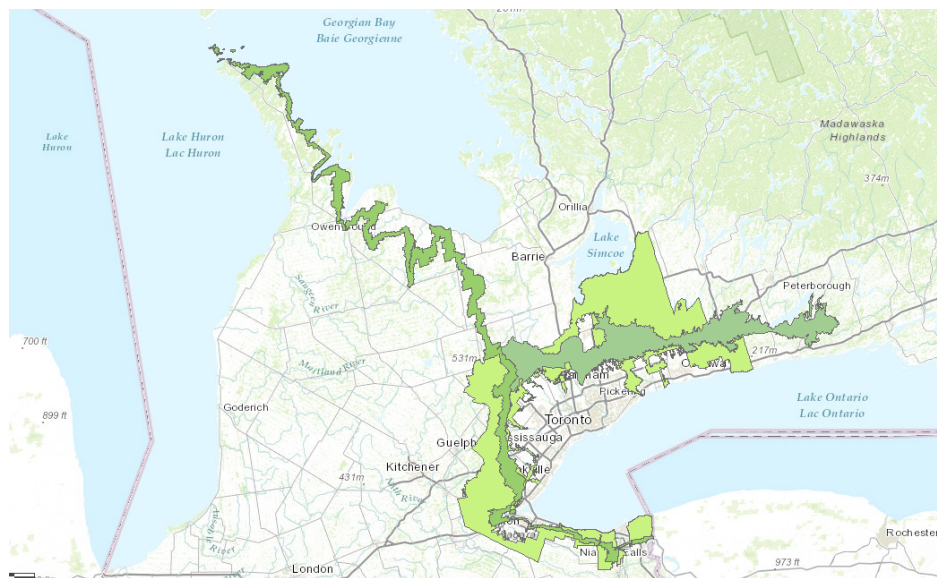
*“...the fish don't get to drink that treated water...and the wildlife don't get to drink the treated water. And we eat the animals, and we eat the fish, we eat the aquatic life, we get medicines along the water.” -- Deborah McGregor (2016)*

## Ecosystem Services

For millennia, humans have managed their environments, altering landscapes in the pursuit of agriculture, civilization, and comfort. Human land use change has accelerated over the past few centuries. As the impacts of industrial revolution and the growth of the twentieth century began to manifest, it quickly became apparent that our growth paradigm was wreaking havoc on the environment on both local and global scales. Further, the organization of human societies, has meant that the environment has been managed on scales too small, with goals too narrow (Farber et al, 2002). Cumulative impacts on the environment remain to be under-emphasised in environmental, land use, and resource management policies. As the transboundary and global nature of the environment and climate have become better understood, trends have shifted towards protecting and restoring ecosystems on greater natural scales. This is particularly true at the watershed level. Recent advances in research have brought the significance of ecological preservation into lay terms. For example in 1997, Robert Costanza et al evaluated the world's ecosystems in terms of the essential services they provide (such as clean air, purified water, flood control and pollination), and attached an economic value of \$33 trillion (USD) per year. This study was ground breaking, and not without controversy.

Ecosystem services are the benefits human society obtains from ecosystems. The concept of assigning a monetary value to ecosystem services remains to be problematic for some. While this approach remains controversial, the controversy is beyond the scope of this paper. Since the publication of Costanza's initial global valuation, similar methodologies have been applied by other scholars to specific locations. For example, it is estimated that the natural capital of Ontario's Greenbelt (see Figure 8) provides \$2.6 billion in ecosystem services, with the value of

watersheds alone at over \$1 billion (Molnar et al, 2012). These services are not captured by markets, and are considered to be free. Notably, the watersheds of the Greenbelt provide drinking water for millions of people, water purification, flood control, nutrient cycling, and wildlife habitat. It has been estimated that the Greenbelt provides an equivalent of \$131 million in water filtration services (Molnar et al, 2012). With such a wealth of ecosystem services provided to millions of Ontarians, the protection of the Greenbelt is vital.



*Figure 8: Ontario's Greenbelt is approximately the same size as Prince Edward Island.  
(from: Scholars Geoportal)*

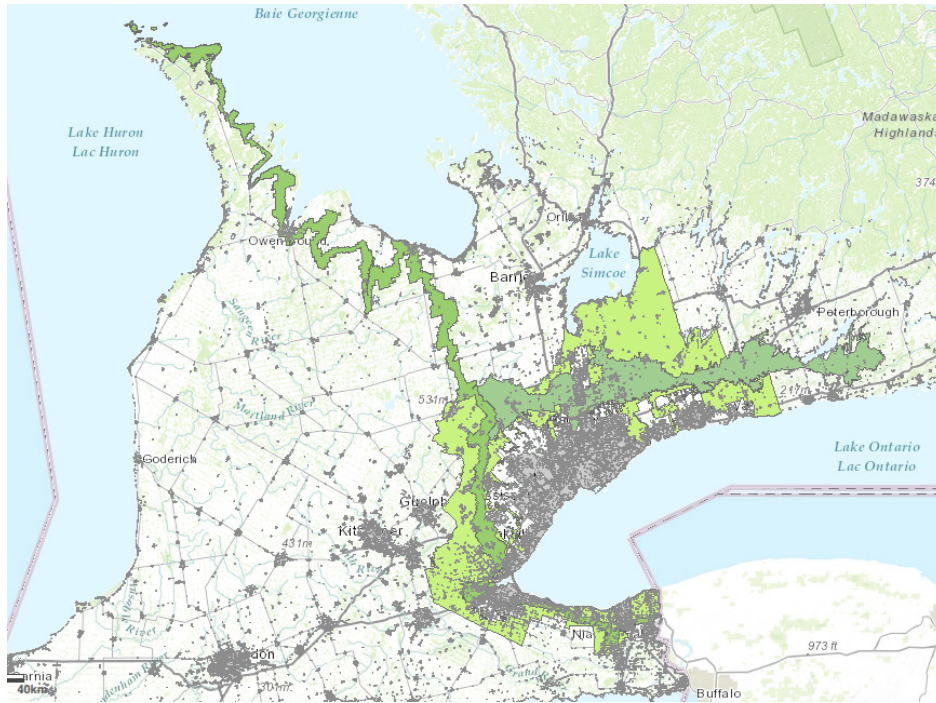


Figure 9: Ontario Greenbelt (green) with built-up areas (grey) (from: Scholars Geoportal)

Natural water purification is significantly more cost effective than capital-intensive treatment plants. For example, a 2004 study by Ernst studied 27 water supplies in the United States, and concluded that watersheds with at least 60 percent of forest cover halved the costs of water treatment, compared to watersheds with less than 30 percent forest cover. Conversely, a 2007 study found a 20 percent cost increase in filtration for every 10 percent of forest cover lost (Ernst et al, 2007). The methodology of these studies were applied to the Greenbelt, and it was found that if forest and wetland cover decreased from 30 to 10 percent, the City of Toronto would experience an increase in water treatment costs from \$0.60 to \$0.94 per cubic meter (Wilson, 2008). Moreover, this treatment cost increase would translate into an average increase of \$381 on consumers' water bills (Molnar et al, 2012).

The recognition of ecosystem services has triggered an important shift in the way that we understand and practice resource management. As the environment degrades, the implications resulting from the reduction in ecosystem services has taken a toll on our economy, infrastructure, and health and safety. Valuing ecological services can result in better management and protection practices to ensure human development does not interfere with them. Some additional ecological services that human societies depend on include air and water purification, water supply, flood mitigation, soil renewal, detoxification and decomposition of wastes, and pollination (Prato, 2005). Healthy watersheds are a critical component that underlines the ability of the aforementioned ecosystem services. Wetlands also provide some of the most valuable services to society, including: water supplies for agricultural and human uses; water filtration/purification; flow regulation; flood control; erosion and sedimentation control; recreation/tourism; habitat for biodiversity preservation; and climate stabilization (Postel and Thompson, 2005). It has been estimated that nearly 85 percent of Ontario's wetlands have been lost due to urban expansion, from activities including agriculture, development, land clearance, and filling (Ducks Unlimited Canada, 2010). Furthermore, forest cover has also diminished, and old growth forest accounts for less than 0.1 percent of the land in Southern Ontario (Ontario Nature, 2006).

As urban, industrial, and agricultural areas expand, ecosystem services become more important for the health and wellbeing of humans in those settlements. However, paradoxically, they become more compromised as changes to land cover and use fragment and interfere with the functioning of ecosystems. The impacts of these changes will be discussed at length in the following section.

## Anthropogenic Disruption of Natural Systems

The land conversion associated with urban growth means more extensive cover by impervious surfaces (i.e. asphalt, concrete, roofs) resulting in fewer ecosystem services provided by soil and vegetation such as filtration, protection against erosion, potentially compromising water quality and quantity. Landscape fragmentation and impervious land cover limits ecosystem services, disrupts hydrological systems and modifies energy flow and nutrient cycling (Alberti, 2004).

The ecosystems within a watershed affect the water quantity and quality that pass through it (Brauman et al, 2007). Contaminates can be removed or added to surface and groundwater, depending on the surrounding terrestrial ecosystem (Brauman, 2007). Similarly, an ecosystem can modify the quantity of water as it moves through a landscape (Brauman, 2007).

Anthropogenic land uses affect surface and groundwater resources at rates and in scales significantly different from natural land covers. The impact of this anthropogenic alteration can induce imbalances in the aquatic ecosystem and natural water quality and quantity. For example, the type of land cover in a watershed affects the levels of evapotranspiration to the atmosphere, percolation and recharge to the groundwater, and surface runoff to surface waters (Waco & Taylor, 2010). As a result, these processes influence base flows and underlying stream thermal systems. Changes in vegetation cover can affect evapotranspiration, percolation and runoff. In urbanizing settings, natural permeable surfaces are replaced with paved, impermeable coverings, with limited vegetation.

In addition, the increase of urban build-up means the creation of more roads that require salting in winter. Road salting can increase salinity in groundwater and aquifers, and consequently in

downstream rivers and lakes, which affect fish habitat and possibly human health (Furberg & Ban, 2012). In some cases, in lieu of municipal sewage systems, individual homes have septic systems. A poorly maintained septic system can contaminate groundwater, and hence impact well supplies. While large-scale withdrawal of groundwater for consumption and industry affect the quantity and the effect of agrochemicals have been described as potentially affecting the moraine aquifer (Howard et al, 1995).

Normally, groundwater systems consistently discharge into lakes, streams, and wetlands, and they recharge from precipitation. This natural cycle maintains an equilibrium. However, anthropogenic landscape changes and withdrawals from groundwater sources can profoundly disturb this natural equilibrium (Waco & Taylor, 2010). For example, when groundwater is withdrawn at a rate that exceeds the natural rates of aquifer recharge, the result is reduced input to streams from springs. This disruption can alter stream temperatures by reducing the cold water temperature inputs groundwater provides (Waco & Taylor, 2010). Changes to thermal regimes in river systems can adversely affect aquatic life, which are important for the overall health of an aquatic system.

### **Rapid Urban Expansion in the Greater Toronto Area**

Southern Ontario has experienced rapid growth over the past two decades. The Greater Toronto Area (GTA) is projected to be home to an additional 2.8 million residents by 2041 (Ontario Ministry of Finance, 2016). The GTA includes the City of Toronto and four regional municipalities (Durham, Halton, Peel, and York), and at present, has a combined population of approximately six million people (Furberg & Ban, 2012; Ontario Ministry of Finance, 2016).

Decades of urban sprawl have left the natural landscape fragmented, and the natural resources strained. Important natural features, notably the Oak Ridges Moraine (ORM), have come under threat with land use change, and increased industrial and commercial activity.

Twenty-year urban growth patterns in the GTA have been studied using information from Canada's National Topographic Database, the Ontario Land Cover Database, the Geological Survey of Canada's ORM boundary dataset and the Toronto Region Conservation Authority. Over this period, urban expansion has predominantly occurred at the rural-urban fringe boundary. Between 1985 and 2005, Durham Regional Municipality's urban areas grew by 50 percent (88 km<sup>2</sup>); urban portions of Halton Regional Municipality grew by 53 percent (79 km<sup>2</sup>); Peel by 60 percent (181 km<sup>2</sup>); Toronto by 1 percent (10 km<sup>2</sup>); and York by 108 percent (234 km<sup>2</sup>), (Furberg & Ban, 2012). In addition, several new small urban areas emerged near regional municipalities towards the northern boundary of the GTA. It should be noted that urban areas were extensive at the beginning of the study period (1985), and hence only a small amount of natural area was available for conversion (Furberg & Ban, 2012). Most of the conversion to urban cover occurred on agricultural land, and this was predominately a conversion to low-density build-up (Furberg & Ban, 2012).

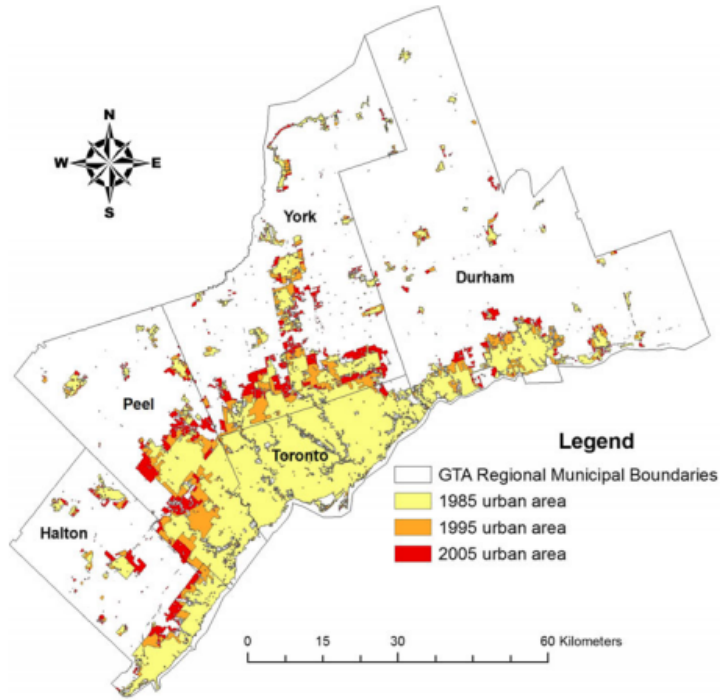


Figure 10: Sprawl over time. (Source: Furberg 2012)

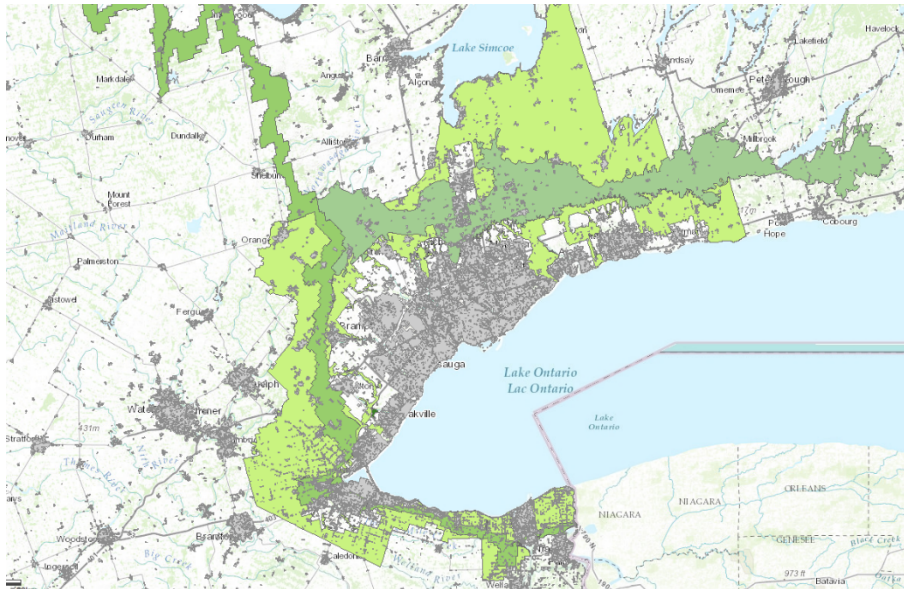


Figure 11: Urban coverage and Greenbelt on same map. (from: Scholars Geoportal)





*Figure 13: Map of natural cover within the boundaries of the Toronto and Region Conservation Authority  
(Source: Scholar's Geoportal)*

The maps above depict the scale of urban sprawl and the extent of natural and built-up land coverage in the GTA. Strong provincial Growth Plans limit the extent of future sprawl. However, continued growth will continue to strain water resources.

With the GTA's population expected to grow by almost 50 percent over the next two decades, it is reasonable to expect this growth to further contribute to urban sprawl -- despite the fact that provincial plans already exist to protect natural heritage features from development. As the previous section emphasized, our watersheds provide critical ecosystem services that are necessary for the region to thrive. Exercising the precautionary principle and curbing growth entirely would logically be the best option for the sake of ecosystem health. However, this is not a realistic approach. Development in the City of Toronto alone has surged over the past 10 years.

From 2011 to 2015, a total of 311,350 residential units and 7.94 million square meters of non-residential space were proposed in the City of Toronto (City of Toronto, 2016).

There is a significant amount of inertia driving Toronto's growth. According to David Harvey's theory of the urban development process under capitalism, capital flows through three circuits. The primary circuit is investment in basic commodity production. Once over accumulation has occurred in this circuit, capital is channeled into the secondary circuit. This consists of fixed capital, or the built environment. After over accumulation occurs in the secondary circuit, capital investment moves into the tertiary circuit is investment in science and technology and social expenditures. This also includes expenditure to increase labour productivity (Harvey, 1985) Toronto's growth is undoubtedly tied to this movement of capital, which will continue to grow until over accumulation has occurred in both the secondary and tertiary circuits. Therefore, urban development and urban sprawl will continue, but with adequate, proactive planning, the impact of the growth on our critical water resources can be reduced.

It is imperative that land use decisions made today account for environmental impacts. Watershed remediation is significantly more costly than protection. Hence, taking a precautionary and proactive approach to protect watersheds in development also makes economic sense. Decisions regarding developments that may have long term implications on the environment and ecological services too often apply short-term logic and inadequate discount rates. Economists justify applying discount rates to projects that may take a long time to pay off or have significant impacts for future users on the grounds of expected future economic growth. It is assumed that the next generation(s) will be better off, more efficient, and have better

technology than the present. Hence it is assumed that the future can incur certain costs that are required to produce or build something in the present that will also benefit the future. High, constant, discount rates give low value to the future -- therefore betting against the environment and future generations. Low, or even negative discount rates, may actually result in proper valuation and internalization of future impacts from a project (Goulder & Stavins, 2002; Arrow et al, 1995). The Canadian government tends to apply a discount rate to large infrastructure projects. The current rate is 8 percent, and a cost-benefit analysis is not required (Miller, 2014).

As long as capital and investment is flowing, and the future continues to be discounted, urban sprawl will continue in the GTA. Of course, there are numerous social factors and opportunities that also make this region a great place to live, which has an obvious effect of attracting people. Stressed resources will not curb this growth, without deliberate policy intervention. A 1963 study by Barnett and Morse concluded that scarcity of natural resources has no effect on constraining growth. However, extraction costs will increase over time as the most accessible resources are depleted first. This phenomenon exists because in conventional economics, it is assumed that decision-makers have perfect information about a resource. However, a rational person would know that the reality is quite the contrary. As this paper will reveal, experts know very little about our groundwater resources, which are being extracted at startling rates -- a reality that is especially true on the Oak Ridges Moraine. It can be reasonably expected that municipal suppliers will incur additional costs for water supplies, as continued degradation of water quality will require more treatment.

## Spotlight on the Oak Ridges Moraine: Growth and Development Challenges

The Oak Ridges Moraine (ORM) is a geological landform that was formed approximately 12,000 years ago by glacial retreatment, which created the irregular sandy hills that define the landform today (Ministry of Municipal Affairs and Housing, 2015). Rainwater and snowmelt are absorbed by the ORM's sand and gravel deposits. Over time, the water is filtered and stored in underground aquifers, or slowly released to surface water sources (Garfinkel et al, 2008). The ORM stretches east-west approximately 160 kilometers across southern Ontario, with around 65 percent existing within the boundaries of the Greater Toronto Area (see Figure 14) (Hanna & Webber, 2010). While the ORM serves as storage and as a conduit for surface and groundwater, it is also the natural habitat for 70 threatened plant and animal species (Hanna & Webber, 2010; Ministry of Municipal Affairs and Housing, 2012). In total, the moraine crosses 32 municipalities and four counties, providing direct drinking water for over 250,000 people (Ko et al, 2004). Furthermore, it is a groundwater recharge area that provides drinking water to millions of Ontarians. The ORM serves as the headwaters to 65 river systems, which form and shape a large number of streams, woodlands, wetlands, kettle lakes, and kettle bogs (Garfinkle et al, 2008). The ORM is a natural feature of immense importance to Ontario, and it has been informally dubbed “the rain barrel of southern Ontario” (Environmental Commissioner of Ontario, 2012).

The ORM accounts for 18 percent of the total GTA area. The major land cover in the area includes: water, forest, golf courses, agriculture, low-density built-up (LDB, i.e. residential areas), high-density built-up (HDB, including roads and industrial areas), construction sites and parks/grass fields (Furberg & Ban, 2012). These land covers have unique functions and

processes related to water. Agriculture is a source of nitrogen and phosphorus water pollution. Golf courses contribute increased concentrations of pollutants to water sources, pose a risk of erosion, and withdraw large quantities of groundwater. Low density and high-density build-up pose risks of water pollution and erosion from increased runoff and concentration times. Construction sites contribute increased concentrations of pollutants to water sources. Conversion of land to roads results in increased pollution from automobiles, erosion, increased runoff into water sources, and fragment the landscape. Forests and parks provide land cover for filtration, infiltration and water cycle regulation, and rivers support with flood control (Furberg & Ban, 2012).

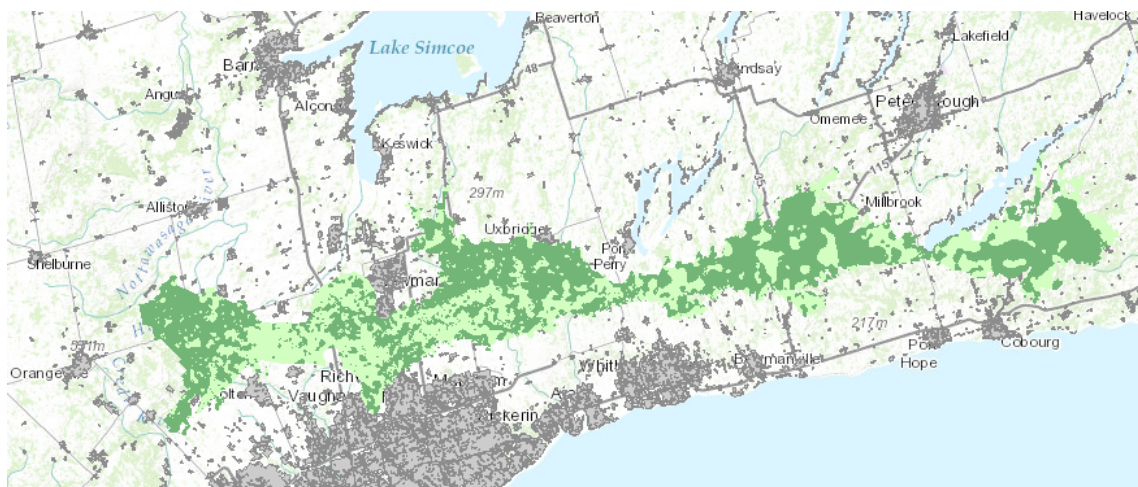


Figure 14: The Oak Ridges Moraine (ORM) (Green) and built-up areas (grey) (from Scholars Geoportal)

For a number of years, the ORM has been under threat by encroaching sprawl and development. In 2001, this impending threat prompted the passing of the Oak Ridges Moraine Conservation Act, which gave the legal framework for the Oak Ridges Moraine Conservation Plan (ORMCP). The goal of the Act was in part to protect the natural water resource features on the moraine,

with the protection of the hydrological integrity of the ORM stated as an explicit goal (Garfinkel et al, 2008).

## Contaminated Lands in the GTA

In 2012, the Auditor General of Canada published a report on the state of federal contaminated sites in Canada. A contaminated site is defined by the Federal government as, "one at which substances occur at concentrations (1) above background (normally occurring) levels and pose or are likely to pose an immediate or long term hazard to human health or the environment, or (2) exceeding levels specified in policies and regulations," (Treasury Board of Canada Secretariat, 2016). The report revealed that the government lacked a plan with measurable expectations for the identified contaminated sites (Office of the Auditor General of Canada, 2012). As of 2011, there were over 22,000 contaminated federal sites across the country. Specific locations of contaminated sites can be viewed on an interactive map hosted by the Treasury Board of Canada Secretariat. As shown in the figures below, there are hundreds of contaminated federal sites in southern Ontario, and a significant cluster along the border of the Oak Ridges Moraine near Markham.

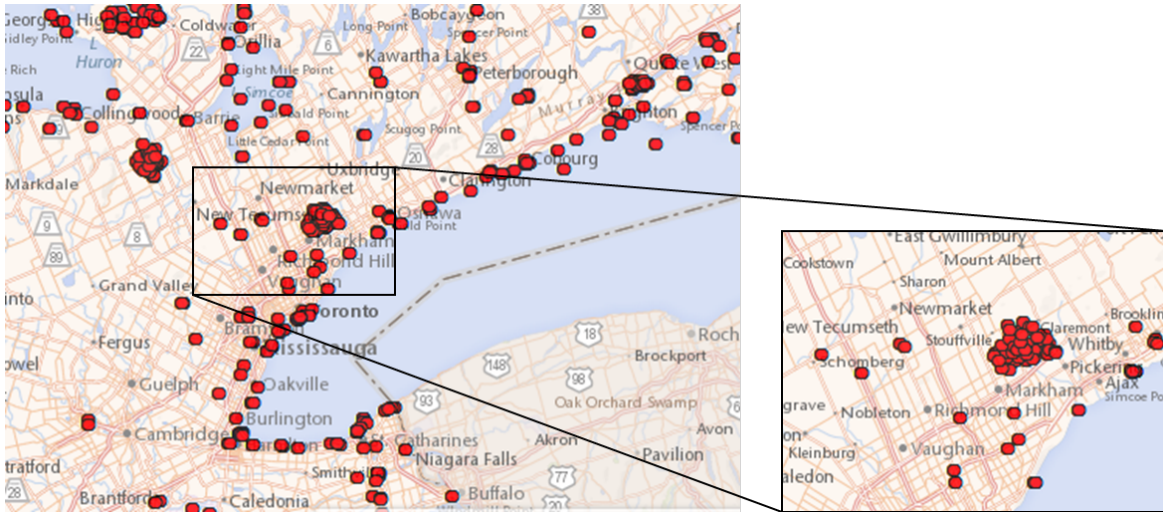


Figure 15: Federal contaminated sites in the GTA

A profile of each site is available through the Treasury Board of Canada’s website, detailing the location, property, contamination details and scale estimates, remediation priority, and local population estimates. No details are presented about nearby water sources, which is concerning since soil contaminants can leach into groundwater or runoff into surface waters over time. Most of the sites contained soil contamination from petroleum hydrocarbons (PHCs), polycyclic aromatic hydrocarbons (PAHs), metals, metalloids, and organometallics. PHCs are some of the most common soil contaminants in Canada. They primarily come from bitumen sources and can cause soil degradation, which may interfere with water retention and nutrient flows (CCME, 2014). PAHs consist of hundreds of separate chemicals, and are derived from the burning of carbon-containing materials. PAHs are known to be toxic to humans and other animals, including aquatic life (NC State, 2014). In more than one site in the cluster, benzene, toluene, ethylbenzene, and xylene (collectively known as BTEXs) were found in the groundwater. BTEXs are a group of volatile organic carbons (VOCs), several of which are known carcinogens (Minnesota Department of Health, 2016; Environment and Climate Change Canada, 2016). The

contaminated site profiles contained no indication of any assessments carried out regarding the possible cumulative impacts on the soil or water supplies from this cluster of contaminated sites.

The source water protection measures that are described and provided in the Clean Water Act are not applicable to federal land (with the exception of First Nations reserves, which can be included in a source water protection plan should the governing band council actively opt to be included). In this area of Ontario (GTA/Southern Ontario), federal contaminated sites are significant, but relatively contained and small in scale compared to elsewhere in the province. The severity of this contamination is notable because of their proximity to prime agricultural land, source waters, and human settlements.

There are a significant number of contaminated sites outside of Ontario's source water protection boundaries, many with devastating impacts on watersheds. Although the topic is well beyond the scope of this paper, it is worthwhile to briefly comment on the impact of resource extraction on watersheds. The Ontario Ministry of Northern Development and Mines administers a provincial abandoned mines database, which provides location and details of over 5600 abandoned mines. Abandoned mines pose serious threats to surface and groundwater. When exposed to air or water (oxygen), oxidation of metal sulphides that are within the surrounding rock or overburden generates acidity. Colonies of bacteria and archaea that are found within the rock accelerate the decomposition of metal ions. Limited availability of oxygen within the rocks typically keeps their numbers low, however extraction greatly increases the surface area of rocks, consequently increasing exposure to oxygen (Robinson, 2010). This process is known as acid mine drainage. While many mines are located in remote areas, across the Canada, there are 1200 Aboriginal

communities within 200 kilometers of active mine sites (Kielland, 2015). There are serious impacts from these mine sites on local watersheds and communities<sup>8</sup>.



*Figure 16: "Nickel Tailings #30", Sudbury Ontario, Edward Burtynsky (1996)*

## Soil Movement

Recently, a number of experts and citizen groups have raised concerns regarding the movement of soil from construction sites to locations on the ORM (Welsh, 2014; Garfinkel, 2015). A 2014 *Toronto Star* report revealed that the province does not track the movement of construction fill. This is likely because there is a jurisdictional gap and ambiguity when fill is considered to be semi- contaminated or compromised, as opposed to contaminated. When soil is determined to be contaminated, it is regulated as “waste” under the Environmental Protection Act, and there are clear disposal methods (Environmental Commissioner of Ontario, 2015). However,

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<sup>8</sup> See Montgomery M, (2016) Canada, and the world’s, water crisis (CBC Radio)

compromised soil is managed under a number of legislations, including the Aggregate Resources Act, which applies in cases where fill is deposited into quarry pits as part of site rehabilitation (Environmental Commissioner of Ontario, 2015). One issue is that a large amount of contaminated soil from construction sites (notably condominium construction) in the City of Toronto is being transported and dumped into these old quarries -- some within the boundaries of the ORM (Welsh, 2014; Garfinkel, 2015). Most of the soil within the City of Toronto is contaminated with heavy metals such as lead, PACs and metals (City of Toronto, 2011). In 2014, the *Toronto Star* requested information from the province in regards to the final location of the soil removed from development projects including the Pan Am Athletes' Village in Toronto. It is troubling that neither the province nor any other agency was able to provide that information, sparking a remark from the Minister of the Environment and Climate Change that soil movement was a serious issue (Welsh, 2014). The site of the Village (now the Canary district) is located within a few hundred feet of the Don River and was once a site of industrial activity, which raises questions about the toxicity levels of the soil (Welsh, 2014). The *Toronto Star* investigation revealed many troubling facts, from the lack of compromised soil tracking and regulation, to the lucrative soil dumping industry, to the concerning results of testing of the soil that was not considered to be contaminated. The dumping of contaminated or semi-contaminated soils on the ORM is troubling for the local ground and surface waters -- especially when considering the cumulative effects of other local contamination.

## **Groundwater**

Groundwater is the water below the Earth's surface in fractures of rock formations or in the porous spaces within and between rocks. Precipitation and runoff percolates through soil and

accumulates in aquifers, layers of sand, gravel and rock. Groundwater circulates as part of the hydrologic cycle. As precipitation and other surface water sources recharge the groundwater it drains progressively, often very slowly, towards a discharge point. This process can take tens of years, or tens of thousands of years, depending on the surrounding materials. Groundwater discharge contributes to surface water levels, providing important functions to wetlands, surface water quality, and surface water quantity -- especially during dry periods (Environmental Commissioner of Ontario, 2010). It is vitally important for groundwater input to equal output over time, since the recharge process can take so many years. There is more groundwater than surface water in Canada (Environment Canada, 2016). But this fact does not diminish the need to be concerned about the management and quantity of these resources. After all, the Passenger Pigeon was once the most common bird in the world.

Small municipalities and individuals are especially reliant on groundwater in Ontario. It is often a much more reliable and cost effective to draw municipal water from groundwater, as opposed to the large, capital-intensive facilities that are necessary for surface water (Environment and Climate Change Canada, 2016). Furthermore, not all municipalities are located within a close enough proximity to a surface water source. Consequently, in Ontario, more than 25 percent of the population relies on groundwater.

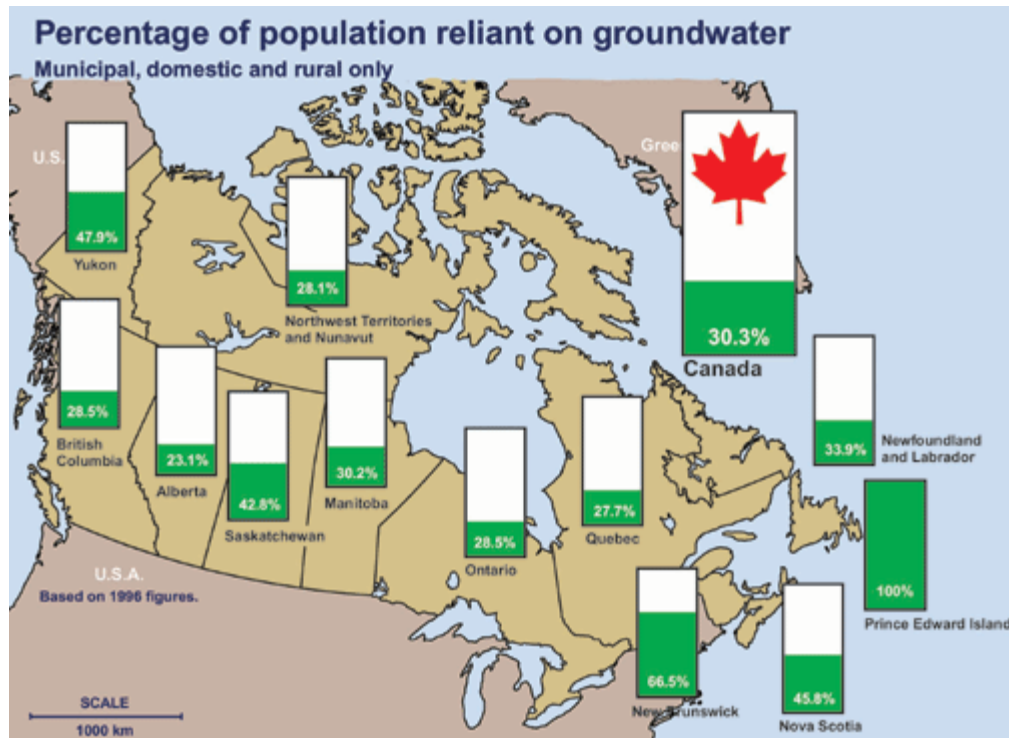


Figure 17: Environment and Climate Change Canada: percentage of populations reliant on groundwater in Canada (2016). There are two common types of aquifers: confined and unconfined aquifers. Confined aquifers are found beneath layers of impermeable surfaces. While unconfined aquifers are those that are bounded by the water table, and are hence much shallower than confined aquifers

Approximately three million people in Ontario rely on groundwater as their primary source of water (Ontario Ground Water Association, 2016). This includes numerous municipalities, such as Waterloo, Guelph, and Kitchener, whose municipal systems draw from a groundwater resource. Additionally, across the province, agriculture, businesses, and industries rely on groundwater for daily operations. While water is a renewable resource, groundwater, on a human time scale, is effectively non-renewable. Only about six percent of the groundwater worldwide is replenished within what is considered to be a human lifetime – about 50 years (Gleeson, 2012). For groundwater in Ontario, rate of recharge could be 10 years, or it could be upwards of 10,000 years, depending on the source. Little is actually known about many of our groundwater

resources (Environment and Climate Change Canada & the United States Environmental Protection Agency, 2016).

## Groundwater Contamination

In Ontario, groundwater resources face issues of contamination from a multitude of sources. Poor groundwater quality can have devastating implications. The infamous Love Canal in Niagara Falls, U.S. was one of the first recognized sites of groundwater contamination in the 1960s. This incident initiated the very first Environmental Protection Agency's superfund project. Elsewhere, groundwater contamination from agricultural fertilizers has resulted in wetland eutrophication (Lavoie et al, 2015). And of course, groundwater contamination has resulted in outbreaks of illnesses, such as E. coli.

Private wells on the moraine are more at risk from contaminating activities than municipal systems, since well water is not usually treated before consumption. Further, well water quality monitoring is the responsibility of the owner, and therefore occurs significantly less frequently than larger systems. Private wells fall outside of the source water protection program under the Clean Water Act, which means that they are not subject to policies that protect them from nearby land uses and activities. The province does have minimum rules for licensing individuals and companies who construct a well; choosing a location for a new well; constructing a well; maintaining a well; abandoning a well; reporting well activities (completing and submitting well records) (Ministry of Environment and Climate Change, 2016). However, protection of private wells is limited and informal, and there are tens of thousands located on the ORM, and over 400,000 in the province (Ministry of Environment and Climate Change, 2016). For the most part,

recent measures to protect groundwater from contamination have been successful in Ontario, including source water protection under the Clean Water Act. Troubling though, is potential for groundwater overuse.

### **Groundwater Quantity Challenges**

Currently, groundwater in Ontario faces little protection when it comes to over extraction. York Region is implementing recharge policies in tandem with source water protection policies into its Official Plan. The recharge policies are based on water balance studies conducted by York region and two conservation authorities. Wellhead quantity protection will be introduced to nearly 70 percent of York Region, and new development will be required to maintain recharge by meeting infiltration targets (Best, 2016). No information is available regarding how this recharge requirement will be monitored or enforced. However, this requirement is a step in the right direction towards maintaining groundwater quantity. Unfortunately this new policy will not address any of the current land uses that already contribute to poor ground water recharge. Nor will it address activities that take a significant amount of water. York Region should go one step further and provide incentives and/ or policies regarding recharge on existing developments.

Groundwater over extraction has become a contentious issue in recent years, as revelations have mounted regarding the millions of liters of water per day that Nestle is extraction from the Arkell aquifer, near Guelph. Troubling for most is the added strain on the ground water resource, combined with outrage about how little the food and beverage giant is paying for the resource – at three dollars and seventy-one cents per one million liters, that anger is justified. At a time

when public awareness is growing about the sensitive nature of our groundwater resources, the opportunity to protect it has never been greater.

In 2010, the Canadian Council of Ministers of the Environment (CCME) surveyed over one hundred Canadian groundwater regulators, consultants, researchers, and users about the level of knowledge, and knowledge gaps of groundwater resources across the country. This included knowledge of water governance, linkages between surface and groundwater management, and the status of groundwater research in Canada (CCME, 2014). It was revealed that there are significant knowledge gaps among the participants when it came to groundwater sustainability, quality, mapping, and monitoring. At a time when development is presenting increasing pressure on groundwater resources, groundwater sustainability is undoubtedly one of the biggest issues facing groundwater resources (CCME, 2014). Respondents indicated that there are few mechanisms to resolve the increasing conflicts between municipal water supplies, commercial and industrial users, and ecosystems (CCME, 2014). Most of the available information regarding groundwater sustainability analysis is through the various permits to take water programs (CCME, 2014). Hence, knowledge and consideration of the cumulative effects of withdrawals is infrequent, and applications are considered on an individual basis. The survey respondents indicated that a lack of regulation and available management mechanisms coupled with insufficient groundwater information contribute to challenges related to groundwater management (CCME, 2014).

Furthermore, the CCME's survey revealed that extensive groundwater mapping is lacking in most provinces, including Ontario – which sheds light on the fact that groundwater knowledge is

extremely deficient. Most of the groundwater in Ontario simply has not been mapped. At present, provincial groundwater data mostly/primarily comes from data sources such as water well records, pumping test data, hydrogeological maps and studies, and groundwater vulnerability mapping (CCME, 2014). Additionally, while it is known that groundwater has an important role to play with surface water, little is actually known about what happens at these points of interaction (Environment and Climate Change Canada & the US Environmental Protection Agency, 2016).

The CCME survey revealed a pressing need for the advancement of groundwater knowledge in Ontario and across the country. It is alarming that so little is known about this resource, yet communities and ecosystems are so dependent on it. History and scholars like Garrett Hardin and Elinor Ostrom have demonstrated the disastrous consequences of users acting independently while sharing a common pool resource. Without shared knowledge and management efforts in place, individuals will increase their own short-term benefits, while ignoring the long-term implications of their actions. Resources including water are subject to rivalry and excludability, making management of these even more critical.

While there are reasonable concerns about the lack of knowledge of groundwater resources, the extensive research required for source water protection plans' Assessment Reports has brought forth an immense amount/volume of new information and knowledge about Ontario's groundwater. For example, advanced mapping of vulnerable areas and groundwater has revealed the location, depth, and extent of some resources. However, a 2014 report published in the Canadian Water Resources Journal has raised questions about whether or not this newly gained

knowledge has been integrated into the daily decision-making on water taking (Environmental Commissioner of Ontario, 2015). Furthermore, the Environmental Commissioner of Ontario concluded that there was insufficient public input into decision-making around the permitting. It was revealed that the public did not have the ability to comment on the Environmental Bill of Rights (EBR) registry on 75 percent of high-risk permits issued. After much public outcry, the Ministry of the Environment and Climate Change has recently announced potential changes to the EBR, and a possible moratorium on Nestle's permit to take water renewal (Environmental Commissioner of Ontario, 2015).

Under the Ontario Water Resources Act, users wishing to use in excess of 50,000 litres of water per day must apply for a permit to take water from the Ministry of Environment and Climate Change. The Ontario Water Resources Act exempts individual households, fire fighting, livestock and poultry watering, and takings that predate 1961 from the permit to take requirement. Activities requiring permits include electricity generation, manufacturing, drinking water supply, agriculture, and quarry de-watering (if they plan to use more than 50,000 liters of water per day). As of March, 2015, there were more than 6000 active permits issued, totaling over 500 trillion liters permitted to be taken annually by all permit holders – an amount roughly equal to one-third of the volume of Lake Ontario (Environmental Commissioner of Ontario, 2014). This outrageous permitted amount underscores the lack of cumulative impact assessments occurring in the permit to take water program.

$$V_{Lake\ Ontario} = 1640\ km^3 = 1.64 \times 10^{15}\ L$$

$$V_{\text{permit}} = 5.0 \times 10^{14} L$$

$$\frac{V_{\text{permit}}}{V_{\text{Lake Ontario}}} = \frac{5.0 \times 10^{14} L}{1.64 \times 10^{15} L} = 0.304 = 30.4\%$$

The Director of the MOECC has the discretion to approve or reject an application, and has the authority to set maximum daily limits for permit holders. Permit holders are required to monitor and report to the MOECC on quantities of water taken from the permitted source. Regulatory changes in 2004 require that water availability be a consideration in all PTTW decisions, and for an assessment of whether water conservation will be implemented (Environmental Commissioner of Ontario, 2012).

Under the permitting program, there are three categories of permits. Category 1 is considered low risk and renewals can be granted if there is no history of complaints; Category 2 is for water takings whereby there is a greater potential of adverse environmental impact; Category 3 is considered high risk (and the permit application fee is slightly higher) (Ontario Ministry of the Environment and Climate Change, 2015). In 2004, amendments were made to the water taking and transfer regulation under the OWRA, which included maps that designate watersheds as high, medium or low water use. Certain industries are not allowed new or expanded water taking permits in high-use areas. These are primarily industries that include water into their final products, such as bottling activities.

In free markets, increases in the scarcity of a resource will increase its relative price. But the price does not reveal any more information about its scarcity in the environment. In Ontario,

water pricing does not reflect its true value, and consequently households and industries pay very little. Industries pay just \$3.71 per million litres of water. Hence, prices do not account for its scarcity, because we assume an endless supply. While it is true that Ontario is endowed with a significant amount of water, scarcity is growing as water quality becomes degraded and groundwater continues to be extracted at a rate much higher than it can be replenished. There are reasonable ethical considerations for pricing water (especially for households and individual consumers). However, industries should be expected to pay more for water resources in Ontario.

The link between groundwater management and source water protection is obvious. But clearly the management of groundwater is extremely complicated. Moreover, much more can be done to manage and understand Ontario's groundwater resources. Perhaps the situation is most pressing in and around the Greater Toronto Area, where development pressures, industry, and the environment are in competition over groundwater. An exemplary case of this is in the area on and surrounding the Oak Ridges Moraine (ORM).

The ORMCP, local municipalities and nine Conservation Authorities have worked within their capacities to protect, restore, and enhance the ground and surface water of the ORM for nearly two decades (Hanna & Webber, 2007). Municipal watershed plans and water budgets are required under the ORMCP (ORMCP, Bradford, 2008). However, there is serious disconnect between local and provincial initiatives with the Permit to Take Water (PTTW) system administered by the Ministry of Environment and Climate Change (MOECC).

While conservation efforts have attempted to protect, restore and enhance the water supply of the ORM, the MOECC has continued to issue and renew PTTW that are counter to the conservation

goals of other provincial, regional or municipal initiatives. For example, a review by Ecojustice (formerly Sierra Legal Defense Fund) found that nine of the nearly 70 golf courses that are either on or within five kilometers of the ORM are permitted to take 3,117,791,560 liters of water per day from the sensitive Yonge Street Aquifer on the ORM -- an area with a history of water shortages. It was found that most of the nine golf courses were failing to submit the required annual reports to the MOECC of the quantity of water they were taking, and yet their permits were being continually renewed (Garfinkel et al, 2008). Under current regulations, no individual permit holder is responsible for cumulative impacts on the wider environment. It is concerning that the MOECC has failed to perform its regulatory duties to ensure that that these golf courses are not exceeding their total allowed amount of water, and further to ensure there are no larger impacts to the moraine from these water taking activities.

Moreover, the PTTW and the MOECC are not aligned with other provincial, regional and municipal initiatives. It is counter to these conservation initiatives to issue permits to take large quantities of water for activities inherently working against legislative efforts like the provincial ORMCP. There are currently no regulatory requirements for water permits on or adjacent to the moraine to meet the ORMCP objectives or for individual permit holders to consider cumulative impacts (Environmental Commissioner of Ontario, 2012). Furthermore, part of the challenge is the fragmented regional governance. The Moraine boasts five upper-tier municipalities, each with their own development policies. Legislation such as the Greenbelt Act and the ORMCA have led to more unified planning and Official Plans have evolved to include greater protection as more is understood about the Oak Ridges Moraine. However, when it comes to the protection of moraine groundwater quality and quantity protection, the precautionary principle should be

executed. The resource is far too important to jeopardize for the sake of a golf course or a subdivision. While applications for development on the Moraine must now be accompanied by a storm water management plan, with the objective of minimizing the risk of flood, there remains little about protection of groundwater quantity. (Bradford, 2008).

The ORM's importance as a source of water for millions of people must not be taken for granted. It is a resource under incredible stress, and the extent of which is beginning to show. Numerous rivers flow from the ORM. The base flows of these rivers are important indicators of groundwater quantity, as this is the portion of water that comes from the subsurface. The Lake Simcoe region is north of the Moraine, and has been observed for decades. For example, trends of declining base flow in the East Holland River have been observed over a 40-year period (see Figure 18). The East Holland River is located near the towns of Aurora and Newmarket, which have seen unprecedented development and population growth over the same period of time. The impacted base flow is likely the result of numerous, cumulative effects. However, the withdrawal of millions of liters of water per day from the ORM combined with effects of development, and the transition from natural surfaces to impervious coverings have undoubtedly had an effect on groundwater recharge.

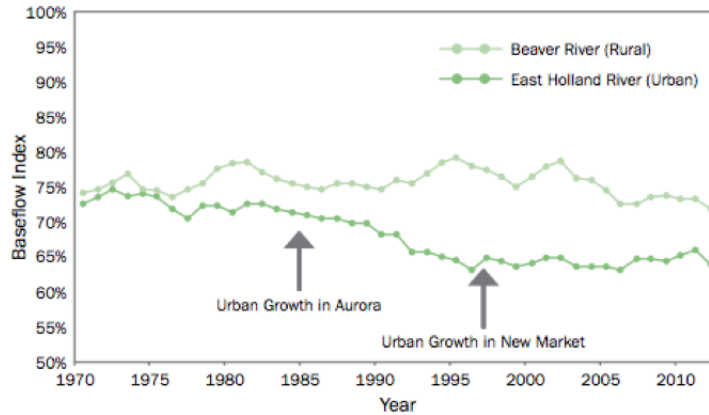
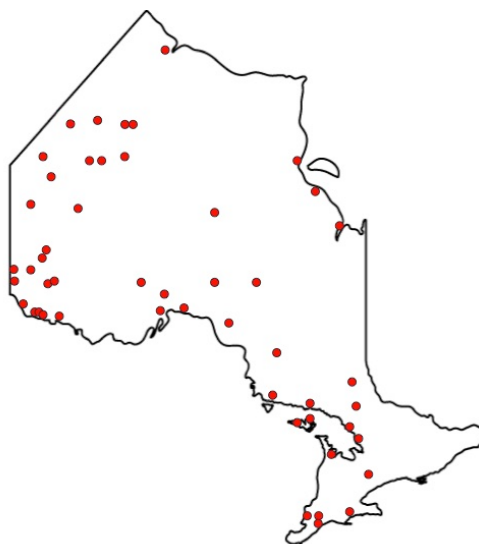


Figure 18 Declining base flow of the East Holland River.  
 (From Lake Simcoe Region Conservation Authority 2014)

## First Nations

In the report of the Walkerton Inquiry, Justice Dennis O'Connor identified First Nations in Ontario as having, "some of the poorest quality water in the province" (O'Connor 2002b, 486). Remarkably, the drinking water situation in many First Nations communities has not improved in the 14 years since this statement was made, remaining well below provincial standards.

Source water currently poses a high risk to 72, and a moderate risk to 61 First Nations drinking water systems out of the 151 systems in total (high risk community locations shown in Figure 19). These are communities that have water assets such as water treatment systems, and draw source water from surface water, ground water, ground water under direct influence (i.e. shallow ground water) or a Municipal Type Agreement. There is no available data for the five communities that exclusively rely on individual wells for their drinking water. Further, these high and medium risk figures do not account for the affected source water in the communities that get their drinking water through a Municipal Type Agreement (whereby a contract is signed with for a First Nation to receive piped drinking water from a neighbouring municipal system).



*Figure 19: First Nations communities considered to be at high risk for unsafe drinking water quality.*

## Challenges in Governing Water with First Nations

Water jurisdiction in Canada is fragmented and complex. There are numerous water and drinking water-related statutes and a number of actors and levels of government responsible for some aspect of water management. The fact that water does not adhere to jurisdictional boundaries makes water management under a fragmented system even more difficult to manage. The complexity surrounding water governance is especially true for First Nations communities. Complicated legal and historic relationships with the government further add to this problem.

In October of 2015, Prime Minister Justin Trudeau acknowledged the chronic water crises affecting First Nation communities across the province. At that time there were 93 communities under 133 boil water advisories across the country (excluding British Columbia). Upon his election as Prime Minister, Trudeau promised to eliminate all water advisories in First Nations communities over the next 5 years. Canada's water crises in First Nations communities have been criticized worldwide as a violation of human rights, and in a country with abundant water

resources, the issue sheds light on the disproportionate burden of environmental justice concerns that First Nations communities face on a daily basis.

In Prime Minister Trudeau's 2016 mandate letter to Environment Minister, Catherine McKenna, he called on her to "treat our fresh water as a precious resource that deserves protection and careful stewardship" (Trudeau, 2016). Problematic though, is the fact that "water" was not even mentioned in his mandate letter to Indigenous and Northern Affairs Minister, Carolyn Bennett, which calls into question his commitments to ending the First Nations water crisis. In 2016, Ontario's Premier, Kathleen Wynne released new mandate letters for her provincial Ministers. She called upon Minister of the Environment and Climate Change, Glen Murray, and Minister of Indigenous Relations and Reconciliation, David Zimmer, to work together to improve drinking water for indigenous communities.

Under Canadian Constitutional law, water has shared jurisdiction. The Constitution Act gives the provinces the primary responsibility over water management. The federal government, however, retains the power and responsibility to manage drinking water over the Federal House, which includes military bases, prisons, national parks, and First Nations reserves (Canada Water Act; Fin, 2010). There is currently no federal, legally enforceable standard for drinking water quality in Canada -- making Canada the only OECD country without any national standards. Since the provinces are primarily responsible for drinking water management, the real impacts of this are felt in First Nations communities, where the fragmented responsibilities and a lack of standards

have left gaps, making these communities more vulnerable to poor water quality and management<sup>9</sup>.

The Federal government has a fiduciary relationship with indigenous peoples in Canada. The fiduciary obligation of the Crown is *sui generis*, meaning of its own kind, and is meant to be one of trust (on paper). However, many Canadians believe that the federal government is failing First Nations communities, especially when it comes to drinking water. Moreover, the evidence could not be clearer that the Federal Government is failing to meet its fiduciary responsibility.

### How First Nations Depend on Water

Section 35 of the Canadian Constitution guarantees aboriginal Treaty Rights. Few written treaties explicitly mention water, apart from the use of waterways as boundaries. However, oral versions of treaties affirm the importance of waterways for travel, sustenance and maintaining Indigenous ways of life (University of Manitoba, 2016). It should be remembered that many Treaties were signed at a time when language barriers impacted communications between British and French settlers and Indigenous peoples. This history, and consequently differences in interpretation, is the source of many issues and conflicts between First Nations and the federal and provincial governments.

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<sup>9</sup> In 2013, the Federal government implemented the Safe Drinking Water for First Nations Act, which will allow the Government to develop, with First Nations, enforceable federal regulations to ensure access to safe, clean and reliable drinking water; the effective treatment of wastewater; and the protection of sources of water on First Nation lands. The Act received widespread criticism. Much of the criticism stems from the fact that the Minister has the authority to repeal existing Aboriginal or treaty rights “to the extent necessary to ensure safe drinking water” (CELA, 2014).

The right to live off the land is protected by Treaty (Constitution Act, 1982). Hence, for some communities, the right to hunt, fish, and trap is severely impacted by contaminated surface water. If a lake or river is contaminated, then it will not be safe to consume the fish from that same source. Indigenous people understand treaties as agreements to share land and resources, which often differs from the Crown's interpretation. To honour and respect this Treaty right, more inclusion in water management and decision-making responsibility should be bestowed upon First Nations peoples.

From a drinking water perspective, impacted source water also means that many communities have had to rely on bottled water at the household level, and expensive chemical treatments at the community supply level. These practices have the effect of weakening the relationship between a community and its water (Chiefs of Ontario, 2007). Water holds an important, often spiritual significance to many indigenous peoples. The loss of this relationship would be a loss of culture. In addition, from a health perspective, under boil water advisories, tap water is still used for bathing and other household uses, which has been linked with outbreaks of rashes in numerous communities, including Kashechewan and North Caribou. Recently, schools have had to close because of impacted drinking water in North Caribou reserve, which can profoundly impact children's' education (CBC, 2016).

Water can be a contentious subject for some aboriginal people. It can be the catalyst to issues and debates surrounding public health, sovereignty, and environmental protection, which can result in conflict (Finn, 2010). For decades now, water management across Canada has not incorporated traditional indigenous knowledge and perspectives. Indigenous peoples have not

been provided sufficient and meaningful opportunity in decision-making and policy implementation. The unique voices of First Nations people across the country have been hushed, as contemporary policies and laws favouring growth, development and economic prosperity have prevailed.

The lack of Indigenous voice and perspectives in water management has serious consequences for the health and wellbeing of the environment and millions of Canadians. Typical water management practices have typically led to end-of-pipe solutions that do not address the underlying causes of degradation and are non-preventative (Finn, 2010). Safe drinking water as a bottom line is anthropocentric and narrow in scope. It fails to consider and capture the pressing needs, opportunities, and benefits of protecting water sources for the sake of the environment and ecological health. In contrast, First Nations approaches to water management are holistic, and environment-centric, as opposed to anthropocentric. It is well understood that the trickle down effects of a healthy environment and watershed are positive to all life within in. The diversity in indigenous environmental knowledge should not be overlooked. These are merely common themes. The idea that water must be respected as a life force is a consistent guide in indigenous water management.

### **Water Contamination on First Nations Reserves**

Two significant threats for source water quality for First Nations communities include contamination from off-reserve activity, and poor on-reserve wastewater management.

The water that First Nations communities rely on is often degraded by activities and land uses off-reserve. Therefore, in places outside of provincial source water protection regions/ areas (where most First Nations communities are located), it would be necessary to work with neighbouring municipalities to develop something similar to a source water protection plan, whereby water resources are identified, threats are assessed, protection zones are delineated, and an agreement is made to manage all associated risks. Without a governing framework and guaranteed cooperation and compliance, this approach may be difficult to effectively implement.

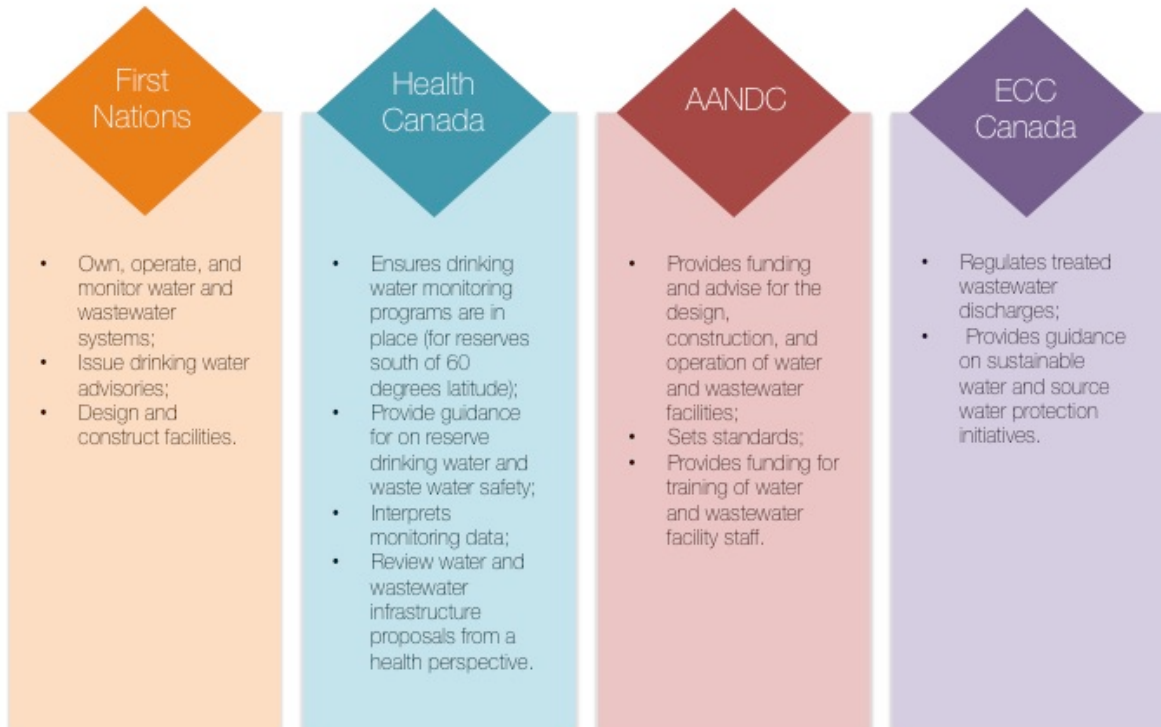
In Ontario, there are 77 wastewater systems serving 67 First Nations (as of 2011). The remaining 53 First Nations are serviced individual wastewater systems, such as septic tanks. The 77 systems include: 6 systems are provided treatment through a Municipal Type Agreement (MTA); 71 First Nation wastewater treatment systems, consisting of 38 systems that use either facultative or aerated lagoons, 27 systems that use a mechanical plant, 4 communal septic systems and 2 other treatment type systems (Burnside, 2011). Of the 77 wastewater systems: 28 are categorized as high overall risk, 38 are categorized as medium overall risk 11 are categorized as low risk (Burnside, 2011). Individual septic tanks also pose risk to source water quality. Poorly maintained septic systems can fail, resulting in the release of inadequately treated household wastewater into the environment. Untreated wastewater from failing septic systems can contaminate nearby wells and groundwater sources (British Columbia Ministry of Water, Land and Air Protection, n.d.).

## First Nations and the Clean Water Act

The Clean Water Act is an enabling legislation that relies on tools provided in other provincial statutes for implementation, notably the Planning Act. The Planning Act details the rules for land use planning in Ontario and describes how lands can be controlled. A First Nation can manage land uses by utilizing many of the same tools that are authorized in the Planning Act, such as zoning by-laws and site plan controls. This technically means these communities have many of the same tools available to them as described in the Clean Water Act. To use these tools, a First Nation must unanimously pass a Band Council Resolution (BCR), and opt out of 34 land related sections of the Indian Act. Once this is done, a First Nation can govern lands and resources through their own code (a First Nations Land Management Regime (FNLMM)). This type of land management regime may include waterway/watershed protection, or use tools like site plan control to regulate septic tanks, for example. Land codes are only enforceable on reserve, however, which makes comprehensive source water protection difficult to achieve (Canadian Environmental Law Association, 2014).

In 2011, a national assessment of First Nations water and wastewater systems was carried out. The assessment revealed that few communities had a source water protection plan in place, and that for many of these communities, the lack of plan was a primary threat driver to the quality of their source water. A Protocol for Centralized Drinking Water Systems in First Nations Communities was developed by First Nations technical representatives, Aboriginal Affairs and Northern Development Canada (AANDC), Health Canada, and Environment and Climate Change Canada. It was stipulated that all communities with centralized water systems funded in whole or in part by AANDC, serving five or more households or a public facility, must comply

with the requirements of the protocol (AANDC), which incorporates the Multi-Barrier approach to drinking water. The first step of the multi-barrier approach is source water protection.



*Figure 20: Who does what -- responsibilities of First Nations, Health Canada, Aboriginal and Northern Affairs Canada, and Environment and Climate Change Canada in First Nations drinking water provision. Adapted from CELA, First Nations' On-Reserve Source Water Protection*

Under the protocol, a First Nation “shall participate where possible with local stakeholders (such as conservation authorities and neighbouring municipalities) in the development and implementation of a local watershed and aquifer protection plan. First Nations communities shall also develop and implement community-specific (on-reserve) source protection plans to prevent, minimize, or control potential sources of contaminants in or near the community's raw water sources” (AANDC, 2011). A guide to source water protection followed the release of the protocol, which “will steer First Nations through a process that will help them manage their

drinking water sources and to locally take concrete actions to support human health and ensure a healthy environment for now and for future generations” (AANDC, 2011).

In Ontario, First Nations communities that fall within the boundaries of source water protection areas under the Clean Water Act are able to participate in the provincial source water protection in two ways. First, they are entitled to send a representative to sit on the local source water protection committee. Second, the Act authorizes a regulation to be made to include a First Nations drinking water system in the source water protection plan. To do so, a First Nation must be located within a source water protection area/region, and must first pass a Band Council Resolution, requesting that their drinking water system be included in the protection planning process (Clean Water Act, 2006). Twenty-eight of the 133 First Nations in Ontario have reserve land within a source protection region (not including land with outstanding land claims) (see Figure 21).

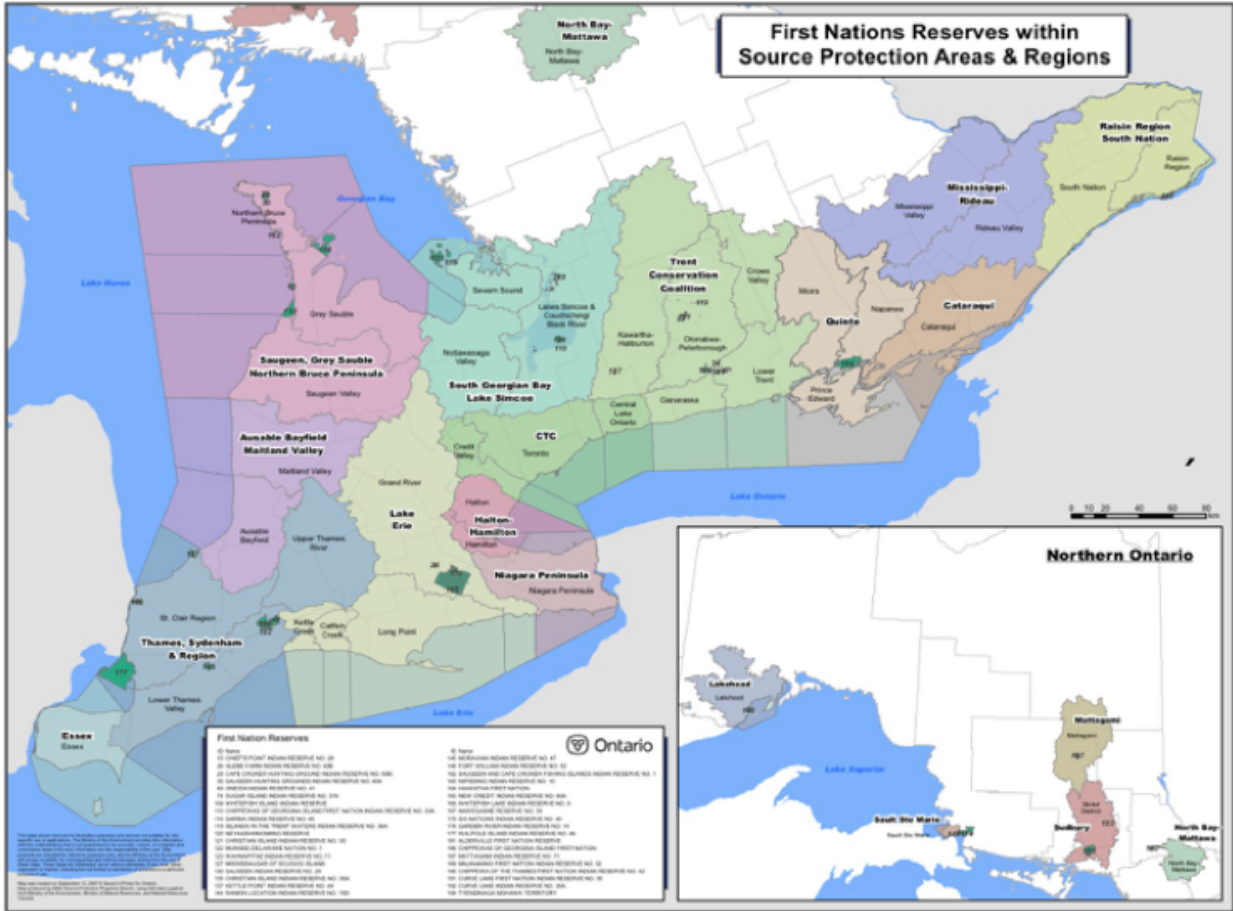


Figure 21: First Nation communities within source water protection boundaries.

Apart from the Kettle and Stoney Creek, Six Nations, and the Chippewas of Rama, few First Nations are fully participating in the province’s source water protection program. The above-mentioned communities have passed band council resolutions and expressed their intent of being part of the formal provincial source water protection program to the Minister of the Environment. Amendments to the Clean Water Act have subsequently been made to include these communities in the source water policies. The remaining 25 First Nations that fall within the source water protection regions are able to send representatives to sit on the source water protection committees -- and many do (based on information posted on local source water authority websites). According to the Chiefs of Ontario, very little input was sought from First

Nations peoples in the development of the Clean Water Act. (Chiefs of Ontario, 2007).

Furthermore, much concern has been cited by First Nations about the scope of source water protection as too human-focused, and the possibility of infringement by the Province on Treaty rights.

Another challenge to source protection is the underlying issue of a lack of human resources and capacity to effectively manage water resources. Delineating vulnerable areas and implementing land use control measures are only a small part of the story. Because of the Duty to Consult many First Nations are completely overwhelmed by the sheer number of Environmental Assessments and development applications/ plans that are sent to for review (Rowinski, 2015). These documents are often highly technical, and take hundreds of hours for a professional read and interpret. Therefore, the communities often have to be selective in what projects and applications they choose to devote their time and resources to. This leaves dozens of other projects without any review or insight by a First Nations communities. Bands and community environmental officials alike have expressed how this lack of capacity means that they are unable to do their due diligence on project assessment to their community (Rowinski, 2015; Charles, 2016).

The fact remains that the majority of First Nations communities in Ontario are not located within the provincial source water protection regions. Achieving local source water protection outside of the formal process in First Nations reserves is very difficult without the cooperation of adjacent municipalities and landowners.

## Spotlight on Chippewas of Georgina Island

The Chippewas of Georgina Island occupy Georgina, Fox, and Snake Islands in Lake Simcoe, within the boundaries of the Greater Toronto Area. Development is a major threat to the Lake, which in recent years has seen a drastic deterioration in water quality, in part due to increased phosphorus levels from agricultural activities, sewage treatment plants, septic tanks, drained wetlands, urban areas, and the atmosphere (Environmental Commissioner of Ontario, 2010). The Lake Simcoe watershed is expected to experience more growth over the next two decades, in part because of designations in the Growth Plan for the Greater Golden Horseshoe under the Places to Grow Act, 2005 (Environmental Commissioner of Ontario, 2010). The Places to Grow Act allows the province to plan for growth and designate any region in Ontario as a growth plan area (Ministry of Municipal Affairs and Housing, 2016). In 2008 the Lake Simcoe Protection Act was passed, and an associated plan was developed to address long term environmental issues in Lake Simcoe and its watershed -- including a phosphorus reduction strategy. The plan includes 119 policies that are directed at protecting and restoring ecological health in the entire watershed (Environmental Commissioner of Ontario, 2010). The watershed also encompasses a portion of the ORM and the designated Greenbelt. In recent years, a significant amount of agricultural lands has been converted into housing developments. The influx of development and land uses changes has severely impacted the state of Lake Simcoe.

Under natural conditions, Lake Simcoe is an oligotrophic lake, meaning it has low nutrient levels, and consequently little algae, and high amounts of dissolved oxygen (Environmental Commissioner of Ontario, 2010). From the 1970s and into the 1990s, Lake Simcoe experienced significant amounts of nutrient loadings, which altered the concentrations of dissolved oxygen,

creating “dead zones” and eutrophication. The impacts of eutrophication on the aquatic life was devastating. Species including lake trout and whitefish have drastically declined over the same period of time. Development is creating new challenges for Lake Simcoe, while phosphorus remains to be a problem (Environmental Commissioner of Ontario, 2010). Agricultural activity, stream flows from agricultural areas, sewage treatment plants and septic systems continue to add phosphorus into Lake Simcoe.

The Chippewas of Georgina Island are at the epicentre of this activity. The Department of Upper Canada moved the group to Snake Island in the early 1800s, and eventually to Georgina Island as well (Hoeg, n.d.). These small islands are the only territory that the Chippewas of Georgina Island have to practice their traditional ways of life and exercise their treaty rights, guaranteed by the Canadian Constitution.

In a climate change adaptation session held by the Ontario Centre for Climate Impacts and Adaptation Resources with members of the Chippewas of Georgina Island reserve, elders reflected on the changes to Lake Simcoe over the past several decades. They noted changes to the ice cover and character on the Lake during the winter; unfamiliar smells; increased amounts of weeds and aquatic plants; a loss of shoreline; and more rashes after swimming in the lake (Charles, 2016). In addition, people no longer eat the fish or drink the water from Lake Simcoe. The community has also been under a boil water advisory since May, 2016 (Chippewas of Georgina Island, 2016). All of these observations have serious and significant source water implications. Lake Simcoe is not unique in many of its experiences.

In support of the Lake Simcoe Protection Plan, a moratorium was placed on the construction of new water and wastewater treatment facilities on the lake. A proposed sewage treatment plant on the Holland River, which flows directly into Lake Simcoe, essentially undermines this protection. The Upper York Sewage Solutions project is currently in the Environmental Assessment phase of development, and could possibly be given approval since it does not directly release effluents into Lake Simcoe. Band representatives from Georgina Island have called this a loophole in the legislation, and are committed to fighting the project with the support of other community groups. The treatment plant will contribute to the phosphorus levels of the Lake, which is counter to the plans in place to protect it (Sathasivan, 2008). However, since effluents from the plant will be released directly into the East Holland River, and not Lake Simcoe, the plan has been able to progress to the Environmental Assessment phase. Band Chief, Donna Big Canoe, has expressed dissatisfaction with the consultation that has occurred with the community (Riedner, 2016).

Recent Supreme Court of Canada decisions require that the federal and/or provincial Crown consult with and, when appropriate, accommodate First Nations when considering activities that may adversely affect a potential or established Aboriginal or treaty right. In *Delgamuukw v. British Columbia*, Chief Justice Lamer noted that “there is always a duty of consultation . . . in good faith, and with the intention of substantially addressing the concerns of the aboriginal peoples whose lands are at issue . . . . Some cases may even require the full consent of an aboriginal nation” (Anaya & Williams, 2001). All consultation conducted by the Crown must be “meaningful” and uphold the “honour of the Crown” while considering societal interests alongside those of First Nations peoples. At minimum, consultation should be meaningful

enough to minimize long-term conflicts. Many believe that this results in cases where the Crown makes decisions that may not meet the aboriginal peoples' expectations (Bergner, 2005).

Consultation typically takes on one of three forms. It could result because of the Crown's legal obligation, statutory compliance, or it is done on a voluntary basis. Hence, while the legal duty to consult is the responsibility of the Crown, some procedural elements of consultation are passed on to the development firm or project proponent on a voluntary basis. Often proponents use Impact Benefit Agreements (IBAs) to secure local support and reduce the likelihood of legal action due to inadequate consultation -- despite the fact that the company has no legal obligation to consult and accommodate.

The Upper York Sewage Solutions treatment plant will enable the construction of new housing developments in the East Gwillimbury area (within the Lake Simcoe watershed). A lack of critical water and wastewater infrastructure has been a barrier for development in this area (Tuckey, 2016). This project exemplifies the conflict between growth, changing land uses and protection of source water and watersheds.

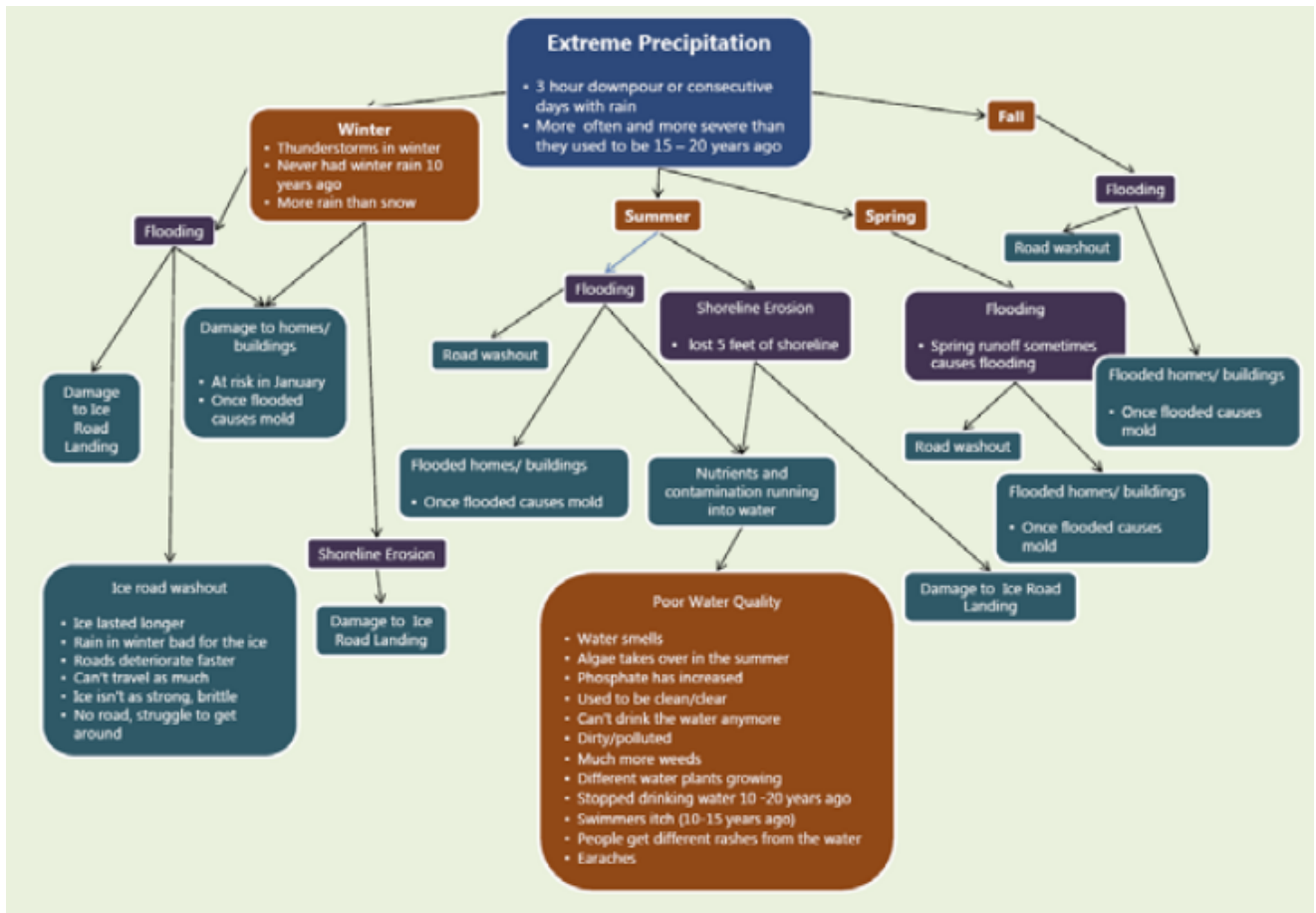


Figure 22: Output from Georgina Island Climate Change Adaptation Session (Charles, 2015)

## Recommendations and Conclusions

Source water protection policy in Ontario has demonstrated that the quality of drinking water sources can be protected with very deliberate planning and strong governance and institutions. Much can be learned, replicated, and expanded from Ontario's experience with source water protection elsewhere in the world. As this paper has demonstrated, source water protection is not perfect. It is narrow in scope, and anthropocentric in nature. However, at a time when global human population growth, urban expansion, industry, and agriculture are growing at unprecedented rates, global water resources are at significant risk. Similar comprehensive

legislation is often absent, or poorly implemented around the world. In many cases, reductions in water quality and quantity are irreversible in a human lifetime, and in timescales unknown. Further, in situations where water quantity and quality can be restored, the costs of doing so make it prohibitive to do so (especially because of the chronic problem of thinking in election cycles instead of generations).

The global population has more than tripled over the past 70 years, while the amount of water available has remained a constant (Bernstein, 2002). The water required for agriculture and personal needs is increasing with population growth at a rate that will be difficult to maintain. With some 80 million people added to the human population each year, the amount required for them is almost equal to the flow of the Rhine River (Beck, 2014; Bernstein, 2002). Water needs do not account for the amount of water diverted or contaminated from changes in land cover associated with population growth and increases in affluence. Aquifer levels have dropped by as much as 50 meters since baseline recordings in Manila, Bangkok, Shanghai, Mexico City, and Beijing (United Nations, 2015). As it is, many people live in situations where clean and safe water is difficult to access, and climate change has exacerbated droughts, water shortages, and floods (which can result in contamination).

The availability and abundance of safe, clean drinking water has a profoundly positive impact on health, economic and social progress of a society (WHO, 1999). Waterborne diseases account for over three million deaths annually (United Nations, 2015). Furthermore, it is predicted that water shortages will fuel violent intra and inter-state conflicts in the near future. Already, it is widely

believed that water scarcity and recurring droughts were significant contributing factors to the 2011 uprising that resulted in the ongoing conflict in Syria (Beck, 2014).

Following a decade dedicated to “Water for Life” (2005 - 2015), and the deadline of the Millennium Development Goals, the United Nations formally adopted the 2030 Agenda for Sustainable Development, as well as a set of new Global Goals. The Global Goals are a list of 17 goals for sustainable development. Goals six and fourteen explicitly address water (Clean Water and Sanitation and Life Below Water, respectively), while a number of the other goals indirectly encompass sustainable water resource management.

Achieving the Global Goals requires bold solutions to big problems. Constructing large water treatment facilities and trucking freshwater to communities is a band aid solution that will not address the underlying issues. As this paper has emphasized, there needs to be a greater shift towards holistic watershed protection to capture the many benefits provided by watershed ecosystem services and to protect groundwater quantity. Cumulative impacts and ecosystem integrity must be at the forefront of our environmental agendas. Further, the fragility of the anthropogenic environmental protection agendas must be acknowledged. Good governance is critical to resource protection, as is the recognition that a shift in our growth and trade practices is necessary to ensure sustainable use of our resources.

Economic growth and international trade are backed by the theory of comparative advantage. Missing from the theory of competitive advantage, and policies worldwide, is the consideration of natural resources as capital (natural capital). Without the consideration of natural capital in international economic decision-making, pervasive externalities exist in the form of pollution

and environmental degradation as resource exploitation and industrialization is facilitated without the full costs of production internalized. Countries seek to attract capital and investment to advance their economies and promote growth and development through industrialization. In many cases, stringent environmental regulations are regarded as a competitive disadvantage, and therefore these are relaxed in order to attract investment, achieve economies of scale, and maintain a competitive advantage in the production of certain goods. The phenomenon has had devastating impacts on groundwater quantity (from overuse) and surface water quality (from point source and non-point source pollution).

As economic production shifts, human settlements follow. Rural to urban migration is occurring on an extraordinary scale. The pace of economic growth and urban expansion is too quick to adequately ensure the protection and restoration of natural resources. Ontario's source water resource management is far from a siren song, and yet far from a gold standard. The Clean Water Act is a commendable first step to achieving water sustainability in Ontario. However, the consideration of ecological services, groundwater, contaminated sites, and areas outside of the formal boundaries receive little attention by the regulation. Furthermore, the absence of First Nations voices at the decision-making table is concerning. The consideration of traditional management perspectives, and the voices of citizens who are the traditional stewards of the land must be considered should the province wish to sustain our bountiful water resources. Too often the protection of water resources occurs as an afterthought, and thus, reactive environmental policies are pervasive.

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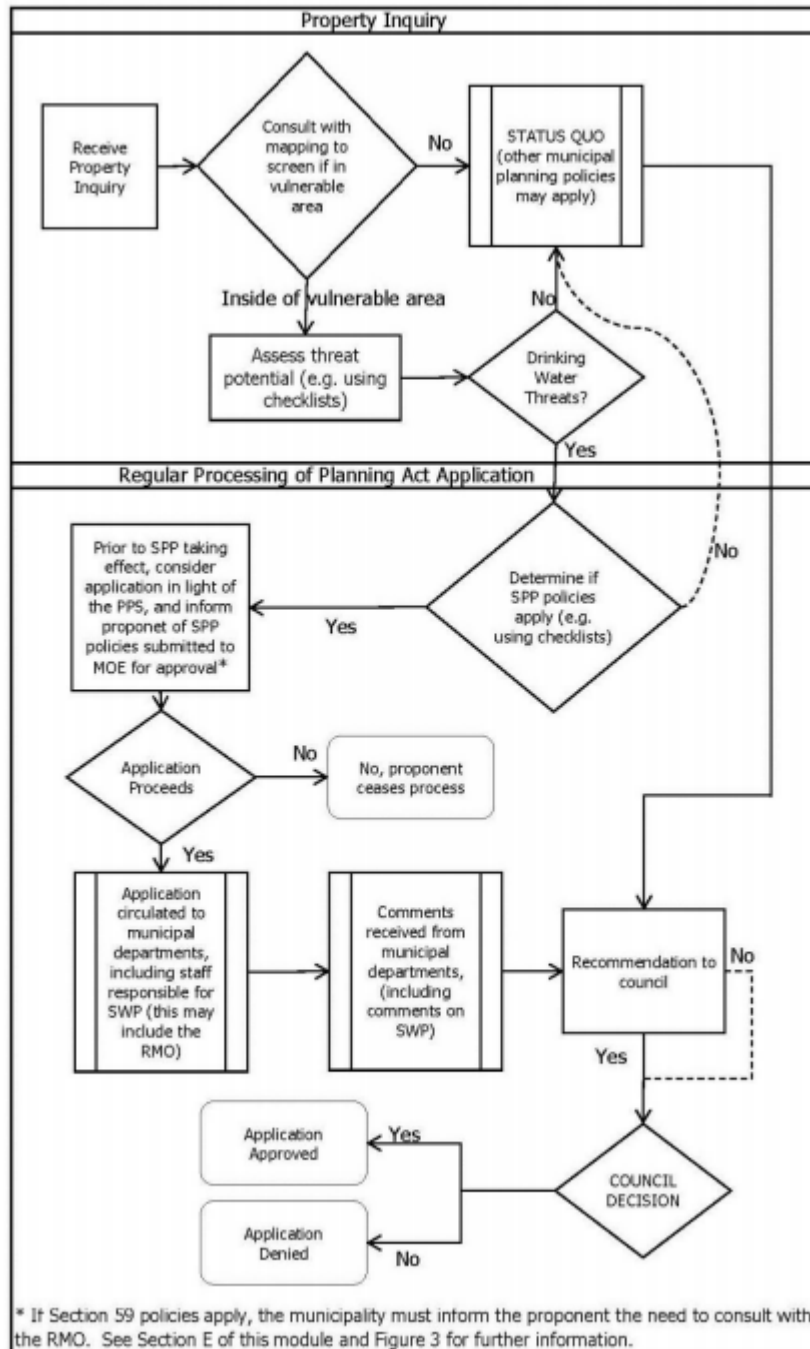
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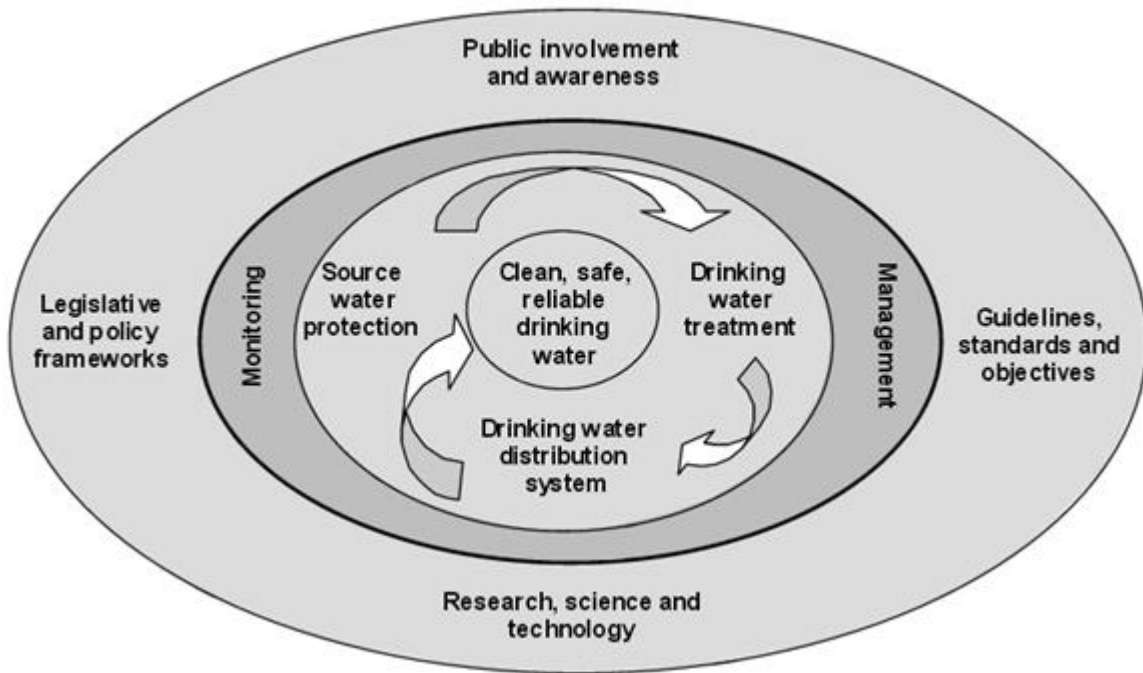
# Appendices



Example of how source water protection fits in with the planning process (from York Region)



Map of Ontario eco regions



*Health Canada, 2008: the Multi-Barrier approach to drinking water*