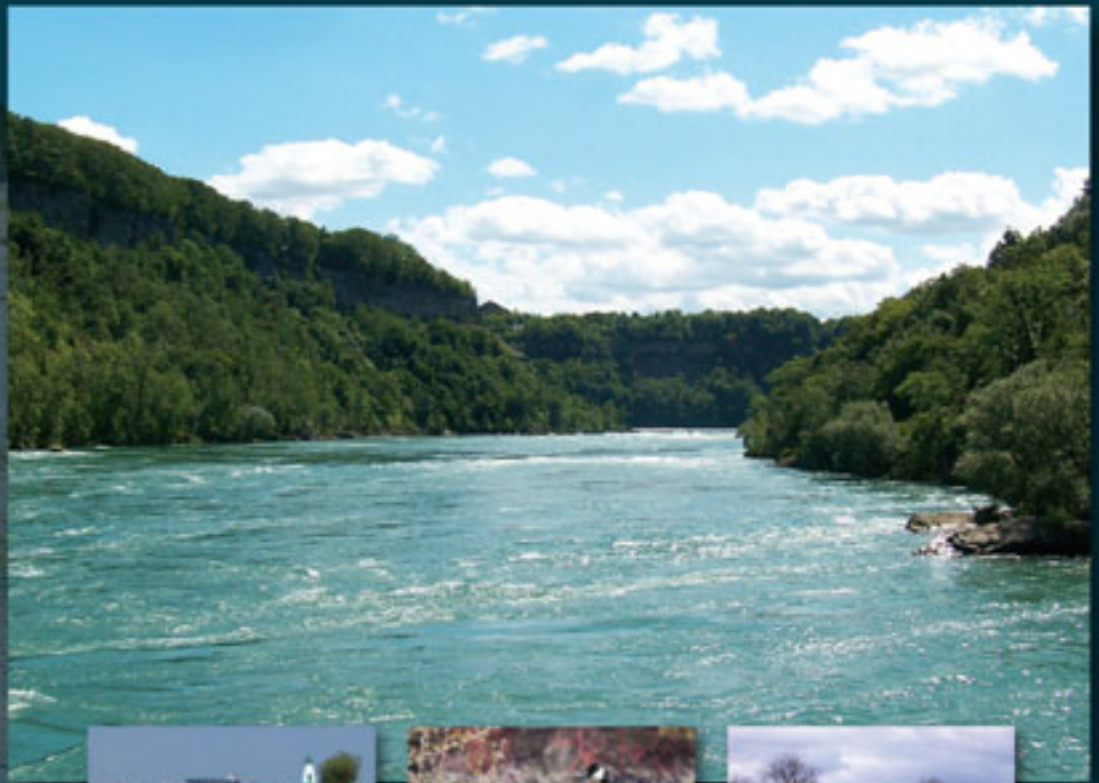


# LIQUID ASSETS:

## Assessing Water's Contribution to Niagara



Niagara  Region

**Brock**  
University

Environmental Sustainability  
Research Centre



## Table of Contents

Executive Summary	4
Acknowledgements	5
Creating the report	6
<b>1. Water: a liquid asset to Niagara</b>	<b>9</b>
<b>2. How is water used in Niagara?</b>	<b>11</b>
Summary	19
<b>3. Water's contribution to well-being in Niagara</b>	<b>21</b>
Withdrawals	24
Agriculture	24
Domestic Water Use	25
Industrial/Manufacturing/Commercial Water Use	25
Utilities	26
In-situ Uses	27
Commercial Navigation	27
Recreational Use	28
Tourism	29
Ecosystem Services	29
Summary	30
<b>4. Water governance in Niagara</b>	<b>31</b>
Overview of water governance in Niagara	31
Constitutional and international context of Niagara water governance	32
Legislative context of the Niagara Region	34
Examples of Niagara residents perceptions of water use conflicts	38
Illustrative examples of Niagara water use conflicts	39
Summary	41
<b>5. Climate change, water vulnerability and adaptive capacity in Niagara</b>	<b>43</b>
Predicted climate changes in Niagara	43
Expected impacts of climate change to water quantity and quality in Niagara	45
Water vulnerability	46
Adaptive capacity	47
Adaptive capacity: addressing vulnerabilities	48
Summary	48
<b>6. Conclusions and research needs</b>	<b>49</b>
About the research team	50
About the advisory committee	51
References	52
References for Tables in Chapters 2 and 3	56
<b>Appendix A.</b> Range of water uses in the Niagara Region within each category of water use	59
<b>Appendix B.</b> Semi-structured interview script	65
<b>Appendix C.</b> Interview data	67
<b>Appendix D.</b> Workshop agenda and student reflections	75

## Executive Summary

Water is an integral element to Niagara: the region's geography is defined by it; the region's industries rely on it; and the region's residents and visitors use and enjoy it every day. However, our understanding of the magnitude of the impact water resources has on the economy and on our well-being is unclear. This report provides a 'snapshot' of the state of knowledge of how, and in what quantities, water contributes to the well-being of Niagara, as well as how water is governed, and how climate change may impact water resources. In order to better capture the benefits water resources provide to the region, we must understand what is known right now.

Our research (which included interviews with a number of stakeholders) identified a myriad of ways in which water is used in the region. The quantities used and the values associated with those uses; however, are less clear, and often estimates were taken from reports and research studies undertaken in other jurisdictions and applied to the region in absence of current and region-specific information.

Water governance in Niagara is complex. Legislation and governing bodies from international to local influence water management and use in the region. Conflicts arise from water use and legislation. Initiatives to begin to manage the governance complexity, such as the Niagara Peninsula Source Protection Plan, were highlighted.

The Niagara Region will be impacted by climate change, and Niagara exhibits some potential vulnerability to these impacts. The region's capacity to adapt to climate change impacts is uncertain. More information is needed about where vulnerabilities exist and adaptive capacities should be strengthened for the region.

In addition to summary points provided at the conclusion of each chapter, three main needs were identified by the report:

- NEED #1:** Water use and value information that is current, relevant for the region, and available from a central agency.
- NEED #2:** Maintain a current understanding of how the complex web of water governance operates in Niagara to minimize ongoing and potential conflicts.
- NEED #3:** Gain a strong understanding of the region's vulnerabilities and areas where adaptive capacity exists to minimize negative impacts of climate change to Niagara's well-being.



## Acknowledgements

The authors would like to thank the Advisory Committee: Ken Brothers; Murray Clamen; Hugh Fraser; and Mary Stack for their guidance in the interview process. We greatly appreciate the time and thoughtful responses provided by community members who participated in the research for this report. We would also like to thank Ilze Andzans for assistance in the early stages of planning the report, and Katelyn Vaughan, Project Manager for the Niagara Water Strategy, for her assistance throughout the project. We are particularly appreciative of the participation of community members who attended the workshop and provided feedback on a draft version of the report. We wish to express our gratitude to research assistants Katrina Krievins, Samantha Purdy, and Angela Van Goolen for their assistance with research, report preparation, and to Kerrie Pickering for planning the workshop. We thank student rapporteurs Erin Duffy and Tanya Woodhead for their reflections on the workshop proceedings. Finally, we wish to thank Samantha Purdy for kindly providing the photographs of the Niagara region.



This project was made possible with the financial support from the Niagara Region's WaterSmart Niagara program.



## Creating the report

Niagara WaterSmart provided the opportunity for researchers from Brock University's Environmental Sustainability Research Centre to create a report that focused on the importance of water to the Niagara Region in late 2011. Researchers from the Departments of Economics, Political Science, and Tourism and Environment collaborated to conduct the research and writing of this document. The report also provided an opportunity for short-term training of several undergraduate research assistants. An advisory committee was formed to aid in and guide the interview development and selection process. The advisory committees represented a range of organizations active in the Niagara Region, including the International Joint Commission, Niagara Region Public Works, Niagara Peninsula Conservation Authority and Ontario Ministry of Agriculture, Food, and Rural Affairs.

The initial stage of the project involved identifying the range of ways in which water is used in Niagara. Extensive database and internet searches were carried out and a list of water uses in the region was created and grouped according to general 'sectors' (Appendix A). Peer-reviewed literature and national, provincial and regional report searches were conducted to identify what is known about the value of water, water governance, and vulnerability in relation to climate change, both within the region and beyond it. Publicly-available reports from the Niagara Region related to these topics were used when possible, and the peer-reviewed literature was relied upon for a broader perspective.

To better understand the range of ways in which each sector benefits from water, as well as other aspects of water use (including conflicts and future threats) from a region-specific perspective, an interview instrument was created and ethics clearance was granted by Brock University (REB File #11-170) in March, 2012. Potential interviewees were identified for each sector, and the advisory committee members were instrumental in aiding the research team in this capacity. Fifty-two individuals were identified and invited to participate in the research. Twenty-eight interviews were ultimately conducted over the course of a few months, and a wide range of sectors were represented in these interviews (Appendix B).

Responses from the interviews were analyzed using content analysis for identification of themes. The responses are presented in terms of these themes for each question from the survey instrument in Appendix C, and responses are used throughout the report to highlight Niagara Region-specific information and perspectives.

The penultimate draft of this report was presented to community stakeholders at a workshop held on October 24, 2012 for feedback and discussion around the findings of the report and next steps. The workshop agenda and reflections from two Brock University undergraduate student rapporteurs are presented in Appendix D.

This report is organized in a series of chapters. The first chapter introduces the reader to the important role water plays in everyday life in Niagara. It highlights some of the benefits and potential challenges associated with our reliance on water. The second chapter presents what is known about water quantities used by sectors in the region, and the third chapter identifies what is known about the benefits we derive from those quantities used. Where Niagara-specific information exists, it is identified and where this information is not available, comparable quantities are presented. The fourth chapter provides an overview of the complex water governance structure in Niagara, and some of the conflicts arising from this structure that were identified by community members in interviews. The fifth chapter highlights the potential impacts of climate change for water use and benefits, and identifies some of the areas where Niagara may experience vulnerabilities, as well as where the region is well-situated to adapt to challenges. At the end of chapters two through five, concise summary points are identified. The final chapter summarizes the findings from the report and offers guidance for future research efforts.









## 1

## Water: a liquid asset to Niagara

Water is a key component of all aspects of Niagara's economy. Water is used in production, processing, and manufacturing. It supports the region's unique ecosystem and it is the main attraction for the region's important tourism industry. We all rely on it for innumerable activities each day, yet we have little sense of the magnitude of the contribution water makes to the region. It is important to understand the entire range of uses so that water quantity and quality can be preserved and the region can realize further benefits from it.

Water uses requiring withdrawal of water from the system alone amount to up to an estimated 537 million cubic metres per year. That is equivalent to using a volume of water similar to a full Olympic-size swimming pool every two and a half minutes!

Over 13 million tourists travel to Niagara each year, and many take part in, or enjoy, water-related activities. Large quantities of water are also used for domestic consumption, agriculture, wine production, industry and manufacturing. Hydroelectric power relies on water flows for production of power. Ecosystems require water to function, and some, like wetlands, improve the water quality by regulating water systems and filtering wastes and wastewater.

The changes that have been occurring in the region present challenges for the future level of enjoyment and use of water in the Niagara Region. According to forecasts made out to 2031, the current population of 431,346 people (Stats Can, 2011) is expected to rise to between 511,000 and 700,000 (Niagara Region, 2008). This may cause stress to the environment and to infrastructure, for example the need to expand transportation networks, housing options, and resource maintenance and management systems in the region. As the economy shifts, with a decline in construction, manufacturing, agricultural employment and industrial development (Niagara Region, 2007) and an increased focus on bio-product, software, and green technology production (Niagara Region, 2008), water demands may change.

Climate change also has significant potential impacts on the region's ability to enjoy and use water sources. Warmer temperatures and seasonal shifts (Niagara Region, 2012) change the suitability of the region for some economic activities such as some types of agricultural production, and may impact human health and wellbeing and ecosystem services. It is important that we preserve water quantity and quality in order to promote long term sustainability of water resources in Niagara.

Despite the challenges facing the region it is important to realize that if we are aware and knowledgeable about water use and its value in Niagara, and continue to act and adapt to these potential challenges the region can sustain and even increase the benefits and well-being derived from water.

This report presents an opportunity to take a 'snapshot in time' of water use and its contribution to the region, identifying areas where knowledge, use, and governance can be improved and where it is possible to gain greater benefits from water resources than we do at present.





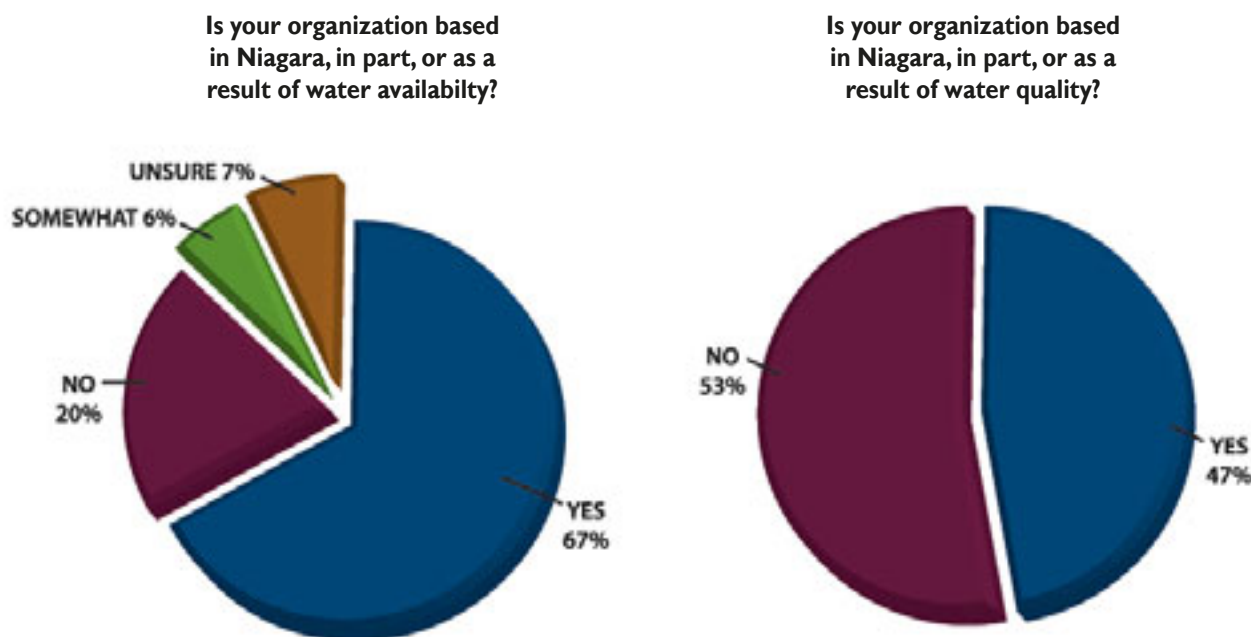
## 2

## How is water used in Niagara?

Water plays an important role in many aspects of life in Niagara, from work to play. The potential to benefit from water is dependent upon the quantity, the quality, the location of the source, and the timing of water use and availability.

Interviews with community members indicated that water played a role in the location of many organizations in the Niagara Region. Of the 22 organisations that were interviewed, representing 15 different sectors, the majority agreed that they were based in Niagara in part or as a result of water availability (shown in Figure 2.1). Reasons included reliance on water for services, production of goods, and protection and conservation of water as a driver of the organization. Respondents identified less often that their organisations were based in Niagara in part, or as a result of, water quality. Where water quality was a consideration, reasons included the aesthetic value of the water and use for human consumption.

**FIGURE 2.1.** Interviewee responses to the question, "Is your organisation based in Niagara, in part, or as a result of water availability and/or quality?"



Available information about employment and revenues from major sectors in Niagara is presented in Table 2.1. These industries all contribute to Niagara's economy in a significant way, providing a large number of jobs and business for the region and each relies on water in a range of ways for their operations.

It is important to understand the wide variety of uses and sectors of the economy that are involved in using water resources in the region. This use includes not only consumption of tap water by households but also use by agricultural and industrial sectors, as well as use of water in-situ for commercial navigation and to support recreation and tourism. Water resources used by residents, industry, and tourists in the region are supported by the ecosystem we all work and live within. Ecosystems also require an adequate quantity and quality of water to be sustained, and it is important to understand those uses associated with ecosystem health as well.

**TABLE 2.1.** Economic and employment figures for the Niagara Region (estimates)

Sector	Employment	Revenues (2008)
Manufacturing	21,000	7 billion
Retail and wholesale trade	28,000	6.2 billion
Construction	12,000	2 billion
Accommodation and food services	19,500	1.2 billion
Finance and insurance	9,000	1 billion
Transportation and warehousing	Not available	0.9 billion
Agriculture	8,575 <sup>a</sup>	0.5 billion
Professional, scientific, and technical services	8,000	0.5 billion
Health care and social assistance	23,000	Not available
Education	12,000	Not available
Information, culture, and recreation	11,500	Not available
Other services	8,000	Not available
Estimates from Scholtens and Papastavrou (2010)		
<sup>a</sup> Data from Statistics Canada (2006)		



Because our ecosystem provides us with water resources for use, it is appropriate to use an ecosystem-based framework to describe and categorize water uses in Niagara. The water use framework, from Brauman et al. (2007) focuses on the range of benefits provided by water to society. Four categories describe the range of uses and benefits we realize from water:

- 1 Provisioning:** Creating of goods for human use. This includes food, fibre, commercial and industrial goods and processes, and power generation;
- 2 Regulating:** Maintaining a healthy ecosystem that provides services such as flood risk mitigation and climate stabilization;
- 3 Cultural:** Creating and maintaining of attributes humans enjoy, such as aesthetic, recreational, and spiritual enjoyment; and,
- 4 Supporting:** Ensuring all other categories are maintained through required quantity and quality, including the preservation of options for future use.

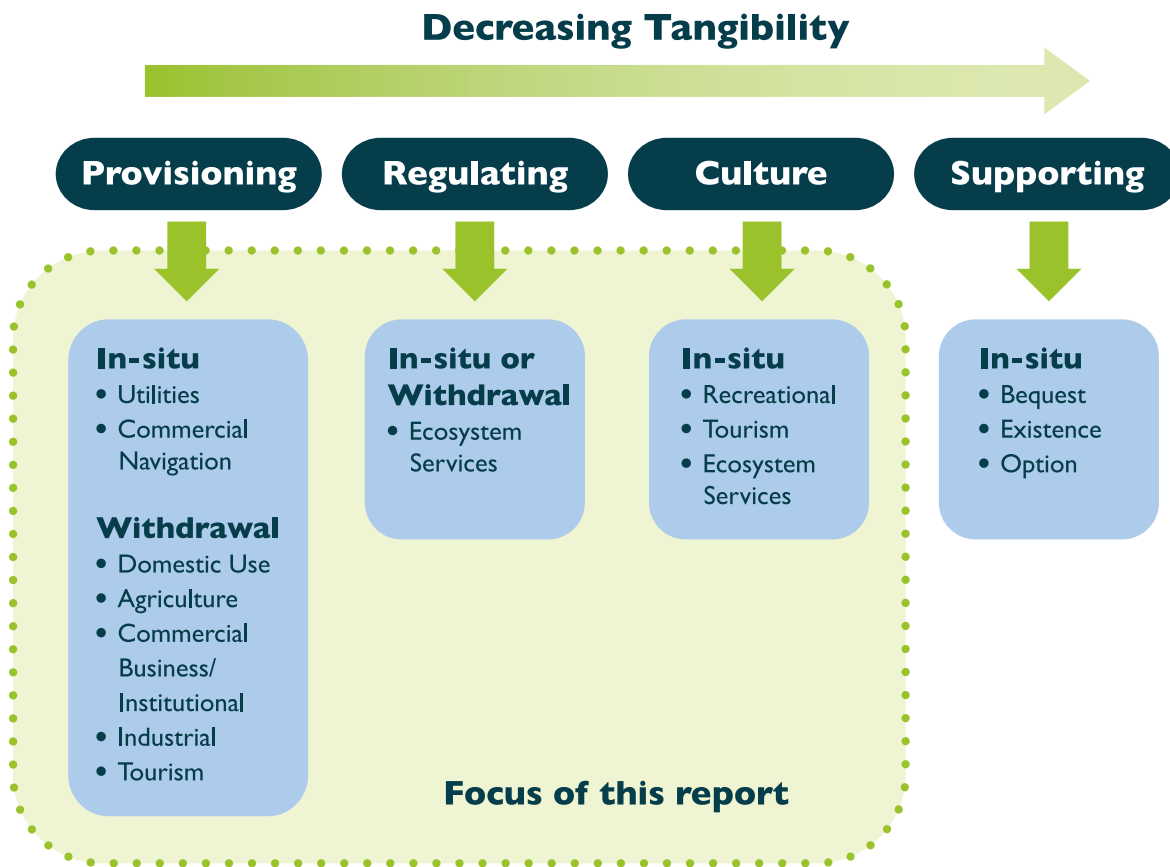
There are several benefits from using this water use framework. First, it is comprehensive enough to cover the wide range of contributions water makes to Niagara society, ecosystems and economy. It also provides a systematic way to identify the information and data needed for valuation, and, it highlights the important role that ecosystems play in the provision of water quantity and quality.

The framework (Figure 2.2) outlines services that water provides that benefit Niagara. In this study there is an emphasis on the services that water provides both through withdrawals (where water is removed from the system for use) and through in-situ use (where water remains in the system when used). Withdrawals are generally easier to understand and measure, in other words more tangible. Tangibility is highest for provisioning uses because they are directly related to water use and withdrawal. Tangibility decreases with regulating and cultural uses that are generally in-situ and more difficult to measure. Supporting uses are the least tangible and most difficult to define in terms of quantities and qualities used. The supporting category includes uses such as existence (the knowledge of use and enjoyment for current and future generations), bequest (the preservation of environmental quality for future generations), and option (the option for future direct or indirect use). Little attention has been paid to this category and, as a result, this report will focus on the first three categories (as indicated in Figure 2.1) with the acknowledgement that there are other intangible uses that also exist and should be considered in future studies.



For this report water quantities used are organized by major categories of water users in Niagara and the type of use (withdrawal or in-situ) (Figure 2.2). Table 2.2 presents those water quantities in cubic metres used per year, and quantities are defined in terms of the number of Olympic-size swimming pools worth of water used per day as our frame of reference. Each swimming pool holds 2500 cubic metres (m<sup>3</sup>) of water.

**FIGURE 2.2.** Water use framework (adapted from Brauman et al., 2007)






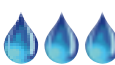

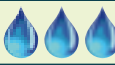


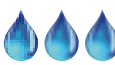
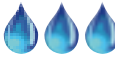
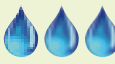


In Table 2.2, the information is presented in terms of our confidence that the estimates are accurate, relevant and applicable to Niagara. Box 2.1 describes the system for using water drops to represent our confidence in the estimates of water quantities used.








### Box 2.1. Water drop rating system

No drops	No information is available within Niagara or that is reasonably applicable to the Niagara Region
💧	Information is out of date (more than five years old) and not specific to the Niagara Region
💧💧	Information is out of date but may be specific to the Niagara Region
💧💧💧	Information is estimated, but not specific to the Niagara Region
💧💧💧💧	Information is current, measured and specific to the Niagara Region



**TABLE 2.2.** Overview of water quantities used by major categories of water use in Niagara

Major category of water use		Best estimate of quantity used annually	Number of Olympic swimming pools/day	Confidence in estimate
WITHDRAWALS	Agriculture	Water use: 5-10 million m <sup>3</sup> /year (excluding golf courses)	5.5 – 11	
		Golf course permits <sup>a</sup> : 16.7 million m <sup>3</sup> /year (maximum withdrawal)	18	
	Domestic Use	Water use: 66.1 million m <sup>3</sup> /year	72	
		Private wells supply: 7.8 million m <sup>3</sup> /year	8.5	
		Permits (drinking water): 279,000 m <sup>3</sup> (maximum withdrawal)	0.3	
		50% (St. Catharines) – 58% (Environment Canada [EC] estimate) of municipal supply: 43-50 million m <sup>3</sup> /year	47 – 55	
	Industrial	Permits: 10.5 million m <sup>3</sup> /year (maximum withdrawal)	11.5	
		4.4% (St. Catharines) to 11% (EC estimate) of municipal supply: 3.8 - 9.5 million m <sup>3</sup>	4 – 10.5	
	Commercial Business/ Institutional Use	Permits: 187 million m <sup>3</sup> /year (maximum withdrawal)	205	
		19% (EC estimate) to 32% (St. Catharines) of municipal supply: 16 - 28 million m <sup>3</sup>	17.5 – 30	
	Tourism	Total estimated water use for accommodation and services: 3 million m <sup>3</sup> /year	3.3	

	Major category of water use	Best estimate of quantity used annually	Number of Olympic swimming pools/day	Confidence in estimate
IN-SITU	Utilities	1,825 m <sup>3</sup> /second flow capacity (entire hydro dam series), maximum 57.5 billion m <sup>3</sup> /year	63,072 at peak flow rate	
	Commercial Navigation	Welland Canal: 3,296 vessels (2011) carrying 34.4 million tonnes	Not applicable	
	Recreation	Beach days lost (2010): 1,210 days at 38 beaches in region (32% lost)	Not applicable	
		158,000 fishing visits (2008)		
	Tourism <sup>b</sup>	Number of day tourists in Niagara: 8.8 million (2008)	Not applicable	
		Number of overnight tourists: 4.6 million (2008)		
	Ecosystem services preservation/remediation	Permits <sup>c</sup> : 7.6 million m <sup>3</sup> /year (not withdrawn) for maintaining ecosystem health	Not applicable	
<p><sup>a</sup> Permits to withdraw water reported are from inland surface sources, groundwater and Great Lakes. Any withdrawal less than 50 m<sup>3</sup>/day does not require a permit.</p> <p><sup>b</sup> Water is enjoyed by tourists, though not consumed, in a variety of built and natural tourist attractions, including Niagara Falls.</p> <p><sup>c</sup> Usually a one-time, non-consumptive taking.</p>				

In addition to the multitude of ways in which water is used, a substantial amount of water is 'lost' within the supply system. This phenomenon, called leakage, accounts for between 13 per cent of municipal supply in St. Catharines (approximately 1.1 million m<sup>3</sup> per year) and 17 per cent in Niagara-on-the-Lake (equivalent to 1.47 million m<sup>3</sup> per year). Water leakage is difficult to measure, and presents a barrier to sustainable and efficient water supply (Bakker, 2003). However, there may be some unintended benefit to groundwater recharge in urban areas from these losses (Lerner, 2002).

# Challenges in collecting water use information

A challenge in gathering data is the relevance of the information. In some cases, such as the permitted water use for several sectors, more recent data for the Niagara Region exist but are not yet publicly available. Other water use estimates were from studies conducted several years ago. These represent important gaps in the information that is available. The column for confidence in the water use information presented in Table 2.2 illustrates this. Also noteworthy is that water use is not evenly distributed throughout the year, and that substantially more water is used in the summer months especially for agriculture and tourism.

For some categories there were gaps related to the dispersed nature of the information. For example, each municipality within the region holds information about water quantities used but not all records were accessible. Indirect uses of water such as commercial navigation, recreation, and tourism also do not have reliable numbers for water use because water is not consumed and is thus difficult to quantify. We may, however, be able to get a sense of the quantity by looking at the minimum amount required for the service to be performed.

It is also important to note that the amount of water used is not equal to the amount consumed, and that the vast majority of water used in Niagara is returned in some form (Box 2.2). A recent report from the Niagara Peninsula Conservation Authority and AquaResources Inc. (2011) indicated that, on average, the percentage of consumptive water use (water that was consumed) was 78 per cent of agricultural water use, 70 per cent of commercial, 25 per cent of industrial, 25 per cent of recreational, and 20 per cent of non-municipal water used. Based on the available information for water quantities allocated for use in Niagara, consumptive use may amount to between 149 million and 163 million cubic metres of water per year (178 Olympic swimming pools per day) for agricultural, commercial and industrial uses.

## Box 2.2. Two types of water usage

<b>Consumptive:</b> Water which is withdrawn from the ecosystem for use. Examples include using water for crops, drinking water, and manufacturing.	<b>Non-Consumptive:</b> Water which is used but not withdrawn. Examples include: hydroelectricity production, water use for recreational boating, and commercial navigation.
--	---



Related to the issue of consumptive use are permits to take water. The provincial Ministry of Environment issues 'Permits to Take Water' (PTTW) that specify the maximum quantity of water taking allowed rather than actual amounts taken or transferred. These PTTW rights apply to both ground and surface water and are required for withdrawals of more than 50,000 L/day (50 cubic metres, or 1/50 of an Olympic swimming pool). More than 6,000 active permits existed in 2010, 42 per cent of which were agricultural, 17 per cent for drinking water supply and 8 per cent for golf course irrigation. Permits are not required for emergency firefighting situations, livestock watering, and private domestic use. These figures are important for Niagara because they provide us with a better understanding of water that has been allocated for use in the region. However, the quantity of water allocated may be much greater than the actual amount of water used.

Table 2.2 also highlights the many ways that water is enjoyed and the range of ways in which the region benefits from water use. The great diversity in these uses and in the quality and availability of information about them necessitates a systematic approach to the contributions water makes to the region. The water use framework provides a way to organize water uses and the corresponding values to society according to the ways in which ecosystem services provide water.

## Summary

- There is great diversity in the way water is used and enjoyed in Niagara;
- Not enough is known about the quantity of water used in Niagara to support organizations' mandates, and the information that is available is dispersed among many agencies and organizations; and,
- Clarity and measurement of actual quantities of water withdrawn from permits to take water would provide important information about water use.









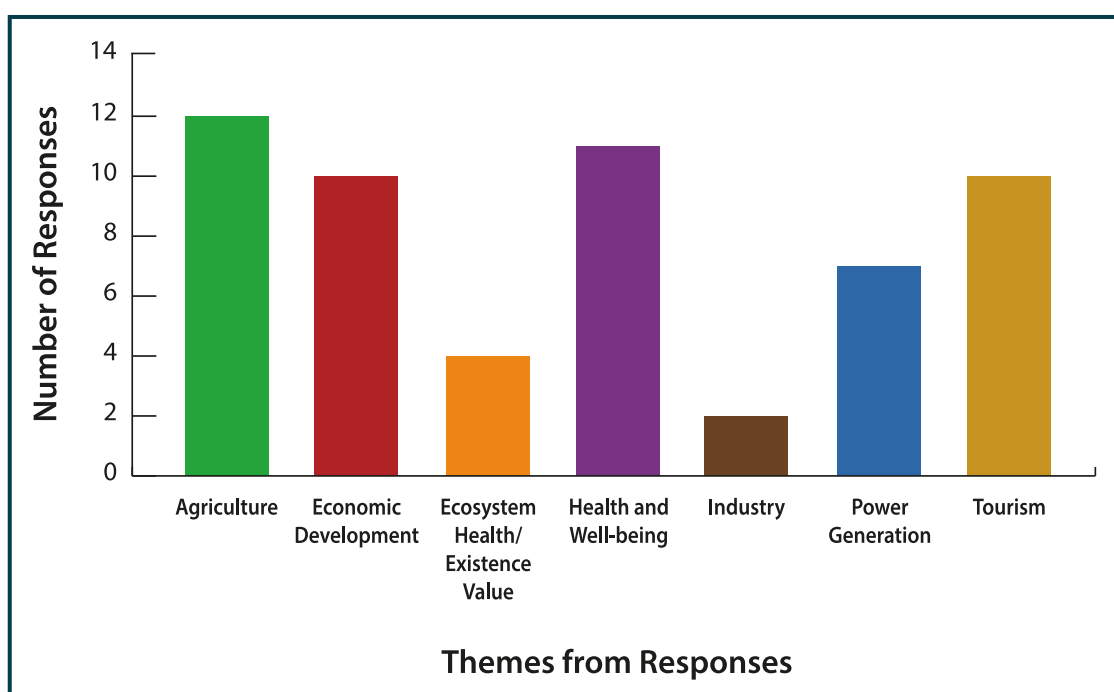
## 3

## Water's contribution to well-being in Niagara

Water plays a vital role in many aspects of life in Niagara; it contributes to our economic, ecological, and human health and well-being. As an example, Niagara is an important tourist region because of its natural appeal and because of the volume of fresh water sources and water-related activities available, most notably Niagara Falls. There are immense social benefits that arise from water, and the region's economy and sustainability are dependent upon maintaining it. In this way, water is like land: its many uses provide value, there are competing uses for a limited amount, and there isn't enough to accommodate all demands. In contrast to land, however, the value of water is not consistently determined in the marketplace through the forces of supply and demand. It is challenging to estimate the value of water when some of its uses have values reflected in the marketplace (e.g., the price of electricity produced by hydropower) while many are not (e.g., recreational opportunities).

Community stakeholders interviewed identified a range of ways in which water contributes to the economy in Niagara. Figure 3.1 illustrates this diversity of responses from interviewees regarding their perception of the most important way in which water contributes to the economy. As shown in Figure 3.1, sectors such as agriculture, health and well-being, and tourism were identified often.

**FIGURE 3.1.** Interviewee's perceptions of the most important contributions water makes to Niagara's economy.



This chapter focuses on the contribution water makes to Niagara in terms of economic activities, enjoyment, and well-being. The water use framework and organization of major categories of water use by withdrawals and in-situ use in Niagara described in Chapter 2 will be used to understand what is known about the benefits of water. In this chapter we focus on identifying the information about values for water that exists for Niagara, and what those values might be – particularly where those benefits are not captured by markets. The water use framework is also a useful tool for identifying gaps in our understanding of the magnitude of the contribution that water makes to the Niagara Region.

There are several ways in which possessing accurate and timely value information will improve decision-making regarding water:

- 1 Decisions relating to private and public sector investments relating to water.
- 2 Allocating water. As demands grow over time, the challenge of meeting these demands in a timely way from a fixed supply of water grows. Accurate information regarding the value of alternative water uses can support and inform decision-making regarding water allocations.
- 3 Decision making regarding source water protection and other land use decisions.

In order to assess the accuracy and relevance of the value information regarding benefits that Niagara receives from water it is important that we understand the meaning of the word 'value'. The values that we have presented in this report are not synonymous with social or personal value of a resource. For this report, values reflect economic conditions. Renzetti et al. (2011, p.28) provide us with an explanation:

"Economic value" is the difference between the increase in profit or well-being derived from something's use and the cost to enjoy that benefit. To establish the economic value of water to a particular user, therefore, requires subtracting what they paid for the water from the benefit they enjoyed by using it.

In theory, the sum of all Canadian users' willingness to pay [Box 3.1] for water and its services determines its total economic benefit to Canada. Subtracting from this the total cost to society of providing that water (including the cost of impaired eco-services) would then reveal water's total economic value.

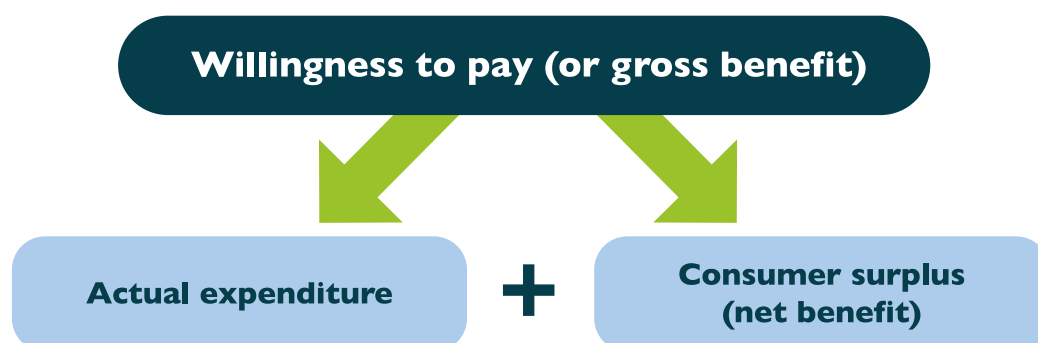
### Box 3.1. Willingness to Pay

“The maximum amount a consumer is prepared to pay for a good or service. It is therefore a monetary measure of the satisfaction of consuming a good.”  
(Jechlitschka et al., 2007, p.17)



Thus, the contribution of water to the well-being of Niagara is described in this report as the consumer surplus; that is, the difference between the 'willingness to pay' and actual expenditure (Figure 3.2).

**FIGURE 3.2.** Consumer surplus and the value of water



Parallel with the discussion of water quantities, this report's discussion of water values for Niagara does not include 'Supporting' uses and their corresponding values. This report focused upon the most tangible and readily observed contributions that water makes to the Niagara Region. That is not to say that the less tangible, and more difficult to observe, values are not important, or should not be included. However, given that this is the first effort at assessing water's value, we focused our attention on the more tangible values relating to the left side of Figure 2.2 in Chapter 2. There are only a limited number of studies that have attempted to identify separate values on aspects such as option, bequest, and existence values. When these are estimated, the values are often very large (Box 3.2). For example, Dupont (2003) estimated that the per-person willingness to pay for improvements to recreational activities in Hamilton Harbour per year was \$10.94 for boating, \$11.68 for fishing, and \$20.50 for swimming from those who did not undertake these activities (option/bequest values). When these values are attributed to the population of the Hamilton Harbour area and aggregated over time, it is evident that supporting (non-use) values are very large; in fact, Austin et al. (2007) estimated the non-use value of remediating Great Lakes areas of concern (existence and bequest values) to be "potentially single digit billions or higher".

### Box 3.2. Non-Use Values

“the value that is not associated with the actual consumption of the environmental goods and services” (Ahmed and Gotoh, 2006, p.6).

Non-use values indicate that even those who do not directly use a resource may still value its existence or the availability of the resource for future generations.



The tables presented below provide estimates of water's contribution to well-being. All of the values have been converted to 2011 Canadian dollars so that they are comparable. The confidence column, as used earlier, illustrates our confidence in the values, that is, how relevant it is to the region and how accurate the value is. Values that are averages or were calculated or estimated more than five years ago (older than 2007) are considered less reliable than more recent estimates; where they are presented they represent the most relevant or recent data available.

## Withdrawals

### Agriculture

Agricultural net value for irrigation water and livestock watering has been calculated for Canada and is presented below. The net value of water to golf courses is included in agricultural water use because the primary use for water is irrigation. Values related to golf course uses are not available for the region (Table 3.1).

**TABLE 3.1.** Agricultural water values

Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Irrigation water	Total water use: 5-10 million m <sup>3</sup> /year	n/a <sup>a</sup>	\$0.015 - \$1.517 per m <sup>3</sup>	Both (focus on quantity)	
Livestock watering		n/a	\$0.963 - \$173.71 per m <sup>3</sup>	Both	
Golf Courses	Golf course permits: 16.7 million m <sup>3</sup> /year (maximum withdrawal)	n/a	n/a	Quantity	
<b>Total for Niagara based on available quantities and values: \$75,000 - \$1.7 billion</b>					


Note: Canadian estimates from 2007.

<sup>a</sup> n/a = estimates are not available for the Niagara Region

### Domestic Water Use

This category encompasses water use by households; uses such as water for drinking, cleaning, and outdoor use. This category of use is very important for human well-being, and the net residential value for Canada is presented (Table 3.2). Of note is the cost of a lack of available water of sufficient quality for drinking, for example the boil water advisory that has been in effect in the Township of Wainfleet since 2006, however, the actual costs of this advisory and its impacts to the Niagara Region are not publicly available.

**TABLE 3.2.** Domestic water use values


Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Residential net value	58-66 million m <sup>3</sup> per year	n/a	\$0.015 – 0.627 per m <sup>3</sup>	Both	
Total for Niagara based on available quantities and values: \$870,000 - \$41.4 million					

Note: Estimate from 2007.

### Industrial/Manufacturing/Commercial Water Use

In this category the focus is on the benefits received from water in reference to industry activities, manufacturing, and commercial endeavours (Table 3.3). Water is used in some production processes such as the heating and cooling of equipment, in the final product (e.g., beverages), and in the transportation of materials and final products for use or sale. The estimates presented are examples of the costs and benefits society receives from these water-related activities.

**TABLE 3.3.** Industrial, manufacturing and commercial water use values


Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Value of commercial, industrial & municipal water use	Commercial: 203-215 million m³ per year	n/a	\$1.89 - \$2.91 per m³	Both	
	Industrial: 14.3 – 20 million m³ per year				
Total for Niagara based on available quantities and values: \$410.7 million - \$684 million					

Note: Estimate from 1996.

## Utilities

Although utilities refer to more than just electricity production, hydropower stations are major users of water. Water is used to run turbines and other equipment and thus the amount of power produced by these companies is directly impacted by water availability and capacity. Power generation may be used to give us a better understanding of the value of this resource (Table 3.4).

**TABLE 3.4.** Utilities water use

Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Power generation (hydro and thermal)	1,825 m <sup>3</sup> /second flow capacity (entire hydro dam series), maximum 57.5 billion m <sup>3</sup> /year	n/a	\$0.000148 – 0.000329 per m <sup>3</sup>	Quantity	
Total for Niagara based on available quantities and values: \$8.5 million - \$18.9 million					

Note: Estimate from 2007.




## In-situ Uses

Net values for in-situ uses cannot be calculated on a per cubic metre basis, as water is not withdrawn and the value associated with this category of uses is not directly related to quantity. However, some estimates of the costs of a reduction in water quantity and quality, and the overall value of ecosystem services are available and presented below.

## Commercial Navigation

Commercial navigation encompasses the use of vessels for shipping cargo and passengers. This category, however, will be focused on imports and exports shipped via the Welland Canal. These estimates provide some indication of the cost of lower levels of water in the Great Lakes, and the impact to the shipping industry as a result. These values provide an understanding of the range of potential costs, or reduction in value (Table 3.5). While not specific to Niagara, the estimate provides an understanding of the value of this activity to the region.

**TABLE 3.5.** Commercial navigation water use




Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Increase in shipping costs based on reduction in Great Lakes levels		n/a	\$4.4 – 20.9 million (depends on scenario modelled – to the year 2050)	Quantity	

Note: Estimate from 2001, from a Great Lakes – St. Lawrence River System study.

## Recreational Use

The recreational use of water involves many activities, including: fishing, beach activities, many sports, canoeing, windsurfing, wildlife viewing, camping, and hiking. These activities generally involve physical activity and aesthetic appreciation for nature, and there are a range of benefits that society receives from recreational use of the Niagara Region. Available information about the estimated value of these activities is presented in Table 3.6.

**TABLE 3.6.** Recreational water use

Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Sport fishing direct spending on trips		n/a	\$621.5 million/year	Both (emphasis on quality)	
Recreational fishing	158,000 fishing visits (2008)	n/a	\$0.307 per person per trip - \$148.75 per person per day	Quality	
Recreational fishing value for Niagara based on available information: \$48,500 - \$23.5 million					
Value of beaches	Beach days lost (2010): 1,210 days at 38 beaches in region (32% lost)	n/a	\$228 – \$285 million/year	Quality	
Beach value for Niagara (based on days lost): \$155 million - \$194 million					
<b>Total for Niagara based on known values of recreational use: \$776 million – \$839 million</b>					

Notes: Estimates range from 2000 – 2007.

These values represent direct spending on trips for sport fishing, the range of willingness to pay values for recreational fishing in Canada, and total willingness to pay for beach-going for the Ontario portion of the Great Lakes. These are just a few of the recreational activities available in Niagara, but provides an understanding of both how much people spend on recreational activities and the monetary value the public places on some recreational opportunities.

## Tourism

Tourism is an important sector to the Niagara Region. Abundant and quality water sources are vital for the health of tourism in Niagara. The value of the tourism experience and the total benefits received as a result of this industry is difficult to determine because tourism encompasses many attractions and activities, and the value of purely water-related tourism is not available. In addition, visitors to the region purchase food and material products, use drinking water, benefit from utilities, enjoy recreational activities, and more generally may improve both their health and wellbeing as a result of the experience. Thus, the total benefit received by tourists from water is very difficult to calculate and unfortunately there is no relevant Canadian information that may be applied for this category<sup>1</sup>.



## Ecosystem Services

All benefits society enjoys from water identified in the major categories of water use above are dependent upon ecosystem processes and services. The value of ecosystem services to society have been estimated from a 'total benefits' perspective; an alternative to the approach used in this chapter which divided water use and value into categories and assessed each separately. The ecosystem valuation used here is an approach that estimates overall benefits from the Provisioning, Supporting and Cultural categories of ecosystem services originally identified in the development of the water use framework (Table 3.7). This estimate, although not Niagara-specific and not water-specific, provides a better understanding of the magnitude of benefits that we receive from the ecosystem every year.



<sup>1</sup> No Niagara specific tourism information could be found upon substantial time spent investigating publicly-available reports

**TABLE 3.7.** Ecosystem services water use

Value description	Quantity estimate	Estimate from Niagara	Estimate from Canada (2011 CAD)	Value derived from water quantity or quality?	Confidence in estimate
Value of natural capital flows in ecological services		n/a	\$398.27 million/year	Both	
Wetlands goods and services	11,000 hectares of wetlands in Niagara	n/a	\$6,362 – 29,573 per hectare	Both	
<b>Total value of wetlands goods and services for Niagara: \$98 million - \$456 million</b>					

Note: Estimates from 2007.

The benefits that are enjoyed by different sectors of the Niagara Region from water use, through withdrawals and in-situ, are diverse and encompass a range of economic, environmental, and social benefits. While the limited available estimates are suggestive of water's sizeable contributions, there is not enough information available for an accurate estimate of the value of water in the Niagara Region. It is important to highlight that we faced significant challenges and difficulties in accessing information about how much water people use and the value of that water for tourism and for agriculture – the two major contributors to economic health for the region. The simple fact of the matter is that we were unable to find a single peer reviewed published estimate for the value of water for any sector in Niagara despite literature searches and systematic inquiries within the region. As identified throughout this chapter, the estimates presented here are either out of date or not from the region, an excellent indication of the need for a more involved governance system and policies designed to collect this information more efficiently.

## Summary

- The water use framework provided a systematic way to understand what is known about the value of water to Niagara;
- Based on available Canadian data, water values for Niagara are potentially very large, with many sector calculations resulting in estimates in the hundreds of millions of dollars;
- No central agency exists in Niagara that holds responsibility for maintaining a database of values. Capitalizing on the value of water and creating new opportunities for greater benefits requires access to information about how water is used and valued;
- Current and region-specific research regarding the value of water is needed for all categories of water use described in this chapter.



## 4

## Water governance in Niagara

### Overview of water governance in Niagara

To understand the process of decision-making in organisations and countries it is important to understand the difference between “government” and “governance”. Government is a group of representatives that make and implement policies about affairs within their jurisdiction. In contrast, governance is the act of governing; the institutions and processes through which societies make decisions (Box 4.1). In the case of water in Niagara, the governance structure involves decision making bodies from the international to the municipal scale. In addition to government authority over water, there has been a relatively recent move towards a model of governance in which non-governmental organizations, private industry and local citizens take on a more engaged and significant role in decision-making. This aspect of water governance links stakeholders across scales and is not strictly bound by political boundaries. These bodies hold varying sets of responsibilities for water in Niagara, and water “is thus subject to jurisdictional, territorial and scalar fragmentation ... creating a series of governance gaps, overlaps and challenges” (Bakker and Cook, 2011, p. 277).

#### Box 4.1 Water governance

“ The range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society. ”

(Global Water Partnership, 2003, p. 7).

## Constitutional and international context of Niagara water governance

Water is an area of shared authority in Canada; the Canadian constitution does not allocate jurisdiction to one level of government. Rather, each level of government holds responsibility for regulating different aspects of water use and enjoyment.

The federal government's authority concerning water resources is limited to waters adjacent to and within federal lands. Federal authority spans "harbours, national parks, northern lands, and armed forces bases, navigation and shipping, sea coast and inland fisheries, trade and commerce, interprovincial waters, taxation and Aboriginal lands and peoples" (Johns and Rasmussen, 2008, pp. 63-64). The responsibilities of the federal government often overlap with the responsibilities of provincial governments and are more broadly defined and distributed among departments. Water quality issues, for example, are distributed among Environment Canada, the Department of Fisheries and Oceans, Transport Canada, and the Department of Indian Affairs and Northern Development (Saunders, 1988).

By contrast, the authority that provinces have over water is based primarily on section 109 of the *Constitution Act*, 1867 which grants provincial governments proprietary rights over all publicly owned lands, mines, minerals and the royalties that arise from them, notwithstanding those specifically reserved to the federal government. Though water is not explicitly mentioned in section 109, common law principles grant the provinces primary exploitative rights to this resource based on their ownership of the land underlying and adjacent to most of the freshwater resources within their borders. A number of provincial legislative powers outlined in sections 92, 92A, and 95 of the *Constitution Act*, have also been used to justify provincial involvement in water governance, however, most of these have been complementary to the more fundamental provincial proprietary right. Each province has the authority to allocate water for private and public use, though the federal government has control over the fisheries and inland water sources that constitute fish habitat which often results in a conflict of responsibilities (Saunders and Wenig, 2007).

At the regional level, the authority of municipal governments in regards to water governance is restricted to those water bodies that are within the borders of each respective municipality. Municipal governments hold responsibility to maintain drinking water quality and supply, including the management, operation and maintenance of treatment plants and distribution systems within their specific jurisdictions (Health Canada, 2007). The municipal government is required to manage water, wastewater, and storm water systems as well as maintain municipal drains (Conservation Ontario, 2001, p. 26). In the Niagara Region, we have a two tier municipal structure, so these responsibilities are shared by the area municipalities and the Region.

First Nations also play an important role in water governance. Section 35 of the *Constitution Act*, 1982 outlines that all Aboriginal and treaty rights existing at the time when the Act came into effect be recognised and further, that they no longer be infringed upon by the government (Christensen and Lintner, 2007; Walkem, 2007). However, the actual governance structure for water for First Nations is complex and water rights are, in many places, still negotiated with governments and specified in the courts.

The division of authority regarding water in Canada described above makes water governance in the country quite complex. Overlapping authority, interests and concerns have the potential to create a complicated system of water management and the potential for water use conflicts.

### Governance bodies

The Niagara Region has numerous organizations and governing bodies involved in managing water sources. The province of Ontario has put in place a number of Conservation Authorities, tasked with natural resource conservation at the watershed scale. The Niagara Peninsula Conservation Authority (NPCA) has a mandate to further the conservation, restoration and development of natural resources, including water. With respect to water this is fulfilled by advocating and implementing programs that improve water quality, protect against flooding, and allow for water recreation and education activities, such as the Children's Water Festival. Other agencies such as the St. Lawrence Seaway Management Corporation (a federal non-profit corporation) and Ontario Power Generation (a provincial Crown corporation) have authority to make land and water management decisions that impact the Niagara Region.

Niagara's location within the Great Lakes region includes additional layers of international water governance. An important international body with authority in this respect is the International Joint Commission (IJC). The IJC was established under the *Boundary Waters Treaty* (1909) as an agreement between the Canadian and American governments and has an important role in water governance in the Region. The commission's mandate to manage and protect shared boundary waters was initially aimed at water diversions, but has since grown to include working to reduce both air and water pollution that affects rivers and lakes shared by the two countries. In Niagara, the IJC has authority over joint waters such as the Niagara River and both Lake Erie and Lake Ontario, approving water-related projects, organizing and setting up a number of boards to deal with international environmental matters, and setting flow levels to ensure adequate water levels for various purposes such as navigation and hydropower production. For example, the *Niagara Treaty* (1950) regulates water flow in the Niagara River, especially in reference to water diversion for power production purposes and other needs.



## Legislative context of the Niagara Region

### Federal scale

Water resource management at the federal level is distributed among several departments, including Health Canada, Environment Canada, Department of Fisheries and Oceans, Transport Canada, and Aboriginal Affairs and Northern Development (Saunders, 1988). One of the main federal agencies with authority for water is Environment Canada through the *Canada Water Act*. Established in 1970, it was “the first piece of legislation explicitly related to water resource management” (Johns and Rasmussen, 2008, p. 65), aimed at encouraging sustainable water use rather than placing regulations on water quality and use. The *Fisheries Act*, the *Navigable Waters Protection Act* and the *Fishing and Recreational Harbours Act* also provide federal authority to better manage and control habitats, pollution incidents, emergency measures and harbour infrastructure. Other laws, such as the *Canadian Environmental Protection Act*, also have an impact on water quality. Health Canada is another federal agency holding water-related responsibilities; it maintains current guidelines for drinking water quality. Aboriginal land and treaty rights to water, as well as water quality on reserve lands are also managed at the federal level.

### Provincial scale

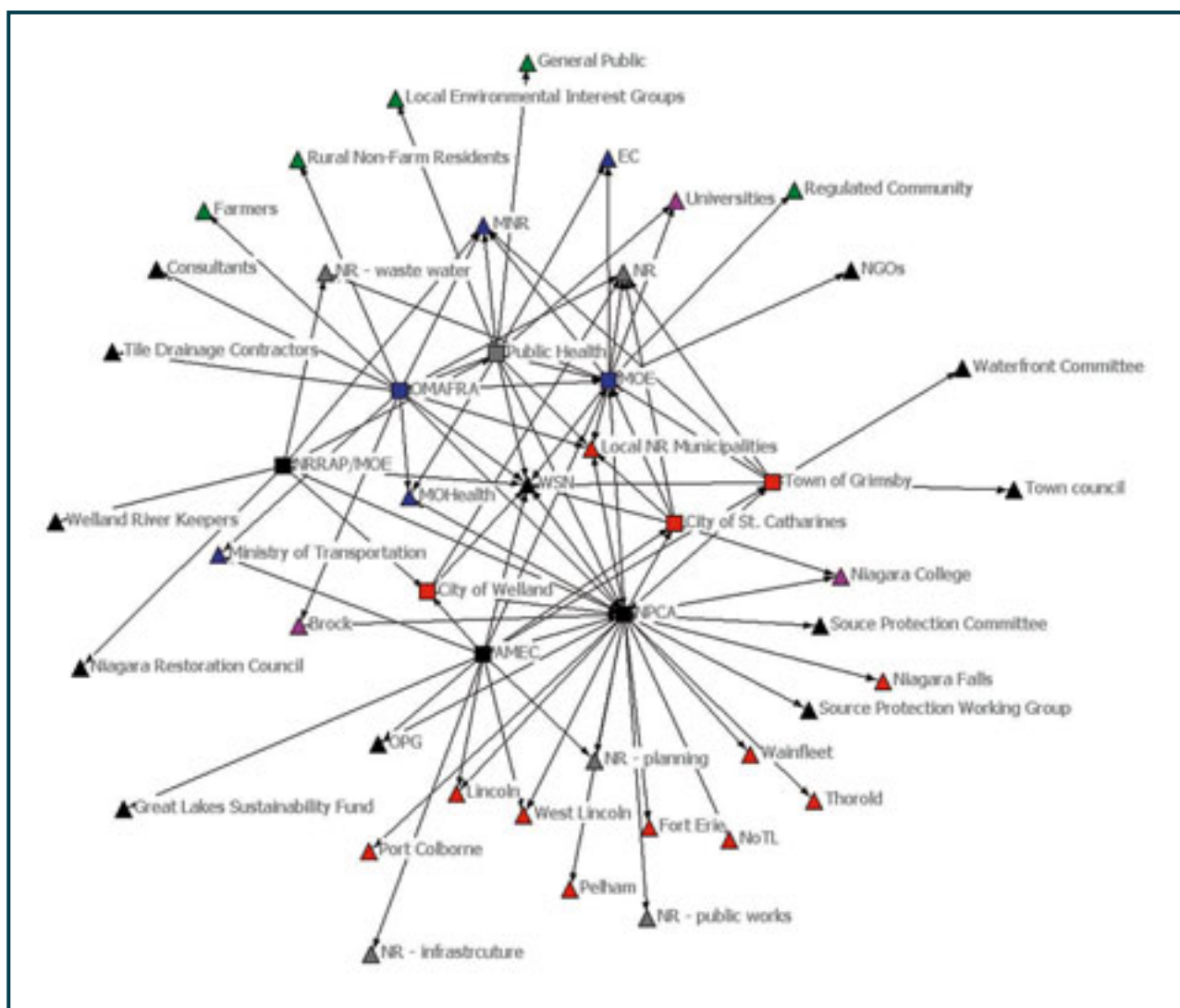
Water bodies within Ontario are under the authority of the province and regulated under the *Ontario Clean Water Act*, the *Safe Drinking Water Act*, the *Ontario Water Resources Act*, the *Water Opportunities Act* and a number of other environmental and health regulations. The provincial government also takes part in other regulations that are inter-provincial or cross-border such as the *Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement* which Ontario signed along with Quebec and the eight Great Lakes U.S. states. The provincial government also has authority over the regional and municipal governments, introducing and adapting standards and facilitating decision-making between regions or municipalities.

### Regional scale

At the regional level there are different geographic boundaries for authority: the Niagara Peninsula Conservation Authority (NPCA) and Source Protection Committees (SPC) work within the bounds of the Niagara watershed, the regional government works within the political boundaries of the Regional Municipality of Niagara, and individual municipalities create by-laws and manage water within their own jurisdictions. Source Protection Committees and the Conservation Authority pursue watershed management. Upon approval from the Ministry of the Environment, the Source Protection Plan for Niagara will hold the potential to influence water management in the region. The regional level regulators also include public works departments with important administrative powers.

The Niagara Region also initiated the WaterSmart Niagara strategy in 2003. The role of WaterSmart Niagara is to “guide the protection and conservation of Niagara’s water resources” (Niagara Region, 2012a). The strategy was based upon extensive stakeholder consultations that have guided the Region and partners in the community to work toward water protection, restoration and management. Since its inception, the strategy has become an important part of the network of organizations and individuals engaged in water management and governance in Niagara (Figure 4.1).

**FIGURE 4.1.** Network of organizations involved in water governance in the Niagara Region linked to WaterSmart Niagara. Reproduced with permission from Purdy (2012).





Each of the twelve municipalities in Niagara has its own specific powers and responsibilities related to water governance. For example, under *Ontario Regulation 170/03* municipalities are responsible for providing Water Quality Reports in addition to reports provided by the Region (Niagara Region, 2012b). Along with the regional governing bodies, these groups have a responsibility to carry out much of the implementation of policies made by higher levels of government and for the protection of significant ecological sites. The Niagara Region also publishes overall quality reports and strategies which regulate water testing procedures and order beach and well water tests. Further examples of regional initiatives focused on maintaining water quality and source protection are: 1) the Niagara Water Strategy (now WaterSmart Niagara), begun in 2003. Based on extensive consultations with a variety of stakeholder groups from several jurisdictions, the ultimate aim of WaterSmart Niagara is to guide “the respective authorities on how best to protect and manage water-dependent resources” (Mahood et al., 2004, p. 2); and, 2) the Drinking Water Quality Management Systems that municipalities and the region are required to put in place to govern drinking water quality systems to ensure consistent documentation, effective operation, greater mitigation of risk, and increased confidence in drinking water (MOE, 2006). In Niagara, representatives of the municipalities and the region meet to collaborate and share information.

The complex nature of water governance described above is illustrated in Table 4.1. Authority over water is divided into four types: Great Lakes, inland surface water, groundwater, and drinking water and selected examples of legislation and guidelines/plans are provided.



**TABLE 4.1.** Selected examples of legislation and plans that may impact the Niagara Region

Selected Legislation / Agreements/Guidelines	Scale/Agency	Type of water				Issues addressed	
		Great Lakes <sup>a</sup>	Inland surface	Ground-water	Drinking water <sup>b</sup>	Quantity	Quality
<i>International Boundary Waters Treaty</i>	International Joint Commission (IJC)	x				x	
<i>Great Lakes Water Quality Agreement</i>	IJC	x					x
<i>Great Lakes – St. Lawrence River Basin Sustainable Water Resources Agreement</i>	International (includes Provincial Ministry of Natural Resources [MNR])	x	x	x		x	
<i>International River Improvements Act</i>	Federal – Environment Canada (EC)	x				x	
<i>Guidelines for Canadian Drinking Water Quality</i>	Federal – Health Canada				x		x
<i>Canada Water Act<sup>c</sup></i>	Federal – EC	x	x	x		x	x
<i>Canadian Environmental Protection Act</i>	Federal – EC	x	x	x			x
<i>Fisheries Act</i>	Federal – EC	x	x			x	x
<i>Canada Shipping Act</i>	Federal – Transport Canada	x	x				x
<i>Drainage Act</i>	Provincial – Ontario Ministry of Agriculture, and Rural Affairs		x	x		x	
<i>Safe Drinking Water Act</i>	Provincial – Ministry of Environment (MOE)				x		x
<i>Clean Water Act</i>	Provincial – MOE	x	x	x	x		x
<i>Nutrient Management Act</i>	Provincial – MOE		x	x			x
<i>Ontario Water Resources Act</i>	Provincial – MOE	x	x	x		x	x
<i>Environmental Protection Act</i>	Provincial – MOE		x	x			x
<i>Lakes and Rivers Improvement Act</i>	Provincial – MNR		x			x	
<i>Conservation Authorities Act</i>	Provincial – MNR		x	x		x	x
<i>Niagara Peninsula Source Protection Plan</i>	Regional – Source Protection Committee	x	x	x	x		x
<i>Greenbelt Plan</i>	Regional		x	x		x	x
<i>Niagara Escarpment Plan</i>	Regional		x	x		x	x
<i>Niagara River Remedial Action Plan</i>	Multi-scale – Niagara Peninsula Conservation Authority	x	x				x
<i>By-laws</i>	Municipal		x	x	x	x	x

<sup>a</sup> 'Great Lakes' includes the Welland Canal and Niagara River

<sup>b</sup> Acts where drinking water is an explicit concern and focus

<sup>c</sup> The Canada Water Act is mainly concerned with water monitoring and reporting

## Examples of Niagara residents perceptions of water use conflicts

Despite a substantial list of agencies with authority over water and a longer list of regulations and standards employed to govern water in the Niagara Region, water conflicts occur regularly. The twenty-eight community members representing a range of sectors in Niagara interviewed were asked to identify water conflicts that were occurring within the region. Specifically, interviewees were asked to identify their perceptions of conflicts of which they had knowledge, or in which they were involved, and describe the outcomes. Similar to the complexity of water governance clearly illustrated above, water conflicts were also complex because of the range of groups involved and the diversity of disputes (Table 4.2). The following section describes the nature of those perceived conflicts and how governance of water aids in, or hinders, their resolution.

**TABLE 4.2.** Interviewee perceptions of water conflicts and challenges in Niagara

Sectors identifying conflicts	Nature of conflict	Frequency
<b>Quantity conflicts and challenges</b>		
Municipal and provincial governments; Recreation; Ecosystem services; Industry	Human induced change of water flow or availability (redirection, discharge, in stream use, dams/ construction)	Discrete incidents
Municipal governments and Ecosystem services	Vandalism, sabotage, and interference with water sources (hydrants, pumps)	Dry summers
Health and well-being	Conservation to avoid water treatment costs	Ongoing
Ecosystem services	Agricultural use for irrigation, creek levels, conservation of water	Anticipated
Agriculture	Damage to industry from infrastructure problems and maintenance (debris causing flooding)	Occasional
<b>Quantity conflicts and challenges</b>		
Ecosystem services and Agriculture	Agricultural water quality impacts on the ecosystem – need for wildlife corridors, buffer strips	Ongoing
Ecosystem services and Agriculture	Runoff from agriculture, industry, and urban centers damaging streams and ecosystems	Ongoing
Recreation	Damage to water sources due to erosion from recreational use	Seasonal
Commercial navigation	Chemical/fuel spills near water sources (fish quality, drinking water)	6 times in 10 years

## Illustrative examples of Niagara water use conflicts

### *Example 1: Water flows and hydropower*

An illustrative example of water conflict in the Niagara Region involves the taking and diverting of water for the generation of hydropower, generally considered a non-consumptive use although evaporation from storage reservoirs could be considered marginally consumptive (Mekonnen and Hoekstra, 2011). The hydropower generating stations along the Niagara River divert large quantities of water from the river to run hydraulic turbines. The volume of water in the Niagara River is, through this process, controlled depending on the season and needs of both the United States and Canada. The 1950 Niagara Treaty puts limits on how much water may be diverted at certain times of year, requiring that during the major tourist season the flow rate may be no less than 2,830 m<sup>3</sup> of water per second or 1,415 m<sup>3</sup> in the off season (Niagara Frontier, n.d.).

The diversion of water by hydropower generating stations and other water users often results in reduced water levels and conflicts due to ecosystem damage, human health issues and a reduction in recreational value. The hydropower stations supply large quantities of power which, together with the DeCew Falls plant, produce on average 1.2 billion kWh annually, enough to supply over one million homes year round (Ontario Power Generation, 2012). An additional capacity of 1.6 billion kWh is being created via the Niagara Tunnel which will divert an additional 500 m<sup>3</sup> of water per second from the Niagara River to the Adam Beck generating station. Diversion from the Niagara River is considered beneficial in some ways as it reduces erosion of Niagara Falls thus sustaining both the aesthetic value of Niagara Falls as a natural landform as well as the economic value of the region through the continued investment of businesses in the area (Friesen and Day, 1977). It is evident that a balance must be struck so that water levels are maintained in a manner that ensures that the greatest number of stakeholders, both human and ecological, benefit and that water is distributed fairly.



### ***Example 2: Conservation Authorities, the Niagara Source Protection Committee and Source Protection Planning***

The Conservation Authority holds the responsibility to coordinate and participate in the Niagara Peninsula Source Protection Committee, mandated by the provincial government through the *Clean Water Act*. Source protection committees are considered “the first layer in a multiple defense system for ensuring that clean water is available to all water users” (Conservation Ontario, 2001, p. 42). Committees include representatives from a number of stakeholder groups including farmers, businesses, municipalities and residents who work together to assess current water conditions, offer recommendations and create source protection plans for implementation. The source protection plan for the Niagara Peninsula focuses on safeguarding current and future drinking water sources by addressing drinking water threats in vulnerable areas around water treatment plants within the watershed and subsequently creating policies to deal with such threats (Niagara Peninsula Source Protection Committee, 2012). While the provincial government is responsible for the approval of the plan and the creation of standards and any policies outside of municipal control, it is primarily the municipality that is charged with the duty of implementing the plan. To a lesser degree, Conservation Authorities also have responsibilities in the implementation of the plan, providing technical and planning advice and promoting stewardship and best management practices. The Niagara Peninsula Source Protection Plan (NPSPP) requires changes in existing policies and legislation at a range of scales from a variety of agencies, which may make it challenging to implement.

The policies outlined in the plan will impact water resource management at multiple scales, creating the potential for conflicts. The NPSPP explicitly identified potential conflicts with the *Greenbelt Plan*, the *Niagara Escarpment Plan*, and the *Growth Plan for the Greater Golden Horseshoe*. Where there are conflicts between the NPSPP and other policies, plans and by-laws, the most stringent provision will apply unless it is on federal lands, where the NPSPP is not applicable.

Governance of the Niagara Region is complicated by this additional plan although it also promotes a level of cooperation between different groups involved. Decisions made at the NPSPP level have implications for municipalities and other stakeholders as well as costs associated with the changes that are recommended.



## Summary

- Water governance in Niagara is complex and includes several jurisdictional scales, from international to local, and a wide range of public, quasi-public, and private actors;
- This governance complexity developed organically, over time, as governments and actors at various scales passed legislation, created policies and formed agreements to address discrete water use conflicts. It is the accumulation of these various laws, regulations, commitments, programs and rules, many of which are uncoordinated, that has resulted in the contemporary complexity of Niagara water governance;
- New water use conflicts continue to arise. The resolution of the conflicts, through the creation of new rules and programs, contributes even further to governance complexity; and,
- Complexity is a reality of modern water governance and must be actively managed rather than ignored. One approach to doing so is embodied in the NPSPP which seeks to coordinate and provide overall purpose and direction to disparate sets of water governance rules for municipal supplies. The time, effort and political capital needed to manage governance complexity in this way are substantial.







## 5

## Climate change, water vulnerability and adaptive capacity in Niagara

### Predicted climate changes in Niagara

Canada is home to a range of unique ecological, social, and economic systems. Because of this, every region will experience climate change differently. Within the last few decades, there has been an increasing amount of research done which focuses on climate change broadly, but until recently, very little research has focused on climate change in the Niagara Region. Looking forward to 2050, recent studies focused on the Niagara Region describe anticipated climate changes in Niagara, including:

- Average temperatures increasing, approximately 3-4°C
- Decreased number of cold days
- Increased number of hot days
- Changes in temperatures will lead to abnormal freeze-thaw cycles
- Abnormal precipitation patterns
- Higher frequency of droughts
- Increased frequency of thunderstorms, lightning strikes, hail storms, high winds, and tornadoes

Sources: Penney (2012); Bourdages and Huard (2010); Fenech and Shaw (2010)

Figure 5.1 outlines the impact climate change will have on the different water use categories in Niagara. For more information about specific impacts of climate change on Niagara specifically, or Canada more broadly, please refer to Penney (2012) and NRTEE (2010), respectively.

**FIGURE 5.1.** Examples of expected climate changes in each water use category

	Water use categories							
	Withdrawals					In-situ Use		
	Agriculture Agriculture	Commercial and Industrial	Utilities	Domestic Use	Municipal Water	Commercial Navigation	Tourism	Recreation Ecosystem Services
Possible climate change impacts in Niagara								
Temperature increases								
Increases in extreme weather events (e.g. tornadoes, thunderstorms, etc.)								
Increased concentration of chemicals due to lower water levels								
Increase in blue-green algal blooms due to higher temperatures. These blooms impact the taste and odour of water, and can increase beach closures								
Increased contaminants and infectious organisms become present due to increased runoff from more frequent intense rainfalls								
Increase in annual precipitation. This may lead to a rise in lake levels.								
Increased temperatures will decline ice cover, and increase lake evaporation. Eventually, this increase in evaporation can lead to a decrease in lake levels.								
More frequent hot spells and heat waves								
Freezing rain and freeze thawing events								
Decreased summer precipitation								

Source: Penney (2012)



## Expected impacts of climate change to water quantity and quality in Niagara

The myriad of anticipated changes to Niagara's climate will impact many sectors in Niagara, such as agriculture, tourism, and public health and well-being. Climate change has the potential to reduce the quality and quantity of water available in Canada, which may lead to increased conflict regarding its supply and demand (Chiotti, 1998). Individuals interviewed within Niagara identified other water-related challenges for the future. Climate change was a potential challenge identified by a broad range of individuals, indicating that climate change is a common concern that cuts across industry, government, non-governmental groups and commercial sectors (Table 5.1). Among the other future challenges identified several issues related to water quantity, water supply, and compliance with new regulations.

**TABLE 5.1.** Future water challenges described by interviewees

Challenges	Sector(s) that identified challenge
New regulations	Commercial navigation, Industry, Ecosystem services, Agriculture, Municipal
Climate change	Commercial navigation, Ecosystem services, Municipal (2) <sup>a</sup> , Agriculture, Provincial government
Water shortage	Recreation & Tourism, Agriculture, Municipal, Ecosystem services (2)
Aging infrastructure	Public works, Municipal
Competing interests: cheap rates vs. high quality system	Recreation & Tourism, Public works (2), Municipal, Agriculture
Invasive species	Recreation & Tourism, Manufacturing, Municipal
Oil and gas extraction methods (e.g., fracking)	Municipal
Urbanization (urban/rural runoff)	Municipal, Provincial government
Septic/sewage contamination	Recreation & Tourism, Ecosystem services, Provincial government
Industrial or transportation spillage	Recreation & Tourism, Ecosystem services (2)
Ecosystem damage (fish populations, algae levels)	Ecosystem services (2), Agriculture
<sup>a</sup> numbers in parentheses denote how many interviewees from the sector identified the associated challenge	

## Water vulnerability

Acknowledging that climate change will likely have an impact on the water in Niagara is important; and mitigating and adapting to these impacts also requires an understanding of the region's areas of vulnerability to climate change. Vulnerability can be described as the probability of harm to the Niagara as a result of climate change impacts now and/or in the future (Haddad, 2011). There are in-depth methods that can be utilised to assess water vulnerability (called a 'vulnerability assessment'); however, completing a vulnerability assessment is beyond the scope of this study, and is acknowledged as a gap in our understanding. Main water related vulnerabilities in the Niagara Region are outlined in Table 5.2.

**TABLE 5.2.** Reported vulnerabilities in Niagara

Vulnerability	Niagara information
Water stress (high consumptive demand)	Significant or moderate degree of surface water (and in some cases, groundwater) demand stress in most areas of Niagara based on water budget under average current conditions
Financial uncertainties	The cost to adapt wastewater treatment infrastructure in Niagara is estimated to be between \$8,000,000 and \$24,000,000
Cost of operating infrastructure	Decreased water levels will lead to higher costs to pump water
Cost of maintaining infrastructure	Water equipment and infrastructure failing unexpectedly (from lack of maintenance, old age, failure of backup system during peak demand, or electrical failure)
Storage capacity	Inability to store enough water for peak demand periods
Lack of water meters	Not metering in some areas of Niagara may cause excessive water usage during times of water shortages
Illegal water use	Use of water via illegal connections to hydrants or water mains can reduce flow and pressure during droughts

Sources: Kreutzwiser et al. (2003); Simonovic (2008); NPCA and AquaResources (2010)

## Adaptive capacity

By uncovering and acknowledging water vulnerabilities in Niagara, individuals and organisations become better able to adapt to climate change. “Adaptive capacity is the ability of a system to adapt to climate change, reduce adverse effects or take advantage of beneficial effects” (Smith et al., 2003, p. 2). Similar to vulnerability, adaptive capacity can be measured using a wide variety of methods, and is dependent on a large number of factors such as the institutions, the task network, organisations, and available human resources (Ivey et al., 2004). Adaptation to climate change can be achieved at many different levels, and can take the form of adapting technologically, institutionally, or behaviourally (de Loë et al., 2001). By using adaptive practices and/or responses, Niagara citizens may be able to reduce climate change impacts and discover ways in which they can benefit from the changing climate. Selected sources to build adaptive capacity to climate change in Niagara are shown in Table 5.3.

**TABLE 5.3.** Ways in which Niagara can enhance adaptive capacity for climate change impacts on water quantity and quality

Actions	Resources	Policy
<ul style="list-style-type: none"> <li>■ Conserve water resources (households and industries)               <ul style="list-style-type: none"> <li>● Process changes will help balance the demand for water. For example, more efficiently irrigating in the evenings</li> <li>● Promote the use of recycled water in processing and cooling</li> <li>● Provide incentives to industries that use best water management practices, such as using recycled water</li> </ul> </li> <li>■ Create stormwater management master plans</li> <li>■ Install stormwater infiltration systems</li> <li>■ Disconnection of downspout and weeping tile to storm sewers</li> <li>■ Creation of backflow prevention and flood alleviation programs</li> <li>■ Combined sewer separation and treatment for combined sewer overflow</li> <li>■ Rehabilitate natural areas in Niagara. This can cool the air, reduce flooding, improve the water quality, and improve the health of the ecosystem.</li> </ul>	<ul style="list-style-type: none"> <li>■ Availability of and accessibility to water resources</li> <li>■ Technology to adapt</li> <li>■ Human capital</li> <li>■ Social capital</li> <li>■ Information management</li> </ul>	<ul style="list-style-type: none"> <li>■ Municipal contingency plans to adapt to reductions in water quantity</li> <li>■ Institutional structure and individuals key in decision-making</li> <li>■ Creation of operation rules for water resource systems can increase the capacity to cope with earlier runoff in the spring, and higher summer demands</li> <li>■ The incorporation of adaptation strategies/ responses into policy</li> <li>■ Creation of mandatory consumption/use restrictions</li> </ul>

Sources: de Loë et al. (2001); Kreutzwiser et al. (2003); Lemmen et al. (2007); Armitage and Plummer (2010); Hill (2012); Penney (2012)

## Adaptive capacity: addressing vulnerabilities

Taking adaptive actions to climate changes can help address areas of vulnerability. In Niagara it is important to understand where major vulnerabilities in the water sector exist, so politicians, business owners, residents, and other people can take action to mitigate and adapt to climate change. For example, one of the major vulnerabilities related to water is the limited storage capacity to provide water for peak demand periods. Adapting in this circumstance may occur in the form of policies to limit water usage during peak periods, or actions to increase Niagara's total storage capacity. Another area of vulnerability in Niagara's water sector, as discussed above, is the cost of maintaining infrastructure. Adapting to this vulnerability can occur in the form of policies that consider long term planning and management. With an understanding of current and projected impacts of climate change, and resulting areas of vulnerability, the people of Niagara will be in a better position to adapt and benefit from the changes.

### Box 5.1 Adaptive capacity in Niagara

“ In a study by Purdy (2012), the capacity to protect water in the Niagara Region was examined through a social network analysis of **WaterSmart Niagara**. This research uncovered hundreds of individuals, organisations, and groups concerned about water in the Niagara Region, and determined that **WaterSmart Niagara** positively impacts the capacity to protect water in the Niagara Region. Studies similar to this can help enhance the knowledge of Niagara's ability to adapt to climate change in the water sector by uncovering who is involved, in what capacity they are involved, and determine who *should* be involved in planning and management within the water sector. ”



## Summary

- There are numerous implications that a changing climate has to water in Niagara in terms of both quantity and quality, and the implications of this will impact many sectors and uses;
- Climate in Niagara has and will continue to change into the future. It is important to understand areas of vulnerability, areas where we have the capacity to adapt to the changes, and where capacity to adapt must be built;
- A further understanding of all areas of water vulnerability in Niagara is important. This could be achieved through a vulnerability assessment. An impact assessment would be beneficial to help understand what impacts climate change will have on water quantity and quality in Niagara; and,
- Building capacity for adaptation in Niagara is imperative. Integrated assessments of adaptive capacity offer a valuable first step to addressing present and future changes.









## 6

## Conclusions and research needs

Water is a key component of Niagara in terms of its geography but also in terms of the contribution it makes to the vibrancy and well-being of those in the region. Water supports a vast range of economic, ecological and social activities. However, this report has highlighted the dearth of information about the quantity and values of water used in the region.

### ***NEED #1: Water use and value information that is current, relevant for the region, and available from a central agency***

The available information on water quantities used and the values associated with water use is highly dispersed among organizations and governments at various levels (municipal, regional, provincial, federal). In addition to the absence of a central agency that maintains an information database, there is a lack of information that is specific to the Niagara Region. Water quantities and values that were presented were often estimates based on (often outdated) Canadian studies rather than actual figures. This general deficiency of information inhibits the region to capitalize further on the vast benefits to be derived from water resources available in Niagara.

### ***NEED #2: Maintain a current understanding of how the complex web of water governance operates in Niagara to minimize ongoing and potential conflicts***

Water governance in the region has become increasingly complex over time. Governments and other actors at various scales have passed legislation, created policies and formed agreements to address water conflicts resulting in the current governance structure that is, at times, uncoordinated and prone to conflict. Further governance efforts, specifically the Niagara Peninsula Source Protection Plan, will contribute to the coordination of water governance rules. An understanding of its implications and the impacts of other legislation, policies, and agreements to all water users in the region is important.

### ***NEED #3: Gain a strong understanding of the region's vulnerabilities and areas where adaptive capacity exists to minimize negative impacts of climate change to Niagara's well-being***

Climate change information at the regional scale is available for Niagara (see Penney, 2012). Using this information as a springboard for examining the region's vulnerabilities and capacity for adaptation to climate changes is key to maintaining and improving the benefits realized from water resources. Vulnerability and adaptive capacity assessments offer a valuable first step in this process.

## About the research team

### Diane Dupont

---

Diane is the principal investigator for this report. She is a professor in the Department of Economics at Brock University and has experience working with researchers across Canada, and in the United States, England, and Australia. Diane has served on the Board of Directors for the North American Association of Fisheries Economists and the Canadian Water Network, as a Member and Chair of the Scientific Advisory Committee for WorldFish Centre in Malaysia and is currently an associate editor for three water-related journals. Her current studies focus on water resources and their efficient and sustainable use especially in reference to the market and non-market valuation of ecosystem services.

### Steven Renzetti

---

Steven is a Professor of Economics at Brock University specializing in Microeconomics, Environmental Economics and Water Resources. He is a past member of the Council of Canadian Academies' Expert Panel on Groundwater and the International Joint Commission's International Lake Ontario-St Lawrence River Study Board as well as a current editor of Water Resources Research. One focus in Steven's research is on the pricing of water as a method for use monitoring.

### Ryan Plummer

---

Ryan is a Professor in the Department of Tourism and Environment at Brock University, a Senior Research Fellow at Stockholm University, and an Adjunct Faculty member at the Universities of Waterloo, Wilfred Laurier, and Guelph. His research concerns the management of resources: the strategies required for their governance, the mechanisms for cooperation among stakeholders, the vulnerability and adaptive capacity of social-ecological systems, and the integration of various social actors involved in decision-making.

### Tim Heinmiller

---

Tim is an Associate Professor in the Department of Political Science at Brock University, specializing in Public Policy and Administration as well as Environmental Politics. His research focuses on environmental policy and political processes related to natural resource management, with research sites in the Great Lakes and Prairie Regions of North America and the Murray Darling Region of Australia.

### Julia Baird

---

Julia is a Post-Doctoral Fellow with the Environmental Sustainability Research Centre at Brock University. Her research focus is the social aspects of collaborative and adaptive environmental governance in the context of water resources and climate change.

## About the advisory committee

### Ken Brothers

---

Ken has extensive experience in water, waste, and wastewater infrastructure management and environmental programming. He has served as the Director of the Utility Services Branch for the City of Ottawa as well as the Halifax Regional Water Commission prior to his appointment as Commissioner of Public Works for the Niagara Region in 2007.

### Murray Clamen

---

Murray is a registered professional engineer and the Secretary of the Canadian Section of the International Joint Commission, as well as an Adjunct Professor in the Department of Bioresource Engineering at McGill University. Murray was the lead Engineering Advisor for trans-boundary water management of Great Lakes - St. Lawrence River system providing him with a unique perspective on government responsibilities with water resources and the engineering and management of Niagara's water systems.

### Hugh Fraser

---

Hugh is an Extension Agricultural Engineer with the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA). He is an active member of advisory committees in the Niagara Region, including for WaterSmart Niagara.

### Mary Stack

---

Mary is the Director of Communications at the Niagara Peninsula Conservation Authority. She actively participates in community relations, keeping the public and the many stakeholders involved in NPCA projects interested and informed of current plans and projects that the authority is involved in.





## References

- Ahmed, S. U., and Gotoh, K. (2006). *Cost-Benefit Analysis of Environmental Goods by applying the Contingent Valuation Method: Some Japanese Case Studies*. New York, NY: Springer.
- Armitage, D., and Plummer, R. (Editors) (2010). *Resilience in Social-Ecological Systems: The Role of Learning and Education*. Abingdon, UK: Routledge.
- Austin, J., Anderson, S., Courant, P., and Litan, R. (2007). Healthy waters, strong economy: The benefits of restoring the Great Lakes ecosystem. *The Brookings Institution – Great Lakes Economic Initiative*. 1-16.
- Bakker, K. (2003). *Good Governance in Restructuring Water Supply: A Handbook*. Federation of Canadian Municipalities. Ottawa, ON. Retrieved from [http://www.collectivitesviables.fcm.ca/files/capacity\\_building\\_-\\_water/good\\_governance\\_v33.pdf](http://www.collectivitesviables.fcm.ca/files/capacity_building_-_water/good_governance_v33.pdf)
- Bakker, K., and Cook, C. (2011). Water governance in Canada: Innovation and fragmentation. *International Journal of Water Resources Development*, 27(2): 275-289.
- Bourdages, L., and Huard, D. (2010). *Climate change Scenario over Ontario Based on the Canadian Regional Climate Model (CRCM4.2)*. Consortium on Regional Climatology and Adaptation to Climate Change. Retrieved from: [http://www.ouranos.ca/Ontario/Results\\_html/Rapport.pdf](http://www.ouranos.ca/Ontario/Results_html/Rapport.pdf)
- Brauman, K., Daily, G., Duarte, T., and Mooney, H. (2007). The nature and value of ecosystem services: An overview highlighting hydrologic services. *Annual Review of Environmental Resources*, 32: 67-98.
- Chiotti, Q. (1998). An assessment of the regional impacts and opportunities from climate change in Canada. *The Canadian Geographer*, 42(4): 380-393.
- Christensen, R., and Lintner, A. (2007). Trading our common heritage?: The debate over water rights transfers in Canada. In K. Bakker (Editor), *Eau Canada* (219-241). Vancouver: UBC Press.
- Conservation Ontario. (2001). The importance of watershed management in protecting Ontario's drinking water supplies [online]. Retrieved from [http://www.conservation-ontario.on.ca/projects/pdf/COpos\\_paper.pdf](http://www.conservation-ontario.on.ca/projects/pdf/COpos_paper.pdf)
- de Loë, R., Kreutzwiser, R., and Moraru, L. (2001). Adaptation options for the near term: Climate change and the Canadian water sector. *Global Environmental Change*, 11: 231-245.
- Dupont, D. (2003). CVM Embedding Effects When There Are Active, Potentially Active and Passive Users of Environmental Goods. *Environmental and Resource Economics*, 25(3): 319-341.
- Fenech, A., and Shaw, T. (2010). *Niagara Region's Changing Climate: Preliminary Results*. Presentation to the Niagara Climate Change Network, December.
- Friesen, B. F., and Day, J. C. (1977). Hydroelectric power and scenic provisions of the 1950 Niagara Treaty. *Journal of the American Water Resources Association*, 13(6): 1175-1189.

Global Water Partnership. (2003). GWP-TEC Background Paper 7, Effective Water Governance. Sweden: Elanders Novum.

Haddad, M. (2011). Water scarcity and degradation in Palestine as challenges, vulnerabilities, and risks for environmental security. In H. Günter Brauch, U. Oswald Spring, C. Mesjasz, H. Grinn, P. Kameri-Mbote, B. Chourou, P. Dunay, J. Birkmann. (Editors). *Coping With Global Environment Change, Disasters and Security: Threats, Challenges, Vulnerabilities and Risks* (409-420). Springer: Heidelberg, Germany.

Health Canada. (2007). *Water Talk: Drinking Water Quality in Canada*. Retrieved from [http://www.hc-sc.gc.ca/ewh-semt/alt\\_formats/hecs-sesc/pdf/pubs/water-eau/drink-potab-eng.pdf](http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/water-eau/drink-potab-eng.pdf)

Hill, M. (2012). Characterizing adaptive capacity in water governance arrangements in the context of extreme events. In W. L. Filho (Editor). *Climate Change and the Sustainable Use of Water Resources* (339-365). Springer: New York, NY.

Ivey, J. L., Simthers, J., de Loë, R. C., and Kreutzwiser, R. D. (2004). Community capacity for adaptation to climate-induced water shortages: Linking institutional complexity and local actors. *Environmental Management*, 33(1): 36-47.

Jechlitschka, K., Kirschke, D., and Schwarz, G. (2007). *Microeconomics using Excel: Integrating Economic theory, Policy analysis and Spreadsheet Modelling*. Routledge, New York, NY.

Johns, C., and Rasmussen, K. (2008). Institutions for water resource management in Canada. In M. Sproule-Jones, C. Johns, B. T. Heinmiller (Editors), *Canadian Water Politics: Conflicts and Institutions* (59-89). Montreal: McGill-Queens University Press.

Kreutzwiser, R., L. Marani, R. de Loë, B. Mills, and K. Schaefer. (2003). Drought sensitivity of municipal water supply systems in Ontario. *The Great Lakes Geographer*. 9(2):59-70.

Lemmen, D. S., Warren, F. J., Lacroix, J., and Bush, E. (Editors). (2008). *From Impacts to Adaptation: Canada in a Changing Climate 2007*. Government of Canada: Ottawa, ON, 448p.

Lerner, D. (2002). Identifying and quantifying urban recharge: a review. *Hydrology Journal*. 10:143-152.

Mahood, T., Conetta, M., Scheckenberger, R., Steele, B., and Znadja, S. (2004). Niagara's Water Quality Protection Strategy. Retrieved from [http://www.escarpment.org/\\_files/file.php?fileid=filesJjbIRmwMb&filename=file\\_Scheckenberger.pdf](http://www.escarpment.org/_files/file.php?fileid=filesJjbIRmwMb&filename=file_Scheckenberger.pdf)

Mekonnen, M. M., and Hoekstra, A. Y. (2011). The water footprint of electricity from hydropower. Retrieved from <http://www.waterfootprint.org/Reports/Report51-WaterFootprintHydropower.pdf>

MOE. (2006). *Drinking Water Quality Management Standard*. Ministry of the Environment. Retrieved from [http://www.downloads.ene.gov.on.ca/envision/env\\_reg/er/documents/2006/Drinking%20Water%20Quality%20Management%20Standard%20-%20October%202006.pdf](http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2006/Drinking%20Water%20Quality%20Management%20Standard%20-%20October%202006.pdf)

Niagara Frontier. (n.d.). *A water diversion: Niagara River water diversion – the International Boundary Waters Treaty (1909), the Niagara River Water Diversion Treaty (1950) & Niagara River water diversion & water outflow charts*. Retrieved from <http://www.niagarafrontier.com/riverdiversion.html>

NPCA and AquaResources Inc. (2010). *Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment: Final Report Niagara Peninsula Source Protection Area. Niagara Peninsula Source Protection Authority*. Welland, Ontario.

Niagara Peninsula Source Protection Committee. (2012). *Proposed Source Protection Plan* [online]. Retrieved from <http://www.sourceprotection-niagara.ca/pdf/ProposedSPP/SPP%20Proposed%20120516.pdf>

Niagara Region. (2007). *The Regional Municipality of Niagara growth management strategy: understanding Niagara – Phase 1 Report*. Retrieved from <http://www.niagararegion.ca/government/initiatives/2031/pdf/Understanding%20Niagara.pdf>

Niagara Region. (2008). *The Regional Municipality of Niagara growth management strategy: anticipating Niagara – Phase 2 Report*. Retrieved from <http://www.NiagaraRegion.ca/government/initiatives/2031/pdf/Anticipating%20Niagara.pdf>

Niagara Region. (2012). *Adapting to climate change: Challenges for Niagara*. Retrieved from <http://www.niagararegion.ca/government/planning/pdf/climatechangerport.pdf>

Niagara Region. (2012a). *WaterSmart Niagara*. Retrieved from <http://www.niagararegion.ca/government/initiatives/nwqps/default.aspx>

Niagara Region. (2012b). *Water quality reports*. Retrieved from <http://www.niagararegion.ca/living/water/water-quality-reports.aspx>

Renzetti, S., Dupont, D., and Wood, C. (2011). *Running through our fingers: How Canada fails to capture the full value of its top asset. Blue Economy Initiative*. Retrieved from <http://www.blue-economy.ca/report/running-through-our-fingers-0>

Ontario Power Generation. (2012). *Niagara Plant Group*. Retrieved from [http://www.opg.com/power/hydro/niagara\\_plant\\_group/](http://www.opg.com/power/hydro/niagara_plant_group/)

Penney, J. (2012). *Adapting to Climate Change: Challenges for Niagara*.

Purdy, S. (2012). *Water protection in the Niagara Region: A social network analysis of WaterSmart Niagara. Undergraduate Thesis, Department of Tourism and Environment*. Brock University, St. Catharines, ON, Canada.

Saunders, J. O. (1988). *Interjurisdictional issues in Canadian water management*. Calgary: Canadian Institute of Resources Law.

Saunders, J. O., and Wenig, M. M. (2007). *Whose water? Canadian water management and the challenges of jurisdictional fragmentation*. In K. Bakker (Editor), *Eau Canada* (119-141). Vancouver: UBC Press.

Scholtens, K., and Papastavrou, S. (2010). *The Changing Economic Structure of Niagara*. Policy Brief #5. Prepared for the Niagara Workforce Planning Board. Retrieved from [http://www.brocku.ca/webfm\\_send/13790](http://www.brocku.ca/webfm_send/13790)

Simonovic, S. P. (2008). Engineering Literature Review: Water Resources – Infrastructure Impacts, Vulnerabilities and Design Considerations for Future Climate Change. *Prepared for Canadian Council of Professional Engineers and PIEVC*. Retrieved from [http://www.pievc.ca/e/Appendix\\_C\\_Literature\\_Reviews.pdf](http://www.pievc.ca/e/Appendix_C_Literature_Reviews.pdf)

Smith, J. B., Klein, R. J. T., and Huq, S. (Editors). (2003). *Climate Change, Adaptive Capacity and Development*. Imperial College Press: London, UK.

Statistics Canada. (2006). *Community profile: Niagara, Regional Municipality*. Retrieved from <http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CD&Code1=3526&Geo2=PR&Code2=35&Data=Count&SearchText=niagara&SearchType=Begins&SearchPR=01&B1=All&Custom=>

Statistics Canada. (2011). *Census profile: Niagara, Regional Municipality*. Retrieved from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CD&Code1=3526&Geo2=PR&Code2=35&Data=Count&SearchText=Niagara&SearchType=Begins&SearchPR=01&B1=All&Custom=&TABID=1>

Walkem, A. (2007). The land is dry: Indigenous peoples, water, and environmental justice. In K. Bakker (Editor), *Eau Canada* (303-319). Vancouver: UBC Press.



## References for Tables in Chapters 2 and 3

- Habermebl, C. (2012). *Niagara Region Diversion Initiatives - Economic Impact*. Retrieved from <http://www.swanaon.org/symposium6/SWANA%20PDF%20Presentations/Catherine%20Habermebl.pdf>
- Kennedy, M., and Wilson, J. (2009). *Estimating the Value of Natural Capital in the Credit River Watershed*. Retrieved from <http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CFMQFjAA&url=http%3A%2F%2Fpubs.pembina.org%2Freports%2Fnatural-credit-report.pdf&ei=M-7gT4uXC8Tm0QG3woiODg&usg=AFQjCNFEH3n4cLEopn5kTRjE5lpEovWPcA>
- Krantzberg, G., and de Boer, C. (2006). *A Valuation of Ecological Services in the Great Lakes Basin Ecosystem to Sustain Healthy Communities and a Dynamic Economy*. Retrieved from <http://www.eng.mcmaster.ca/civil/facultypages/krantz2.pdf>
- Kulshreshtha. (2004). Water resources evaluation and Millennium Ecosystem Assessment Framework: Application to value of water in the South Saskatchewan River Basin. Paper 49. Retrieved from [http://opensiuc.lib.siu.edu/ucowrconfs\\_2004/49](http://opensiuc.lib.siu.edu/ucowrconfs_2004/49)
- Mansur, E., and Olmstead, S. (2011). The value of scarce water: Measuring the inefficiency of municipal regulations. *Journal of Economic Literature*, 1-48. Retrieved from [http://www.dartmouth.edu/~mansur/papers/mansur\\_olmstead\\_water.pdf](http://www.dartmouth.edu/~mansur/papers/mansur_olmstead_water.pdf)
- Millerd, F. (2007). Global climate change and Great Lakes international shipping. *Transportation Research Board Special Report 291*. Retrieved from [http://onlinepubs.trb.org/onlinepubs/sr/sr291\\_millerd.pdf](http://onlinepubs.trb.org/onlinepubs/sr/sr291_millerd.pdf)
- Ministry of Tourism, Culture, and Sport. (2011). *Regional Tourism Profile 2008: CD26 Niagara Region Municipality*. Retrieved from <http://www.mtc.gov.on.ca/en/research/rtp/2008/cd26/index.htm#RANGE!A128>
- Niagara Falls. (2011). Tourist and economic impact statistics. *Business Development Department*. Retrieved from <http://www.niagarafalls.ca/pdf/business/tourist-economic-impact-statistics.pdf>
- NPCA. (2005). Watershed Report Card 2005. [online] URL: <http://www.npca.ca/wp-content/uploads/2005-Watershed-Report-Card.pdf>
- NPCA and AquaResources Inc. (2010). Niagara Peninsula Tier 1 Water Budget and Water Quantity Stress Assessment: Final Report Niagara Peninsula Source Protection Area. *Niagara Peninsula Source Protection Authority*. Welland, Ontario.
- Ontario Power Generation. (2012) Niagara Power Group. Retrieved from [http://www.opg.com/power/hydro/niagara\\_plant\\_group/](http://www.opg.com/power/hydro/niagara_plant_group/)
- Renzetti, S. and Dupont, D. (2007). *The Economic Benefits of Water Use in Canada*. Canadian Water Network.
- Statistics Canada. (2012). 2011 *Census of Agriculture*. Retrieved from <http://www.statcan.gc.ca/daily-quotidien/120510/dq120510a-eng.htm>



# APPENDIX A

## Range of water uses in the Niagara Region within each category of water use

<b>Agricultural Water Use</b>			
<b>Category of Water Use</b>	<b>Water Use Amounts</b>	<b>Range</b>	<b>Source</b>
<b>LIVESTOCK</b>			
Livestock Watering	1,656,155 m <sup>3</sup> /year	NPSPA, 2006	NPCA and Aqua Resource Inc., 2010
Bulls	15,415 L/kg bovine	Global, 2011	Mekonnen & Hoekstra, 2011
Dairy Cattle	115 L/day/head, 17,599,340 L/animal	Niagara, 2007	Rahman et al., 2011
Beef Cattle	41 L/day/head, 2,746,400 L/animal	Niagara, 2007	Rahman et al., 2011
Sheep and Lambs	5.25 L/day/head	Niagara, 2007	Rahman et al., 2011
Hogs	92670 L/animal	Niagara, 2007	Rahman et al., 2011
Egg Production	Laying hen: 25,000 L/animal	Niagara, 2007	Rahman et al., 2011
Poultry	3,740 L/animal	Niagara, 2007	Rahman et al., 2011
<b>CROPS/OTHER</b>			
Tender fruit	962 L/kg	Global, 2011	Mekonnen & Hoekstra, 2011
Vegetables	322 L/kg	Global, 2011	Mekonnen & Hoekstra, 2011
Greenhouse Production	1.9 to 4.1 mm/day/greenhouse	Niagara, 2005	Niagara Region, 2005
Viticulture	610 L/kg	Global, 2011	Mekonnen & Hoekstra, 2011
<b>GOLF COURSE WATER PERMITS</b>	217 million m <sup>3</sup> /year maximum	Niagara, 2007	Ontario Ministry of the Environment, 2009
<b>OVERALL AGRICULTURAL WATER USE</b>	5-10 million m <sup>3</sup> /year (excluding golf courses)	Niagara, 2001	de Loe et al., 2001

### Infrastructure/Municipal Water Supply (water treated and supplied by municipalities)

Category of Water Use	Water Use Amounts	Range	Source
<b>MUNICIPAL WATER USE</b>	86,396,085 m <sup>3</sup>	Niagara, 2009	Environment Canada, 2009

### Domestic Water Use

Category of Water Use	Water Use Amounts	Range	Source
<b>DOMESTIC WATER USE</b>	Domestic Water Use	Domestic Water Use	Domestic Water Use
<b>PRIVATE WELL SUPPLY</b>	7.8 million m <sup>3</sup>	Niagara, 2008	NPCA and AquaResource Inc., 2010
<b>PRIVATE WATER SUPPLIERS</b>			

### Industrial/Manufacturing/Transportation Water Use

Category of Water Use	Water Use Amounts	Range	Source
<b>Water Permits</b>	197.5 million m <sup>3</sup> /year maximum withdrawal	Niagara, 2007	NPCA and Aqua Resource Inc., 2010
<b>MANUFACTURING</b>			
Minerals and Metals Sector			
Gross Water Use	8,330.9 million m <sup>3</sup>	Canada, 2009	Statistics Canada, 2009
<b>ACCOMMODATION AND FOOD SERVICES</b>			

**Utilities**

Category of Water Use	Water Use Amounts	Range	Source
<b>HYDRO DAM SERIES FLOW CAPACITY</b>	1,825 m <sup>3</sup> /second = 57.5 billion m <sup>3</sup> /year	Niagara, 2012	Niagara Frontier, n.d.

**Commercial Business**

Category of Water Use	Water Use Amounts	Range	Source
<b>WATER PERMITS</b>	2.16 million m <sup>3</sup> /year maximum withdrawal	Niagara, 2007	NPCA and Aqua Resource Inc., 2010
<b>WHOLESALE AND RETAIL TRADE</b>			
<b>WAREHOUSING</b>			

**Leakage (Municipal Supply)**

Category of Water Use	Water Use Amounts	Range	Source
<b>MUNICIPAL LEAKAGE</b>	1.1 million m <sup>3</sup> of municipal supply (13%)	Canada, n.d.	Environment Canada, 2011

**Commercial Navigation**

Category of Water Use	Water Use Amounts	Range	Source
<b>WELLAND CANAL</b>			
Water Use for Lock Transit	91 million litres/transit 32 vessels/day (busiest days)	Niagara, 2011	The St. Lawrence Seaway Management Corporation, 2011
<b>LAKE ERIE</b>			
<b>LAKE ONTARIO</b>			

<b>Recreation</b>			
<b>Category of Water Use</b>	<b>Water Use Amounts</b>	<b>Range</b>	<b>Source</b>
<b>FISHING</b>			
Licensed Anglers	1.46 million people	Ontario, 2010	Statistics Canada, 2009
Fish Caught	96 million	Ontario, 2010	Statistics Canada, 2009
Fishing Visits	158,000	Niagara, 2009	Ministry of Tourism, Culture, and Sport, 2009
<b>SWIMMING/BEACH ACTIVITIES</b>			
People Involved	2.33 million people	Ontario, 1996	Environment Canada, 2011
Swimming Days Lost (Lake Ontario)	681/year	Niagara, 2010	Niagara Research and Planning Council, 2011
Swimming Days Lost (Lake Erie)	515/year	Niagara, 2010	Niagara Research and Planning Council, 2011
<b>WATER PARKS AND SPLASH PADS</b>			
<b>TRIATHLON</b>			
<b>SNORKELLING, SCUBA DIVING</b>			
<b>CANOEING, KAYAKING, SAILING</b>	1.02 million people	Ontario, 1996	Environment Canada, 2011
<b>ROWING/Dragon Boating</b>			
<b>KITEBOARDING/WIND-SURFING</b>			
<b>POWER BOATING</b>	905,000 people	Ontario, 1996	Environment Canada, 2011
<b>SKATING/ICE HOCKEY</b>			
<b>HUNTING</b>			
People Involved	1 in 20 people	Canada, 1996	Environment Canada, 2011
<b>WILDLIFE VIEWING</b>			
% of people 15 and over	19%	Canada, 1996	Environment Canada, 2011
<b>PHOTOGRAPHY</b>			
<b>BIRD WATCHING</b>			

### Recreation (continued)

Category of Water Use	Water Use Amounts	Range	Source
CAMPING			
PICNICKING			
USING WATERSIDE TRAILS FOR BICYCLING, RUNNING, ETC			
HIKING			
Visits to Nature Parks	293,000	Niagara, 2009	Ontario Ministry of Tourism, Culture, and Sport, 2009

### Tourism

Category of Water Use	Water Use Amounts	Range	Source
TOURIST WATER USE	222 L/day/tourist	Global Average, 2005	Gossling, 2005
TOURIST TRIPS (TO NIAGARA)	13.4 million people	Niagara, 2004	Niagara Region, 2005
PURPOSE-BUILT ATTRACTIONS			
SPECIAL EVENT ATTRACTIONS			
NATURAL ATTRACTIONS			
CULTURAL ATTRACTIONS			

### Ecosystem Services

Category of Water Use	Water Use Amounts	Range	Source
PERMITS FOR ECOSYSTEM PRESERVATION AND RESTORATION/ REMEDIATION	7.6 million m <sup>3</sup> maximum withdrawal	Niagara, 2007	NPCA and Aqua Resource Inc., 2010



## References for Appendix A

- Environment Canada. (2011). *Wise Water Use*. Retrieved from <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F25C70EC-1>
- Environment Canada. (2009). *Municipal Water Use Data*. Retrieved from <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=ED0E12D7-1#X-201110201124054>
- Gossling, S. (2005). Tourism and water. In M. Hall & S. Gossling (Editors). *Tourism and Global Environmental Change: Ecological, Economic, Social and Political Interrelationships* (p.180-194). Florence, UK: Routledge.
- Mekonnen, M.M., and A.Y. Hoekstra. (2011). The green, blue and grey water footprint of crops and derived crop products. *Hydrology and Earth System Sciences*, 15:1577-1600.
- Natural Resources Canada. (2010). *Water Use by Natural Resource Sectors: Facts - Forest Sector*. Retrieved from <http://www.nrcan.gc.ca/publications/water-use/259>
- Niagara Frontier. (n.d.). *Niagara Falls: History of Power*. Retrieved from <http://www.niagarafrontier.com/power.html>
- Niagara Region. (2005). Feasibility study - raw water for agricultural irrigation purposes project report. *Stantec*. Retrieved from <http://www.niagararegion.ca/living/ap/farmfacts.aspx>
- Niagara Research and Planning Council. (2011). *Beach monitoring: Postings for E. coli and swimming days lost*. Retrieved from <http://www.livinginniagarareport.com/03-environment-2011/beach-monitoring-postings-for-e-coli-and-swimming-days-lost/>
- NPCA, and AquaResources Inc. (2010). Niagara Peninsula tier 1 water budget and water quantity stress assessment: Final report Niagara Peninsula source protection area. *Niagara Peninsula Source Protection Authority*. Welland, Ontario.
- Ontario Ministry of the Environment. (2009). *Permits to Take Water*. Retrieved from [http://www.ene.gov.on.ca/environment/en/industry/assessment\\_and\\_approvals/water\\_taking/STDPROD\\_075554.html](http://www.ene.gov.on.ca/environment/en/industry/assessment_and_approvals/water_taking/STDPROD_075554.html)
- Ontario Ministry of Tourism, Culture and Sport. (2009). *Regional Tourism Profile, 2009: Niagara Falls and Wine Country*. Retrieved from <http://www.mtc.gov.on.ca/en/research/rtp/2009/RTO2/index.htm>
- Rahman, M., M. Karunanathan, and M. Barlow. (Editors) (2011). Leaky exports: A portrait of virtual water trade in Canada. *The Council of Canadians*. Retrieved from <http://canadians.org/water/documents/virtual-water-0511.pdf>
- Statistics Canada. (2009). *Water Use Parameters in Manufacturing Industries, by Industry Group, Canada*. Retrieved from <http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/envir05a-eng.htm>
- The St. Lawrence Seaway Management Corporation and the Saint Lawrence Seaway Development Corporation. (2011). *The St. Lawrence Seaway Traffic Report 2011 Navigation Season*. Retrieved from [http://www.greatlakes-seaway.com/en/pdf/traffic\\_report\\_2011\\_en.pdf](http://www.greatlakes-seaway.com/en/pdf/traffic_report_2011_en.pdf)

# B

## APPENDIX

# Semi-structured interview script

## Introduction

Hello, my name is \_\_\_\_\_ and I am working with Dr. Diane Dupont at Brock University on a research project that investigates the range of water uses, and benefits and challenges of water use to organizations in the Niagara Region. I will be asking you a series of questions but please feel free to ask any questions of me as they arise.

First, I'm wondering if you have signed the consent form.  
Second, is it okay that I record this conversation?

## Interviewee and Organization Information

Date: \_\_\_\_\_

Organization Name: \_\_\_\_\_

Interviewee: \_\_\_\_\_

E-mail: \_\_\_\_\_

Phone: \_\_\_\_\_

1. What is your position at your organization, and for how long have you held this position?

---



---

2. Briefly, what are the priorities of your organization? (mission, or goals)

---



---

**The next few questions focus on how your organization uses water in achieving its goals.**

3. Is your organization based in Niagara, in part, as a result of water availability or quality?

---



---



---

- a) If yes, if the water quality and/or quantity was inadequate for your organization's needs, where might you relocate, or where would you access adequate water resources (if known)?

---

---

4. In achieving your organization's goals (or outcomes) in what ways is water used?

- a) Quantity (or volume) \_\_\_\_\_

---

---

- b) Quality \_\_\_\_\_

---

---

5. What proportion of your organization's output is sold outside of the region (if applicable)? What is the value of that output?

---

---

**The next questions focus on water in Niagara in general.**

6. Aside from the benefits your organization realizes from water, what do you think is the most important contribution water makes to the economy in Niagara?

---

---

7. Do you have any experience with, or knowledge of, water use conflicts in Niagara? If so, what was the nature of the conflict and the outcome?

---

---

8. Do you have any experience with government regulation of water quality or water quantity in Niagara? If so, what was the nature of this experience and the outcome?

---

---

9. Finally, are you aware of any future threats to your organization as a result of water quality and/or quantity in Niagara?

---

---

***Thank you very much for your time and input.***

# C

## APPENDIX

### Interview data

#### Data collected from interviews

Interviews were conducted with 28 representatives from a range of sectors connected to water use and governance identified within the Niagara Region. These include agriculture, commercial navigation, ecosystem services, health and wellbeing, industrial, manufacturing, ministry of the environment, municipal demand, municipal supply, recreation, and tourism. Interviewees were asked a set of nine questions related to the value of water to Niagara broadly and to their sector specifically as well as about any water conflicts that they were aware of or future threats to water in the Region. Information gleaned from these interviews provides us with more insight into the benefits received from water sources as well as challenges that might affect different groups in the region. Responses to questions 3 – 9 from the interview (Appendix B) are presented here.

#### *Question 3: Influence of water on choice of location*

Respondent were asked whether the organization or company the person represented was based in Niagara because of water quantity or quality primarily. The majority of people cited water availability as being the most important (10 respondents), noting that water is a major means of transportation, and is important for drinking water, fish habitats, and power generation in the Niagara Region. Seven respondents made mention of quality-related reasons for their organisation, for example aesthetics, consumption and the health of ecosystems (Table C-1).



**TABLE C-1.** Influence of water on location of organization.

Responses	Sector	Number of times mentioned	Details
Water Availability	Yes	10	Means of transportation Stewards of the resource Stream protection Water and wastewater system reliance Existence of municipal department (2) Fishing resource Hydroelectric power generation Drinking water/municipal use
	No	3	Not the reason established (agricultural value - the area, temperature, good soil conditions) (3)
	Yes and No	1	Irrigation use, rainfall (use municipal and non-municipal sources)
	Unsure	1	Possibly - unsure of motivations of original owners
Water Quality	Yes	7	Aesthetic value Stream protection, water/wastewater quality Number one priority Human consumption and treatment (3)
	No	8	No intake of water (2) Irrigation water - many possible source choices, not main consideration (2) Not the reason established (2) Not our responsibility

### Question 4: Proportion of goods sold outside the region

This question asked respondents about the proportion of their organization's output which is sold outside of the region and the value of that output if applicable. These figures give us a sense of Niagara's output in terms of products produced using water or transported using water sources. Around 40 per cent of the respondents mentioned at least some goods produced or connected with their company were sold outside the region, ranging from 10 per cent to 85-90 per cent of sales. The actual value of goods sold was only expressed by respondents in the quarrying and environmental services and commercial navigation sectors, those being the easiest to estimate.

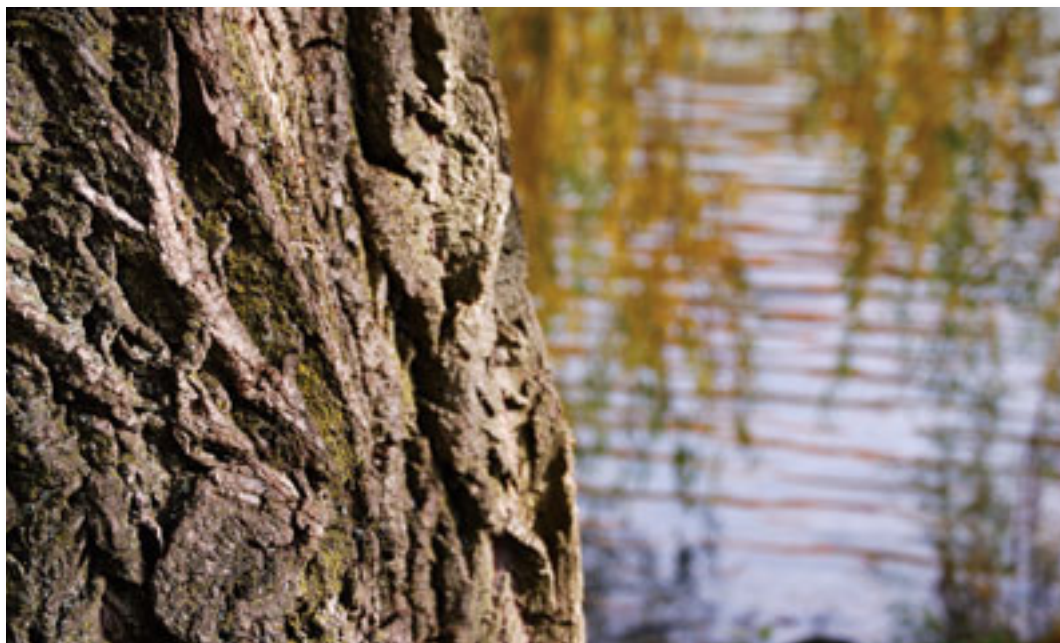


**TABLE C-2.** Proportion of goods sold outside the region

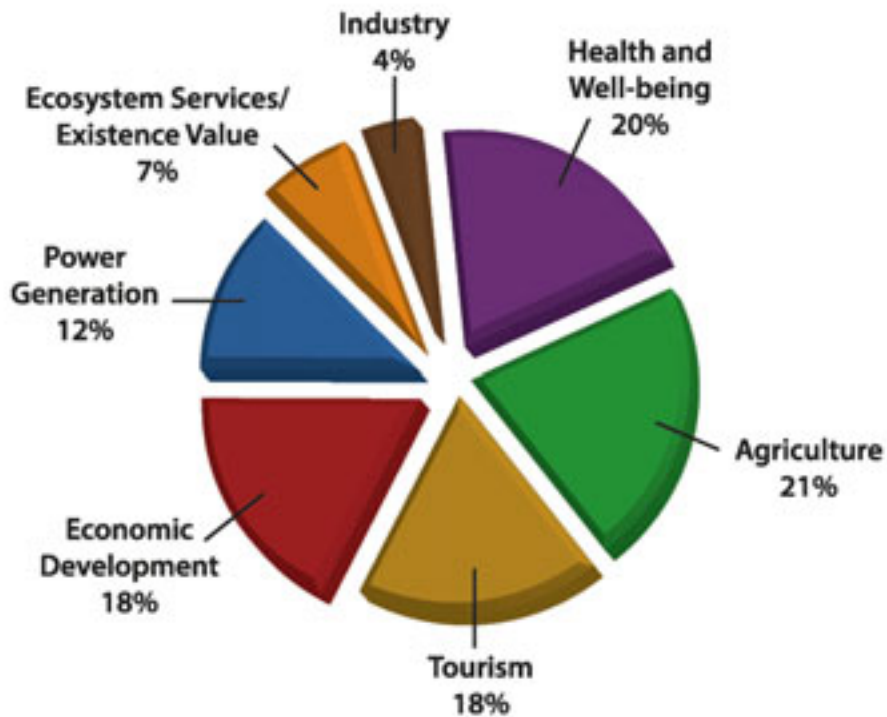
Amount of goods sold outside of region	Number of respondents	Value of goods	Respondent sector
85-90%	1	not sure	Agriculture
70%	1	not sure	Manufacturing
50%	1	\$100,000,000	Industry
10%	1	not expressed	Agriculture
Some	1	unknown	Recreation & tourism
N/A	8	\$0	Recreation & tourism , Ecosystem services, Municipal (4), Public works (2)
Indirect economic impacts	1	Direct: \$150 million, Indirect (Job Market): \$36 billion	Commercial navigation

### Question 6: Water's contribution to the economy

When asked about how water contributes to the Niagara economy, interviewees identified a number of ways this occurs. Responses were aggregated into six categories presented in Figure C-1.



**FIGURE C-1.** Water's contribution to Niagara's economy: responses from interviewees and percentage of times mentioned.



### Question 7: Niagara water use conflicts

Respondents were asked about their experience with water use conflicts along with the nature and outcome of conflicts if they had been resolved. Sectors identified in conflicts included industrial users, utilities, fisheries, agriculture, tourism, and public work (Table C-3). Also important to mention is that 11 of the 28 respondents did not identify any conflicts, and in some cases interviewees were unwilling to discuss conflicts in the Niagara Region.

**TABLE C-3.** Perceived conflicts identified by each group of water users interviewed

# of respondents	Conflict	Details	Potential solutions
1	Human health/ commercial navigation	Chemical/fuel spill affecting community water intake	Environmental containment and cleaning of water by intervening agency, prevention from a management/functionality point of view
2	Farming/creek level and conservation	Irrigate farms from groundwater would take too much water from the stream system - conserve	
1	City water channel maintenance/ vineyards	Irregular maintenance of water channels and added debris - heavy rains wash debris into the river - dam effect, flooding	Recent dyke upgrade (helps)
1	Quarry/golf course	Pump water out of quarry to extract rock - water to open sources but golf course began to use water from the creek from quarry - expected constant flow but it's not an actual river	Golf course permitted to pump at certain times, filling a pond for later use
3	General public/ vandalism	Hooking up to hydrants, people turning on hydrants and flooding properties, open dams, sabotage other people's pumps/valves, well interference	Some hydrants locked, report individual if possible to Ministry of Environment (responsible to resolve)
2	Construction/dam/ municipal drain/ fishing	Water levels fall as more construction and damming being done (new tunnel project), fisheries or wetland habitat - municipal drainage	
1	Recreationalists/ conservation	Theory - jet boats continual wave action cause erosion of shoreline	
3	Farmers/farmers/ governments	Irrigation, permits, noise issues from irrigation pumps, wildlife corridors, buffer strips, levels of water use	
1	Land use change/ golf course	Raw to developed (golf course development)	
2	Industry/ conservation	River redirection (stormwater management - OPG redirecting Welland river for their use)	
1	Municipality/ conservation	Drains used for irrigation ditches now Drinking/treated water conservation so that costs will remain low	
2	Pollution (general)	Contamination - The water looks good, seems healthy, the ecosystem seems health not sure what levels of contaminants are present	

### Question 8: Experience with water-related regulations

Respondents were asked about their experience with government regulation, particularly those related to water quantity and quality issues that they personally or as an organization were subject to or had been involved with (Table C-4). The *Safe Drinking Water Act*, the *Environmental Protection Act*, and water testing and analysis certification (required of employees or associates) were most often mentioned; however, a wide range was identified.

**TABLE C- 4.** Interviewee experience with water regulations and guidelines

<b>International</b>
Water Boundary Treaty
US Clean Water Act
<b>Federal</b>
Canadian Marine Act
Environmental Protection Act
Canadian Shipping Act
Canadian Environmental Assessment Act
Organic Certification
Power plant development regulations
Environmental regulations dealing with pesticides and fertilizers
<b>Provincial</b>
Ontario Clean Water Act
Safe Drinking Water Act 2002 – reg. 128/04, 169/03, 170/03, 248/03
Water Opportunities Act
Ontario Water Resources Act – reg. 129/04
Drinking Water Quality Management Standards
Ontario Environmental Assessment Act
Power plant development regulations
MOA Inspections
Permit To Take Water
Buffer Zone Regulations
Ontario Ministry of the Environment Wastewater System (MEWS) Regulations
<b>Organizational</b>
Self regulation related to water testing

### Question 9: Future threats or changes in water quality and quantity in Niagara

Respondents identified a range of potential challenges and threats related to water quantity and quality to the region in the future. We have organized these challenges and threats under three broad categories: institutional aspects; impacts of economic activities (e.g., manufacturing, agriculture, transport); and, changes to the natural environment (Figure C-2). These categories are not mutually exclusive, but serve as a preliminary method of organizing identified challenges and threats to the region.

**FIGURE C-3.** Future threats and challenges to water in the Niagara Region identified by interviewees

Institutional impacts	Sector activities impacts	Changes to the natural environment
<ul style="list-style-type: none"> <li>■ New regulations</li> <li>■ Financial threat - cheap rates vs. high quality system</li> </ul>	<ul style="list-style-type: none"> <li>■ Industrial/ transportation spillage</li> <li>■ Aging infrastructure</li> <li>■ Oil &amp; gas extraction methods (e.g., fracking)</li> <li>■ Urbanization (urban / rural runoff)</li> <li>■ Septic / sewage contamination</li> <li>■ Human-induced climate change impacts</li> <li>■ Bad raw water quality</li> </ul>	<ul style="list-style-type: none"> <li>■ Climate change (droughts, flood risks, weather pattern changes, etc.)</li> <li>■ Invasive species</li> </ul>





# D

## APPENDIX

## Workshop agenda and student reflections

### Agenda for “Liquid Assets: Assessing Water’s Contribution to Niagara” Workshop

**Date:** Wednesday, October 24, 2012

**Location:** Four Points by Sheraton Hotel, 3530 Schmon Parkway, Thorold

#### WORKSHOP AGENDA

10:00 – 10:30 am	Registration and coffee
10:30 – 10:35 am	Opening remarks from Mayor Bill Hodgson
10:35 – 10:40 am	Opening remarks from Dr. Ian Brindle ( Brock University)
10:40 – 10:45am	Welcoming remarks from Dr. Ryan Plummer, Director of the Environmental Sustainability Research Centre (ESRC), Brock University
10:45 – 11:45am	Presentation of findings from ‘Liquid Assets: Assessing Water’s Contribution to Niagara’ report 1) Dr. Diane Dupont, Principal Investigator (Economics) 2) Dr. Steven Renzetti (Economics) 3) Dr. Tim Heinmiller (Political Science) 4) Dr. Julia Baird (ESRC)
11:45 – 12:15 pm	Opportunity for initial feedback from participants
12:15 – 12:45 pm	Lunch
12:45 – 1:30 pm	Plenary address: Dr. Zafar Adeel (United Nations University - Institute for Water, Environment and Health) <b>Water Trends Worldwide – Challenges in a Changing World</b> In many parts of the world water quality and water quantity are under threat, leading to adverse impacts on societies and ecosystems. For water resources that are shared across national borders, water security poses an additional challenge. Many interweaving global trends indicate that the situation will exacerbate if we continue with business as usual. In order to address the ‘World Water Crisis’, resources and governance mechanisms need to be put in place. Few examples of how to do this successfully exist, leaving the door open for a new vision and leadership.
1:30 – 2:30 pm	Breakout sessions to discuss next steps based on report findings <i>Group 1:</i> How should we prioritize data needs? How might we begin to fill the gaps in knowledge for Niagara-specific water uses and benefits? <i>Group 2:</i> How can multi-level water governance be reframed to better promote efficiency and sustainable water use in Niagara? What steps could we take to begin to this process? <i>Group 3:</i> In what areas can we strengthen our adaptive capacity in order to increase benefits realized from our water resources?
2:30 – 3:00 pm	Reconvene to share thoughts and ideas generated during the breakout sessions Concluding remarks



## Liquid Assets Student Reflection #1

*Erin Duffy, Undergraduate student, Brock University*

On Wednesday, October 24, I had the pleasure of attending the Liquid Assets Workshop hosted by the Environmental Sustainability Research Centre (ESRC). The purpose of this workshop was to reflect upon a report which focused on water use and governance in the Niagara Region. Before reading the preliminary report and attending this workshop, my knowledge regarding water use in Niagara was very limited. Attending this workshop increased my awareness and made me think critically of water use and administration in the Region.

The findings of the report were presented by four of the contributors. Dr. Diane Dupont introduced the report. I learned that there are four main benefits provided by water: (1) provisioning, (2) regulating, (3) cultural, and (4) supporting. These benefits are both tangible and intangible. Here I also learned what some participants in the Niagara Region think about the benefits of water, and I was interested to learn that the participants did not place a high value on the intrinsic worth of water.

Dr. Steven Renzetti spoke of the economics of water use. He mentioned that Niagara is a blue economy, but there is a significant knowledge gap in what we know about water use in the Region due to a lack of current data. Dr. Tim Heinmiller discussed water governance in the Niagara Region. This was one section that I had very little knowledge about, thus I was surprised and interested to learn that water governance is very complex due to there being multiple scales, actors, and users in the region. This complexity is the main reason why water governance in the Niagara Region is difficult to understand.

As a tourism and environment student, Dr. Julia Baird's section on climate change was especially interesting to me. Much like other aspects of the environment, water is easily impacted by climate change. Our ability to reduce these effects or take advantage of the beneficial effects of climate change, or our adaptive capacity, is extremely important to help reduce these impacts. Dr. Baird outlined three research needs: (1) better water use and value information, (2) a better understanding of governance, and (3) a better understanding of the regions vulnerability.

I was privileged to have the opportunity to listen to such established academics speak of this topic, but what was the most beneficial to me was to sit in on the breakout sessions and learn what professionals within the field had to say regarding water use. I was the rapporteur for the question regarding how water governance can be improved to be more efficient and sustainable. After learning everything I did about water governance, my first thought was that it needs to be less complex. Then, after listening to what my group had to say, it became clear that even those working within this field are also confused about how the system works. The current system for water governance either needs to become more comprehensible or people need to be provided with the resources to better educate themselves.

Changing the current system may include getting rid of redundant laws, clearly outlining which level of government is responsible for what, and placing leadership at a local level.

One of the most important limitations regarding water use in the Niagara Region is the lack of data and information. Before water use in Niagara can be fully understood, the proper information must be collected. Such information includes water use, water quality, and water governance. We might begin to fill these knowledge gaps by establishing one main data base to store and retrieve information. We might also partner with a nearby school, such as Brock University, to collect data. Thesis students may be very interested in such a project and this would be an efficient and inexpensive way to collect the necessary data.

Another limitation that needs to be addressed is the Niagara Region's adaptive capacity. Since we are so limited in our knowledge about water quality and use in the region, the first step is to acquire all the necessary data and information. We must do this in order to be proactive and anticipate change. It is also important to understand our water's vulnerability and exactly how climate change impacts our water. We might also collect data from regions who have already implemented methods to protect their water. Our adaptive capacity regarding water quality is linked with both data and governance. Once we understand what we need to do, appropriate action needs to be taken in the form of laws and regulation.

Overall, attending the WaterSmart Liquid Assets Workshop was a great and constructive experience. I learned many things about water in the Niagara Region which I did not know before. The multi-disciplinary approach made me critically think about different aspects of water use and the problems associated with it. From what I learned, water use in the Niagara Region needs to be critically analyzed, especially considering the current knowledge gaps in water use, quality, and governance. This workshop in combination with the report will provide for an excellent tool to fill these current gaps.



## Liquid Assets Student Reflection #2

*Tanya Woodhead, Undergraduate student, Brock University*

The Liquid Assets report and workshop held on October 24, 2012, is a crucial starting point for identifying the Niagara region's water resource issues. The workshop revealed that Niagara region has many vulnerabilities that can however be met with opportunity for improvement. Content and discussion throughout the workshop produced some very interesting and proactive solutions to existing problems. Three broad issues were identified and discussed throughout the workshop. The following issues were identified as needing to be addressed in order to progress:

- (1) Gaps exist in our region-specific water use information, these gaps must be filled.
- (2) The current water governance has potential to be more efficient. It must be restructured to maximize benefits and efficiency while minimising cost.
- (3) Our adaptive capacity is unknown. We must capitalize on opportunities to strengthen our adaptive capacities so that we can effectively anticipate and respond to change.

Unfortunately, solutions to these issues are not as attainable as one may suspect. Differing motivations make developing a measure for water value very difficult. As with many of the world's other resources, various sectors prioritize and use water in very different ways according to their desired product or purpose. The Liquid Assets workshop produced essential steps to begin a process of improvement in the Niagara Region while still keeping the objectives of all sectors in sight. Education and engagement of water's contribution was identified as a high priority in the Niagara region. Suggestions toward implementation of this priority included the use of social media as well as curriculum changes in schools. Additionally, the need for region specific information was recognized as a necessary step to move forward. A central repository for information was identified as the most promising and practical tool to start to fill in these gaps. Furthermore, governance of water was unmistakably the most complex issue discussed at the workshop. Although a solution is indefinite, suggestions for improvement were made. A bottom up approach was suggested as most appropriate. This would entail conflict being solved locally involving the general public rather than depending on multi-level government intervention.

Moving forward, the Liquid Assets report and workshop effectively illustrate the urgency for progression toward a more coordinated system of water assessment in the Niagara region. Niagara has the tools needed to better equip themselves against the uncertainties of future resource changes, however these just need to be used more efficiently. Engaging in dialogue and sharing knowledge is perhaps the most valuable step toward a more harmonized system. The Liquid Assets report and workshop are evident of this. Both have produced remarkable results and suggestions that will be integral in moving forward.







Niagara Region  
2201 St. David's Road  
P.O. Box 1042  
Thorold, ON L2V 4T7  
Canada

[www.niagararegion.on.ca](http://www.niagararegion.on.ca)



Environmental Sustainability  
Research Centre

Brock University  
500 Glenridge Avenue  
St. Catharines, ON L2S 3A1  
Canada

[www.brocku.ca/esrc](http://www.brocku.ca/esrc)

