SCHOOL OF
Urban and
Regional Planning
Queen's University

Planning for Climate Change Adaptation

in the Cataraqui Region

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CATARAQUI REGION CONSERVATION AUTHORITY

Standard Limitations

This report was prepared by students at Queen's University in the School of Urban and Regional Planning enrolled in SURP 825: Environmental Services Project Course for the account of the Cataraqui Region Conservation Authority. The disclosure of any information in this report is the sole responsibility of the Cataraqui Region Conservation Authority. The material in this report reflects the researchers' best judgment in light of the information available at the time of preparation. The findings and recommendations herein are the opinions of the researchers and have not been reviewed or endorsed by the Cataraqui Region Conservation Authority.

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Queen's School of Urban and Regional Planning

The project course is an intensive four month course designed to give students in the School of Urban and Regional Planning (SURP) an opportunity to engage with planning professionals and apply newly acquired theories and skills in a professional setting. The course results in a high-quality report and final research project produced by students in the program, under the guidance of project coaches and a coordinator. This year, the School of Urban and Regional Planning was retained by the Cataraqui Region Conservation Authority for a project involving planning for climate change adaptation in the Cataraqui Region.

The project aimed to evaluate whether the existing land use planning policies in the Cataraqui Region were supportive of climate change adaptation. Students enrolled in the Environmental Services and Land Use and Real Estate concentrations completed an extensive review of existing literature and best practices, an analysis of existing planning documents, and provided recommendations for further adaptation policies. The skills, experience, and knowledge gained from this project enhance the students' education and prepare them for professional planning careers.

Project Team

Back row (left to right): Dr. John Meligrana (faculty supervisor), Spencer Skidmore, Daniel Kucharczuk, Jim Avram, Eric Joyal, Graham Rathwell, Matthew Marsili.
Front row (left to right): Rob McRae (project coach, Cataraqui Region Conservation Authority), Ryan Snowball, Megan Rueckwald, Andrew Carr, Amy Shanks, Ashley Taylor.

Executive Summary

Overview

Changes in the global climate have become increasingly evident in recent decades. While scientific and media rhetoric have demonstrated the anticipated effects of climate change on a global scale, local impacts are less understood and often overlooked. However, the past few years have shown warmer, wetter, and more variable weather at a local scale. As such, municipal policy and decision-makers may lack the necessary knowledge or tools to effectively manage climate change.

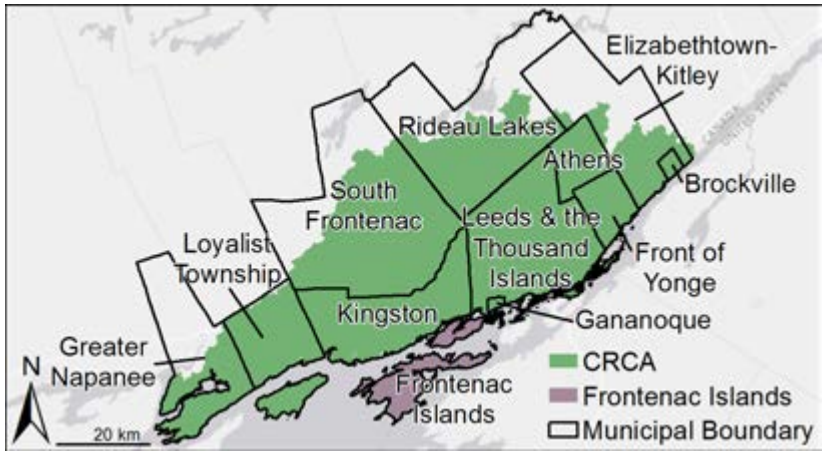
In the 2015 fall academic term, the Cataraqui Region Conservation Authority (CRCA) engaged a student project team from the Queen's University School of Urban and Regional Planning to contribute research towards the development of their climate change adaptation strategy. This research seeks to answer the following research question:

Are the current land use policies in the Cataraqui Region supportive of climate change adaptation?

Historically, much of the global discourse has revolved around mitigation strategies; those focused on reducing greenhouse gas (GHG) emissions. However, with mitigation alone the impacts of climate change are unavoidable. Mitigation strategies should be implemented in tandem with adaptation strategies, wherein adjustments are made to natural or human systems to moderate harm. One method for climate change adaptation is effective land use planning. Municipalities in the Cataraqui Region can minimize the negative effects of climate change by regulating the form and function of land and the built environment.

The Cataraqui Region

The Cataraqui Region extends over approximately 3,500 square kilometres of land in southeastern Ontario (see below). Its boundaries are defined by watersheds under the jurisdiction of the CRCA. The Region consists of fifteen distinct municipalities, including three counties, eight townships, and three separated municipalities. The Township of Frontenac Islands is not formally included within CRCA boundaries, but works with the conservation authority on matters of shared interest.



Map showing the extents of the Cataraqui Region, one of 36 Conservation Authorities in Ontario.

Methodology

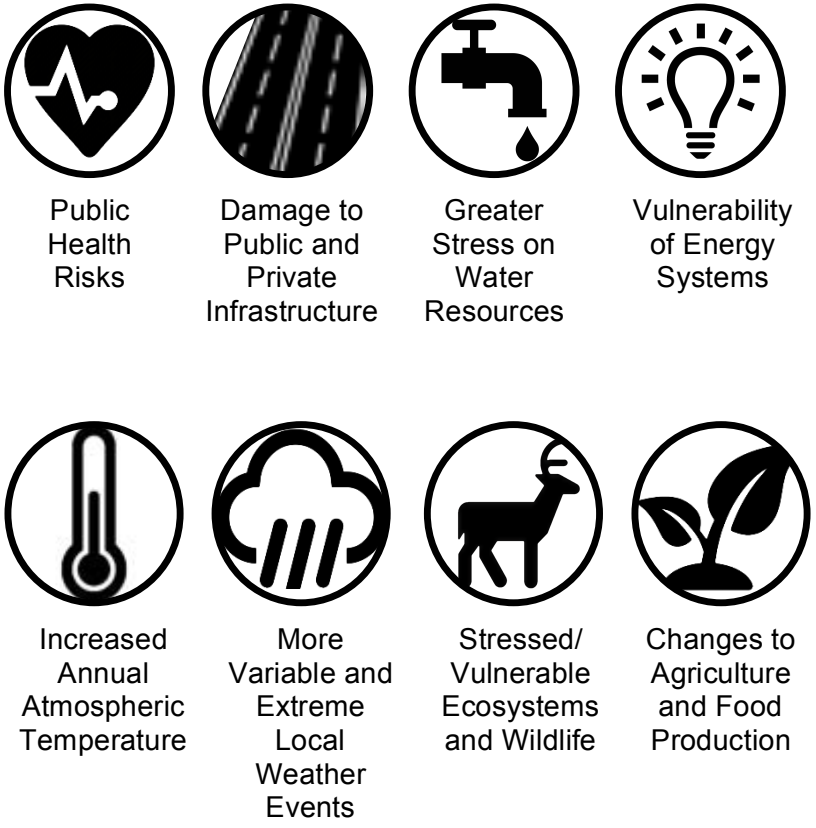
The project was completed in four stages:

- Background research;
- Official Plan review;
- Review of common and innovative land use solutions; and
- Development of model land use policies.

Initial background research was conducted to establish the broad global impacts of climate change. Further research revealed the anticipated local impacts of climate change for the Cataraqui Region.

From this research, eight major impact themes were identified (shown on the right). Using these themes, a detailed review of ten of the Region's fifteen municipal official plans was conducted to determine their level of support for climate change adaptation.

A review of academic and grey literature was then completed to compile common and innovative land use solutions from around the world. After selecting those most applicable to the Cataraqui Region, these solutions were translated into an extensive list of model land use policies.



Eight major anticipated impact themes for the Cataraqui Region.

Policy Context

Both the Canadian federal and Ontario provincial governments advocate for climate change adaptation and mitigation. In Ontario, however, the provincial government has constitutional authority over municipal governments and local planning matters.

The 2014 *Provincial Policy Statement,* issued under the *Ontario Planning Act,* contains a series of broad policy directives that ensure climate change is a priority in land use planning decision-making. The Ontario *Planning Act* includes a number of planning tools that can be used by municipalities to implement specific adaptation measures. Some of these tools include official plans, Community Improvement Plans, zoning by-laws, and site plan control. The provincial government also recently passed the *Great Lakes Protection Act*. It focuses on ensuring that communities in the Great Lakes/St. Lawrence River watershed are prepared for the effects of climate change around these large bodies of water. It also encourages action throughout the Great Lakes – St. Lawrence River Basin with respect to environmental protection and stewardship.

When creating or updating official plans, municipalities must abide by the overarching policy directives in these acts.

Official Plan Review

Ten of the fifteen municipal official plans in the Cataraqui Region were reviewed to determine their level of support for climate change adaptation. Policies with both direct and indirect climate change-related objectives were reviewed and summarized. While some plans have dedicated climate change sections, most plans do not. Generally, existing official plans in the Region fail to consider or account for the anticipated impacts of climate change.

Cataraqui Region Official Plans reviewed for this report (shown in black).

Separated Municipality	
City of Kingston City of Brockville Town of Gananoque	
County	**Township**
County of Frontenac	Township of South Frontenac Township of Frontenac Islands
County of Lennox and Addington	Town of Greater Napanee Loyalist Township
United Counties of Leeds and Grenville	Township of Athens Township of Elizabethtown-Kitley Township of Front of Yonge Township of Leeds and the Thousand Islands Township of Rideau Lakes

Land Use Solutions

An extensive review of both academic and grey literature was completed to inform the recommendations for official plan policy improvement. This research identified common and innovative land use planning solutions for climate change adaptation from elsewhere in Canada and in other parts of the world. Multiple solutions were identified for each of the eight major anticipated climate change impact themes.

Green roof in Waterloo, ON

Bioswale project in Kingston, ON

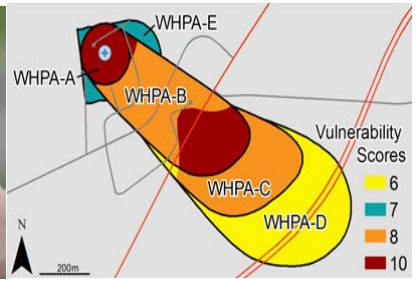
Notable Land Use Solutions

- Urban greening
- Green roofs
- Bioswales
- Riprapping
- Firebreaks
- Conservation easements
- Land Trusts
- Compact growth
- Speciality crop designation
- Mixed-use development
- Resilient materials
- Community solar gardens
- Alternative Land Use Systems
- Land use regulation around Wellhead Protection Areas

Riprapping in St. Clair Region, ON

Road used as firebreak in B.C.

Ontario wine grapes



Cana WHPA in Kingston, ON

Recommendations

Feasible land use solutions for the Cataraqui Region were identified and translated into model official plan policies. These policies were grouped into new themes to better reflect common official plan objectives. Policy recommendations are intended to show local municipalities how existing land use planning policies may be modified to better support climate change adaptation.

Policies fall under themes of: rural agriculture, urban agriculture, water conservation, energy management, natural hazards, air quality and urban heat island effect, infrastructure, stormwater management, winter preparedness, active transportation, and natural heritage.

Notable Model Policies

Rural Agriculture: Identify the need for, and incorporate a Unique Agricultural Area designation, in order to maximize opportunities for specialty crop production.

Urban Agriculture: Encourage and promote opportunities for urban agriculture such as green roofs and home/community gardens through the development application process.

Water Resources: Incorporate special land use zones to protect and preserve groundwater recharge areas.

Energy Management: Incentivize, through the use of Community Improvement Plans, that any new construction, retrofitting or redevelopment within [*The Municipality*] meets LEED, BOMA BEST or other industry standard of efficiency in capital projects.

Natural Hazards: [*The Municipality*] will undertake periodic studies to refine natural hazard areas that reflect the impending impacts of climate change.

Air Quality and the Urban Heat Island Effect: Through incentives, demonstration projects, height and density bonusing, and educational programs [*The Municipality*] shall promote tree planting and innovative green spaces, such as green roofs and green walls, with the goal of reducing air temperature and energy use through shading and sheltering.

Infrastructure: Where feasible and reasonable, seek opportunities to coordinate efforts to bury existing utilities and require underground installation of utilities in new developments.

Stormwater Management: Promote the use of Low Impact Development when reviewing design standards that reduce stormwater runoff such as permeable surfaces, green roofs, and native landscaping.

Winter Preparedness and Safety: Ensure adequate space to store increased volumes of snow is provided during the development application process. [*The Municipality*] shall encourage these spaces to be designed using permeable surfaces to minimize snowmelt runoff.

Active Transportation: Prioritize sustainable transport, by providing required infrastructure, regulations, safety measures and funding to take advantage of more favourable climate conditions.

Natural Heritage: [*The Municipality*] shall consider the establishment of a permissive By-law that permits the naturalization of yards on private residential and institutional properties.

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List of Acronyms

ALUS – Alternative Land Use Services

ANSI – Area(s) of Natural and Scientific Interest

BOMA BEST – Building Owners and Managers Association of Canada Building Environmental Standards

CIP – Community Improvement Plan

CMA – Census Metropolitan Area

CRCA – Cataraqui Region Conservation Authority

EIS – Environmental Impact Study

EPCCA – Expert Panel on Climate Change Adaptation

EWS – Emergency Warning System

GHG – Greenhouse Gas(es)

IPZ – Intake Protection Zone

IPCC – Intergovernmental Panel on Climate Change

LEED – Leadership in Energy and Environmental Design

LID – Low Impact Development

MDS – Minimum Distance Separation

MMAH – Ministry of Municipal Affairs & Housing

MOECC – Ministry of the Environment & Climate Change

NASA – National Aeronautics and Space Administration

OCCIAR – Ontario Centre for Climate Impacts and Adaptation Resources

OMAFRA – Ontario Ministry of Agriculture, Food and Rural Affairs

OP – Official Plan

PPS – Provincial Policy Statement

SURP – School of Urban and Regional Planning

UNESCO – United Nations Educational, Scientific, and Cultural Organization

WHPA – Wellhead Protection Area

CHAPTER 1: INTRODUCTION

Image courtesy of Caleb Sylvester, 2009

CHAPTER 1: INTRODUCTION

1 Introduction

The Cataraqui Region Conservation Authority (CRCA) has engaged a student project team from the Queen's University School of Urban and Regional Planning to contribute research towards the development of their climate change adaptation and mitigation strategy. Mandated by the *Provincial Policy Statement* (PPS), climate change adaptation strategies are becoming increasingly important to the long-term vitality of communities in the CRCA. While scientific and media rhetoric demonstrate the expected effects of climate change on a global scale, local impacts are less understood and often overlooked. As such, the objective of the SURP-825 project course is to answer the following research question:

Are the current land use planning policies in the Cataraqui Region supportive of climate change adaptation?

1.1 Objectives

The objectives of this report are to:

- evaluate whether existing land use planning policies in the Cataraqui Region are supportive of climate change adaptation;
- identify successful land use solutions for climate change adaptation; and
- provide recommendations that will help inform municipal land use policy change for climate change adaptation in the Cataraqui Region.

1.2 Context

The Cataraqui Region extends over 3,500 square kilometres of land in southeastern Ontario, stretching from Greater Napanee to Brockville (see Figure 1.1.1). While not formally included in CRCA jurisdiction, the Township of Frontenac Islands is also considered in the study area of this report; the Township collaborates with the CRCA on matters of shared interest. Approximately 210,000 people live in the Region, spread across three counties, eight townships (excluding the Township of Frontenac Islands), and three separated municipalities. Most of the population resides in urban areas; the City of Kingston is the largest with a 2011 Census Metropolitan Area (CMA) population of approximately 160,000. The majority of the land area is rural, strewn with lakes, rivers, and farmland. There are a total of 12 watersheds in the Region, which define the boundaries of the CRCA; the largest are the Cataraqui and Gananoque Rivers.

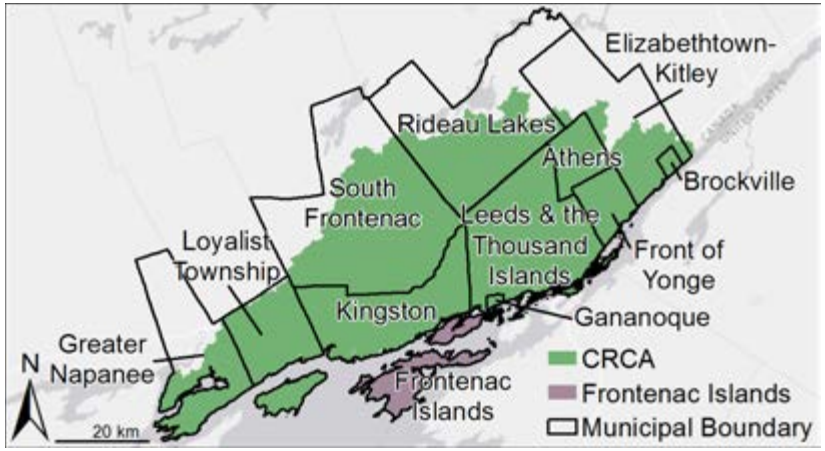

Figure 1.1.1: Map showing the extent of the Cataraqui Region.

The CRCA is corporate body under the *Conservation Authorities Act of Ontario* that facilitates environmental management, protection, and conservation efforts in the Cataraqui Region. Working with local stakeholders, the CRCA:

> "…implements an integrated systems approach to watershed management, balancing human, environmental and economic needs and recognizing the relationship between ecosystem functions and human activities" (CRCA, 2015).

1.3 Project Scope

The focus of this project is on using municipal land use planning tools for climate change adaptation. The Intergovernmental Panel on Climate Change (IPCC) defines adaptation as:

> "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC, 2014).

Adaptation strategies are divided into two categories, both of which are relevant to climate change and land use planning in the Cataraqui Region. *Proactive* adaptation takes place before the impacts of climate change are observed. *Planned* adaptation is awareness of the issue and planned or deliberate policy changes used to return to, maintain, or achieve a desired state (IPCC, 2014).

Adaptation is necessary due to the inertia of climatic systems and the current state of the environment. It is important to distinguish between adaptation, the focus of this report, and mitigation. Mitigation is defined as:

> "An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks" (IPCC, 2014).

Historically, much of the global discourse has revolved around mitigation strategies, those focused on reducing greenhouse gas (GHG) emissions. However, with mitigation alone the impacts of climate change are unavoidable. Mitigation and adaptation strategies are complementary, and addressing them jointly provides the best opportunity to manage climate change. Adaptation strategies should be incorporated into municipal policy documents and work in tandem with mitigation strategies.

The purpose of this report is to evaluate whether existing land use planning policies in the Cataraqui Region are supportive of climate change adaptation. While mitigation strategies are equally important, they are not the focus of this report.

This report was produced for use primarily by the CRCA. It is intended both as an educational and research document that can be used by the CRCA to help inform municipal policy change.

1.4 Sufficiency of Approach

Land use planning at the municipal level is a powerful tool for adapting to climate change. Land use planning is defined as the process of protecting and improving the living, production, and recreation environments in a community through the proper use and development of land. Adaptation can be achieved through land use planning by regulating and arranging the structure and function of the land to ensure its preparedness for anticipated climate change impacts. This section discusses the 'no regrets' approach to land use planning and it helps to place land use planning in the greater context of the holistic approach needed to adapt.

1.4.1 'No Regrets' Approach

There is some uncertainty regarding the impacts of climate change and the severity of those impacts. There is also considerable uncertainty regarding whether or not the adaptive policies are a sufficient response to prepare communities for climate change. However, even though there remains a substantial amount of uncertainty on the level of future human vulnerability to climate change, it is useful to adopt a 'no regrets' approach.

The 'no regrets' approach is defined as an approach to climate change that implements adaptation policies that generate social, environmental, and economic benefits under all future scenarios of climate change and impacts (Heltberg, Siegel, & Jorgensen, 2009).

When applying the 'no regrets' approach it is apparent that adaptive policies generate social, environmental, and economic benefit under all anticipated outcomes and impacts of climate change in the Cataraqui Region. Further, even with climate uncertainty, the adaptation recommendations will indirectly benefit many facets of the communities they are implemented within.

It is important to note how climate change adaptation policies may contribute to furthering complementary policy objectives. Specifically, many adaptive land use planning policies are also best practices for the conservation and preservation of the natural environment and represent sound environmental policy. For example, many of the recommended land use planning adaptation policies regarding water resources, natural heritage, agriculture, and energy are also considered strong land use practices for environmental planning policy.

1.4.2 Part of a Holistic Approach

In order to sufficiently prepare a community for climate change it is important to consider methods beyond land use planning; land use planning is simply one step in the adaptation process

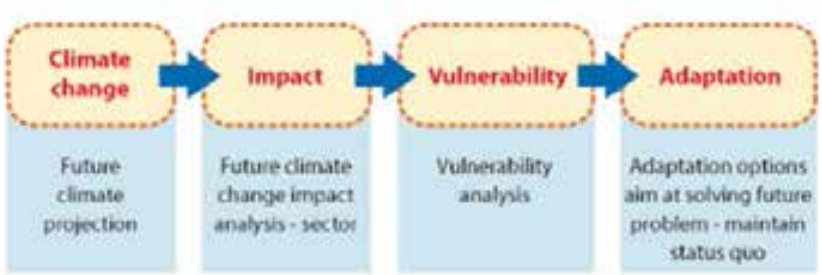

Figure 1.1.2: Climate change adaptation model (Chinvanno, 2013).

and has limitations under the *Planning Act* (Figure 1.3). Therefore, land use planning must be used in conjunction with other approaches to best prepare communities for the anticipated impacts of climate change.

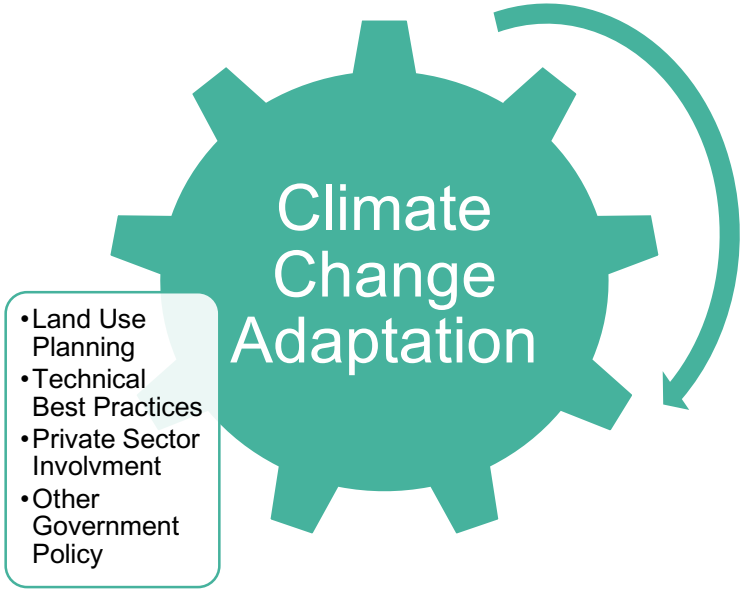

Figure 1.3: Land use planning as one of many techniques to achieve climate change adaptation.

This holistic approach involves efforts from all levels of government in the creation of adaptive policy and supportive actions by private and public services. Beyond policy, the development and implementation of new technologies and sustainable practices, additional research on localized impacts, and cooperation between various sectors, must all be included in order to create communities that can adapt. All of these approaches must be implemented in order to achieve the most sufficient result of climate change adaptation.

1.5 Resiliency to Climate Change

Resilient municipalities are better able to withstand, respond to, and adapt to chronic stresses and acute shocks (100 Resilient Cities, 2015), including those that are anticipated to occur due to climate change. Ensuring that municipalities are resilient to climate change is imperative as the stresses that result from climate change can weaken the urban and rural fabric of municipalities. The Rockefeller Foundation defines resilience as:

> "[…] the capacity of individuals, communities and systems to survive, adapt and grow in the face of stress and shocks, and even transform when conditions require it. Building resilience is about making people, communities and systems better prepared to withstand catastrophic events – both natural and manmade – and able to bounce back more quickly and emerge stronger from these shocks and stresses" (The Rockerfeller Foundation, 2015).

For the same reasons, identifying the vulnerabilities of a municipality to climate change and subsequently ensuring that these vulnerabilities are lessened is critical in developing and sustaining resilient municipalities. In the Kingston Climate Action Plan vulnerability is defined as:

> "[…] the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. It is a function of the character, magnitude and rate of climate change and to which a system is exposed, its sensitivity and its adaptive capacity" (City of Kingston, 2014).

Municipal governments play a fundamental role in creating communities that are resilient to climate change. This responsibility is founded in social, environmental, and economic concerns. For example, the social, environmental, and economic cost of municipal inaction on climate change resiliency and adaptation might be much greater than proactively planning and developing resilient communities from the outset (City of Toronto, 2014).

100 Resilient Cities (an organization pioneered by the Rockefeller Foundation) lists seven qualities of resilient cities, which allow them to withstand, respond, and adapt to stresses and shocks (100 Resilient Cities, 2015). Municipalities should be:

Reflective – they should use past experience to inform future decisions;

Resourceful – they should recognize alternative ways to use resources;

Robust – they should be well-conceived, constructed and managed systems;

Redundant – they should use spare capacity purposively to accommodate disruption;

Inclusive – they should prioritize broad consultation to create a sense of shared ownership in decision making;

Flexible – they should be willing and able to adopt alternative strategies in response to changing circumstances; and

Integrated – they should bring together a range of distinct systems and institutions (100 Resilient Cities, 2015).

Municipalities can achieve resiliency in the face of climate change by integrating these qualities into their local policies, procedures, and overall governance structure. They can further achieve this through land use and emergency planning, as well as through local codes, bylaws, and standards (City of Toronto, 2014). In fact, preventing the anticipated impacts of climate change can be

> "[…] greatly enhanced through better and smarter land-use planning and building codes so that [municipalities] keep their ecological footprint to the minimum, and ensure their residents… are protected as best as possible against disaster" (Otto-Zimmermann, 2011).

Although better and smarter codes must be developed and mandated through senior governments, municipal governments are

> "[…] [the best unit of government] to implement informed decisions in areas such as land use planning, building standards, freshwater supply, wastewater and waste management [and] transportation" (Otto-Zimmermann, 2011).

Examples of land use planning solutions include investing in critical infrastructure, updating building regulations and land use planning policies to reflect climate adaptation strategies, planning for vulnerable populations, and protecting and restoring natural systems. The City of Kingston, in its *Climate Action Plan* speaks to both mitigating and adapting to climate change. The vision for the Plan is provided below.

> "Kingston is capable of producing all of the energy that residents and industry consume, and is responsible for offsetting all GHG emissions created by the community. Kingston has clean, fresh, and breathable

> air because the community has minimized emissions harmful to the health of the community, the environment, or the atmosphere. Kingston is a resilient community and is able to mitigate the risks and benefits from the opportunities presented by a changing climate" (City of Kingston, 2014).

The goal of the climate resiliency section of the *Plan* is "to be resilient to climate change" (City of Kingston, 2014). The objectives to meet this goal are listed as:

- understanding the potential changes to our climate and the resultant risks and opportunities;
- minimizing the impact of risks to benefit from the opportunities of a changing climate; and
- weather-proofing public infrastructure and public systems.

Although the Kingston Climate Action Plan is, by nature, focused on climate change, the recommendations proposed in the Plan represent 'no regrets' recommendations. As such, if implemented, they will create healthier and more liveable communities even if the local impacts are not as severe as anticipated by the best available climate change models. Further, integrating the seven qualities of resilient cities into the planning documents and processes of any municipality will help the municipality not only adapt to climate change but to other stresses and shocks; these include chronic stresses such as high unemployment, inefficient public transportation systems, endemic violence, chronic food and water shortages, and acute shocks such as earthquakes, floods, disease outbreaks, and terrorist attacks (100 Resilient Cities, 2015).

To conclude, the best available scientific information indicates that the climate will change in the future, even if human causes of climate change, such as greenhouse gases, are mitigated. As such, it is imperative that municipalities adapt to the locally anticipated impacts of climate change in order to protect their social, environmental, and economic resources. Municipalities should strive to be resilient whether or not there is political and societal recognition of climate change, as municipal resiliency achieves much more than climate change adaptation.

1.6 Report Overview

This report consists of eight chapters. The opening chapter has provided an introduction to the report, including the project objectives, scope, and context.

Chapter Two explains the concept of climate change, outlining the projected impacts both around the world and in the Cataraqui Region.

Chapter Three presents a comprehensive overview of land use planning policies and the imperative for climate change planning. Key legislation and policy documents are discussed, including the *Planning Act* and the *Provincial Policy Statement, 2014*. The chapter concludes with a discussion of land use planning tools that may be used by municipalities to guide climate change adaptation planning.

Chapter Four details the research methodology employed throughout the project. This includes methods for document review, research on land use solutions, and public engagement.

In Chapter Five, ten municipal official plans in the Cataraqui Region are reviewed: three separated municipalities, three counties, and four townships. Each plan is analyzed to determine the level of land use policy support for climate change adaptation. An in depth review of the policies, grouped

into eight distinct themes representing major effects of climate change, are presented in Appendix A.

Chapter Six presents land use solutions for climate change adaptation, including examples of both common and innovative practices from Canada and abroad. Using the same themes as introduced in Chapter Four, these solutions are evaluated according to their feasibility in the Cataraqui Region.

Using the research from the previous chapter, Chapter Seven outlines recommendations for the improvement of municipal official plans in the Cataraqui Region. These specific recommendations will bolster municipal policy to better prepare the Cataraqui Region for climate change.

To conclude the report, Chapter Eight revisits the research question and objectives. Key limitations and future research directions are also discussed.

Appendix A contains an in depth review of the Official Plans reviewed in Chapter 5.

Appendix B provides details about a successful public event, held at Portsmouth Olympic Harbour in Kingston, Ontario with the CRCA on November 4, 2015.

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CHAPTER 2: IMPACTS OF CLIMATE CHANGE

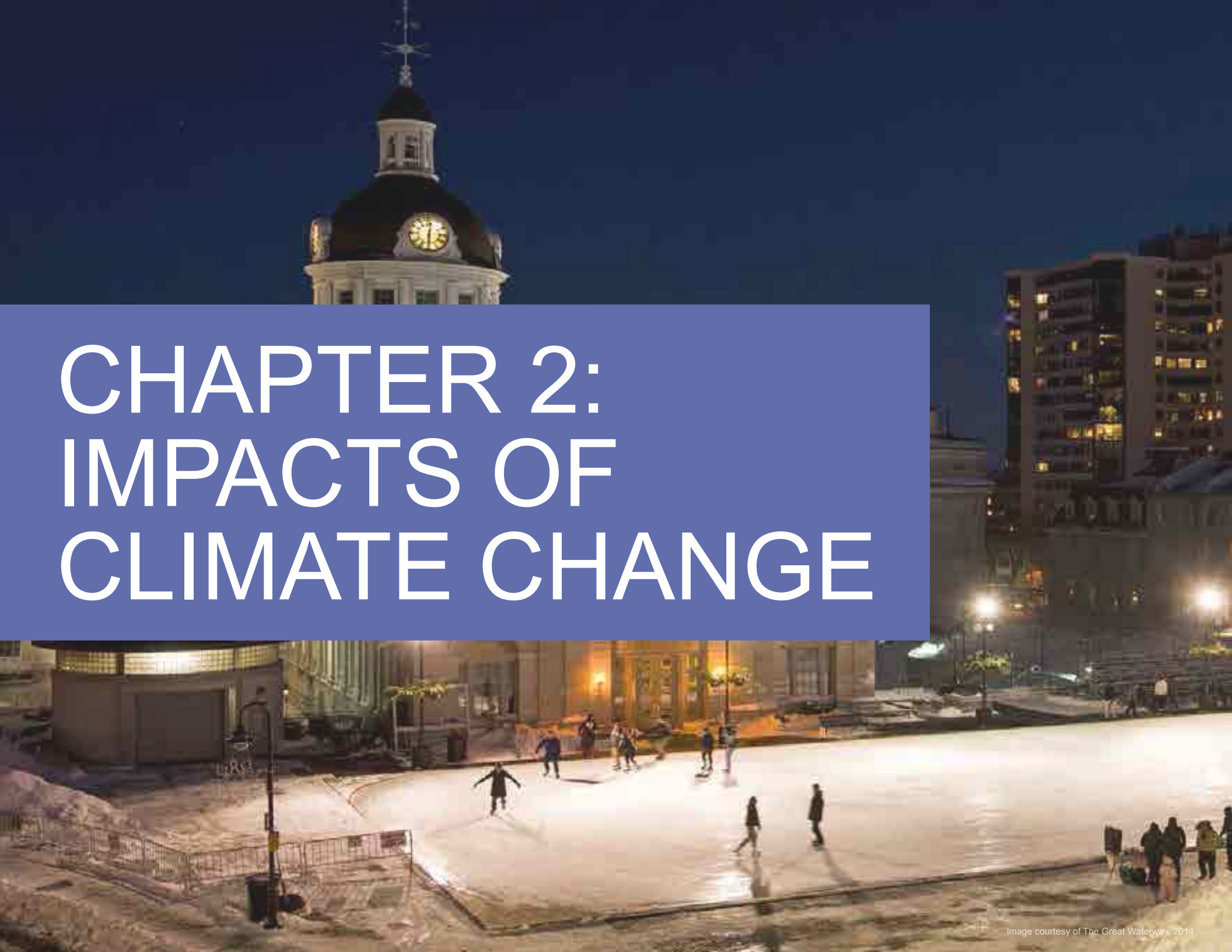

Image courtesy of The Great Waterway, 2014

CHAPTER 2: IMPACTS OF CLIMATE CHANGE

2 Impacts of Climate Change

Climate change is an issue that has gained attention recently due to its widespread effects and the risks it poses to humanity. The effects of climate change are both global and local in nature. To effectively prepare for climate change, governing bodies at all administrative levels need foremost to understand the projected changes associated with climate change. The following section provides an overview of the forces behind climate change, global climate trends and projections, and anticipated impacts in the Cataraqui Region. Climate change is a vast and complex issue, thus an exhaustive analysis was impractical and unnecessary for the purpose of this report. Rather, this section is intended to provide a sufficient overview of the most pertinent climate trends and projected impacts.

2.1 Climate Change

The United States' National Aeronautics and Space Administration (NASA) defines climate change as an observed change in the typical patterns of the Earth's overall climate (NASA, 2015). Natural variations in the Earth's climate take place over long periods of time – tens, hundreds, thousands of years – and may involve gradual shifts in climate such as observed warming or cooling periods (NASA, 2015). However, recent human influence on climate systems has resulted in unequivocal rapid change in the form of atmospheric warming (IPCC, 2014). These observed changes are unprecedented and are the focus of climate change in this report.

In each of the last three decades, the Earth's surface has been successively warmer than any preceding decade since 1850 (IPCC, 2014). Anthropogenic emissions of greenhouse gasses are the highest in history and have increased at unparalleled rates since the Industrial Revolution. The IPCC states that it is *extremely likely* that this increase in anthropogenic emissions is responsible for the observed climate warming (IPCC, 2014). Anthropogenic emissions are primarily from the daily burning of fossil fuels, such as coal and oil, which release greenhouse gasses into the atmosphere (NASA, 2015). This accumulation of greenhouse gasses is warming the Earth's climate through the Greenhouse Effect.

The Greenhouse Effect is a naturally occurring phenomena that is responsible for maintaining the Earth's surface at a life-supporting temperature (NASA, 2015). Greenhouse gasses form a thermal layer around the Earth that acts like a blanket. Sunlight passes through Earth's atmosphere to warm the surface of the planet and is subsequently radiated back to space. Most of this radiated heat is trapped by greenhouse gas molecules, further warming the planet. This process is shown in Figure 2.1.

The burning of fossil fuels increases the amount of primary greenhouse gasses emitted into the atmosphere, creating a denser thermal layer. These molecules re-emit a larger release of primary greenhouse gasses since the pre-industrial era has

resulted in the highest concentrations measured in the last 800,000 years, shown in Figure 2.2 (IPCC, 2014).

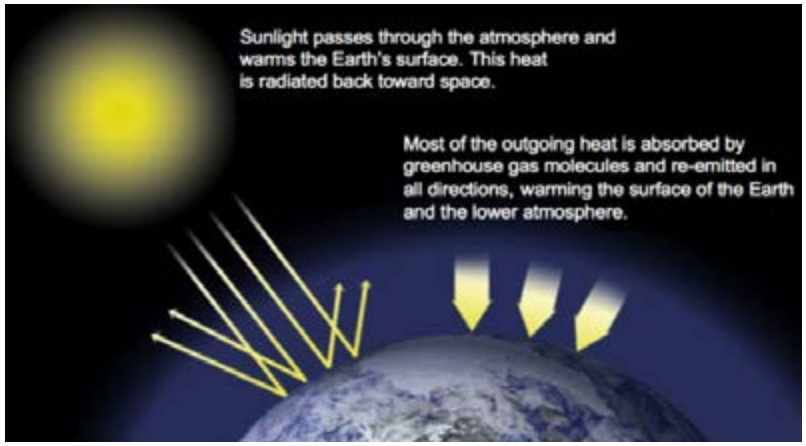

Figure 2.1: Illustration of the greenhouse effect (NASA, 2015).

2.2 Global Climate Projections

Since the 1950s, changes in the frequency of extreme weather and climate events have been observed. The IPCC states that it is *very likely* that human influence has contributed to the observed changes in climate on a global scale (IPCC, 2014). Projected changes in the climate system from the cumulative effects of greenhouse gasses include:

- increased surface air temperature;
- increased frequency and intensity of extreme precipitation events; and,
- acidification of oceans.

Changes in precipitation and surface pattern temperatures will not be uniform across the globe. Relative to 1850-1900, the global surface temperature is projected to rise by 1.5°C by the end of the 21st Century (2081-2100) (IPCC, 2014). Projected

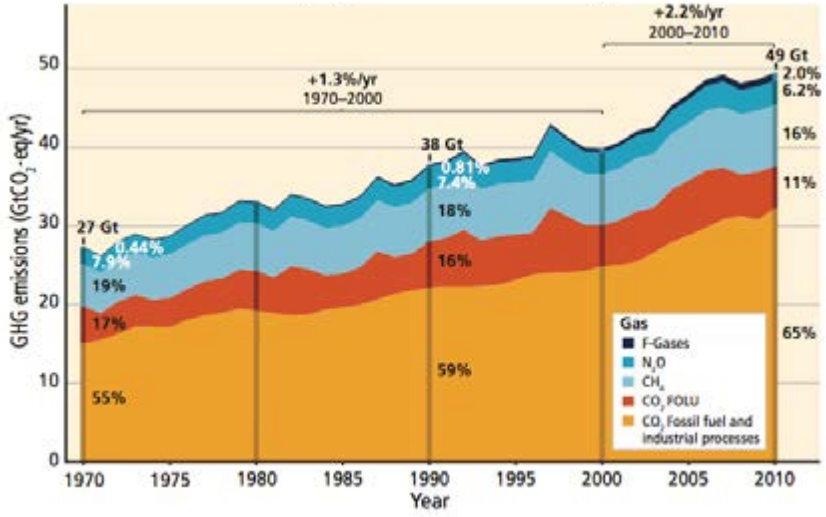

Figure 2.2: Total annual anthropogenic greenhouse gas emissions in gigatonnes of CO_2-equivalent per year (GtCO2-eq/yr) from 1970 to 2010. Gasses shown include: fluorinated gases (F-gases), nitrous oxide (N_2O), methane (CH_4), carbon dioxide from forestry and land uses (CO_2 FOLU), and carbon dioxide from fossil fuels and industrial processes (CO_2 fossil fuel and industrial processes) (IPCC, 2014).

changes in surface air temperature are expected to be amplified in northern regions; arctic air temperatures are projected to rise by 4-7°C by the end of this century (Arctic Climate Impact Assessment, 2004). Many mid-latitude and subtropical dry regions are expected to see a decrease in precipitation, whereas an increase in precipitation is expected for mid-latitude wet regions. The global ocean systems are expected to warm as well, with the strongest surface warming projected for the tropical and Northern Hemisphere subtropical regions (IPCC, 2014). A global increase in ocean acidification is also expected.

The projected changes in average surface temperature and average precipitation are illustrated in Figure 2.3.

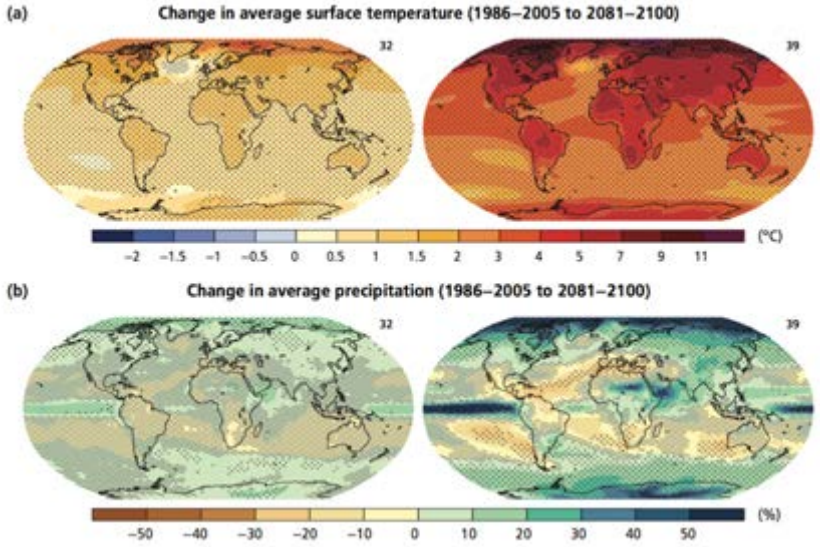

Figure 2.3: Change in the average surface temperature (a) and average precipitation patterns (b) based on predictions for 2081-2100 relative to 1986-2005 conditions (IPCC, 2014).

2.3 Future Risks and Impacts

Predicted global climate change impacts include rising sea level, decrease in snow and ice cover, increasingly frequent and more severe extreme weather events, and changes in precipitation patterns. Climate-related extremes, such as droughts, wildfires, and cyclones have also increased on a global and local scale (IPCC, 2014). Continued anthropogenic greenhouse gas emissions will further warm the planet, resulting in irreversible impacts for natural and human systems.

In recent decades, climate-related changes to natural and human systems have been observed worldwide. The IPCC categorizes observed impacts attributable to climate change into physical, biological, and human and man-made systems. Contributions to climate change on a global scale include melting glaciers and permafrost, coastal erosion, sea level rise, changes in terrestrial and marine ecosystems, food production and livelihood, health, and economic systems (IPCC, 2014).

2.4 Climate Change in the Cataraqui Region

In 2009, the Ontario Ministry of the Environment and Climate Change (MOECC) produced *Adapting to Climate Change in Ontario* (EPCCA, 2009). The projections for Ontario show that, relative to 1961-1990 levels, surface air temperatures are expected to increase 2.5-3.7°C by 2050. Using moderate assumptions about future volumes of greenhouse gas emissions, the projected annual average temperature increase for the Cataraqui Region is 2.7°C by 2050. Winter annual air temperatures are predicted to rise by 3.1°C, while summer annual average temperatures will only rise by 2.5°C. Annual average precipitation for the Cataraqui Region by 2050 is expected to increase 5.84%. A larger increase of 11.04% is expected over the winter months, whereas 1.6% is projected for the summer months.

In 2014, the City of Kingston released *Kingston's Climate Action Plan*. From this model it is projected that Kingston's local weather will get warmer, wetter, and have more extremes (City of Kingston, 2014). All current values are derived from average temperatures from 1981-2010. The current average year-round temperature for Kingston is 7.8°C and is projected to rise to 11.1±0.7°C by 2050 (City of Kingston, 2014). Average temperature increases are expected across all seasons. The cold minimum is projected to increase from -34.0 to -29.7°C by 2050, while the extreme heat maximum is projected to increase from 35.0 to 38.5°C. Total annual

precipitation in Kingston is projected to increase from 951mm currently to 1024±39mm. This is attributed to increases in precipitation during the fall, winter, and spring seasons. Total precipitation over the summer is not projected to change. It is important to recognize that short-duration events such as heat waves and intense precipitation events are expected to increase in frequency and severity as well. For instance, short-duration precipitation events may account for greater levels of precipitation, but more concentrated events may create longer periods of drought interspersed with severe weather.

Together, *Adapting to Climate Change in Ontario* and *Kingston's Climate Action Plan* provide detailed projections for what climate change might look like in the Cataraqui Region.

2.5 Impacts of Climate Change in the Cataraqui Region

Municipalities are vulnerable to climate change; it is expected to adversely impact the natural, social, and built environments of municipalities across the globe (Lindley, Handley, Theuray, Peet, & Mcevoy, 2006). Anticipated impacts of climate change in the Cataraqui Region were derived from an understanding of the projected climate changes in the Region. Eight of the most prominent impacts and their associated direct effects are shown in Table 2.1, beginning on the following page. A comprehensive literature review revealed that these impacts will have the largest influence in the Region and the adverse effects can be addressed through land use planning solutions. In Chapter Five, the eight identified impact areas frame the research for the proposed land use solutions and form the basis for policy recommendations outlined in Chapter Seven.

Table 2.1: Anticipated impacts of climate change and their corresponding direct effects in the Cataraqui Region.

Anticipated Impact	Direct Effects
 Atmospheric Temperature	• Increased summer atmospheric temperature (+2.5°C) (EPCCA, 2009) • Increased winter atmospheric temperature (+3.1°C) (EPCCA, 2009) • Increased average annual temperature (currently 7.8°C, 11.1 ± 0.7°C by 2050) (City of Kingston, 2014) • Exacerbation of the urban heat island effect
 Extreme Weather Events	• Increased risk of flooding • Increased risk of erosion • Increased risk of wildfires • Increased risk of heat waves • Increased risk of tornadoes • Dynamic beach hazards • Migration of 100-year flood lines (EPCCA, 2009) • Increased frequency and intensity of windstorms • Increased number of days with wind gusts >90 km/h (increase 15-20% by 2050) (City of Kingston, 2014) • Increased frequency and intensity of ice storms (50% increase in freezing rain events lasting 6 or more hours by 2050) (City of Kingston, 2014) • Increased number of average annual days with >25 mm precipitation (currently 4.6 days, 8.1 days by 2050) (City of Kingston, 2014)

Table continued on next page…

Anticipated Impact	Direct Effects
 Natural Heritage Features	• Loss of Areas of Natural and Scientific Interest • Loss of Wetlands (provincially significant and otherwise) • Loss of Woodlands (provincially significant and otherwise) • Loss of Valleylands (provincially significant and otherwise) • Valuable wildlife habitat loss • Fish habitat loss (specifically lake trout) • Increased potential for invasive species • Decrease in surface water levels • Migration of natural forests (300-500 km north) (EPCCA, 2009) • Loss of native species • Changes in biodiversity • Increased risk of endangered and vulnerable species loss • Shifts in species geographic distribution and range • Degradation of shoreline and riparian habitat • Loss of greenland to development
 Agriculture	• Prolonged growing season (203 days currently, 233 by 2050) (City of Kingston, 2014) • Changes in crop yields and harvesting patterns • Decreased soil moisture • Decreased soil quality • Food insecurity • Increased demand for urban agriculture • Increased demand for local food production and sale
 Public Health	• Decrease in availability of safely developable land • Decreased air quality • Increased opportunities for active transportation • Increased risk for weather-related safety concerns • Increased opportunity for vector borne diseases (West Nile, Lyme disease) • Disruption of recreational activities

Table continued on next page…

Anticipated Impact	Direct Effects
 Infrastructure	• More rapid deterioration of infrastructure • Greater vulnerability to extreme weather • Increased risk of flooding existing stormwater infrastructure • Greater requirements for efficient waste management • Greater concern for critical infrastructure placement • Increased demand for public transit • Increased stress on heritage buildings • Increased pressure to build in publically serviced areas • Longer season for construction and infrastructure maintenance
 Potable Water Resources	• Deterioration of source water quality (ground and surface water) • Groundwater depletion • Increased risk of eutrophication and acidification • Increased risk of single event contamination • Increased risk of contamination from agricultural activity (manure, phosphorus, pesticide use)
 Energy	• Increased vulnerability of energy systems • Increased reliance on green energy (wind, solar, nuclear) • Increased demand for energy efficiency

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CHAPTER 3: POLICY CONTEXT

Image courtesy of Sebernest 2006

CHAPTER 3: POLICY CONTEXT

3 Policy Context

Both the Canadian federal and Ontario provincial governments have recognized the threat climate change poses to local communities. They have put forth a variety of policies and programs targeted at helping communities mitigate and adapt to its anticipated impacts. Land use planning has been a significant focus of these efforts, given its ability to address how natural events influence the human environment, and vice versa.

3.1 Federal Policy

To date, most federal policy related to climate change has been focused on mitigation rather than adaptation. In 2002, the federal government ratified the *Kyoto Protocol*, and agreed to join 193 other countries in taking steps to reduce worldwide greenhouse gas emissions. Canada ended up withdrawing from the *Kyoto Protocol* in 2011, however the recently-elected federal Liberal government has signalled an interest in rejoining this international agreement. It therefore stands to reason that mitigation will become a more significant federal priority in the years to come.

In terms of adaptation, the federal government has primarily taken an advocacy role. They have stressed that municipalities need to carefully evaluate their existing policies and use the land use planning tools available to them to ensure negative situations related to climate change are avoided. They have also acted as knowledge translators, advising municipal governments of best practices of climate change adaptation found throughout the country, as seen in a 2012 federal report entitled *Land Use Planning Tools for Local Adaptation to Climate Change*.

It is too early to tell how the recent change in leadership will impact the federal government's interest in climate change adaptation. The Prime Minister has given both the Minister of Environment and Climate Change and the Minister of Infrastructure and Communities a mandate to work together to "protect […] communities from the challenges of climate change" (Office of the Prime Minister, 2015). What this will entail remains to be seen though. The federal government does not have direct legislative power over municipal planning, and therefore any actions that are taken will likely not directly relate to land use planning. However, there may be changes that indirectly influence land use planning decision-making.

3.2 Provincial Policy

Land use planning in Ontario is regulated through the *Planning Act*. Section 3(1) of this Act states that the Minister of Municipal Affairs and Housing may issue policy statements on matters relating to the provincial interest. Furthermore, Section 3(5) of the Act states that all municipal planning decisions in the province must "be consistent with" these policy statements. In other words, municipal planning decisions cannot contradict the goals and vision of the province.

The Ontario provincial government has used this policy framework to ensure climate change is a priority in land use planning decision-making. The most recent *Provincial Policy Statement* (PPS), published in 2014, makes several references to planning for climate change. These references are outlined in Table 3.1.

Although these policy directives are rather general in nature and do not contain any firm, numerical stipulations for municipalities to follow, they are still influential. If it is determined that a municipality has made a planning decision that is not consistent with what the province has set out, that planning decision can be overturned, or altered in a way that makes it consistent. The policies contained within the *PPS* are also influential when upper-tier (county) and single-tier (separated municipality) municipalities are formulating their official plans (OP). The Ministry of Municipal Affairs and Housing (MMAH) reviews these official plans to ensure they are consistent with the *PPS*.

The Ontario provincial government recently passed the *Great Lakes Protection Act* (Ontario, 2015b). One purpose of this Act is to ensure that communities within the Great Lakes – St. Lawrence River Basin are prepared for the impacts of climate change. Under Section 20(1) of this Act, the Minister of the Environment and Climate Change will have the legislative power to force:

> "[…] Any decision under the *Planning Act* or the *Condominium Act* made by a municipal council, municipal planning authority, planning board, other local board, minister of the Crown or ministry, board, commission or agency of the Government of Ontario, including the Ontario Municipal Board […]"

to conform with designated policies that are included in any initiative approved in relation to this Act (Ontario, 2015b). In other words, the *Great Lakes Protection Act* will prevail over municipal planning decisions made in certain areas where regional plans called "geographically-focused initiatives" have been put into effect.

On November 25, 2015, the Ontario provincial government announced their *Climate Change Strategy*. Section 5 of this strategy outlines the province's plans for fostering climate change adaptation efforts. While most of the text in this section is broadly-focused, and there is little in the way of actual targets or implementation plans, it signals that the province is serious about the directives they have laid out in both the *PPS* and the *Great Lakes Protection Act*. Climate change adaptation will only become an even higher provincial priority as time progresses. Municipalities will need to take the steps necessary to ensure they keep up with this precedence.

Figure 3.1: Ontario's Climate Change Strategy.

Table 3.1: Climate change related land use policy directives found in the 2014 Provincial Policy Statement (PPS).

PPS Section Number	Policy Text
1.1.1(h)	"Healthy, liveable and safe communities are sustained by […] promoting development and land use patterns that conserve biodiversity and consider the ***impacts of a changing climate***".
1.1.3.2(a)3	"land use patterns within settlement areas shall be based on […] densities and a mix of land uses which […] minimize ***negative impacts*** to air quality and ***climate change***, and promote energy efficiency".
1.7.1(j)	"Long term economic prosperity should be supported by […] minimizing negative ***impacts from a changing climate*** and considering the ecological benefits provided by nature".
1.8.1	"Planning authorities shall support energy conservation and efficiency, improved air quality, reduced greenhouse gas emissions, and ***climate change adaptation*** through land use and development patterns which: a) promote compact form and a structure of nodes and corridors; b) promote the use of active transportation and transit in and between residential, employment (including commercial and industrial) and institutional uses and other areas; c) focus major employment, commercial and other travel-intensive land uses on sites which are well served by transit where this exists or is to be developed, or designing these to facilitate the establishment of transit in the future; d) focus freight-intensive land uses to areas well served by major highways, airports, rail facilities and marine facilities; e) improve the mix of employment and housing uses to shorten commute journeys and decrease transportation congestion; f) promote design and orientation which: 1. maximizes energy efficiency and conservation, and considers the mitigating effects of vegetation; and 2. maximizes opportunities for the use of renewable energy systems and alternative energy systems; and g) maximize vegetation within settlement areas, where feasible".
3.1.3	"Planning authorities shall consider the potential ***impacts of climate change*** that may increase the risk associated with natural hazards".

3.3 Land Use Planning Tools in the *Planning Act*

The *Planning Act* contains several tools municipal governments can use to guide development within their communities. The province has stressed that municipalities should use these tools to ensure their communities are ready for climate change (MMAH, 2009). Each tool is briefly explained in the following section. This information will help inform climate change adaptation recommendations presented in Chapter 7.

3.3.1 Official Plan

Governed by Sections 16-27 of the *Planning Act*, an official plan is a document produced by either an upper tier (county), lower tier (township), or single tier (separated municipality) municipality which directs that municipality's planning framework. It contains broad goals and objectives pertaining to the physical environment the municipality wishes to achieve in the coming years. Additionally, the use of many of the planning tools discussed below is guided by an official plan. Official plans are required to be updated at least every five years.

3.3.2 Delineation and Protection of Settlement Area Boundaries

Settlement area boundaries indicate where urban land uses can be located within a municipality. They must be delineated within an official plan.

While many aspects of an official plan can be appealed to the Ontario Municipal Board (OMB), the refusal of a proposal to expand or establish a new settlement boundary is not one of these aspects. Under Sections 22 and 34 of the *Planning Act,* Council can either refuse or choose not to make a decision on such proposals and individuals are not permitted to appeal these actions to the OMB.

3.3.3 Complete Application Requirements

Within an official plan, municipalities can state the information, materials, or studies they require in order to assess applications for official plan amendments, zoning amendments, subdivisions, and consents. They cannot ask for anything additional to what is listed within their official plan.

3.3.4 Community Improvement Plans

Regulated by Section 28 of the *Planning Act,* a Community Improvement Plan (CIP) is a tool that allows a municipality to target an area or areas of a community for strategic development or redevelopment. Once an area is designated as a "Community Improvement Area" via the passage of a municipal by-law, municipalities are permitted to acquire, hold, clear, lease, and sell land in this designated area, as well as provide grant and loan incentives for landowners to undertake specific activities in these locales. Permitted activities under this provision include:

- environmental site assessment;
- environmental remediation;
- development, redevelopment, construction, and reconstruction of lands and buildings for either:
  a) rehabilitation purposes; or,
  b) for the provision of energy efficient uses, buildings, structures, works, improvements or facilities.

3.3.5 Zoning By-laws

Zoning by-laws allow municipalities to indicate permitted and prohibited uses, as well as detailed physical requirements for individual properties and/or structures within a designated area. Zoning by-laws are not permitted to prohibit certain groups of people or regulate building materials.

Zoning by-laws are the primary tool municipalities use to implement the policies and objectives contained within their official plan; as such, it is rare they conflict with this document. The passage of zoning by-laws is regulated by Section 34 of the *Planning Act.*

3.3.6 Height and Density Bonusing

Section 37 of the *Planning Act* permits municipal councils to authorize additional building height and density above what is allowed within the zoning by-law. This bonusing is in exchange for the delivery of specified facilities and/or services by a developer. The official plan must contain provisions for this exchange.

3.3.7 Site Plan Control

Governed by Section 41 of the *Planning Act,* site plan control allows a municipality to regulate certain external building, site, and boulevard design features. These features include the following:

- widenings of highways that abut on the land;
- facilities to provide access to and from the land such as access ramps, curbings, and traffic direction signs;
- off-street vehicular loading and parking facilities, either covered or uncovered; access driveways including driveways for emergency vehicles; and the surfacing of such areas and driveways;
- walkways and walkway ramps, including the surfacing thereof, and all other means of pedestrian access;
- facilities designed to have regard for accessibility for persons with disabilities;
- facilities for the lighting, including floodlighting, of the land or of any buildings or structures thereon;
- walls, fences, hedges, trees, shrubs, or other groundcover or facilities for the landscaping of the lands or the protection of adjoining lands;
- vaults, central storage and collection areas and other facilities, and enclosures for the storage of garbage and other waste material;
- easements conveyed to the municipality for the construction, maintenance, or improvement of watercourses, ditches, land drainage works, sanitary sewage facilities, and other public utilities of the municipality or local board thereof on the land;
- grading or alteration in elevation or contour of the land and provision for the disposal of storm, surface, and waste water from the land and from any buildings or structures thereon; and,
- the removal of snow from access ramps and driveways, parking and loading areas, and walkways.

Under site plan control, a municipality is prohibited from regulating features pertaining to a building's interior design, the layout of its interior areas (excluding interior walkways, stairs, elevators, and escalators), or the manner/standards of its construction. These features are regulated under the *Building Code Act,* and are under provincial purview. A more thorough discussion of the province's role in other aspects of municipal land use planning is included at the end of this section.

In order to utilize site plan control, a municipality must have a site plan control by-law in place that pertains to the development in question. It is also good practice to have guidelines and policies regarding site plan control within the municipality's official plan.

3.3.8 Parkland Dedication

Section 42 of the *Planning Act* stipulates that municipalities can pass by-laws requiring that a certain proportion of land be conveyed to the municipality for a park or other public recreational purpose. For industrial or commercial developments, the proportion of conveyed land cannot exceed 2%. In all other cases, the proportion of conveyed land cannot exceed 5%.

It is not always possible for land to be conveyed. In these instances, municipalities have the option to allow the developer to pay cash-in-lieu. They are also permitted to provide for a reduction in the cash-in-lieu requirements in exchange for some alternative arrangement. The specifics surrounding this alternative arrangement must be clearly identified in the official plan first.

3.3.9 Plan of Subdivision

Regulated by Section 51 of the *Planning Act,* a plan of subdivision is required anytime someone wishes to subdivide a parcel of land. When reviewing a plan of subdivision, municipalities are permitted to consider many aspects of the proposed subdivision to determine its suitability. These considerations include:

- the proposed subdivision's effect on matters of provincial interest;
- whether the proposed subdivision is premature or in the public interest;
- whether the plan conforms to the official plan and adjacent plans of subdivision, if any;
- the suitability of the land for the purposes for which it is to be subdivided;
- the number, width, location, and proposed grades and elevations of highways, and the adequacy of them, and the highways linking the highways in the proposed subdivision with the established highway system in the vicinity and the adequacy of them;
- the dimensions and shapes of the proposed lots;
- the restrictions or proposed restrictions, if any, on the land proposed to be subdivided or the buildings and structures proposed to be erected on it and the restrictions, if any, on adjoining land;
- conservation of natural resources and flood control;
- the adequacy of utilities and municipal services;
- the adequacy of school sites;

- the area of land, if any, within the proposed subdivision that, exclusive of highways, is to be conveyed or dedicated for public purposes;
- the extent to which the plan's design optimizes the available supply, means of supplying, efficient use, and conservation of energy; and,
- the interrelationship between the design of the proposed plan of subdivision and site plan control matters relating to any development on the land, if the land is also located within a designated site plan control area.

Municipalities are also permitted to impose conditions on the approval of a plan of subdivision, provided it is deemed that these are warranted.

3.3.10 Development Permit System

A development permit system is a streamlining tool that combines zoning, site plan control, and minor variance approvals regulated under Section 70.2 of the *Planning Act* and O. Reg. 608/06. A development permit system by-law describes discretionary uses that may be permitted automatically if criteria within the by-law are met. Development permit systems are still in their infancy in Ontario and are not widely utilized, however the Town of Gananoque (included in the study area) does currently have one in place. In addition to a mandatory by-law, municipalities must also have policies in their official plan pertaining to their use. Once the by-law and official plan policies are in place, development permit system approvals cannot be appealed to the OMB.

3.3.11 Provincial Regulations and Land Use Planning Tools

As outlined in the paragraphs above, municipalities are provided with many tools under the *Planning Act* to regulate land use. Although these abilities are extensive, they must not supersede provincial jurisdiction. Of particular note are the province's powers under the *Building Code Act*—municipalities cannot regulate anything to do with the construction methods of a proposed building, since these are entirely regulated by this Act.

Also of note are regulations surrounding stormwater and wastewater management. The *Ontario Water Resources Act* and the *Environmental Protection Act* give the Ministry of Environment and Climate Change the ability to set thresholds that new development must abide by to ensure wastewater and stormwater is managed correctly. Municipalities cannot force new development to supersede these thresholds; they can only merely encourage or support these efforts in their official plan.

3.4 Conclusion

As discussed in the paragraphs above, climate change adaptation is becoming more of a policy priority for both the Ontario provincial government, and to a slightly lesser extent, the Canadian federal government. Therefore, the objectives of this report are integral to the municipalities of the Cataraqui Region not just from a social, environmental, and economic perspective, but also from a political one. It may soon become legislated that these municipalities must use the various land use planning tools at their disposal to address the most pressing local anticipated impacts of climate change. It is the aim of this report to ensure these municipalities are prepared for this possibility.

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CHAPTER 4: METHODOLOGY

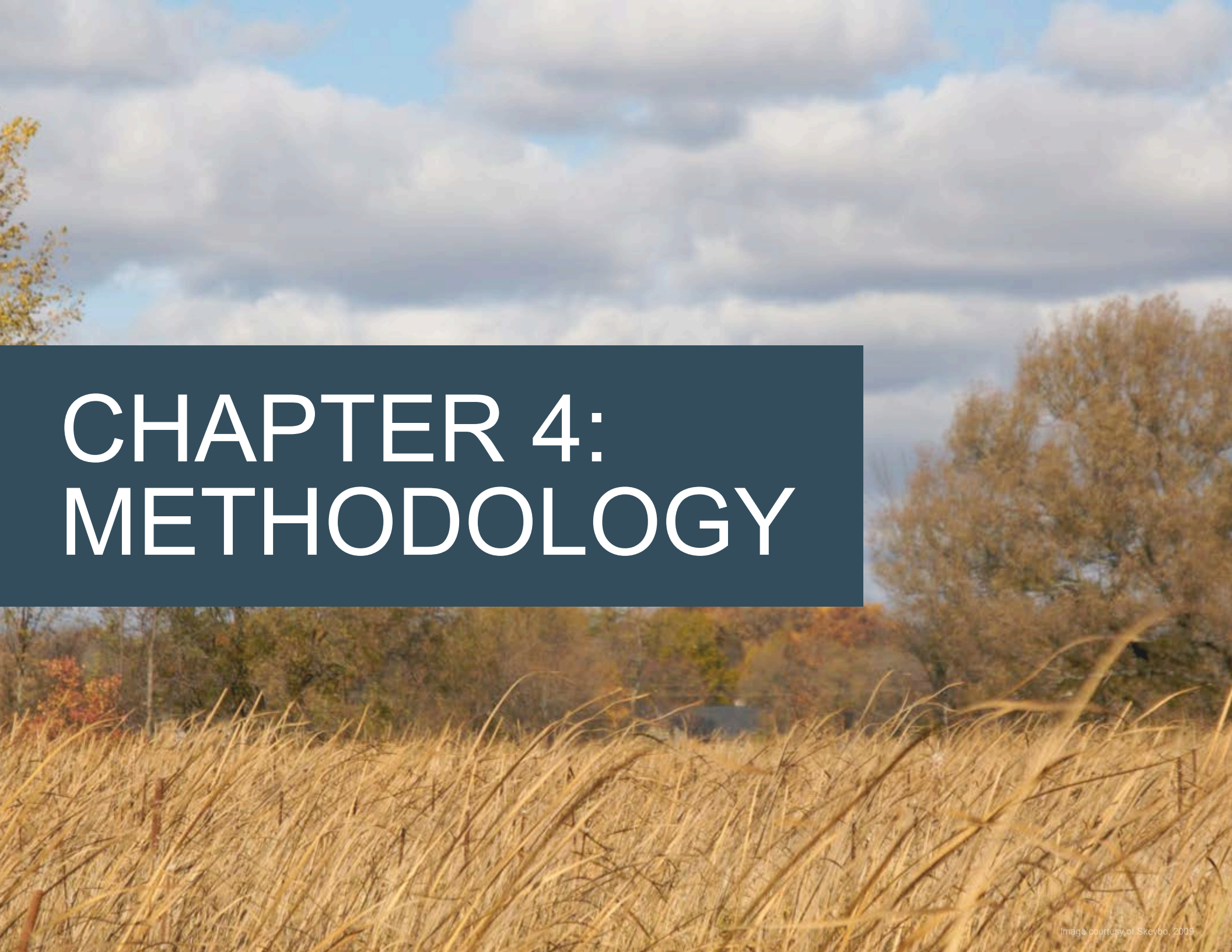

Image courtesy of Skevbo, 2009

CHAPTER 4: METHODOLOGY

4 Methodology

The information presented in this report was established in four major research stages. These were as follows:

Stage One: a review of the literature on climate change and projected impacts, in order to determine what the anticipated impacts of climate change will be in the Cataraqui Region.

Stage Two: a detailed document review of ten of the fifteen official plans in the study region, in order to assess each plan's preparedness for the anticipated impacts of climate change.

Stage Three: a review of the literature on using land use planning to adapt to climate change impacts, as well as the identification of regional, national, and international strategies for climate change adaptation.

Stage Four: the development of policies targeted at ensuring the municipalities of the Cataraqui Region are better prepared for the anticipated impacts of climate change in the Region.

Each of these four major research stages will be discussed in further detail in the sections below.

4.1 Determining Climate Change Impacts

In order to adequately assess the strength of adaptive climate change land use policy within the Cataraqui Region, regional climate change impacts needed to be fully understood. An extensive literature review was undertaken to determine what experts believe the impacts of climate change will be in the Cataraqui Region. Sources such as the Ontario EPCCA, and the City of Kingston's *Climate Action Plan* were consulted in this review. From this, eight major regional impacts of climate change were identified:

- increased annual atmospheric temperature;
- more variable and extreme local weather events;
- stressed/vulnerable ecosystems and wildlife;
- changes to agriculture and food production;
- public health risks;
- damage to public and private infrastructure;
- greater stress on water resources; and
- vulnerability of energy systems.

These impacts and their associated direct effects (also identified via the literature review) were used to scope the remainder of the research contained in the report.

4.2 Official Plan Review

As discussed in Chapter 3, in Ontario, the official plan is the predominant legal document authorizing municipalities to implement land use planning regulations. Therefore, it was paramount that these documents be assessed in order to

determine how supportive current land use planning policies in the Cataraqui Region are of climate change adaptation.

There are a total of fifteen official plans in the Cataraqui Region (when the Frontenac Islands is included): three belong to separated municipalities; three belong to counties; and the remainder belong to townships. For the purposes of the official plan review in this report, all of the separated municipality and county official plans were reviewed. However, only four of the township official plans were reviewed due to workload and time constraints. The township official plans ultimately included in the review were carefully selected based on several considerations; notably:

- Geography: It was ensured that at least one township official plan was selected from each of the three counties within the Cataraqui Region.
- Content: Upon cursory review, it was apparent that several of the township official plans were identical in terms of their content. This was likely a result of their authors reproducing much of the province's Provincial Policy Statement (PPS) within the official plan. Reviewing each of these plans would have resulted in unnecessary redundancy.

Table 4.1 lists the official plans reviewed for this report.

After the plans were selected, a thematic document review was undertaken to determine how much of their content addressed climate change, and more specifically, climate change adaptation. This was accomplished by identifying any and all policies within them that related in some way to one of the eight identified regional climate change impacts, or any of the direct effects associated with these eight impacts. The result of this analysis was the comprehensive table seen in the supplemental file attached to the report. The information contained in this table is further summarized in Appendix A.

Table 4.1: Official plans reviewed.

Separated Municipality	
City of Kingston · City of Brockville · Town of Gananoque	
County	**Township**
County of Frontenac	· Township of South Frontenac
The United Counties of Leeds & Grenville	· Township of Leeds and the Thousand Islands · Township of Athens
County of Lennox and Addington	· Town of Greater Napanee

Following the thematic review, the official plans were each assessed based on their level of support for climate change adaptation. The literature on assessing official plans is extensive, and the evaluation undertaken in this report centred on two overarching principles that are featured in the majority of this literature. These principles are as follows:

- Quantity: How many policies in the plan either implicitly or explicitly address the impacts of climate change? Explicit policies are preferred, since this indicates that the writers of the plan are aware of these impacts, and are thus more likely

to alter the plans in the future if conditions warrant. However, implicit policies are also adequate since they are still addressing the impacts in some way (Berke & Godschalk, 2009; Berke, Spurlock, Hess, & Band, 2013).

- Quality: How many of the climate change adaptation policies feature direct implementation measures? Do they provide thresholds or specific targets that must be followed? If they do not, it can be said that the policies are 'without teeth' and that there is no incentive existing to ensure the goals underlying them are achieved (Berke & Godschalk, 2009; Burby, 2003)

It should be noted that this evaluation scheme is rather rudimentary compared to others that exist in the literature. This was primarily a result of time constraints. The project team did not have the time to follow a more structured and rigorous evaluation scheme without devoting less time and effort to the other stages of research. However, it was felt that this approach was still adequate given the aims of the project. No matter how rudimentary they may be, the official plan evaluations should still give municipalities in the Cataraqui Region an impetus to start thinking about what they can and should do to prepare for the anticipated impacts of climate change in the Region.

4.3 Identifying Land Use Planning Solutions

Once the current state of climate change adaptation in the Cataraqui Region was established via the official plan review, a comprehensive literature review was undertaken to determine how other jurisdictions elsewhere have used land use planning to adapt to climate change impacts. The sources included in this review were far-reaching; in addition to the academic literature, media articles and government reports were consulted. As well, examples were collected from all over the world, not just Ontario, or Canada.

The literature review was organized in terms of the eight impact themes listed above. This ensured strategies were identified for each impact. In order to ensure a wide selection of solutions were identified, there were no limitations placed on where the solutions could come from. Any implementation constraints that may have resulted from this lack of restrictions were dealt with when formulating the recommendations. The results of the literature review are summarized in Chapter 6.

4.4 Developing Recommended Policies

By their nature, official plans are policy-heavy documents. As such, it was decided to formulate the final recommendations of this report as policies, as opposed to a series of summary statements. However, this undertaking added an additional level of complexity to the task at the hand; it needed to be ensured that the created policies were feasible, effective, and most importantly, would comply with Ontario's land use planning legislation when implemented.

The strategy used to accomplish these requirements was as follows:

- First, preliminary policies were written based on strategies identified in the review of land use planning solutions. The goal of developing these policies was to help implement the approaches used elsewhere to successfully adapt to the impacts of climate change. In many instances, policies were paraphrased from the official plans of other communities in Ontario. The most notable

of these were the Town of Ajax and the City of Waterloo.

- After this initial policy creation, the policies were grouped into new theme categories. As opposed to earlier sections of the report, in which the eight impacts were used as themes, new themes were created in order to better facilitate the development of objectives for each group of policies. Together, these objectives spoke to the overall goal of this report, which is to ensure the Cataraqui Region is prepared for the anticipated impacts of climate change.
- Finally, the policies were carefully evaluated and re-written to ensure they: a) made sense; b) were feasible in the Region, and; c) would comply with Ontario planning legislation. This particular task was undertaken several times to ensure nothing was missed.

It is important to note that the recommended policies will require editing to suit local circumstances. Municipalities will also have to ensure any efforts they take to implement the recommended policies follow the appropriate procedures for amending and adopting official plan changes in Ontario.

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CHAPTER 5: OFFICIAL PLAN REVIEW

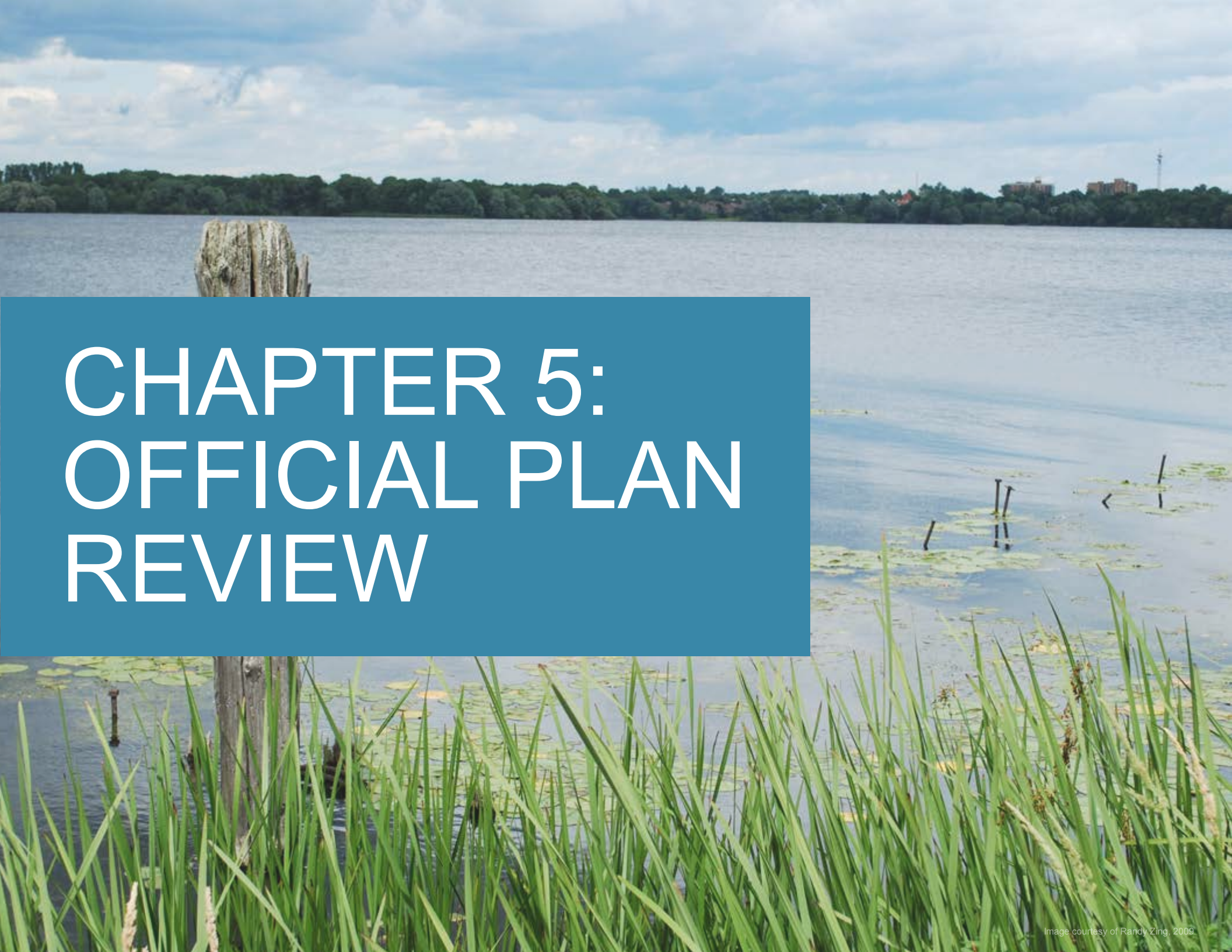

Image courtesy of Randy Zing, 2009

CHAPTER 5: OFFICIAL PLAN REVIEW

5 Official Plan Review

Municipal official plans in the Cataraqui Region were evaluated to determine their level of land use policy support for climate change adaptation. A sample of ten of the Region's fifteen official plans were reviewed due to time constraints and redundancies between similar plans. The Plans reviewed for this report are shown in Table 5.1

Table 5.1 List of municipal official plans in the Cataraqui Region. Plans reviewed for this report are shown in black.

Separated Municipality	
City of Kingston City of Brockville Town of Gananoque	
County	**Township**
County of Frontenac	Township of South Frontenac Township of Frontenac Islands
United Counties of Leeds and Grenville	Township of Athens Township of Elizabethtown-Kitley Township of Front of Yonge Township of Leeds and the Thousand Islands Township of Rideau Lakes
County of Lennox and Addington	Town of Greater Napanee Loyalist Township

Land use planning policies in each of these plans were reviewed using the framework of eight climate change impact themes as discussed in Chapter 2. Policies related to each of these impacts, or their direct effects, were identified and recorded in tables (please see supplemental file). Following this thematic review, each plan was assessed to determine the level of policy support for climate change adaptation.

The following chapter presents a summary of each municipal official plan reviewed and the associated level of support for climate change adaptation. The first section consists of summaries for the counties, the second section for townships, and the third section for separated municipalities. Please refer to Appendix A for the complete analysis of each plan by climate change impact theme.

5.1 Counties

Parts of three different counties are included in the Cataraqui Region. These counties include: the County of Frontenac, the United Counties of Leeds and Grenville, and the County of Lennox and Addington.

5.1.1 County of Frontenac

Population	26,600
Land Area	3,300 km^2
Description	Predominantly rural (villages, hamlets) Frontenac Arch Biosphere Reserve Frontenac, Bon Echo, and Sharbot Lake Provincial Parks
Official Plan	Adopted October 29, 2014 Awaiting final approval by MMAH

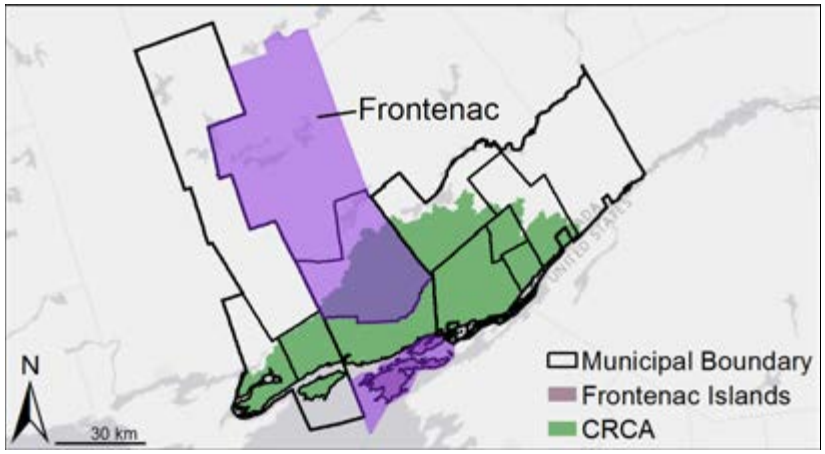

Figure 5.1: Location of Frontenac County within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The County of Frontenac Official Plan generally offers a strong policy framework with regard to natural heritage, potable water resources, energy, and planning in hazard areas. This includes a comprehensive natural heritage system, source water protection, and support for land uses associated with green energy production and conservation. Further, the County uses a restrictive policy approach towards regulating development near environmentally sensitive and hazard areas. This approach effectively controls the type and location of new development and site alterations, but it does not account for the anticipated impacts of climate change.

The Plan contains policies that are broad and directive to the four local townships. Many of these policies are general and open to interpretation, making implementation difficult. After the County OP is approved, it is important for the township OPs to undergo a conformity exercise to ensure consistency with the County Plan.

Many of the identified policies fail to directly target objectives related to climate change adaptation. Rather, they target alternative objectives such as economic growth. Lacking a direct link to climate change, these policies are insufficient.

Policies directly addressing climate change adaptation should be incorporated into the County Official Plan. These policies should be directive and contain requirements to be fulfilled by the townships and the County, rather than those that simply encourage policy objectives.

5.1.2 The United Counties of Leeds and Grenville

Population	99,000
Land Area	3,400 km^2
Description	Rich in natural and cultural heritage Thousand Islands Region Frontenac Arch Biosphere Reserve
Official Plan	Adopted July 2015 Awaiting final approval by MMAH

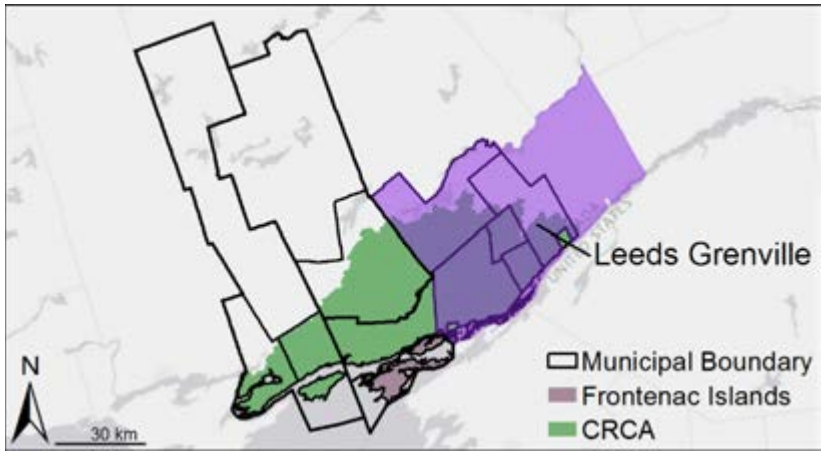

Figure 5.2: Location of the United Counties of Leeds and Grenville within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The United Counties of Leeds and Grenville Official Plan implements a restrictive policy approach to growth management and the protection of natural heritage. Many land use policies direct development away from environmentally sensitive lands or hazardous areas. This approach serves multiple purposes, including:

- protection of natural and ecological resources, including endangered species and their habitats, potable water, and prime agricultural land;
- protection of public health and safety; and
- protection of critical or sensitive infrastructure.

Lacking a direct link to the effects of climate change, however, these policies offer limited support for adaptation. Section 6.6 of the plan attempts to address this missing link with specific sustainability policies, including policies for energy efficiency and conservation, air quality improvement, and climate change adaptation. For example, a unique policy allows tree planting, landscaping, and naturalization initiatives on municipal property to improve air quality. Another policy requires that upgrades to municipal infrastructure must consider the impacts of climate change, including those associated with extreme weather events. While these policies strongly promote adaptation strategies for energy and air quality, similar policies must be woven into other sections of the plan to address topics such as natural heritage, agriculture, and potable water resources.

Direct effects and adaptation strategies for climate change should be considered in all sections of the Official Plan.

5.1.3 County of Lennox and Addington

Population	42,000
Land Area	2,800 km^2
Description	Predominantly rural Mix of farmland, open spaces, forests, lakes
Official Plan	Adopted September 30, 2015 Awaiting final approval by MMAH

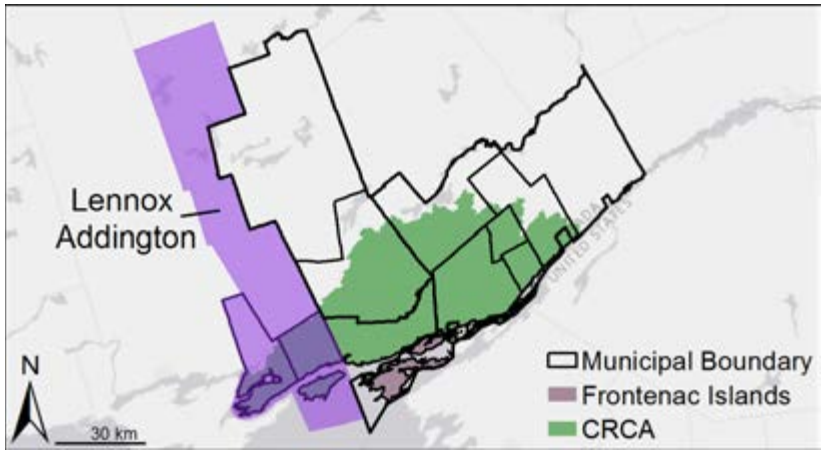

Figure 5.3: Location of the County of Lennox and Addington within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

As stated in Section 4, one of the primary purposes of the County of Lennox and Addington Official Plan is to:

> "Establish a broad, upper tier policy framework that provides guidance to local municipalities in the preparation of updated local Official Plans, Official Plan Amendments, and zoning by-laws."

The County has adopted a restrictive land use policy approach. This approach guides development and site alteration away from hazardous lands, natural heritage features, prime agricultural lands, and potable water resources. While these policies effectively manage present issues, they fail to account for long-term effects of climate change.

Most policies are not directly supportive of, or linked to climate change adaptation. Instead, land use policies are focused on the County's goals for growth management and economic development. Where policies supportive of climate change adaptation do exist, most simply encourage local municipalities rather than set a mandate at the county level. For example, Section E2.2.9 encourages local municipalities to develop interconnected networks of active transportation routes. By failing to mandate specific land use practices, this section lacks the "teeth" for successful implementation.

Many policies are broad, which may lead to misinterpretation or poor implementation at the township level. Specific policies for climate change adaptation are necessary to ensure the long-term vitality of the County.

5.2 Townships

The Cataraqui Region includes eight townships plus the Township of Frontenac Islands, which is not formally part of the CRCA but is considered as part of the study area for this report. A representative sample of four township official plans were examined, including: the Township of South Frontenac, the Township of Leeds and the Thousand Islands, the Township of Athens, and the Town of Greater Napanee.

5.2.1 Town of Greater Napanee

Population	15,500
Land Area	460 km^2
Description	Quiet countryside: family farms and hamlets Historic urban town centre
Official Plan	Consolidated as of May 2014 Approved by MMAH

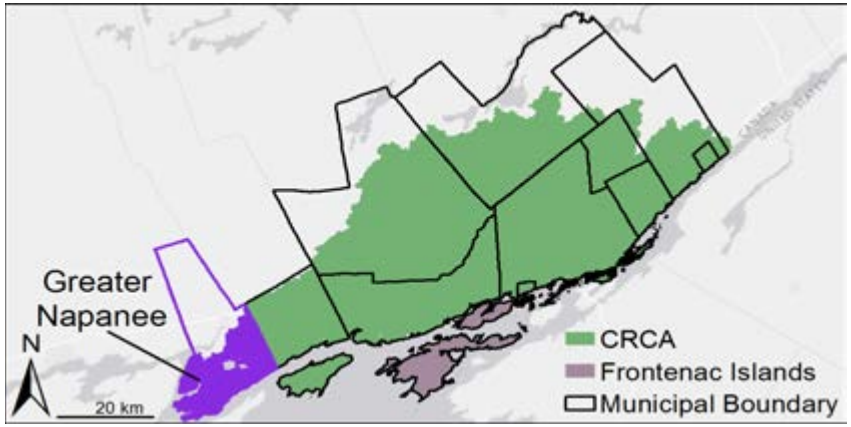

Figure 5.4: Location of the Town of Greater Napanee within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The Town of Greater Napanee Official Plan has numerous policies that support climate change adaptation. Many of the policies are open-ended and provide guidance without being too restrictive. This allows some flexibility as the Town and the Cataraqui Region continue to learn about the effects of climate change. It is also clear that the plan prioritizes potable water resources and environmentally sensitive areas. These are generally addressed by directing development away from sensitive areas.

Additionally, the Plan has significant guiding policies for active transportation, sustainable sites, and reducing residents' ecological footprints.

Most notably, "Part 8 – Sustainability" addresses climate change directly and sets out the Town's sustainability goals. This section is very progressive and may be used as a model in other parts of the Region. While there are some policy gaps to be filled, the Town of Greater Napanee is well positioned to adapt to climate change.

5.2.2 Township of Athens

Population	3,000
Land Area	126 km^2
Description	Rural history, lakes, and cottage country Villages of Athens, Charleston Frontenac Arch Biosphere Reserve
Official Plan	Consolidated as of July 2012 Approved by MMAH and OMB

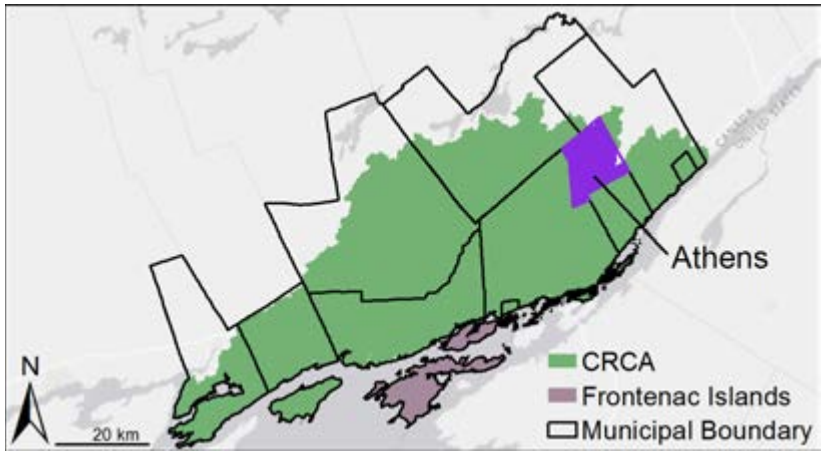

Figure 5.5: Location of the Township of Athens within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The Township of Athens Official Plan contains strong policies for the protection of the Township's valuable natural heritage features. Policies for the protection of agricultural land are also in place, but are not prominent due to decreasing agricultural activity in the Township. While natural heritage features and agricultural land are protected from development-related impacts, there is no consideration for the long-term impacts of climate change.

The Plan also provides meaningful policy support for energy conservation and efficiency. In reviewing planning applications, the Township encourages plans that employ techniques such as building and lot orientation, building design, and vegetation buffering to advance energy objectives. At a larger scale, the Plan also supports alternative and renewable energy systems.

Public health risks in relation to climate change are not discussed. Rather, policies addressing air and water quality advance alternative objectives such as ground water supply, ecological preservation, and responsible development adjacent to waterbodies. Policies regulating development near hazard areas are included in several sections of the Plan but are not linked to climate change.

In general, few land use policies address the long-term effects of climate change in a meaningful way; many policies are focused on present conditions. As it stands, the Township of Athens Official Plan provides little land use policy support for climate change adaptation.

5.2.3 Township of Leeds and the Thousand Islands

Population	9,300
Land Area	640 km^2
Description	Primarily rural with historic villages St. Lawrence River and Thousand Islands Frontenac Arch Biosphere Reserve
Official Plan	Consolidated as of March 2012 Approved by MMAH

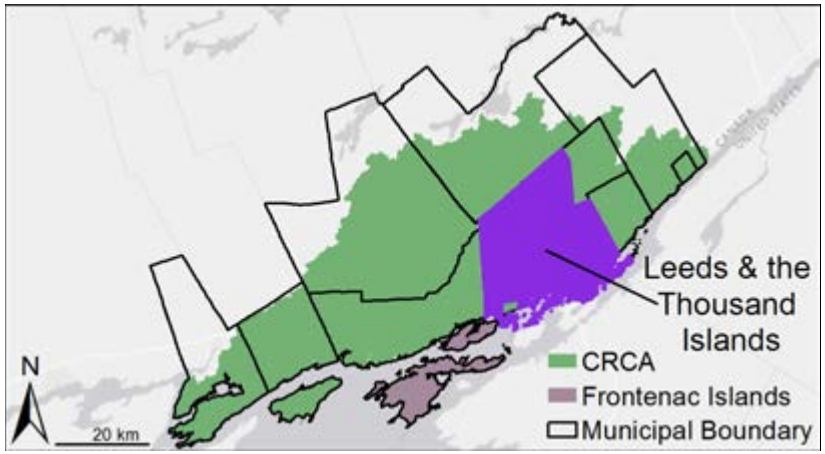

Figure 5.6: Location of the Township of Leeds and the Thousand Islands within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The current version of the Township of Leeds and the Thousand Islands Official Plan provides general development and land use planning policies. The Plan recognizes the Township's valuable natural heritage features and includes policies to protect them in the long term. It also includes meaningful policies for the protection of productive agricultural land, potable water resources, and against natural or human-made hazards. However, these polices do not consider the anticipated long-term impacts of climate change.

The Plan lacks policies relating to public health risks, and energy management. While Section 4.6.2 supports the development of linkages between points of interest (i.e. recreational trails, villages and hamlets, etc.), this policy is linked to the Township's economic objectives. Further, while alternative and renewable energy systems are defined terms in the glossary, there are no supporting policies or objectives.

Climate change, or the anticipated long-term impacts of climate change, are not addressed or considered at any point in the Plan. As such, land use policies in the Plan do not provide sufficient support for climate change adaptation.

5.2.4 Township of South Frontenac

Population	18,000
Land Area	972 km^2
Description	Rural character with many villages Lakes, family farms, wooded areas Frontenac Arch Biosphere Reserve
Official Plan	Consolidated as of March 2012 Approved by MMAH

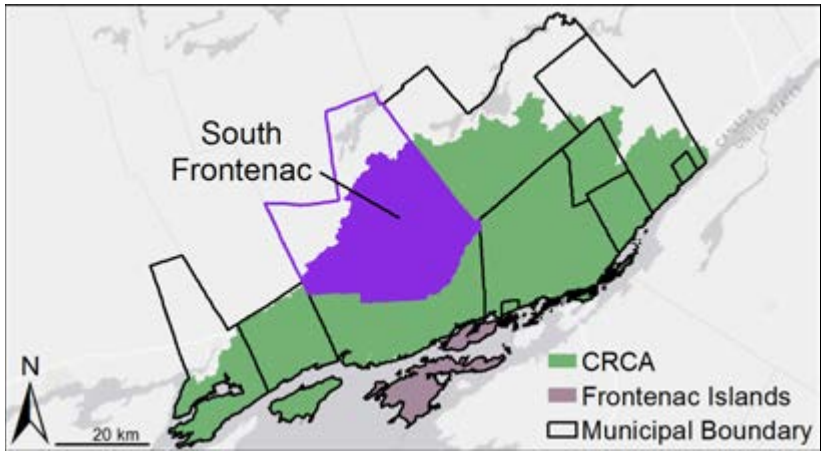

Figure 5.7: Location of the Township of South Frontenac within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The Township of South Frontenac Official Plan has strong policies addressing natural hazard areas and natural heritage features. Extreme weather events are addressed through policies directing development away from natural hazard areas. Development is also directed away from natural heritage areas to ensure their protection in the long-term. While these policies effectively address present conditions, they are not linked directly to climate change adaptation. Instead, they are focused on other general economic or environmental objectives.

Policies relating to other climate change impact themes are very general and fail to account for the projected impacts of climate change. The Plan does not address anticipated changes in atmospheric temperature or consider climate change-related health effects. Agriculturally productive lands are protected from fragmentation and non-agricultural uses, but associated policies do not consider the direct effects of climate change.

The Township recognizes the need for adequate infrastructure but does not consider how infrastructure will be affected by climate change. Lot creation is restricted in non-serviced areas to ensure a sufficient supply of groundwater. However, there are no further policies that protect existing potable water resources or address future threats to potable water due to climate change. Lastly, the Plan contains an objective to reduce reliance on conventional energy systems by encouraging alternative energy systems. However, there are no additional policies supporting this objective.

In its current state, the Plan does not contain adequate land use policies for adaptation to climate change.

5.3 Separated Municipalities

Three separated municipalities are located within the boundaries of the Cataraqui Region. These include: the City of Kingston, the City of Brockville, and the Town of Gananoque.

5.3.1 City of Brockville

Population	22,000
Land Area	21 km^2
Description	Historic waterfront Thousand Islands and St. Lawrence River
Official Plan	Approved by MMAH February 9, 2012

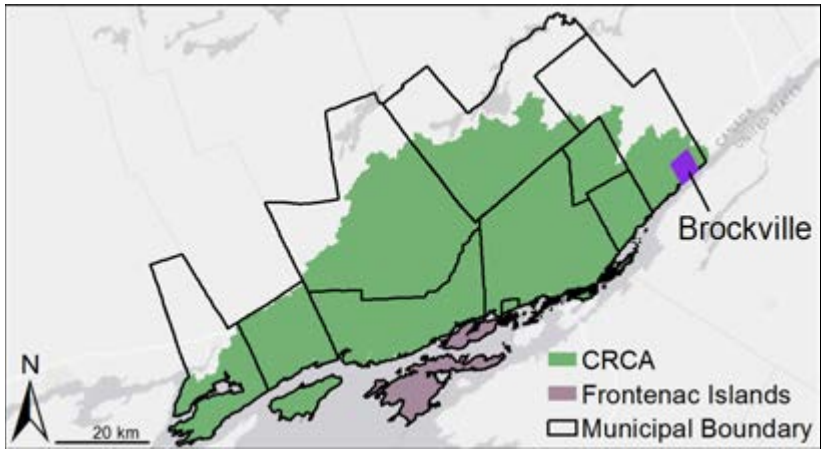

Figure 5.8: Location of the City of Brockville within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The City of Brockville Official Plan consists of many broad policies that address the City's objectives for sustainable growth. Most policies do not provide direct adaptation strategies to address the effects of climate change; rather, they only address existing issues. For example, Sections 3.4.1.1 and 3.4.1.2 promote the creation of innovative green spaces (such as green roofs) that will reduce the Urban Heat Island effect. These policies do address a direct effect of climate change, but fail to consider how the urban heat island effect may be exacerbated under climate change conditions.

Section 3.7.2 directly addresses climate change from a public health perspective. Including both mitigation and adaptation strategies, this section endeavours to enhance the urban tree inventory in an effort to improve air quality and reduce energy consumption. Additionally, the City promotes transit-supportive and compact urban form to reduce harmful vehicle emissions.

Policies relating to other climate change impact themes generally fail to link directly to climate change. The Plan addresses extreme weather events through policies that direct development away from natural hazard areas; however, it does not account for increased frequency or severity of these events. Natural heritage features and potable water resources are protected in the long-term, but there is no consideration of how these features may be affected by climate change. Finally, Section 3.3.3 encourages and facilitates green energy projects at all scales. However, these policies are linked to economic objectives rather than climate change adaptation.

With the knowledge that these issues and others will intensify in a changing climate, the City should modify these policies to better link with climate change.

5.3.2 Town of Gananoque

Population	5,200
Land Area	7 km^2
Description	Gananoque, St. Lawrence Rivers Thousand Islands Region One of Eastern Ontario's most stunning waterfront communities
Official Plan	Published September 15, 2009 Approved by MMAH

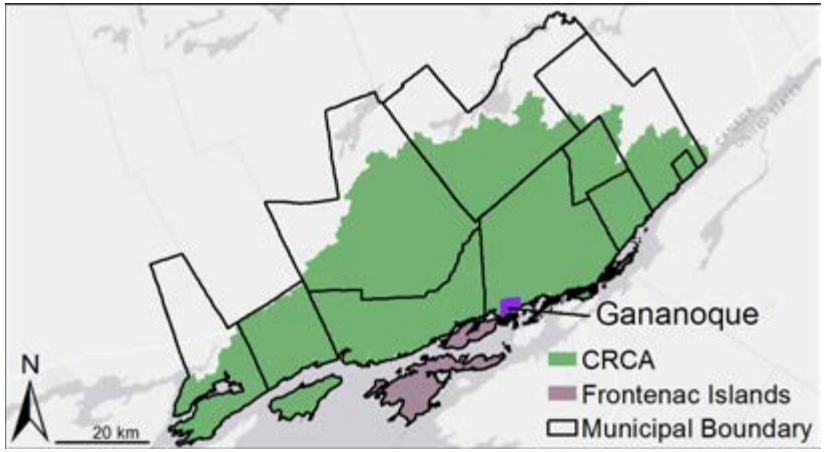

Figure 5.9: Location of the Town of Gananoque within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The Town of Gananoque Official Plan provides effective general policy to protect endangered species, shield residents against hazardous areas, and promote both energy efficiency and the use of renewable sources of energy. However, the term *climate change* and the association between climate change and applicable policies is not evident.

Infrastructure is addressed at length throughout the Plan. While the Town recognizes the need to provide adequate infrastructure on an on-going basis, it does not address how climate change will impact existing infrastructure or the future provision of infrastructure.

Abundant nearby potable water resources are protected in Sections 4.1.4 and 4.1.5 under policies for watershed preservation. These policies account for existing conditions, and do not consider the anticipated long-term effects of climate change.

The Plan promotes both renewable energy sources (primarily wind and solar) and improving energy efficiency in new and existing developments. Several wind and solar farms already exist in the Cataraqui Region, and provisions for these energy systems are included at a variety of scales (from small residential to large industrial).

The Town of Gananoque Official Plan provides effective general land use policies for a number of topics. However, these policies fail to consider the long-term anticipated impacts of climate change. In its current state, the Plan does not provide sufficient land use policy support for climate change adaptation.

5.3.3 City of Kingston

Population	160,000
Land Area	475 km^2
Description	Heritage limestone urban centre Historic Fort Frontenac and Fort Henry
Official Plan	Under review Second draft released October 5, 2015

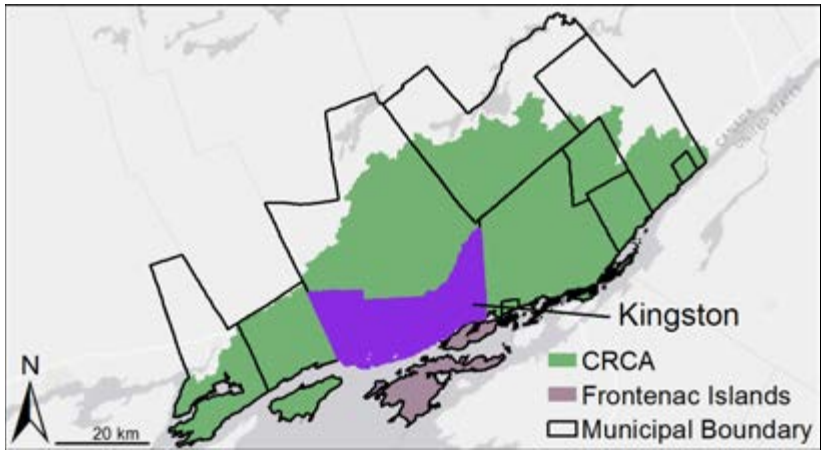

Figure 5.10: Location of the City of Kingston within the Cataraqui Region.

Summary of Climate Change Adaptation Policies

The City of Kingston Official Plan contains many policies that link to climate change adaptation. Notably, policies relating to natural hazard areas, public health, infrastructure, and energy all recognize or consider the role of climate change. These policies offer little beyond a consideration, however, as the City intends to continue investigating the impacts of climate change and adapt accordingly.

The Plan has a number of policies promoting agricultural activity and protecting agricultural lands. In urban areas, Section 3.1.1.1 encourages secondary uses including agriculture and community gardens in hydro corridors. In rural areas, Section 3.12 restricts development and permitted uses to protect prime agricultural lands. While these types of policies may represent best practice in their own right, they are not specifically targeted at climate change adaptation.

Many of the identified policies are enabling rather than directive. Language such as “encourage”, “should”, and “intends” limit the strength of these policies by simply permitting, not requiring. These policies could be strengthened by incorporating language such as “shall”, “must”, and “conform”. For example, Section 4.6.1 could be re-written: “…the City *shall* foster sustainability within the community…”

The City of Kingston Official Plan is progressive, and has started to incorporate visions and strategies designed specifically for adaptation to climate change. Currently, however, the Plan does not provide sufficient support for climate change adaptation.

5.4 Are These Official Plans Supportive of Climate Change Adaptation?

Land use policies in the Counties of Frontenac, Leeds and Grenville, and Lennox and Addington generally support climate change adaptation in an indirect manner. Using a restrictive approach, these policies direct development away from natural heritage features, environmentally sensitive areas, potable water resources, and hazard areas. Many of these policies are broad, simply encouraging local municipalities rather than setting a mandate at the county level. As a result, these policies lack the "teeth" to ensure successful implementation. Finally, many County policies are targeted at alternative economic or growth management objectives. To improve land use policy support for climate change adaptation, counties should link land use policies to the long-term anticipated effects of climate change.

Official plans for the Townships of Athens, Leeds and the Thousand Islands, and South Frontenac contain few policies for climate change adaptation. Relevant policies are not directly linked to climate change, and are often targeted to the advancement of other objectives. Further, they focus only on present conditions, failing to consider the long-term anticipated impacts of climate change. In contrast, the Town of Greater Napanee Official Plan addresses climate change directly through a section targeted at sustainability. This section is progressive, incorporating sustainability principles into policies for energy, growth management, infrastructure, and other topics. Policies in this section are not restrictive which, if required, enables flexibility for future policy adjustment. While some aspects of the Town of Greater Napanee Official Plan can still be improved, the sustainability section may be used as a model for other municipalities in the Region.

The City of Brockville and Town of Gananoque Official Plans provide effective general policies for the protection of natural heritage features, the protection of public health and safety against hazards, and the promotion of energy efficiency and green energy systems. However, these and other identified climate change-related policies do not link directly to climate change adaptation. In their current state, these plans do not provide sufficient support for climate change adaptation. In contrast, the City of Kingston Official Plan is progressive and future-oriented. Many policies recognize or consider the role of climate change. However, the language in the Plan needs to be more directive to effectively strengthen adaptation policies.

Land use policy support for climate change adaptation in the Cataraqui Region falls into a broad spectrum. Some municipal official plans contain progressive policies, providing direct links to climate change and addressing long-term planning issues. These plans are generally the most recent ones, those which have been updated since the release of the *PPS*. Others, however, focus only on present conditions and fail to consider the direct effects of climate change. In many cases, climate change adaptation-related policies are intended to target alternative economic or growth management objectives. While these policies and objectives may represent best practice in their own right, they do not sufficiently support long-term climate change adaptation.

Evidently, all of the reviewed plans can be improved to provide further land use planning policy support for climate change adaptation. The next chapter of this report discusses common and innovative land use solutions for climate change adaptation from elsewhere in Canada and around the world. Using the solutions most applicable to the Cataraqui Region, Chapter 7 provides recommended land use policy improvements.

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CHAPTER 6: LAND USE SOLUTIONS

Image courtesy of Vern Quinsey, 2010

CHAPTER 6: LAND USE SOLUTIONS

6 Land Use Solutions

Following from the official plan review, it is clear that land use planning policies in the Cataraqui Region are generally not supportive of climate change adaptation. While this is a key finding in its own right, it provides little direction to municipalities for the modification of official plan policies. As such, it was necessary to study land use solutions and make specific policy recommendations that could feasibly be implemented in the Cataraqui Region.

Municipalities in other parts of Ontario, Canada, and the world have developed and implemented progressive land use solutions for climate change adaptation. In this chapter, pertinent land use solutions are identified for each of the eight climate change impact themes as discussed in Chapter 1. Each example is examined in detail, including relative feasibility for the Region and applicable mechanisms for implementation. It is important to note that some solutions may require mechanisms other than the land use planning tools available under the *Planning Act*; these are discussed where necessary. The policy gap between the reviewed official plan policies in Chapter 5 and the land use solutions presented in this chapter lay the foundation for the policy recommendations presented in Chapter 7.

6.1 Atmospheric Temperature

The projected general climate warming trend will have significant implications for both the built and natural environments on a global scale. In the Cataraqui Region, however, the projected average annual air temperature increase will itself present many challenges. In the winter months, warmer air temperatures will result in more intense snowfall events, more frequent freezing rain and ice storms, and more slush and ice due to more frequent freeze-thaw events. In the summer, it will result in decreased air quality, increased heat stress, and a higher demand for energy. This section discusses pertinent land use planning and urban design solutions for adapting to an increase in atmospheric air temperature.

6.1.1 Adapting to Warmer Summer Temperatures

Southern Ontario already experiences periods of very hot weather during the summer. Under climate change conditions, the frequency and intensity of extreme heat events is projected to increase (Guindon & Nirupama, 2015). As a result, the problems associated with these events will be intensified. In urban areas of the Cataraqui Region, the primary impact will be an intensified Urban Heat Island effect.

The Urban Heat Island Effect

The Urban Heat Island effect is a phenomenon that occurs when characteristics of the urban environment cause the air temperature within an urban area to be several degrees warmer than the surrounding area. Characteristics that contribute to this effect include:

- loss of vegetation from the urban surface;
- properties of urban materials;
- urban geometry; and
- anthropogenic heat (Carolis, 2012).

Vegetation helps to cool urban areas both by providing shade and through transpiration, which adds water vapour to the air. Typical urban materials have low albedo and high emissivity, properties that allow them to easily warm and transfer heat to the surrounding air and surfaces (Carolis, 2012). Urban geometry provides additional surfaces for heat storage and release. Finally, in dense urban areas there is a high potential for air to be stagnant, trapping radiation between buildings. Occurrences of these urban characteristics lead to an increased warming of the air (Ryu & Baik, 2012).

A variety of land use planning policies can be used to reduce the Urban Heat Island effect. Some feasible solutions for the Cataraqui Region include: urban greening, green and cool roofs, cool pavement, reductions in surface parking, and promoting air flow in dense areas.

Urban Greening

The preservation and enhancement of vegetation in urban areas can help to reduce the magnitude of the Urban Heat Island effect. Many municipalities have updated tree by-laws or policies to address the need to protect and enhance tree cover. For example, the Town of Oakville Official Plan sets a general sustainability objective to increase the urban forest to achieve a canopy cover of at least 40% beyond the year 2031. Furthermore, pursuant to Section 10.12.1 a sufficient number of trees must be planted to replace every square metre of leaf area that is removed from Town property. In the Town of Richmond Hill, developers are required to submit a detailed landscape plan in order to receive approval for a subdivision (Carolis, 2012).

In western Canada, municipalities such as Regina and Vancouver have set ambitious targets for the enhancement of their urban forests. One approach to meeting these targets is the addition of detailed schedules to the Urban Forest Management Strategy. These schedules prioritize areas for landscape and canopy enhancement. Other initiatives include land procurement for greenspace, design guidelines, landscaping coverage requirements in zoning by-laws, and tree planting programs.

Green Roofs

Green roofs consist of vegetation grown on a rooftop. They cool the surface and interior of buildings, and the surrounding air. In addition to reducing the Urban Heat Island effect, green roofs reduce energy use, improve comfort within buildings, improve air and water quality, and contribute significantly to stormwater management (Getter & Rowe, 2006). One method for implementing green roofs is through bonusing, wherein new developments would include green roofs in exchange for increased height or density. Municipalities can also promote green roofs through education, incentives, and demonstration projects on municipal buildings.

The City of Waterloo, ON is considering several approaches to encourage the use of green roofs in the on-going development of their Environmental Strategy. One approach is a reduced

stormwater utility fee for new and retrofitted buildings with green roofs. The City also conducted a feasibility study to determine how many green roofs could be installed on municipal buildings as demonstration projects (Lawlor, Currie, Doshi, & Wieditz, 2006). As of 2014 there were three green roofs on municipal buildings, including one at Waterloo City Hall as shown in Figure 6.1 (Cipriani, 2015).

Figure 6.1: Green Roof on Waterloo City Hall (Community Renewable Energy Waterloo , 2015).

A unique example of land use policy for green roofs comes from the City of Toronto, ON. In 2009 the City adopted a by-law requiring most new buildings over a certain size to have a green roof. Toronto is unique in its authority to pass such a by-law, granted under Section 108 of the *City of Toronto Act*. Other municipalities in Ontario do not yet have this level of authority and are subject to the policies of the *Planning Act* as discussed in Chapter 3. As such, incentives are still the most common mechanism for the implementation of green roofs.

Incentives are also a common mechanism in municipalities outside Ontario. For instance, the City of Kamloops, B.C. has created a development incentive matrix to promote sustainable infrastructure and development, including green roofs. The types of incentives offered can include a combination of:

- property tax reductions;
- development cost charge reductions;
- parking requirement relaxations;
- height and density bonusing;
- beneficial public realm partnering; and
- planning process priorities.

Cool Roofs

Cool roofs have many of the same benefits as green roofs. They consist of materials with high albedo and high emissivity, which minimizes absorption of solar radiation and facilitates a rapid loss of heat (van Tijen & Cohen, 2008). Even at northern latitudes, summer energy savings exceed winter energy penalties (Carolis, 2012). Municipalities can increase the use of cool roof materials through incentives and urban design guidelines. For example, Section 5.5.3 of the Vaughan Metropolitan Centre Plan states that certain types of residential, commercial, and institutional buildings shall be encouraged to have green roofs, cool roofs, solar capture equipment, or a combination of the above.

Cool Pavement

Typical paving materials have low albedo, high emissivity, and are impervious to moisture. Cool pavements use lighter, more reflective materials and are either porous or pervious to moisture. Where appropriate, municipalities can promote the

use of cool pavements through incentives, urban design guidelines, and by incorporating these materials into roads and other surfaces that are municipally owned.

Reduced Surface Parking

In areas that are more prone to the Urban Heat Island effect, reductions to surface parking can help to alleviate this unnatural warming. Some strategies include: eliminating minimum parking requirements, lowering maximum parking restrictions, and providing incentives for more compact forms of parking. Further, through bonusing developers can be granted increased surface parking in exchange for trees or other features that reduce the Urban Heat Island effect.

Promoting Air Flow

Positioning buildings to promote air flow can reduce warming in both dense urban and rural waterfront areas. Along the shores of rivers and lakes, the opportunity exists to channel cool breezes from water bodies into developed areas. This can be accomplished by orienting buildings at a 45 degree angle to the direction of the wind (Yamamoto, 2006).

Building positioning for increased air flow can be achieved through site and area-specific land use policies. Wind paths have been implemented in the City of Stuttgart, Germany and are being created in dense parts of the Tokyo Metropolis in Japan. In Stuttgart, cool winds were channeled down from surrounding mountains and into the city centre through tracts of forested greenspace. Tokyo is undertaking several projects to promote better air flow through dense areas that are prone to the Urban Heat Island effect. One such project includes the removal and construction of buildings in certain areas to allow cool breezes from the Tokyo Bay to make their way into a built up area (Japan for Sustainability, 2003). The removal or re-construction of existing buildings may not be practical in most cases due to high costs. However, the opportunity exists for urban areas in the Cataraqui Region to position new buildings near lakes and rivers to take advantage of increased air flow.

Other Policies for Heat Adaptation

Beyond reducing the Urban Heat Island effect, it is important to develop land use policies that help cities adapt to other aspects of warmer summer temperatures. Many of these policies will be discussed in later sections of this chapter. Policies directly related to extreme heat events include planning more parks, shaded areas, pools, and splash pads. Implementation methods may include bonusing, zoning, and land dedication during the subdivision approval process. Communities can also designate certain buildings and areas to be secondarily used as cooling shelters during heat events. For example, the City of Philadelphia, Pennsylvania *Excessive Heat Plan* and The City of Phoenix, Arizona *Response Plan for Summer Heat* (United States Envronmental Protection Agency, 2015).

6.1.2 Adapting to Warmer Winter Temperatures

Despite a warming climate, winter in the Cataraqui Region will not disappear. Rather, increased average winter temperatures will present new and intensified challenges. More space will be needed to store greater quantities of snow. Winter hazards, such as falling snow and ice, damaged or downed trees and power lines, icy roads and sidewalks, and many others will be intensified. There will also be a need for more resilient infrastructures as the frequency and intensity of snow and ice storms increases. As these effects become more imminent, effective land use policy solutions are necessary.

Snow Storage

Consideration must be made for increased snow storage and to accommodate increased amounts of spring meltwater.

These can be addressed on a variety of scales, including site-specific, subdivision, and community-wide.

Urban design guidelines can allow for easier snow removal and more space for snow storage. For example, wide sidewalks and generous building setbacks are included in the City of Ottawa's winter specific urban design recommendations (The City of Ottawa, 2015). Furthermore, through zoning by-laws and subdivision approval, adequate open space can be provided to accommodate piles of cleared snow and spring meltwater.

Winter Hazards

Falling snow and ice, and icy surfaces pose a risk to human safety. Using ice-resistant or slip-proof materials and heating or covering sidewalks (where feasible) increases comfort and safety. For example, Reykjavik in Iceland uses heated sidewalks (see Figure 6.2). As a secondary benefit, active transportation throughout the wintertime may be much more appealing. Designing roofs to reduce falling ice and snow hazards and directing snow storage space away from intersections and walkways also increases the safety and ease of winter mobility. These measures can be accomplished by a wide variety of planning tools including urban design guidelines and site plan control.

Figure 6.2: A heated sidewalk in Reykjavik, Iceland (CBC News, 2013).

Other Considerations

Municipalities can take many proactive measures to become more resilient to more frequent and severe winter weather. Where feasible, utilities should be buried and trees that are lost during ice storms should be replaced. In the Cataraqui Region, the City of Brockville requires underground installation of utilities in Neighbourhood Development Areas and where feasible and realistic (City of Brockville, 2012). Burying utilities is challenging in some parts of the Region due to shallow bedrock. However, all municipalities should still consider burying utilities wherever feasible. Further, paving materials and outdoor features should be durable and able to withstand increased snow and ice removal (such as machine clearance and salt application).

6.2 Extreme Weather Events

The Cataraqui Region is expected to see an increase in both the frequency and severity of extreme weather events as a result of climate change. Fortunately, there are a variety of land use planning tools that can be implemented to reduce the negative impacts associated with extreme weather events. This section examines methods related to the following: flood hazards, erosion and dynamic beach hazards, wildfires, windstorms, ice storms, and heatwaves.

6.2.1 Flood Hazards

Climate change is projected to increase the number of heavy precipitation events in the Region. As higher amounts of precipitation occur in short periods of time, many areas of the Region will be more susceptible to flooding. Areas not currently at risk of flooding may become susceptible due to migration of the floodline resulting from the 1% probability storm event. Municipalities in the Cataraqui Region have already included development setbacks and restrictions in their official plans to meet provincial requirements. However, they should consider expanding these setbacks and restrictions adjacent to existing at-risk and flood-prone areas to account for changing climatic conditions.

Greenspace, Natural Reservoirs

One of the most common land use methods to address flooding is ensuring that surface cover is limited and ample greenspace is provided in new plans of subdivision (Province of Manitoba, n.d.). Municipalities may also maximize wetland areas that act as natural reservoirs. Restoring and/or preserving existing wetlands has become extremely important due to their effectiveness in retaining floodwater and slowing peak flood flows (Kousky, Olmstead, Walls, Stern, & Macauley, 2011).

Figure 6.3: Wetland reservoir stores water from precipitation events (Bell, 2014).

Stormwater Ponds, Raingardens, Bioswales

Another method for controlling stormwater and flooding is by including stormwater management ponds in new subdivisions. The banks of these ponds should be reinforced with flood-resistant vegetation. Further, raingardens and bioswales are green areas that can be used for water infiltration and to slow runoff (Province of Manitoba, n.d.). It is important for municipalities to know the volume of precipitation these outlets can retain and ensure that they will not be overcome by severe precipitation events.

Many Canadian municipalities have started developing more aggressive policies mandating that new development adhere to specific requirements regarding stormwater runoff levels. These policies require all new development complies with a “zero net runoff”, or mandate that post-development runoff levels equal pre-development runoff levels (Province of Manitoba, n.d.).

Minimum Ground Floor Height

A common adaptation method in coastal regions is to implement minimum height regulations for new developments in at-risk areas (Richardson & Otero, 2012). The ground floor of a new building may be required to be built at a minimum height for protection against rising floodwaters. This method may be implemented using site specific zoning or by designating a special policy area, such as a "storm surge hazard area" or other type of flood risk hazard area. For example, Beaubassin-est, New Brunswick has identified a sea level rise "protection zone" wherein the minimum ground floor elevation of any new building must be at least 1.43 metres above the current floodline resulting from the 1% probability storm event (Richardson & Otero, 2012). Although the Cataraqui Region is not susceptible to general sea level rise, a similar approach may be used in areas that are at risk of increased flooding due to storm surges.

Integrated Reservoirs

Similar to the Cataraqui Region, the City of Rotterdam in the Netherlands is expecting significant increases in overall precipitation and heavy precipitation events in the forthcoming years. In anticipation of this change, the City has begun designing underground reservoirs in new housing developments and other municipal buildings. The purpose of these reservoirs is simple: to collect stormwater and control runoff. The benefits, however, are significant. These reservoirs have the potential to hold a great amount of water when necessary. For example, a new parking garage underneath Museumpark, an urban park in the City, includes a reservoir that can hold up to 10,000 cubic metres of water. Municipalities in the Cataraqui Region should consider the feasibility and suitability of this design strategy in the local context (Centre for Climate Adaptation, 2015).

6.2.2 Erosion Hazards

Increased precipitation and storm events will raise the risk of erosion for many areas in the Cataraqui Region. Notably, the shorelines of Lake Ontario, the St. Lawrence River, and other inland lakes and rivers will be at the greatest risk. Additionally, stable areas adjacent to these coastlines may become at risk of erosion due to a slow inland migration of the floodline resulting from the 1% probability storm event.

Minimum development setbacks from erosion hazard areas are the most common adaptation method. Municipal official plans in the Cataraqui Region already incorporate this approach. Erosion hazards are also addressed by the CRCA through its implementation of Ontario Regulation 148/06. However, municipalities may wish to encourage adding a factor of safety that goes beyond the minimum provincial standards.

Vegetation

Another method is to minimize disturbance and vegetation removal on slopes, especially those already at risk of erosion (Columbia Basin Trust, 2012). Vegetation plays a critical role in ensuring sediment stability. The removal of vegetation on steep slopes weakens the ability for sediment to stay in place and increases the risk of erosion. The effect is intensified when considering more extreme precipitation events due to climate change (Maguire, 1997). Municipalities should aim to ensure the adequate provision of vegetation in erosion hazard areas.

Riprapping

Finally, riprapping is a method that has been widely used in coastal regions (see Figure 6.4). Also known as shot rock, riprap is rock or other material arranged along a shoreline to protect against erosion. Riprapping can be required through site plan control. For example, the City of Bellville, ON requires a gravel or riprap lining for all bioswales to prevent erosion (The Corporation of the City of Belleville, 2005). While it can be expensive and time-consuming, riprapping should still be considered a viable option in the Cataraqui Region.

Figure 6.4: Riprapping to prevent coastal erosion in St. Clair Region, Ontario (St. Clair Region Conservation Authority, n.d.).

6.2.3 Wildland Fires

Due primarily to an increase in summer temperatures (as discussed in Section 6.1.1), the Cataraqui Region is expected to experience more frequent occurrences of wildland fires. This poses a threat to many aspects of the Region's natural, social, and built environments. As such, it is necessary to recognize this threat and prepare strategies to minimize the potential negative impacts.

Minimum Setbacks

There are several common land use planning methods for addressing wildland fires. First and foremost, all development should have a minimum setback from forest types that are subject to wildfire (Smith K. , 2004). At the municipal scale, this may require studies to determine which forest types are most susceptible to wildland fire. Several municipalities in the Cataraqui Region have already incorporated these types of restrictive policies into their official plans.

Minimum Spacing

When considering new developments, municipalities can apply a minimum spacing policy (Smith K. , 2004). Placing buildings a minimum distance apart helps to slow the spread of wildland fires, effectively minimizing potential damage to life and property. Where development is clustered, municipalities should consider regulating a minimum amount of defensible space. These are open areas around a structure where fuels and vegetation are treated, cleared, or reduced to slow the spread of wildfire (Dennis, 2006). Defensible space acts as a buffer and increases the efficiency of emergency response. Municipalities in the Cataraqui Region should consider implementing these land use controls where new developments are at risk of wildland fire.

Firebreaks

Firebreaks are another common practice that is increasingly being used in Ontario and western Canada. Firebreaks are features that slow the spread of fire (Province of Manitoba, n.d.). Typically, firebreaks take advantage of natural features such as rivers or lakes. Unfortunately, natural firebreaks are not always available and human-made breaks may be necessary (see Figure 6.5). The creation of human-made firebreaks can be costly, but should still be considered for areas at a high risk of wildland fire.

Figure 6.5: Road constructed in British Columbia, Canada to act as a firebreak (CBC News, 2015).

6.2.4 Windstorms

Climate change in the Cataraqui Region is projected to result in increased severity and frequency of windstorm events. This includes a 15-20% increase in the number of days with wind gusts greater than 90 km/h (City of Kingston, 2014). Many aspects of the built and natural environments, such as trees, buildings, and power lines, are susceptible to the effects of increased wind loads. As such, municipalities in the Cataraqui Region must recognize and prepare strategies to minimize the potential threat.

Building Code, Urban Design Guidelines

The most common practices for adapting to increased wind loads are not land use policies. Instead, they require municipal and provincial governments to amend building codes and urban design guidelines. It is important that these standards are updated to account for the direct effects of climate change. For example, design standards should be updated to account for increased wind loads, making the buildings more resistant to the increased severity of both windstorms and high-speed gusts (Larsson, 2003). In this regard, one method is to include openings between buildings to allow wind penetration (Upadhyay, Hushodi, & Rijal, 2006). Further, buildings can be oriented in a fashion that limits the impact of wind on ground level features and pedestrians. While not strictly land use policies, municipalities in the Cataraqui Region should consider some of these design practices as a means of creating more wind-resistant infrastructure.

6.2.5 Ice & Snowstorms

Similar to windstorms, the Cataraqui Region is expected to experience an increased the frequency and severity of ice and snowstorm events. The Region expects to see a 50% increase in freezing rain events by the year 2050 (City of Kingston, 2014). As discussed in Chapter 2, the Region is also expected to see an increased average number of days annually with more than 25mm of precipitation. The greatest increases in precipitation are expected to occur in the winter months, resulting in increased freezing rain, ice, and snow.

Building Code, Urban Design Guidelines

Again, the most common adaptation methods are not land use planning policies. Rather, building codes and design guidelines should be updated to account for ice storm risks (Larsson, 2003); increased ice and snow loads will put greater stress on infrastructure. Retrofitting of existing buildings to ensure they are resistant to ice storms is also an option for municipalities in the Cataraqui Region.

Designate Space for Snow Storage

A common strategy for adapting to extreme snow events is to designate additional space for snow storage. The City of Toronto has become a leader in this field, using overflow parking, raingardens, and other areas away from public streets for snow storage (City of Toronto, 2013). Further, the City encourages the use of permeable surface design in snow storage areas as an effective strategy for meltwater control (City of Toronto, 2013).

Burying Utilities

One of the most adverse effects of ice storms is the damage caused to critical infrastructure. Specifically, power lines are very susceptible to ice damage. To address this issue, many municipalities have considered burying power lines below ground (Larsson, 2003). As discussed in Section 6.1.2, the City of Brockville requires this practice where feasible and reasonable. It is acknowledged that the burial of power lines and other utilities can be very expensive. As such, it may not be feasible in some parts of the Cataraqui Region due to shallow bedrock. However, local municipalities should consider encouraging or requiring this practice where feasible to better protect critical infrastructure.

6.2.6 Heat Waves

Due primarily to higher average summer temperatures, the risk of heat waves in the Cataraqui Region will intensify. Heat waves threaten both human and environmental health in a number of ways; notably, by inducing heat stress on humans, plants, and animals.

Urban Greening

The most common land use practice for adapting to heat waves is through the “greening” of urban areas. As discussed in Section 6.1.1, urban areas are subject to a phenomenon known as the Urban Heat Island effect. This effect will intensify as the frequency and severity of heat waves increases. Adaptation methods such as enhancing the urban forest, incorporating green and cool roofs, and promoting the use of materials with low albedo are effective in reducing the Urban Heat Island effect (Luber & McGeehin).

6.2.7 Other Land Use Solutions

In the event of extreme weather, certain populations are more at risk than others. The elderly, young children, and those with disabilities are often at a greater risk. For this reason, it is important that municipalities ensure there are an adequate number of designated community relief locations. These are places people can go for shelter and safety in the event of extreme weather.

6.3 Natural Heritage Features

The Cataraqui Region is home to numerous significant natural heritage features. Some of these features include the Frontenac Arch Biosphere Reserve, the St. Lawrence River, Lake Ontario, Charleston Lake Provincial Park, and many inland lakes and rivers. Municipalities in the Region already recognize the importance of these features and have included official plan policies to protect them in the long term. However, they must also implement adaptation strategies to protect these features from the impacts of climate change. Further, these strategies must enhance the robustness and resilience of natural heritage systems as a whole.

Provincial Imperative

The Province of Ontario provides a policy mandate for the protection of natural heritage features. The *Provincial Policy Statement* acknowledges that the wise use and management of natural heritage resources is a key provincial interest. Individual features should be protected for the long term, and biodiversity and connectivity are important to sustaining natural heritage systems. The *PPS* adopts a restrictive approach to the protection of natural heritage features and systems; development and site alteration are not permitted in or adjacent to identified areas unless it can be demonstrated that there will be no negative impacts on the natural features or their ecological functions. Identified areas include:

- significant ANSIs;
- significant wetlands, woodlands, and valleylands;
- significant wildlife and fish habitat; and
- habitat of threatened or endangered species. (MMAH, 2014)

Ontario Nature, a charitable organization for the protection of nature, recently released the *Best Practices Guide to Natural Heritage Systems Planning*. This report emphasizes Systems-Based Natural Heritage Planning, acknowledging that: "Healthy, functioning and resilient ecosystems require diversity and connectivity" (Ontario Nature, 2014). It also provides numerous examples of leading natural heritage systems planning initiatives from municipalities across southern and eastern Ontario. These examples form the basis for many of the land use solutions presented in this section.

This section discusses a variety of land use planning strategies for the protection of natural heritage features and systems. These strategies are focused on systems-based natural heritage planning and building ecological resilience.

Figure 6.6: Parrot's Bay Conservation Area (Cataraqui Region Conservation Authority, 2015).

6.3.1 Systems-Based Natural Heritage Planning

A systems-based approach to natural heritage planning recognizes that protecting natural heritage features in isolation is inadequate. Rather, these features must be protected in a comprehensive way by considering the system as a whole. As such, this approach strives to maintain ecological linkages between core natural features, corridors, and buffers. This section examines several methods for systems-based natural heritage planning to enhance climate change adaptation in the Cataraqui Region. These include: enhancing connectivity, creating conservation easements, and establishing land trusts.

Enhancing Connectivity

Natural heritage systems include natural core areas and natural linkages (Ontario Nature, 2014). Isolated core areas, however, are more susceptible to biodiversity loss and other effects of climate change. An interconnected natural system of core areas and linkages contributes to climate change

adaptation by protecting and restoring healthy and resilient ecosystems (CPC Climate Change Working Group, 2013). The ability of species to move and adapt to the impacts of climate change depends upon the connectivity of the system as a whole. However, fragmentation and deforestation may weaken the overall capacity of the system to adapt to climate change (CPC Climate Change Working Group, 2013).

The City of Hamilton Rural Official Plan contains policies that recognize the importance of natural core areas and natural linkages for ecological functionality and connectivity of the natural system (The City of Hamilton, 2012). Municipalities in the Cataraqui Region should implement similar policies to preserve and enhance the connectivity of natural heritage systems.

Conservation Easements

A conservation easement is a legal agreement between a landowner and a qualified organization, such as a conservation authority (Ontario Nature, 2014). In this agreement, the landowner maintains ownership and management of the property subject to a set of mutually agreed upon restrictions. This may include restricting development and site alteration to protect water quality, conserve wildlife habitat, preserve open space and farmland, or buffer public lands (The Nature Conservancy, 2015). A conservation easement is registered on title, protecting the property, or a part thereof, long into the future. It also ensures a long-term conservation relationship between the easement holder, the current landowner, and all landowners thereafter. Finally, it may also incorporate financial incentives, including income and property tax reductions (Ontario Nature, 2014).

Often, a portion of natural heritage systems are privately owned and managed (Ontario Nature, 2014). Private ownership and management is often insufficient in maintaining biodiversity, connectivity, and ecological functions in the long term. As such, public ownership plays an important role. As opportunities arise, municipalities in the Cataraqui Region should enhance their natural heritage systems through conservation easements. For example, the Waterloo Regional Official Plan encourages landowners to maintain, enhance, and restore environmental features on their property through measures such as conservation easements (Region of Waterloo, 2015). This type of policy can ensure that natural heritage system areas are protected, more resilient, and better able to adapt to climate change.

Land Trusts

A land trust is a registered, charitable, non-profit and non-governmental organization (such as Ontario Nature) that is dedicated to preserving and protecting natural and cultural areas for the public benefit. There are over 32 volunteer-based land trusts in Ontario that are supported through memberships, donations, and volunteer involvement (Ontario Nature, 2013-2015). Land trusts protect large areas of land that might otherwise be developed, degraded, or damaged (Ontario Nature, 2013-2015). Thus, land trusts can help ensure that natural heritage areas are protected and more resilient to the anticipated impacts of climate change.

The Waterloo Regional Official Plan considers the establishment of land trusts to manage elements of their Greenlands Network (Region of Waterloo, 2015). Municipalities in the Cataraqui Region can incorporate similar policies into their official plans. These policies should consider land trusts for the protection and enhancement of local natural heritage features and systems.

There are currently several land trusts in the Cataraqui Region:

- Rideau Waterway Land Trust;
- Nature Conservancy of Canada Land Trust;
- Thousand Islands Watershed Land Trust; and
- Land Conservancy for Kingston, Frontenac, Lennox & Addington.

Municipalities in the Cataraqui Region should continue to support the operation of these existing land trusts, and support the establishment of new land trusts.

6.3.2 Ecological Resilience

As discussed in Chapter 2, climate change threatens natural heritage features in a many ways. Consequently, land use planning solutions for climate change adaptation must improve the resilience of natural heritage features.

Ecological resilience is the ability of an ecosystem to adapt to climatic changes while maintaining its basic ecological functions (Ontario, 2011). This is critical to reduce the risk of catastrophic change, and is dependent upon efforts to maintain or restore a wide variety of ecosystems (CPC Climate Change Working Group, 2013). Resilience can be achieved through ecosystem-based adaptation and urban naturalization.

Ecosystem-Based Adaptation

Climate change and biodiversity are inextricably linked; it is anticipated that climate change will be the most significant cause of biodiversity loss (Lewington, 2010). However, terrestrial, freshwater, and marine ecosystems play a critical role in adapting to the effects of climate change (UNEP, 2015). Thus, biodiversity must be integrated into land use planning strategies to ensure effective climate change adaptation.

Ecosystem-based adaptation is an integrated approach wherein biodiversity and ecosystem services are combined into one overarching adaptation strategy (UNEP, 2015). This approach supports climate change adaptation by emphasizing:

- protection of biodiversity;
- restoration of ecosystem functions; and
- sustainable use of resources.
  (CPC Climate Change Working Group, 2013)

Specifically, ecosystem-based adaptation can help control flooding and erosion, clean and recharge water sources, manage drought, pollinate crops, provide valuable green space, and store carbon (Lewington, 2010).

The Town of Ajax Official Plan contains policies that employ the ecosystem-based approach; it links the concepts of biodiversity and connectivity (discussed below) within and across jurisdictional boundaries. One of the fundamental principles of the Plan is to:

> "…protect and enhance a strong, biologically diverse Greenlands System that weaves throughout the municipality to interconnect with the broader Great Lakes ecosystem in adjoining municipalities and watersheds." (Town of Ajax, 2015)

Municipalities in the Cataraqui Region can implement similar policies to protect biodiversity, enhance natural heritage features, and restore ecosystem functions.

Urban Naturalization Plan

In urban areas, natural environments have generally been replaced by urban development. Consequently, these areas have been unable to adapt to the impacts of climate change (City of Toronto, 2014).

Urban naturalization is an ecologically-based approach to restoring environmental integrity in the urban landscape (Evergreen, 2001). Similar to urban greening (as discussed in Section 6.1.1), urban naturalization strives to re-introduce native plant species into the harsh urban environment. As such, urban naturalization offers many benefits and assists in adapting to the impacts of climate change.

Some of these benefits include:

- protecting biodiversity and connectivity;
- improving, managing, and conserving water quality;
- improving air quality;
- moderating temperature;
- managing stormwater flows;
- controlling erosion;
- reducing wind velocity; and,
- creating shade
  (Evergreen, 2001).

Urban naturalization can be implemented through official plans, site plan control, subdivision control, environmental strategies, by-laws, and operational procedures (Evergreen, 2001). For example, the Official Community Plan of Burnaby, B.C. requires developers to landscape certain portions of subdivisions with native vegetation (Evergreen, 2001). Further, the City of Waterloo has developed a by-law permitting naturalized yards on private properties.

In 2008, plant growth at 14 Salem Avenue in Toronto, Ontario exceeded the 20cm height limit of the grass and weeds by-law (Municipal Licensing and Standards Division, Toronto and East York District, 2008). The property owner had to submit a request to the Community Council for an exemption to consider it a natural garden. If the City had amended its Municipal Code to permit naturalized yards, the property owner would not have had to engage in the exemption process.

Figure 6.7: 14 Salem Avenue in 2008 (Harrison, 2013).

By fostering urban naturalization, municipalities in the Cataraqui Region can enhance resilience to the impacts of climate change. Criteria should be developed for the identification of suitable candidate sites, especially those around pedestrian paths and trails and on properties designated institutional. This may include developing an inventory of public open space that would be suitable for urban naturalization (Evergreen, 2001). Municipalities in the Region should also consider permitting naturalized yards, such as the example shown in Figure 6.7.

6.4 Agriculture

Ontario contains the highest proportion of Canada's high agro-climatic soil and 52% of Canada's Class 1 (prime agricultural) farmland (Agricultural Adaptation Council, 2002). As the impacts of climate change become imminent, it is critical that municipalities in the Cataraqui Region implement land use strategies to protect agricultural lands in the long term.

Provincial legislation, such as the *PPS*, already aims to protect prime agricultural lands. Additionally, the recently released draft of *Guidelines on Permitted Uses in Ontario's Prime Agricultural Areas* recommends guidelines for local municipalities to further restrict non-farm development in prime agricultural areas (OMAFRA, 2015). However, by subscribing to the "no regrets" approach, municipalities in the Region have the opportunity to go beyond provincial regulations and lead by example. This section outlines several agricultural land use planning solutions for climate change adaptation.

6.4.1 Drought

As a result of climate change, Ontario will experience an increase in extreme weather events including prolonged heat waves, drought, hail, and flooding (MOECC, 2011). These events are expected to have a significant impact on farming operations. Prolonged heat waves and drought conditions will put greater stress on water resources used for agricultural operations, ultimately affecting crop yields. Additionally, municipalities will need to account for changing soil conditions resulting from drought; this should be reflected in official plan policies for agricultural designations (MOECC, 2011). As such, municipalities in the Cataraqui Region should implement land use strategies to protect groundwater resources and promote value-added and ancillary farm uses.

Protect Groundwater Resources

Agricultural operations are water-intensive. Many farmers are reliant on groundwater for crop irrigation and for the cooling of livestock during heat waves. Groundwater supplies may be stressed during times of drought, especially if they were previously over capacity (MOECC, 2011). One method to reduce the stress on groundwater resources is to direct non-agricultural development within the urban settlement boundary. This approach maximizes the amount of non-agricultural uses that are serviced by municipal water systems, therefore reducing stress on groundwater. This could be accomplished through the development and implementation of urban intensification targets.

Another approach is to target the protection of groundwater recharge areas from development and harmful land uses. For example, the Town of Wasaga Beach Official Plan incorporates special land use zones for the protection of groundwater recharge areas (Town of Wasaga Beach, 2003). Inter-municipal cooperation for groundwater management may be required as groundwater resources do not conform to municipal boundaries. The Oak Ridges Moraine Groundwater Program is an excellent example; groundwater is managed through cooperation between the Regional Municipalities of York, Peel, and Durham, the City of Toronto, and the Conservation Authorities Moraine Coalition.

Value-Added & Ancillary Farm Uses

Prolonged drought can also profoundly impact crop yields (Howden, Soussana, Tublello, Chhetrl, Dunlop, & Meinke, 2007). A substantial drought can significantly decrease seasonal yields, placing an economic burden on farmers. In response, municipalities in the Cataraqui Region should permit value-added or ancillary farm uses in agricultural areas. These uses may include small on-farm retail, agri-tourism, or other uses that produce value-added products from the farm operation on the property. The Niagara Regional Official Plan provides an excellent example; policy objectives in the Plan allow farmers to broaden operations and add value to their primary products (Niagara Region, 2015).

6.4.2 Prolonged Growing Season

Many regions in Ontario will experience a longer growing season according to climate change scenarios projected by the Government of Canada (Agriculture and Agri-Food Canada, 2014). Likewise, a longer growing season is expected in the Cataraqui Region. This could create a more viable climate for the growth of specialty crops such as grapes and quinoa.

Designate Specialty Crop Areas

In conjunction with the provincial methods and standards, municipalities should identify and designate specialty crop areas to aid in the transition to new, specialty, or non-traditional crops. For example, the Niagara Region designates a “Unique Specialty Crop Area” in its Official Plan (Niagara Region, 2015). This creates a distinction between general agricultural areas and those that contain unique properties for growing specialty crops. A prolonged growing season can also have benefits for traditional crops such as corn, soybeans, forages and horticultural crops (OCCIAR, 2015). Yields in these cash crops could increase, lessening the demand to expand farming operations.

Figure 6.8: Ontario wine grapes (Henry of Pelham, 2015).

6.4.3 Agricultural Pests

As previously discussed, the average annual temperature in Ontario is expected to increase steadily over the coming decades. This may lead to a change in agricultural pests, invasive species, weeds, and diseases that could negatively affect agricultural production (OCCIAR, 2015). It may also lead to an increase in the risk of illness and death of livestock. The prevalence of vector- and non-vector borne diseases such as, *Leptospirosis* (livestock), *Yersiniosis* (sheep, pigs, goats), *E. coli enteritis*, and *Salmonellosis* (cattle, horses, swine) may increase (Wall, Smit, Wandel, & Brklacich, 2007). These diseases have the ability to significantly impact the viability of a farming operation.

Minimum Distance Separation (MDS)

Municipalities in the Cataraqui Region should ensure compliance with Minimum Distance Separation (MDS) regulations provided by the OMAFRA. The *MDS*

Implementation Guidelines published by the OMAFRA should be considered the minimum; it may be necessary to increase MDS to reflect changing climatic conditions.

6.4.4 Alternative Land Use Services

Alternative Land Use Services (ALUS) is a new approach to climate change adaptation. ALUS pays farmers to retain and reconstruct valuable natural features on their farmland, such as wetlands, grasslands, and riparian areas (ALUS, 2015). The life-supporting processes of the natural environment are thereby rehabilitated, offering many benefits such as:

- creating wildlife habitat;
- promoting water filtration;
- protecting endangered species;
- providing cleaner air and water; and,
- supporting sustainable food production (ALUS, 2015).

ALUS challenges traditional conservation and agricultural practices by emphasizing the retention of key ecological features as an adaptation strategy. While ALUS is a privately funded program, it is possible for local municipalities to get involved and encourage local farmers to operate in a more sustainable manner.

6.4.5 Food Security

An increase in global food insecurity will be evident with climate change (ChwenMing, 2009). The increased state of global food insecurity has the potential to affect traditional import patterns of foreign foods to the Region (ChwenMing, 2009). This could place an increased importance and reliance on producing local food products which, naturally, would require an increase in agricultural land consumption. Therefore, it is important that local municipalities take measures to protect their stock of agriculturally viable lands for future use. This section examines two measures that are applicable to the Region: promoting urban agriculture and protecting prime agricultural land.

Urban Agriculture

It is important to consider the role of urban agriculture in climate change adaptation. Urban agriculture can reduce land consumed for agriculture in rural areas, minimize the distance travelled by consumed foods, and create food secure communities. Municipalities can encourage urban agriculture by:

- permitting community gardens on public and private property, where appropriate;
- establishing partnerships with public, private, and non-profit groups; and,
- ensuring that new development includes opportunities for urban agriculture, including rooftop, home, and community gardens (ChangeLab Solutions, 2012).

For example, the Town of Ajax Official Plan recommends securing agricultural easements to hold land for community gardens in perpetuity (Town of Ajax, 2015). Municipalities in the Cataraqui Region can implement similar policies to encourage urban agriculture.

Municipalities should also set aside areas in public spaces where local farmers can bring their products to market. This can be accomplished by designing public spaces to accommodate large markets and allowing for fresh produce stands to be set up within municipal road easements. Altogether, this has the power to decrease dependence on foreign foods and to promote local, sustainable agriculture.

In addition to traditional community garden crops, urban agriculture may also include the keeping of livestock. For example, residents in Kingston may obtain a hen coop permit to raise a maximum of six hens on any residential property. Kingston By-law 2004-144 sets minimum yard setbacks and other regulations for the keeping of hens in the urban area and encourages the sale of eggs, manure and other associated products where hens are permitted.

In Singapore, municipal and federal governments actively support urban agriculture. Urban agriculture is allowed to be practiced by commercial farmers within the City; however, these farms must be located within a designated Agrotechnology Park. Agrotechnology Parks are modern agricultural estates with the proper infrastructure and lands for farming. These parks are government owned areas ideal for farming, and are located within the urban area or on the urban fringe. They are leased to farming companies to produce hydroponic vegetables, orchids, ornamental plants, aquatic plants, freshwater and sea fish, eggs, milk, and crocodiles. This approach enables intensive farming within the urban area of Singapore, without the occurrence of negative externalities on adjacent land uses (Quon, 1999). While this is certainly a unique example, it should still be considered as a viable option in the Cataraqui Region.

Protecting Prime Agricultural Land

Another important land use approach to support food security is the protection of prime agricultural land. These are the most productive agricultural lands, including class 1, 2, and 3 soils (prime soils) as classified by the Canada Land Inventory. The *PPS* already requires the protection and designation of prime agricultural land for long-term agricultural use. Where applicable, municipal official plans in the Cataraqui Region either already comply or must comply when the official plan is updated.

Halton Region has implemented a systems approach to maintaining and permanently securing their agricultural industry. The Halton Region Agricultural System works in conjunction with the Natural Heritage System to:

- ensure that agriculture is recognized as the primary activity and land use in the Agricultural System;
- maintain as much land as possible for existing and future agricultural use; and
- promote a diverse, innovative, and economically strong agricultural industry by tailoring products and marketing to meet local and regional needs and demands

(Halton Region, 2014).

Halton Region is also one of the only regional municipalities in Ontario that prohibits agricultural lot creation through surplus farm dwelling severance (Halton Region, 2014). Municipalities must limit the ways in which new non-farm lots can be created in agricultural designations in order to limit the fragmentation and loss of valuable agricultural lands. Together, these policies present a firm policy framework for the protection of prime agricultural land that goes above and beyond provincial mandate. Municipalities in the Cataraqui Region should look to Halton as an excellent example of agricultural policy for climate change adaptation.

6.5 Public Health

Humans are sensitive to variations in climate and vulnerable to the impacts associated with climate change. Public health will be a growing concern as the climate changes and, although mediated partially by global conditions, will force humans to adapt locally. Municipal governments must proactively and reactively contend with issues of climate change through regulation of the urban form and fabric, governance practices, upstream health policies, building and urban design guidelines, and stormwater management or other extreme weather event practices. Many of these areas of concentration overlap with other non-human impacts of climate change. The public health response to climate change represents an integrated strategy that is interdisciplinary and spans across multiple approaches.

6.5.1 Urban Form and Fabric

Urban form and fabric describe general land uses and how they are realized in the built environment. Characteristics of the urban environment impact urban climate conditions through the manifestation of Urban Heat Islands, more severe heat wave events, and stress to energy systems (Smith, et al., 2014). Urban form policies should also address wind and heat impacts, as these are both slated to increase in the future climate (Smith, et al., 2014). A variety of land use solutions were already presented in Section 6.2. However, a brief recap is offered below.

Interspersing park space into the urban fabric and implementing green roofs wherever possible will help prevent urban heat problems while not completely altering the compactness of the urban fabric (Jabareen, 2006). Compact urban form also offers other benefits, including: reducing energy demand, reducing utility servicing costs, and increasing opportunities for active modes of transportation. Fewer brownouts and more energy for critical systems, more money to invest in health promotion, and less air pollution are all outcomes that should encourage municipalities to act on these issues. To achieve these outcomes, cities can develop taxation policies that charge higher taxes to low intensity land uses in certain areas. Parking policy is also linked to land use; downtown parking should be restricted in urban areas (Morall & Bolger, 1996).

6.5.2 EWS & Risk Assessments

Emergency Warning Systems (EWS) are a commonly used tool supporting public health and safety. Ontario is at the forefront in this regard; local risk assessments are required for every municipality (UNISDR, 2012). It is crucial, however, that these plans reflect future conditions (Mimura, et al., 2014). Vulnerability assessments are crucial to protecting the most susceptible populations; risk-assessment information should be updated regularly. For example, maintaining an up-to-date database of lands at risk of flooding or erosion can benefit a municipality greatly when it comes to evacuation in the face of a flood disaster. Education, awareness, and training are also important tools for helping maintain public health (Tompkins, Adger, Boyd, Nicholson-Cole, Weatherhead, & Arnell, 2010).

6.5.3 Healthcare

Acute health intervention is a costly process, whereas the prevention of health issues is comparatively cheaper and more effective in the long run. Rising air temperatures as a result of climate change will lead to increased levels of aeroallergens, air pollution, vector-borne diseases, and UV radiation. Increased atmospheric temperature threatens to worsen some existing health problems, such as heart, kidney and psychiatric problems (Franchini & Mannucci, 2015). Simple acts such as

providing increased shade in recreational areas can assists with lowering instances of sunburns and skin cancer.

Airborne pollen is expected to increase due to a longer growing season and increased CO_2 levels. This results in greater allergic sensitization, worse allergy and asthma symptoms, and more hospital visits.

The warming climate is also expected to increase ozone levels; rising temperatures are expected to increase the chemical reactions that form ozone. Ozone in the Earth's troposphere affects air quality, which may lead to a reduction in lung function, worsened asthma symptoms, cardiopulmonary mortality, and an overall increase in the number of hospital visits. Municipalities can reduce the health costs caused by increased ozone by enacting policies that reduce vehicular traffic or limit types of industry to those that are low-emitting.

Vector-borne diseases, such as Lyme disease, will also be affected by changes to our climate. Southern Ontario used to be at the edge of the deer ticks' geographic distribution, but a warming climate has allowed the ticks to migrate further north (Ogden, et al., 2006). Many other diseases, like *Hantavirus*, have worsened outcomes in projected climate change scenarios. Being aware of these hazards is the first step, and disease reduction in citizens can be aided by addressing vector reduction strategies.

As previously discussed, a municipal shading policy is one strategy to adapt to increased temperatures and UV rays. This may include a tree planting program which can be implemented region-wide or target urban cores.

6.5.4 Buildings and Urban Design

In a warmer climate, power consumption may be a concern, especially during heat waves (Smith, et al., 2014). Taking this into consideration, design techniques may be used to minimize heating and increase comfort during hot days (Kwok & Rajkovich, 2010). Incorporating passive cooling systems into developments, designing with solar orientation in mind, and promoting urban greening are all strategies that reduce heat-related risk, save energy for critical systems, and reduce humanity's carbon footprint. Municipalities in the Cataraqui Region should consider placing height restrictions on buildings; in the event of electrical blackouts due to extreme weather, residents may have difficulty walking down multiple storeys, especially in heat waves.

Further, municipalities should ensure an adequate number of community buildings are designated as relief centres. Cooling centres and considerations for institutional building design to accommodate disaster relief should be included in zoning by-laws. Permitting and encouraging these uses will become more important than ever with climate change.

Mixed-use development has been found to foster closer monitoring and provide greater assistance in times of need. In New Zealand, these social connections were responsible for saving people in extreme heat wave events. People were provided with information from their neighbourly social contacts, which prevented many deaths (Howden-Chapman, Chapman, Hales, Britton, & Wilson, 2010).

6.5.5 Stormwater Management and Extreme Weather

Public health and safety will be threatened due to extreme weather events. These events may result in floods, fires, droughts, and wind-related effects (Smith, et al., 2014). As the climate changes, these events will increase in frequency and

severity. As such, it is important for municipalities to plan accordingly.

As discussed previously, regulation of urban form and design offers many benefits. Other land use solutions were discussed in Section 6.2. Many adaptation policies aimed at adapting the built environment to extreme weather events also benefit public health and safety. In the instance of flooding, for example, stormwater runoff control designs such as green roofs, bioswales, and stormwater management ponds are common methods. These methods also reduce nutrient loading in soils and prevent harmful algal blooms in nearby water bodies that may be important to human health (Smith, et al., 2014).

In terms of public health, some extreme weather events can be more difficult to adapt to than others. Fires, for example, have the potential to negatively affect air quality, a direct threat to human health. Therefore, it is important that these policies are coupled with adequate public awareness and secondary strategies, such as the implementation of a fire ban program.

Figure 6.9: Bioswale project in Kingston (Stone & Maple, 2013).

6.6 Infrastructure

As the effects of climate change become more apparent, local governments need to update their legislation to adapt to the negative impacts while amplifying the positive. With respect to infrastructure, there are several methods that can be used to accomplish this. These methods will address concerns in five major infrastructure categories: transportation, buildings, water, wastewater, and marine.

6.6.1 Transportation

Several effects of climate change that affect transportation infrastructure will become more prevalent in the coming years. These include: increased freeze-thaw cycles, flooding, increased atmospheric temperature, and ice storms (Boyle, Cunningham, & Dekens, 2013).

With respect to asphalt wear, there will be an increase in wear during both the summer and winter months. Increased average annual temperatures will soften asphalt in the summer, rendering it less resilient to traffic loads. In the winter, asphalt wear and cracking will be more prevalent due to more frequent freeze-thaw cycles. Municipalities should plan for these changes by modifying their construction schedule and operations budgets to account for more year-round repairs and a decrease in the service life of asphalt surfaces. They can also switch to more resilient asphalt materials that are more resistant to the freeze-thaw cycle and high temperature wear. For example, the City of Hamilton recently approved the use of Superpave asphalt mixes in addition to the traditional Marshall mixes (City of Hamilton, 2013). Finally, municipalities can capitalize on a longer construction season due to the warmer winter months (Boyle, Cunningham, & Dekens, 2013).

In areas where roads and other transportation infrastructure are located near water features, there will be an increase in the likelihood that the road will be washed out during a significant weather event (Boyle, Cunningham, & Dekens, 2013). Municipalities should direct road construction away from water features and adjust their development vision and official plan accordingly.

Increased occurrences of ice storms in the Cataraqui Region will intensify the need for road salting and have the potential to cause a higher number of severe traffic incidents. Municipalities in the Region need to prepare emergency response plans that account for the increase in severe winter weather events (Medhi, Mrena, & Douglas, 2006). Emergency response plans can be modeled after the City of Toronto *Emergency Response Plan*; in the wake of a severe storm in December 2013, it contains a great amount of detail regarding ice storms. Toronto has taken many steps to ensure the population is adequately protected during these extreme weather events, including reviews of above-ground infrastructure and locating trees that may impact hydro lines should they fall (The City of Toronto, 2014).

6.6.2 Buildings

Buildings in Ontario will experience increased wear and significant damage from more extreme weather events due to climate change. This will increase the annual maintenance cost and necessitate more frequent building renewal. An increase in extreme weather events will also increase the likelihood of catastrophic building failure through increased snow loads, ice loads, and an increased rate of corrosion (Medhi, Mrena, & Douglas, 2006). Municipal and provincial design standards should be updated to reflect this change in loading amounts.

6.6.3 Water

In the face of a changing climate, there are many concerns about long-term fresh water availability and conveyance by means of treatment plants and pipe networks. Water infrastructure systems are at risk from the effects of climate change; water mains and other water pipes are at an increased risk of breaking or cracking due to more frequent freeze-thaw events. Water main breaks are costly to repair and are a major inconvenience to people serviced by the line. As such, it is necessary for municipalities in the Cataraqui Region to prevent these breaks rather than face the high cost of repair.

Figure 6.10 shows maintenance crews addressing a water main break in Kingston at the intersection of Princess St. and Sir John A. MacDonald Boulevard.

Figure 6.10: Watermain break in Kingston, 2015 (The Whig, 2015).

Water Main Depth

To reduce the potential for water main breaks, municipalities should require water mains be buried at a lower depth. For example, a study in the Municipality of Red Lake in northwestern Ontario found that deep-buried water pipes have some of the lowest lifecycle costs; there is little maintenance required after installation. Considering that Red Lake has bedrock close to the surface and excavations are expensive, in areas where the bed rock is lower than 3m from the surface this method would be substantially cheaper (The Municipality of Red Lake, 2012).

Water treatment infrastructure will also be affected through decreases in local water tables and through treating source water with higher concentrations of contaminants. Land use solutions to address this issue are examined in Section 6.7.

6.6.4 Wastewater

Due to an increase in significant rain and snow events, there will be a surge in the volume of stormwater to be conveyed to storage ponds or that will need to be treated. This will increase the wear and strain on existing storm sewers and will necessitate design standards to require larger pipes, in turn creating more costly developments (Rosenberg, et al., 2010).

Low Impact Development

Municipalities can implement a Low Impact Development (LID) approach to help reduce the peak flow of water on existing infrastructure (Gill, Handley, Ennos, & Pauleit, 2007). This approach includes measures such as permeable pavement, use of native landscaping, reducing hardscapes, and the creation of green roofs.

The Town of Caledon Official Plan mandates LID; in Section 3.1.3.7.1, the Town shall ensure that appropriate design guidelines, such as LEED, LID, and Energy Star, are developed and implemented to achieve sustainable development (Town of Caledon, 2015). Internationally, the Scandinavian countries of Norway, Denmark, and Sweden have widely use permeable pavement in low intensity areas such as parking lots or pedestrian walkways. These initiatives substantially reduced the impact of rain and snow on stormwater infrastructure; showing that the technology is viable in cold weather climates (Scholz & Grabowiecki, 2007). Municipalities in the Cataraqui Region should consider using LID to avoid the costly replacement of storm sewers. This approach can be implemented through urban design guidelines and municipal demonstration projects.

6.6.5 Marine

The Cataraqui Region is home to hundreds of kilometres of shoreline on Lake Ontario and numerous inland lakes and rivers. Climate change will negatively affect shoreline structures; notably, there will be a reduction in lake ice cover and remaining ice will be more mobile and susceptible to wave action. This can easily damage docks and piers. Further, the water level in Lake Ontario is expected to decrease which will make marine shipping more difficult as some piers may no longer be accessible (Medhi, Mrena, & Douglas, 2006). Municipalities should plan for modified shipping routes and industrial areas on Lake Ontario and through the St. Lawrence River.

6.7 Potable Water Resources

The protection of potable water against the impacts of climate change in the Cataraqui Region can be divided into three themes:

- protecting water infrastructure;
- protecting ground and surface water at the source; and,
- protecting against non-point source pollution.

Under theme 1, water infrastructure is susceptible to climate change impacts like drought, changing freeze-thaw cycles, and changing precipitation levels (International Institute for Sustainable Development, 2013); this was already addressed in Section 6.6.3. Theme 2 addresses the protection of source water by managing surrounding land uses. A recent study in the Cataraqui Region found a causal relationship between land use change and surface water quality (Kaur, 2015). As such, source protection policy is examined below in Section 6.7.1. Finally, theme 3 addresses land use planning to protect against non-point source pollution. This topic is briefly discussed in Section 6.7.2.

6.7.1 Source Water Protection

Land use planning solutions for source water protection are unique as compared with other themes in this report. Ontario has already experienced a major tragedy relating to drinking water. In the year 2000, several people died and thousands became ill in the community of Walkerton in southern Ontario. This tragedy was due in part to poor land use planning. From this tragedy came the *Clean Water Act.* The major goal of this legislation was to protect Ontario's drinking water (both ground and surface water) at the source. The *Clean Water Act* is innovative legislation as it defers enforcement of some of its policies to other legislation such as the *Planning Act*. The *Clean Water Act* mandates that the Province protect source water on a regional or watershed scale through the creation of a series of regional source protection plans. For example, the *Cataraqui Source Protection Plan* covers the same geographic scale as the CRCA. Source protection plans are designed to protect vulnerable areas, including the areas around wellheads, surface water intake areas, recharge areas for ground water, and highly vulnerable aquifers.

Figure 6.11: King St. Water Treatment Plant in Kingston, ON (Knowles, 2012).

After the *Clean Water Act* was introduced, it took until 2015 for most source protection plans to be approved. Ontario municipalities are now concurrently working on strategies to effectively integrate source protection polices into official plans and zoning by-laws. It is particularly challenging as source protection plans regulate activities on land, while the *Planning Act* regulates land uses. Some municipalities, like Waterloo

Region and Wellington County, have developed sophisticated land classification systems to sort land uses into categories of risk to attempt to bridge this gap. Others only defer to their regional source protection plans. The best practice for integrating source protection policy into official plans remains to be seen, but there is a legislative framework in place to support the protection of ground and surface water resources.

Source protection plans have a sophisticated method of protecting source water. Source protection plans identify four types of vulnerable areas:

- Wellhead Protection Areas;
- Intake Protection Zones;
- Significant Groundwater Recharge Areas; and
- Highly Vulnerable Aquifers.

Groundwater is protected using Wellhead Protection Areas (WHPAs). Zones are created around a wellhead based on the time of travel to the well. In the Cataraqui Source Protection Plan there are five zones:

WHPA A – 100 metre radius around the wellhead;
WHPA B – time of travel <= 2 years;
WHPA C – time of travel <= 5 years;
WHPA D – time of travel <= 25 years; and
WHPA E – areas where ground water is under the direct influence of surface water.

Source protection plans are developed in part through using information from Assessment Reports. These are scientific documents that assess how easily contaminants could get into water. WHPAs are assigned vulnerability scores according to these assessments; scores are on a scale of 0 to 10 (10 being the most vulnerable). Source protection plans regulate activities in WHPAs based on the combined WHPA zone and associated vulnerability score.

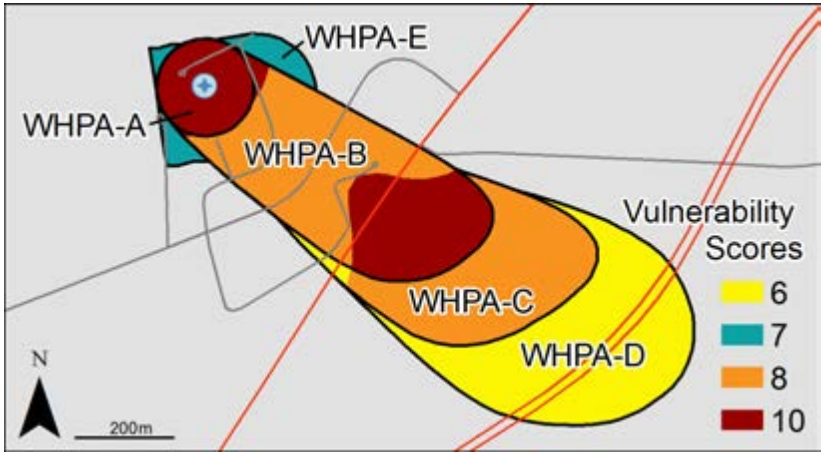

Figure 6.12: Cana WHPA in Kingston ON (Cataraqui Source Protection Plan, 2014).

Surface water is protected through Intake Protection Zones (IPZs). In the Cataraqui Source Protection Plan these are categorized into three zones:

IPZ 1 – one kilometre radius around the intake;
IPZ 2 – within 2 hour current travel time to intake; and
IPZ 3 – areas where a contaminant could reach the intake during and after a large storm.

The same vulnerability score system is used to regulate activities within IPZs.

Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas are both protected as regional areas of sensitive groundwater. They are not protected using zones like WHPAs or IPZs, however, because more than 90% of the

Cataraqui Region is a highly vulnerable aquifer. Thus, protection of these areas is employed on a regional basis.

Source protection policy is challenging to implement and is one of the newest issues in Ontario planning. One unique feature of source protection policy is that protection zones (WHAPs and IPZs) are based on hard science. However, changes in annual precipitation levels and increased extreme weather events were not included in the modeling which led to the creation of WHPAs and IPZs. As such, existing source water protection may not be enough to support adaptation to the impacts of climate change.

Implementation Tools

There are two primary tools to implement source protection policy using the *Planning Act*. These are Section 34 – Zoning By-laws and Section 41 – Site Plan Control.

Municipalities including the City of Barrie, Oxford County, the Region of Waterloo, the City of Orillia, and others have begun to incorporate source protection policy into their official plans. One common approach is creating a series of land use schedules. These schedules are overlay designations and come with a series of development restrictions on top of those outlined in the official plan designation and zoning.

At a broad scale, it is necessary to incorporate source protection policies into official plans and zoning by-laws. At a narrower scale, all vulnerable areas in the Cataraqui Region should be subject to site plan control; this allows specific provisions to be mandated on a site-by-site basis. This is particularly valuable when the line between two vulnerability levels runs through a parcel of land; higher risk operations can then be moved to less vulnerable areas.

For example, developers in Colorado must demonstrate the existence of a 300-year water supply to receive approval for a subdivision; the State was given legislative authority to implement this development limitation in 2008 (Kenney, 2009). The goal of this policy is to ensure that residents in new developments have long-term access to groundwater. However, this policy does not protect depleting groundwater resources. Rather, it protects against already depleted resources. Ontario has a similar policy: MOECC Procedure D-5-5 stipulates that a minimum flow rate of 13.7 L/min. must be obtained in test wells to permit development (MOECC, 1996). In terms of protecting the quantity of water, Ontario has a permit to take program which requires an application to the MOECC to take more than 50,000 litres of water per day (MOECC, 1994).

Source protection policy is the first step in protecting potable water resources against the impacts of climate change. Municipalities in the Cataraqui Region should implement the findings of the *Cataraqui Source Protection Plan* while accounting for the long-term impacts of climate change.

6.7.2 Non-Point Source Pollution

Non-point source pollution comes from multiple sources and can be divided into urban run-off pollutants and agricultural runoff (Great Lakes Science Advisory Board, 2000). A prominent example of non-point source pollution is private vehicles which spill small quantities of hazardous fluids, such as motor oil. Even a small spill from many vehicles adds up.

Unfortunately, few land use solutions have been identified to address non-point source pollution. However, solutions that have already been discussed, such as urban greening and naturalization, enhancing vegetation in riparian zones, and the

creation of bioswales, can help filter run-off contaminants before reaching potable water sources.

6.8 Energy

Climate change in the Cataraqui Region is expected to place unprecedented stress on existing energy generation and distribution systems. Notably, more frequent extreme heat events will necessitate increased energy consumption for the cooling of buildings. Decreased water levels in the Great Lakes and other water bodies will decrease the capacity for hydroelectric power generation. Further, unsustainable or heavy-polluting energy generation systems such as coal power will be phased out in favour of cleaner alternatives. As such, proper planning and management of energy generation and distribution systems will need to account for these and other changes.

In Ontario, all energy generation and distribution is controlled by the provincial government. As such, municipalities sometimes lack the authority to implement any unique or innovative energy solutions. However, there are still some measures that municipalities in the Cataraqui Region can consider to ensure adequate long-term energy generation. It is important to note that policy support and coordination is necessary between the municipal and provincial governments, and other authorities such as Ontario Power Generation, to ensure the success of energy projects.

This section examines a variety of land use solutions that may be considered in the Cataraqui Region. The section is divided by type of energy generation, including: solar, wind, hydro, nuclear, and general green energy standards.

6.8.1 Solar Energy

It is difficult to determine the future accessibility of efficient solar energy technologies. Due in part to technological and economic constraints, solar power generation in the Cataraqui Region is currently limited; less than 1% of Ontario's current energy production is solar (Independant Electricity System Operator, 2015). As technologies improve, however, solar power generation is becoming more viable and should be considered to supplement existing power generation methods.

Community Solar Gardens

On a community basis, there are examples from the United States, as close as Massachusetts, using the innovative idea of community solar gardens (Team Sippican, 2014). Community solar gardens initiatives allow residents to invest in the creation of solar farms. A parcel of land in a developed area is allotted for solar power generation by a member of the public or a corporation; this diminishes the long, expensive, and inefficient transmission of energy from conventional rural solar farms (Hess, 2013). In addition to the benefits of green energy generation, residents in the area are typically offered tax credits.

On a larger scale, municipal governments can work together to allot land for large scale solar farms. For example, the Town of Gananoque Official Plan contains a general land use provision promoting the use of lands for solar projects (Town of Gananoque, 2009). However, this policy is difficult to implement; coordination is necessary between the municipal and provincial governments, Ontario Power Generation, and other stakeholders. Nevertheless, other municipalities in the Cataraqui Region should consider implementing policies for community solar gardens and larger scale solar projects.

6.8.2 Wind Energy

Technological improvements make wind energy more efficient and more viable in a changing climate. Ideally, off-shore wind generation should be promoted; for example, Demark has been very successful in implementing wind energy projects (Knohn, 2002). Unfortunately, these types of wind energy projects are not as feasible in the Cataraqui Region. Instead, wind energy projects in the Region must consider local environmental impacts, strategic placement, and economic feasibility. While some wind energy projects have already been implemented in the Region, such as the Wolfe Island Wind Farm, municipalities should explore opportunities for additional projects to increase wind energy generation.

Large Scale Wind Generation

A great example of a large scale wind generation project is the Parcs Éoliens de la Segneurie de Béaupre near Quebec City. This project, the largest in Canada when completed, will provide 380 MegaWatts of power to Quebec City and the surrounding Region (Parcs Éoliens de la Seigneurie de Béaupre, 2015). Similar projects in the Cataraqui Region can make wind energy economically, socially, and environmentally viable.

6.8.3 Hydroelectricity

As previously discussed, the capacity for hydroelectric energy generation is expected to diminish as a result of climate change. Today, Ontario heavily relies on hydroelectricity; it accounts for roughly 24% of the installed generation capacity (Independant Electricity System Operator, 2015). Decreased water levels in the Great Lakes and lower flows of water in rivers, tributaries, and open water bodies will require careful monitoring for hydroelectric purposes in the future (Expert Panel on Climate Change Adaptation, 2009).

Small Hydroelectric Projects

Planning for hydroelectricity should be primarily focused on small scale hydroelectric projects, which require less water flow and create fewer harmful environmental impacts (Teare, 2013). Combined with the maintenance of existing hydroelectric generation facilities, small scale hydroelectric projects will help ensure the preservation and promotion of hydroelectricity as the climate changes.

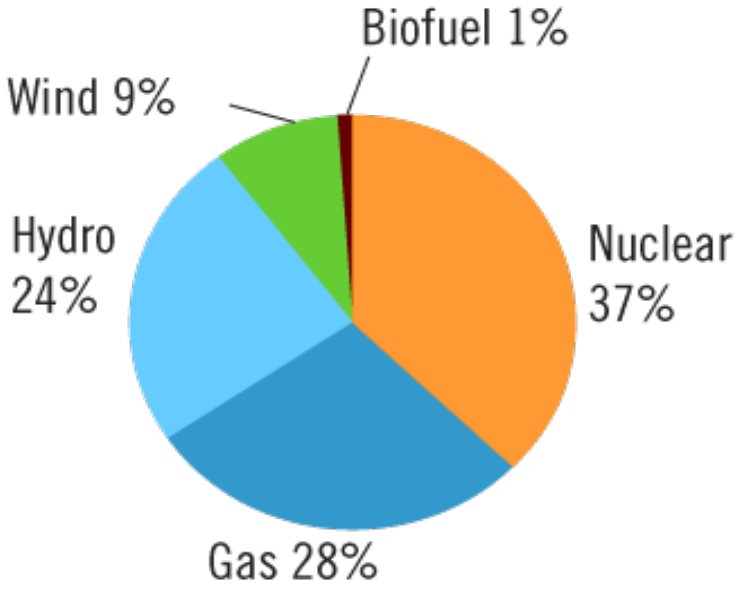

Figure 6.13: Ontario's installed energy generation capacity (Independant Electricity System Operator, 2015).

6.8.4 Nuclear Energy

Nuclear energy has become increasingly popular and now accounts for 37% of the current installed energy production in Ontario (Independant Electricity System Operator, 2015). Climate change can significantly impact solar, hydro, and wind power in the future; investment in these energy sources may be risky. However, nuclear energy does not suffer from these limitations. As long as there is an appropriate supply of water, fuel (U-235 or other), and safe technology, nuclear power may prove to be the best energy alternative for the Cataraqui Region. Seeing this opportunity, France in 1999 pushed for the advancement of nuclear energy production over other forms of renewables after analyzing their costs and benefits. It was found that nuclear energy could help in climate change mitigation through decreasing CO_2 emissions while also addressing adaptation through stability in energy production (World Nuclear Association, 2015). As such, it is necessary to ensure that land of an appropriate size is set aside to accommodate future growth in the nuclear power generation industry.

The United Kingdom holds a high set of standards for the placement and provision of land for new nuclear energy reactors and facilities. Their land use policies strive to appropriate lands that meet specific criteria; for example, low to marginally productive agricultural lands located in a semi-urban environment without significant density change for a 30km radius are preferred (Health and Safety Executive: Nuclear Directorate, 2008). Similar land use policies should be considered in the Cataraqui Region to secure future nuclear energy generation.

6.8.5 Green Energy Standards

The application of green energy standards to new and existing developments is a straightforward approach for climate change adaptation. For instance, it is easier to reduce the amount of energy consumed rather than create more energy at the source to compensate for inefficiency in buildings. In development and redevelopment projects, it is possible to promote advantageous placement of buildings that passively reap the benefits of solar and other energy efficiencies. This is attainable by organizing the creation of new lots and streets to maximize solar energy gain and minimize loss from wind whenever possible (Town of Ajax, 2015). This strategy is particularly beneficial in settlements with rapid growth or large amounts of land set for future growth.

In developed areas, the use of efficient building materials and onsite energy production is encouraged. From a land use policy perspective, implementation of these policies is difficult. However, CIPs may be used to encourage energy neutral requirements for development, redevelopment, or new capital expenditure projects. The City of Kingston, for example, promotes infill to a LEED standard in their CIP (City of Kingston, 2010). Implementation of comparable initiatives may assist in bringing the quality of development in the Cataraqui Region to a higher level of energy efficiency. In turn, this reduces the overall demand for energy generation.

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CHAPTER 7: RECOMMENDATIONS

Image courtesy of Amy Shanks, 2015

CHAPTER 7: RECOMMENDATIONS

7 Recommendations

The following chapter outlines recommendations for climate change adaptation in the Cataraqui Region. Formulated based on the land use planning solutions research summarized in the previous chapter, these recommendations have been written in official plan policy language in order to facilitate their use in the various official plans of the Cataraqui Region. Due to the rather complex nature of policy-writing, many of the recommended policies have been paraphrased from policies contained in official plans from elsewhere in Ontario. Of particular prominence are policies from the Town of Ajax and the City of Waterloo. These two municipalities are seen to be at the forefront of climate change adaptation at this point in time, and it was felt that they would be an excellent frame of reference for this project.

As discussed earlier in the methodology section of this report, every recommended policy below was carefully evaluated to ensure that it:

a) complied with Ontario planning legislation;
b) would be feasible to implement in the Cataraqui Region;
c) would be effective at addressing the impacts of climate change in the Cataraqui Region; and
d) would enhance existing social, economic, and environmental conditions in the Cataraqui Region.

This is not to say that these recommended policies are perfectly ideal; further consideration and editing is necessary. Each municipality will still have to carefully evaluate their usefulness within that particular geographical context before they can be adopted. Further, each municipality will also have to ensure any efforts they take to implement the recommended policies follow the appropriate procedures for amending and adopting official plan changes in Ontario.

Many of the policies outlined below constitute aspects of what is already considered to be “good” land use planning, regardless of climate change adaptation. They are included here because many of them were lacking in the official plans that were reviewed earlier in this report. Furthermore, the duality of their usefulness speaks to how climate change adaptation is very much a ‘no regrets’ approach to land use planning. Even if the anticipated impacts of climate change do not surface, the municipalities of the Cataraqui Region will still benefit from their implementation.

Due to the hierarchical nature of Ontario’s planning framework, the majority of the recommended policies included below are targeted at, but not exclusive to, separated municipalities and counties in the Cataraqui Region. It is our opinion that most can easily be re-written to apply to townships as well if this is desired. Furthermore, many of the recommended policies are targeted towards urban areas within the separated

municipalities, because much of the existing literature pertains to adapting urban centres to climate change. Additionally, urban areas are expected to experience the most extreme impacts of climate change. It is however important to note that the CRCA is predominantly rural; in the future as more literature pertaining to rural areas and adaptation becomes available, the CRCA should incorporate those findings to compliment the recommendations found in this report.

A series of symbols are included at the end of each policy. This indicates which tier of municipality the particular policy applies to, as written. The legend for these symbols is as follows:

C: County

T: Township

S: Separated Municipality

The recommended policies have been separated into eleven subgroups. Below each subgroup is an objective statement that expresses what each series of policies in that subgroup hopes to achieve. Together, each objective addresses the primary goal for this project, which is to ensure the Cataraqui Region is prepared for the locally anticipated impacts of climate change.

7.1 Effective Use of Site Plan Control

Many of the policies below point specifically to the use of site plan control to ensure preparedness for the anticipated impacts of climate change. As such, it is our recommendation that municipalities consider implementing a comprehensive site plan control by-law that covers the entirety of their boundary, and is designed to enforce many of the recommended strategies outlined below. This should only occur where it is feasible; it is understood that many of the municipalities in the Region may not have the economic or staffing resources to implement an immersive site plan control by-law at this point in time.

The creation of a development permit system may also serve to foster the implementation of many of the policies outlined below. However, due to its relative newness within Ontario's planning framework, it is difficult to say with certainty what the benefit of this approach would ultimately be.

7.2 Rural Agriculture

Objective: In order to prepare for the anticipated changes to food security that will accompany a changing climate, preserve and maintain *[The Municipality's]* prime agricultural lands for future use. Maintain a permanently secure and economically viable agricultural industry in *[The Municipality].*

a) Utilize soil information provided by the OMAFRA to ensure that all prime agricultural lands (Class 1, 2, and 3 soils) are protected and secured in perpetuity under Agricultural designations.
C T S

b) Develop an Agricultural System in conjunction with, and in compliment to, *[The Municipality's]* Natural Heritage System.
C T S

c) Ensure the policies of the Official Plan are consistent with technical guidelines published by the Province, including the Guidelines on Permitted Uses in Ontario's Prime Agricultural Areas, once a final version is published.

d) Identify the need for, and incorporate a Unique Agricultural Area designation, in order to maximize opportunities for specialty crop production.

e) Develop urban intensification targets in conjunction with the Province, in order to limit non-agricultural development in rural areas.

f) Adopt a restrictive approach to non-farm lot creation in Agricultural designations.

g) Allow for uses in Agricultural designations that broaden agricultural operations, diversify economic activity, and add value to primary farm products, such as on-farm retail and agri-tourism.

h) Promote the sale of agricultural products produced on-site through the development application process.

7.3 Urban Agriculture

Objective: In order to prepare for the anticipated changes to food security that will accompany a changing climate, maintain a permanently secure and economically viable agricultural industry in [*The Municipality*]. Promote agricultural activities within the Urban Area that are compatible with planned land uses, enhancing access to locally grown produce, lowering energy consumption, reducing transportation costs and greenhouse gas emissions, and augmenting supplies of fresh and preserved foods.

a) Encourage and promote opportunities for urban agriculture, such as green roofs, and home/community gardens, through the development application process.

b) Seek opportunities to incorporate urban agriculture into public spaces such as parks, easements, and other publicly owned lands.

c) Encourage the use of public spaces, such as squares, to facilitate the market and sale of local foods.

d) Develop and implement an urban livestock by-law that allows for the keeping of hens and other farm animals deemed appropriate by [*The Municipality*] in the Urban Area.

e) Promote the sale of agricultural products produced on-site through the development application process.

7.4 Water Resources

Objective: Protect and preserve *[The Municipality's]* surface and groundwater resources, through water conservation and source water protection efforts, in order to ensure their long-

term sustainability and viability in the face of a changing climate.

Water Conservation

a) In cooperation with local municipalities and the Conservation Authority, encourage the creation of a comprehensive groundwater strategy.

b) Incorporate special land use zones to protect and preserve groundwater recharge areas.

c) Encourage the use of rainwater cisterns and barrels to collect water from rooftops to irrigate lawns and gardens.

Source Water Protection

a) Protect and preserve Vulnerable Areas including Wellhead Protection Areas, Intake Protection Zones, Highly Vulnerable Aquifers, and Significant Groundwater Recharge Areas in accordance with the provisions of the *Cataraqui Source Protection Plan*.

b) Promote land uses within Vulnerable Areas that promote, protect, and enhance the quality and quantity of water resources for the long term.

c) Protect potential Vulnerable Areas from uses that threaten the quality and quantity of ground and surface water.

d) Prohibit land uses associated with activities that constitute Significant Drinking Water Threats through Section 59 of the *Clean Water Act* within all Level-A Vulnerable Areas as delineated.

e) Require further study and a Risk Management Plan where land uses with activities that constitute a Significant Drinking Water Threat to be permitted under Section 58 of the *Clean Water Act* within all Level-A Vulnerable Areas as delineated on land use schedule *[#]* of this plan. Further studies can include:

   a. Hydrological and/or Hydrogeological Study
   b. Risk Assessment and Contingency Plan
   c. Land Use Planning Rationale Report
   d. Environmental Impact Study
   e. Stormwater Management Plan
   f. Functional Servicing Plan (sewer and water)
   g. Transportation Master Plan
   h. Snow Storage Plan
   i. Construction Impact Mitigation Plan
   j. Environmental Assessment
   k. Comprehensive Development Plan
   l. Geotechnical Soils Study
   m. Master Environmental Servicing Plan
   n. Disclosure Report

f) Have regard for moderate and low threat policies in all planning decisions and require further study for approval of application if deemed necessary.

g) All Vulnerable Areas as identified on land use schedule *[#]* of this plan are subject to Site Plan Control.

7.5 Energy Management

Objective: Prepare for the anticipated impacts of climate change by encouraging the management, operation, and upkeep of current energy generation, management, and transmission systems in a manner that is environmentally, socially, and economically feasible to *[The Municipality].*

a) Allot adequate land to promote the growth of sustainable and resilient energy systems such as wind, solar, nuclear, and hydroelectric.

b) Encourage sustainable energy practices in existing and new developments that exceed construction standards in order to develop a resilient building supply.

c) The development of wind or solar farms (where energy is sold to the electrical grid) shall not require an amendment to this Official Plan, provided that they are in full compliance with applicable provincial and/or federal legislation; this policy assumes appropriate forecasting into future patterns of wind and solar energy to determine the long-term feasibility of such energy generation projects.

d) Discourage the placement of wind and solar farms on lands designated as Prime Agricultural or Environmentally Sensitive.

e) Identify potential land for the generation of nuclear power, contingent upon a strict set of standards regarding facility placement in *[The Municipality].* These standards should adhere to standards set by the Site Evaluation for New Nuclear Power Plants report and any ancillary documentation.

f) Incentivize, through the use of Community Improvement Plans, that any new construction, retrofitting or redevelopment within *[The Municipality]* meets LEED, BOMA BEST or other industry standard of efficiency in capital projects.

g) Promote street, lot, and building orientation with optimum southerly exposures to maximize passive solar energy gain whenever possible.

7.6 Natural Hazards

Objective: Protect people and property from the flooding, slope instability, erosion, and wildfire hazards anticipated to result from climate change.

a) [*The Municipality*] will work on an ongoing basis with the CRCA to undertake studies that refine the extent of natural hazard areas and reflect the anticipated impacts of climate change.

b) Development and site alteration will generally be directed to areas outside of lands that are subject to natural hazards.

c) In areas where flooding, erosion, dynamic beach, and wildfire hazard concerns are expected to be greater, owing to climate change, *[The Municipality]* will increase the new development mandatory minimum setback distance for new development to provide a factor of safety.

d) *[The Municipality]* may designate an area of land which is deemed to be at heightened risk of wildland fire as a site plan control area, based on wildfire studies conducted by *[The Municipality].*

e) *[The Municipality]* shall promote slope stabilization methods that have been approved based on the completion of the appropriate geotechnical and engineering studies as well as proper consultation with the CRCA.

f) *[The Municipality]* shall consider adopting a minimum spacing policy for developments in areas designated as high-risk for wildfire hazards.

g) In areas designated as high-risk for wildfires, *[The Municipality]* shall promote the use of natural firebreaks, such as waterways. *[The Municipality]* shall consider restricting future development adjacent to these features, where appropriate, to preserve their usefulness as natural firebreaks. *[The Municipality]* shall also consider the benefits of constructing human made firebreaks, where necessary, in controlling potential wildfires.

h) Identify areas vulnerable to hazards and strive to locate critical infrastructure and services outside of these areas.

i) In the anticipation of more frequent and severe storms, *[The Municipality*] shall ensure adequate space for disaster relief centres.

j) *[The Municipality]* shall establish a minimum ground floor height by-law to provide appropriate floodproofing protection within and adjacent to areas subject to flooding hazards; the elevation may include a factor of safety to account for climate change.

7.7 Air Quality and the Urban Heat Island Effect

Objective: Protect people from the adverse effects caused by poor air quality and the Urban Heat Island effect by encouraging development that fosters localized cooling, as well as promoting the enhancement of *[The Municipality's]* urban forest.

Localized Cooling

a) Through incentives, demonstration projects, height and density bonusing, and educational programs, promote tree planting and innovative green spaces, such as green roofs and green walls, with the goal of reducing air temperature and energy use through shading and sheltering.

S

b) Ensure the provision of adequate spaces where people can take relief from summer heat; such spaces include shaded areas, green spaces, splash pads, outdoor pools, and air conditioned community facilities.

S

c) Consider the need or opportunity to reduce the Urban Heat Island effect when drafting landscaping coverage requirements in zoning by-laws and when assessing possible conditions for site plan approval.

S

d) Define Urban Heat Island action areas. Within urban heat island action areas it shall be the policy of *[The Municipality]* that:

   a. the height, massing, orientation and layout of buildings facilitates sufficient air flow as to reduce warming on hot, sunny days;

   b. the use of green roofs and walls, cool roofs, and cool pavements be promoted;

   c. vegetation be protected and enhanced, where possible, to certain coverage requirements;

   d. vegetation types used are effective at cooling the air and surface and will thrive at the temperature and precipitation levels projected for the future in *[The Municipality].*

S

e) *[The Municipality]* will undertake a detailed parking study to determine potential reductions to surface parking requirements and implement maximum parking requirements with the goal of reducing the Urban Heat Island effect.

S

Urban Forestry

a) *[The Municipality]* shall identify adequate space within the urban boundary to implement a progressive tree planting program in order to reduce the impact of increased urban temperatures.

S

b) Enact or update a tree cutting by-law in order to protect and enhance the urban forest. The by-law should ensure that there is no net loss of the existing urban forest, measured in square metres of leaf area.

c) Where feasible and appropriate, replace trees that are lost during ice storms and windstorms.

7.8 Infrastructure

Objective: Encourage the development and re-development of infrastructure in a manner that is resilient to the anticipated impacts of a changing climate.

a) Encourage the location of a development to exceed the 100-year flood value. Construction of critical infrastructure will not be permitted in these areas; non-critical infrastructure will be approved on a site specific basis. In areas of concern where infrastructure already exists, *[The Municipality*] shall relocate the services whenever possible.

b) Encourage the design of stormwater infrastructure to exceed to the 100-year storm value.

c) Plan marine development with regard to changes in lake and river ice that will damage piers and docks as well as change shipping routes.

d) Modify the *[Road Infrastructure Management Plan]* for an increase in road wear and develop future repair timelines and budgets accordingly.

e) Where feasible and reasonable, seek opportunities to coordinate efforts to bury existing utilities and require underground installation of utilities in new developments.

f) *[The Municipality]* will consider increasing the water main design depth to reflect increased freeze-thaw cycles.

g) *[The Municipality]* shall support urban design techniques that take into account the increased wind loading that is expected to occur in the future with more severe windstorms, subject to the requirements of the *Ontario Building Code*.

h) *[The Municipality]* shall support urban design techniques that take into account the increased snow and ice loading that is expected to occur in the future with more severe ice and snowstorms, subject to the requirements of the *Ontario Building Code*.

7.9 Stormwater Management

Objective: Promote the use of stormwater management practices that ensure stormwater runoff is filtered and controlled in a manner that does not adversely impact surface water quality and quantity. Make certain these stormwater management practices are able to adequately handle the increased stormwater loads that are predicted to occur as a result of climate change.

a) Promote the use of Low Impact Development when reviewing design standards that reduce stormwater runoff such as permeable surfaces, green roofs, and native landscaping.

b) Properties designated as *[specific designation]* or zoned as *[specific zoning]* shall not have an impervious area ratio greater than *[#]*.

c) *[The Municipality]* shall ensure that post-development stormwater flows are equivalent to pre-development stormwater flows.

d) Protect, preserve, and enhance all municipal properties designated as Open Space to preserve the water quality and quantity.

e) Encourage clustered developments through the subdivision review process to maximize open green space.

7.10 Winter Preparedness and Safety

Objective: Protect the health and safety of people and infrastructure within *[The Municipality]* from the impacts of the increased ice and snow loads that are anticipated to occur as a result of a changing climate.

a) Ensure that adequate space to store increased volumes of snow is provided during the development application process. *[The Municipality]* shall encourage these spaces be designed using permeable surfaces to minimize snowmelt runoff.

b) Encourage the use of durable materials and outdoor features to withstand more frequent and intense snow and ice removal methods such as machine clearance and salt application.

c) Municipal property shall be developed in a manner that reduces risk from winter safety hazards such as falling snow and ice and slippery surfaces, as well as in a manner that increases comfort and ease of pedestrian mobility during the winter.

7.11 Active Transportation

Objective: Consider strategies for providing elements of the public realm that take advantage of warmer temperatures anticipated to result from climate change. Such elements should provide increased opportunities for outdoor recreation (passive and active), as well as for active transportation in more favourable climatic conditions.

a) Prioritize sustainable transit, by providing required infrastructure, regulations, safety measures, and funding to take advantage of more favourable climatic conditions.
S

7.12 Natural Heritage

Objective: Permanently secure, protect, and maintain *[The Municipality's]* Natural Heritage System for current and future use and ensure that the features and system as a whole are prepared for the impacts of climate change.

a) Prior to any new development or site alteration within or adjacent to an unevaluated wetland, *[The Municipality]* shall require that the wetland in question is properly evaluated to determine its significance and to ensure the development will not result in negative environmental impacts.
C T S

b) *[The Municipality]* shall recognize natural heritage systems planning and ecological-based adaptation as strategic approaches to addressing the uncertainties of climate change.
C T S

c) *[The Municipality]* shall consider natural heritage systems as a whole when reviewing applications that are likely to affect natural heritage features.
C T S

d) *[The Municipality]* shall maintain the strong and biologically diverse linkages between components of natural heritage systems to ensure the functionality, connectivity, resiliency, and adaptive capacity of the Natural Heritage System to climate change.
C T S

e) *[The Municipality]* shall ensure that significant features, functions, and attributes identified through studies that postdate the Official Plan will be subject to [*The Municipality's*] guiding principles, objectives, and governing policies regarding natural heritage systems and climate change policies.
C T S

f) *[The Municipality]* shall encourage landowners to maintain, enhance or, wherever feasible, restore environmental features on their property through measures including conservation easements, buffers, and wherever appropriate ecological fencing.
C T S

g) *[The Municipality]* shall establish a Land Trust to hold, purchase, and manage elements of the Natural Heritage System, or to hold conservation easements as well as support existing ones.
C T S

h) *[The Municipality]* shall require, through the development application process, that developers landscape portions of sites bordering an identified environmentally sensitive area with native vegetation.

i) *[The Municipality]* shall consider the establishment of a permissive by-law that permits the naturalization of yards on private residential and institutional properties.

j) *[The Municipality]* shall encourage, through the development application process, the use of drought tolerant plant material when landscaping is required.

k) *[The Municipality]* shall consider developing criteria to identify candidate public lands suitable for urban naturalization.

CHAPTER 8: CONCLUSION

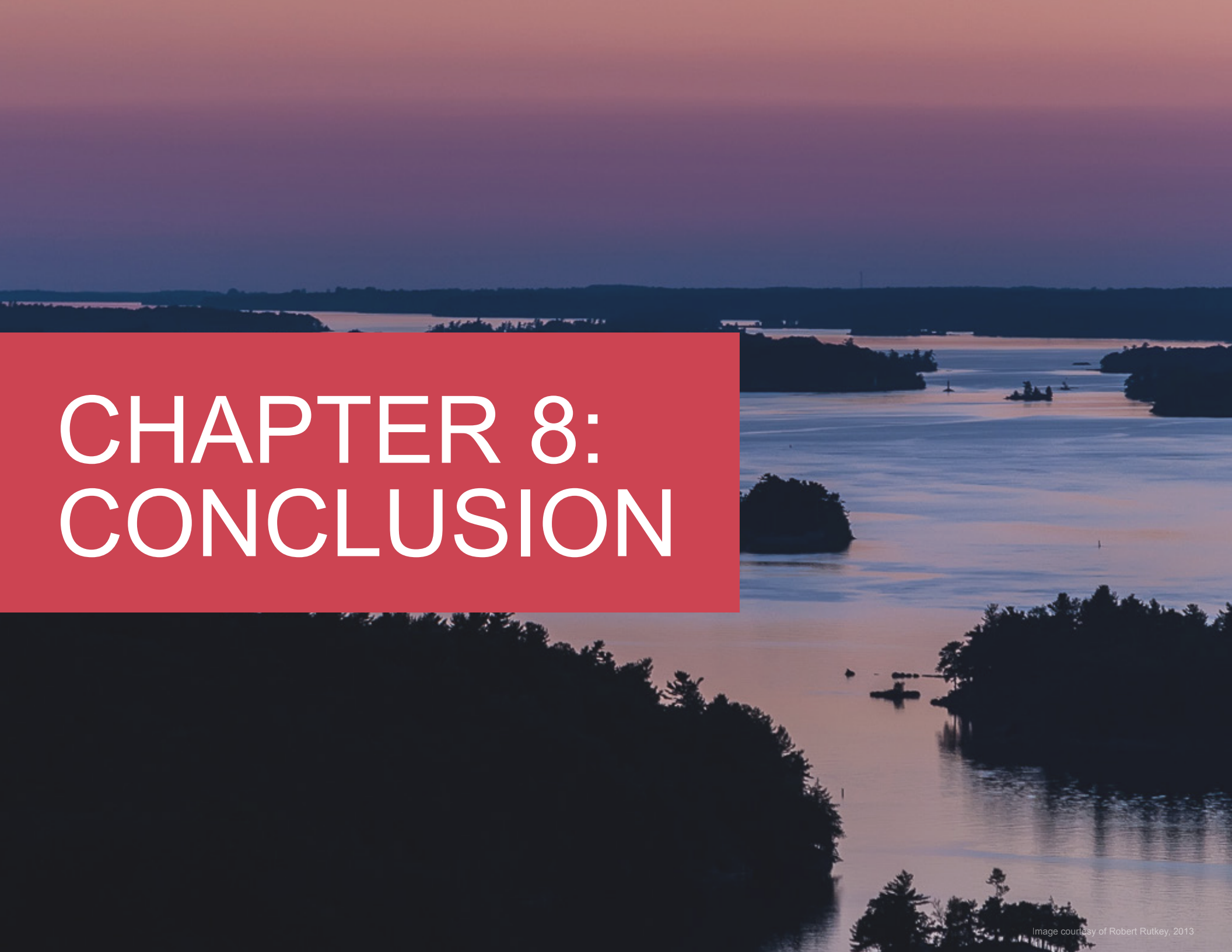

Image courtesy of Robert Rutkey, 2013

CHAPTER 8: CONCLUSION

8 Conclusion

Planned adaptation to climate change is essential for the Cataraqui Region. If implemented, the land use solutions and corresponding policy recommendations in this report will provide the Cataraqui Region with a strong foundation for adapting to the local anticipated impacts of climate change.

This chapter outlines the limitations of this report and provides a strategy for implementation. It also concludes the report by concisely summarizing the findings.

8.1 Limitations

This section outlines limitations of the project team and the research, as well as the limitations associated with using land use policies to adapt to climate change. It is important to note that the limitations listed below should not be considered obstacles, but instead unique challenges, that may require additional analysis and resources to address.

8.1.1 Research Limitations

Climate Change Models and Local Impacts

When implementing adaptive land use planning policies the validity of climate change impact models must be considered. For instance, research has shown that there still remains a large amount of variability among climate change models (Murphy, et al., 2004). These models are also developed using climate change data from the past and extrapolated forward; such extrapolation can prove to be difficult, as climate change is a non-linear phenomenon (Murphy, et al., 2004). Therefore, the ability of land use planning adaptations to sufficiently prepare a community for the impacts of climate change depends greatly on the accuracy of the modelling on which that adaptation was based. It is important that climate change authorities, such as the IPCC, continuously update their modeling methods in order to enable policy makers to develop accurate adaptation methods and policies.

Time Constraints

The timeline for the completion of this project was short. Despite the best efforts of the project team, four months was not enough time to finish a thoroughly exhaustive review of land use planning policies within the Cataraqui Region. As discussed earlier in this report, certain official plans were omitted from the policy review stage of this project. Additionally, the project team did not have time to focus on other land use planning policy documents, such as secondary plans and design guidelines.

The completion deadline for the project also meant that a cut-off time had to be set for reviewing newly modified official plans and recently released legislation. For example, Kingston's Official Plan was reviewed as a second draft in this report, even though more recent editions of the draft document were published during the report-writing process.

8.1.2 Implementation Limitations

Legislative Authority

All provisions within an official plan, including the climate change adaptation policies recommended in this report, must be made within the authoritative boundaries of the *Planning Act.* Certain ideal policies that support climate change adaptation are unable to be implemented due to the limited legislative authority granted to municipalities in Ontario. For instance, suggesting modifications to the exterior of a building, or that involve construction, are under the jurisdiction of the Ontario *Building Code Act.* As well, recommended land use solutions for increased ice storms and windstorms that involve materials and the construction of buildings to withstand additional wind loads or weight from ice hold no legal weight in an official plan. Municipalities can however, pressure the provincial government to update the *Building Code Act* to consider the impacts of climate change. Furthermore, municipal governments may have limited authority to enforce minimum standards beyond those set by the federal and provincial governments.

8.1.3 Land Use Planning and Adaptation

Land use planning is one of many tools that may be used to assist with climate change adaptation. It is important to recognize the limitations of land use planning though. Two of the most notable of these limitations are discussed in the paragraphs below.

Economic

Land use considerations are not solely based on climatic changes, but are also influenced by the economy. As such, the prospect of adaptive initiatives is also reflective of changes to the economy and municipal spending (IPCC, 2014). At a micro-scale, local economies may have difficulty budgeting for new capital projects related to the recommended land use policies, such as burying utility lines or increasing the depth of water mains. Additionally, the proposed policy recommendations may counter existing ideologies and thus gain little political and economic support. To counter this limitation, municipalities within the CRCA should work together to gain both financial and political support to implement the land use initiatives recommended in this report. Incentivizing the private sector to participate in climate adaptation activities may also have success in this regard.

Social

It is important to note that land use planning decisions are influenced by social considerations. Changes to land use planning policy may be met with resistance from local residents. This resistance may be a result of difference in values, culture, or an evaluation of risk. A way to overcome public resistance is to ensure the public is provided with enough data and information to appropriately assess the effectiveness and feasibility of all proposed changes. It is recommended that the CRCA share this report widely to ensure that this is achieved.

Land use planning is also often an exercise in which direct benefits are not always realized by members of the public. Instead, cumulative benefits result. The public must be made aware of these cumulative benefits in order for them to be supportive of any proposed land use planning changes, otherwise these changes may fail to be passed due to lack of public support. It is recommended that the CRCA work to ensure the public fully understands the benefits of any of the recommendations included in this report, so that they are successfully implemented.

8.1.4 Past Planning Practices

It is also important to note here that land use planning policies made under the *Planning Act* do not apply retroactively. There may be many conceivable circumstances where there is a known issue that is related to climate change adaptation, however land use planning policy cannot address the issue because development already exists in that location. For instance, it is not feasible to relocate all existing development within the 100-year floodplain should policies be implemented that restrict development within a 200-year floodplain.

8.1.5 Conflict of Approaches

The land use planning practices recommended in this report highlight many effective planning adaptation tools. However, these adaptation tools may not work together in perfect harmony. For example, one adaptation tool may limit the effectiveness of another. Policies that are designed to help communities adapt to climate change may conflict with those that are designed to preserve environmental features (Fezzi, Harwood, Lovett, & Bateman, 2015).

This is best illustrated by the trade-off between agricultural adaptation policies and the decrease in freshwater quality. The impacts of climate change on agriculture, specifically economic burdens resulting from drought and decreased soil quality, will result in farmers switching to more profitable crops. This adaptive switch to a more profitable crop could lead to an increase or change of agricultural inputs, which are a leading determinant of surface water quality (Fezzi, Harwood, Lovett, & Bateman, 2015). This change in agricultural inputs could lead to nutrient overload and eutrophication of nearby water resources (Fezzi, Harwood, Lovett, & Bateman, 2015). It is therefore important to conduct further study on how varying climate change adaptation policies will interact with one another in order to ensure that all of the policies are congruent.

Conversely, it is important to note how climate change adaptation policies may contribute to furthering complementary policy objectives. Specifically, many adaptive land use planning policies are also best practices for the conservation and preservation of the natural environment and represent sound environmental policy. For example, many of the recommended land use planning climate change adaptation policies regarding water resources, natural heritage, agriculture, and energy are also considered the land use planning best practices for environmental planning policy.

8.1.6 Global Circumstances and Uncertainty

The CRCA plays a critical role in climate change adaptation at the local level. Efforts made and land use policies implemented by municipal governments will assist with local scale adaptation. However, it is difficult to estimate the actions of neighbouring jurisdictions and the impacts that climate change will have upon them. For instance, worsening climatic conditions in other countries, specifically those closer to the equator or vulnerable to sea level rise, may result in widespread immigration to Canada. Uncertainties such as the number of climate refugees and the time of their arrival make it difficult to plan land uses and land needs far in advance.

8.2 Implementation Strategy

This section outlines a brief implementation strategy for the policy recommendations outlined in Chapter 7. Creating a strategy is key to the successful implementation of the recommendations and will help to ensure that climate change adaptation policies are incorporated into official plans throughout the Cataraqui Region. It is recommended that the CRCA establish a comprehensive action plan in order to

implement the recommendations from this report. The following points, if incorporated into the action plan, will help increase the odds of success.

8.1.1 Building Support

In order to implement the policy recommendations outlined in Chapter 7, the CRCA must first build support for climate change adaptation policies in the Region. This involves obtaining the necessary approvals and budget to implement the findings. Ensuring consensus and inter-municipal cooperation will drive the effort forward with a consolidated front. Distributing the copies of the report to the fifteen municipalities who are either wholly or partially located in the Cataraqui Region will build internal support from the local governments.

Public awareness and citizen involvement will also assist with building support for climate change adaptation and implementation of the recommended land use policies. Events such as the public event, “Adapting to Climate Change in the Cataraqui Region”, held on November 4, 2015, are key to building support and ensuring the recommendations are implemented. A demonstration or pilot project may also be used to gain support and highlight short-term successes with the public. The City of Vancouver Greenest City 2020 Action Plan used pilot projects to create small-scale green and climate-ready development (City of Vancouver, 2015). Successes from this project were shared with the community and the policy recommendations were ultimately implemented elsewhere in the City.

8.1.2 Champions and an Implementation Committee

It is imperative that the CRCA act as a champion for climate change adaptation through land use planning for the recommendations in this report to be successfully implemented. Initiating this project illustrates that the CRCA recognizes the importance of planning for climate change and acknowledges the role conservation authorities play in adaptation through land use planning. It is suggested that the CRCA consult and work cooperatively with participating municipalities to bring about positive change.

It is also advised that the CRCA create an implementation committee comprised of local government officials as well as residents and private sector representatives. An implementation committee can ensure communication is fluid between all parties and allow citizens and government officials to work collaboratively with the CRCA. Completing a stakeholder evaluation will assist in determining the makeup of the committee. This committee can share highlights and successes; communicating progress both internally and externally helps those involved gain additional support.

8.1.3 Monitoring and Evaluating

It is imperative that the CRCA monitor the progress of the implemented recommendations and design a monitoring protocol prior to implementation. It is recommended that the CRCA implement an adaptive management framework for monitoring. Adaptive management is a policy implementation approach and is an efficient and effective tool for implementation (Lee, 1999). This process involves monitoring the implemented policies, reviewing and evaluating the successes and failures of the recommendations, and adjusting the recommendations if needed. This form of monitoring will allow the CRCA to learn throughout the implementation process and ensure that climate change adaptation is achieved through land use planning. Figure 8.1 illustrates the cyclical nature of adaptive management.

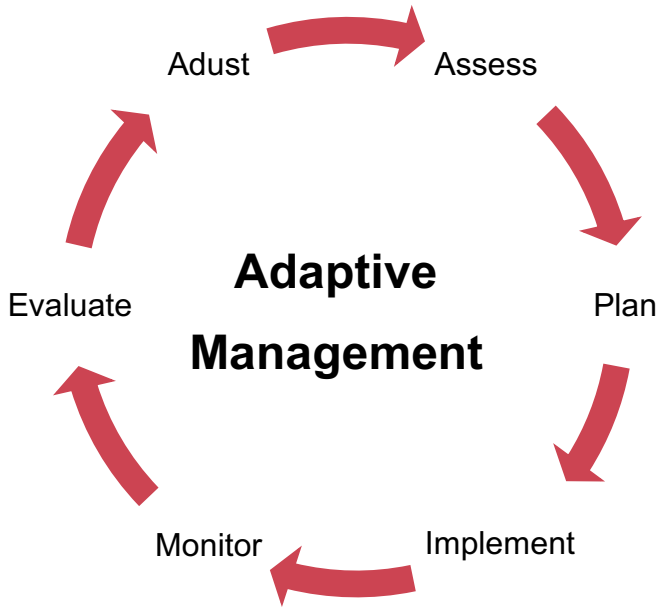

Figure 8.1: The adaptive management cycle.

8.3 Conclusion

The objective of this project course was to answer the following question:

Are the current land use planning policies in the Cataraqui Region supportive of climate change adaptation?

The objectives of this report were:

- to evaluate whether existing land use planning policies in the Cataraqui Region are supportive of climate change adaptation;
- to identify successful solutions in land use planning for climate change adaptation; and
- to provide recommendations that will help inform municipal land use policy change for climate change adaptation in the Cataraqui Region.

The focus of this project was on municipal land use planning as a tool for climate change adaptation. Through a comprehensive literature review, the project team determined that climate change will have eight major impacts on the Cataraqui Region. The eight themes that the project team considered throughout the review of ten of the fifteen official plans in the Cataraqui Region included:

- atmospheric temperature;
- extreme weather events;
- natural heritage features;
- agriculture;
- public health;
- infrastructure;
- potable water resources; and,
- energy.

The project team determined that municipalities in general are vulnerable to the impacts of climate change. However, land use planning tools, including official plans, community improvement plans, zoning by-laws, site plan control, plans of subdivision, and development permit systems, can be used to aid municipalities in adapting to climate change.

For the purposes of this project, ten official plans were reviewed. The official plans were evaluated as to whether their policies are supportive of climate change adaptation. The project team determined that there is a range in the adequacy of land use policies with respect to climate change adaptation across the official plans reviewed. Some official plans, such as those from the Town of Greater Napanee and City of Kingston, have progressive policies that make an explicit link between climate change adaptation and the official plan policies. However, the remaining official plans fail to draw this link. Instead, the policies in these plans either indirectly address the impacts of climate change or have the potential to address the impacts if they are updated. Overall, the project team determined that the official plans in the Cataraqui Region are not supportive of climate change adaptation in their current state. However, they can be improved upon through a conformity exercise with the *PPS*, which now includes several climate change policies. They can also be improved upon through consideration of the land use solutions and adoption of the boilerplate policies presented in this report. The major suggested implementation tools for climate change adaptation include official plan policy and site plan control.

Following the official plan review, the project team undertook a comprehensive literature review, based on the eight anticipated local impact themes, to determine land use solutions for climate change adaptation via land use planning. The land use solutions presented include both common and innovative practices from Canada and internationally. The municipalities within the Cataraqui Region should consider integrating these land use solutions into their various municipal documents, including their official plans.

The project team also developed recommendations in the form of boilerplate policies that municipalities in the Cataraqui Region can transfer directly into their official plans during an official plan review. These boilerplate policies were grouped into new themes in order to better facilitate the development of objectives for each group of policies. The new themes that the project team developed and the objectives of the boilerplate policy recommendations include:

Rural Agriculture

> Objective: Preserve and maintain [*The Municipality's*] prime agricultural lands for future use. Maintain a permanently secure and economically viable agricultural industry in [*The Municipality*].

Urban Agriculture

> Objective: Maintain a permanently secure and economically viable agricultural industry in [*The Municipality*]. Promote agricultural activities within the Urban Area that are compatible with planned land uses in order to enhance access to locally grown produce, lower energy consumption, reduce transportation costs and greenhouse gas emissions, and augment supplies of fresh and preserved foods.

Water Resources

> Objective: Protect and preserve [*The Municipality's*] surface and groundwater resources through water conservation and source water protection efforts in order to ensure their long-term sustainability and viability.

Energy Management

> Objective: Encourage the management, operation, and upkeep of current energy generation, management and transmission systems in a manner that is

environmentally, socially, and economically feasible for [*The Municipality*].

Natural Hazards

Objective: Protect life and property from the flooding, slope instability, erosion, and wildfire hazards anticipated to result from climate change.

Air Quality and the Urban Heat Island Effect

Objective: Protect people from the adverse effects caused by poor air quality and the Urban Heat Island effect by encouraging development that fosters localized cooling, as well as promoting the enhancement of [*The Municipality's*] urban forest.

Infrastructure

Objective: Encourage the development and re-development of infrastructure in a manner that is resilient to the predicted impacts of climate change.

Stormwater Management

Objective: Promote the use of stormwater management practices to ensure storm water runoff is filtered and controlled in a manner that does not adversely impact surface water quality and quantity. Make certain these storm water management practices are able to adequately handle the increased stormwater loads that are predicted to occur as a result of climate change.

Winter Preparedness and Safety

Objective: Promote the health and safety of people and infrastructure within [*The Municipality*] from the impacts of increased ice and snow loads during the winter months.

Active Transportation

Objective: Consider strategies for providing elements of the public realm that take advantage of warmer winter temperatures. Such elements should provide increased opportunities for outdoor recreation (passive and active), as well as for active transportation throughout the winter.

Natural Heritage

Objective: Permanently secure, protect, and maintain [*The Municipality's*] Natural Heritage System for current and future use and to ensure that the features and system as a whole are prepared for the impacts of climate change.

Together, these objectives speak to the overall goal of this report, which is to ensure that the Cataraqui Region is prepared for the predicted impacts of climate change. Adoption of the boilerplate policies will ultimately help the municipalities in the Cataraqui Region update their land use planning policies to support climate change adaptation.

Climate change adaptation is essential to the continued health of the Cataraqui Region. Municipalities should not wait and see if mitigation efforts succeed before taking steps to prepare their communities for the anticipated impacts of climate change. These impacts are already beginning to appear, and being unprepared for them will likely result in significant negative consequences. Furthermore, as was demonstrated at various times throughout this report, many land use planning adaptation strategies constitute what is considered to be "good" land use planning. Therefore, even if the anticipated impacts of climate change are not experienced in the Region, these municipalities will still be taking steps to ensure their

communities are better places to live, work and play for their residents.

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GLOSSARY & APPENDIX

Image courtesy of Amy Shanks, 2015

GLOSSARY

Glossary

Adaptation: actions that prepare for changes that are already occurring, or are likely to occur, in the future due to climate change.

Albedo: the fraction of solar energy (shortwave radiation) reflected from a surface back into space. Light coloured materials have a higher albedo than dark coloured materials.

Assessment Report: a technical document that is prepared by a source protection committee under Section 15 of the Ontario *Clean Water Act* to record its knowledge of a source protection area, and to rank risks to drinking water within that area. Each report is approved by the Ontario Ministry of the Environment.

Bioswale: a vegetated channel to slow, infiltrate, and move stormwater runoff from one place to another.

Building Owners and Managers Association (BOMA) BEST: an organization much like LEED which assesses and certifies existing commercial buildings based on their environmental performance and management through the BOMA BEST program. The main difference between the BOMA BEST program and the LEED program is that BOMA BEST focuses on existing commercial buildings while LEED is applicable to more types of buildings.

Community Solar Garden: a community shared solar array with grid-connected subscribers. Homes and businesses receive a bill credit as if the panels were on their personal roofs.

Conservation Easement: a long-term legal agreement that is registered on the title of the property and exists between a landowner and a qualified organization. It creates a partnership between the landowner and organization such the landowner continues to own and manage the land based a list of mutually agreed land uses and activities.

Ecological Resilience: the ability of an ecosystem to absorb stresses and shocks while retaining the same basic structure and function.

Ecosystem-based adaptation: the integrated use of biodiversity and ecosystem services into an overall adaptation strategy.

Emissivity: the effectiveness of a surface to emit energy as thermal radiation.

Extreme Heat Event: a period of unusually hot temperatures and/or high humidex readings as compared to the typical regional average for that season**.**

Firebreak: a feature, either natural or man-made, used to stop or slow the spread of fire.

Floodline resulting from the 1% probability storm event: an area delineated in hazard maps and land use maps that, based on historical rainfall data, has a one percent chance of flooding in any given year.

Highly Vulnerable Aquifer: an aquifer that is or is likely to be significantly and adversely affected from external sources. This also includes the land above the aquifer.

Intake Protection Zone (IPZ): the area of land and water that contributes source water to a drinking water system intake within a specified distance, period of flow time (for example, two hours), and/or watershed area.

Land Trust: a registered charitable, non-profit, and non-governmental organization that is dedicated to preserving and protecting natural and cultural areas for the public benefit.

Land Use Planning: the process of protecting and improving the living, production and recreation environments in a community through the proper use and development of land.

Leadership in Energy and Environmental Design (LEED): a ranking system to evaluate the design, construction, maintenance, and operation of buildings. LEED is certified to score buildings by the Canadian Green Building Code. The results of the system put buildings in Platinum, Gold and Silver standards based on the energy efficiency of the structure evaluated.

Low Impact Development (LID): a comprehensive land use planning and engineering design approach with a goal of maintaining and enhancing the pre-development hydrologic regime of urban and developing watersheds.

Mitigation: strategies that reduce the greenhouse gas emissions that accelerate climate change.

Natural Heritage System: a system comprising or core natural heritage features, areas, and linkages. The linkages provide connectivity to the system and support the natural processes necessary for an integrated, robust, and resilient system.

Systems-Based Natural Heritage Planning: an approach to planning for natural heritage features that goes beyond a features-based approach. It recognizes that protecting features in isolation is inadequate to the functionality of the system as a whole and as such, is an approach to creating functioning core natural features, corridors and buffers.

Rain garden: a landscaping feature often located in small residential or urban communities aimed at collecting and treating stormwater runoff.

Resilience: the capacity of individuals, communities and systems to survive, adapt, grow and transform in the face of stress and shocks. Resilience is about preparing to withstand catastrophic events and bouncing back more quickly and emerge stronger form these shocks and stresses.

Riprapping: the lining of a coastline with rock or another similar material to prevent further wave erosion.

Significant Groundwater Recharge Area: an area where there is a volume of water moving from the surface into the ground. The groundwater serves either as source water or as water that supplies a cold-water ecosystem such as a brook trout stream.

Source Protection Plan: a document that is prepared by a source protection committee under Section 22 of the Ontario Clean Water Act, 2006 to direct source protection activities in a source protection area. Each plan is approved by the Ontario Ministry of the Environment.

Specialty Crop Area: lands that are suitable for specialty crops, such as tender fruits, and that have the highest priority for preservation.

Transpiration: the passage of water from a plant into the atmosphere.

U-235: a rare nuclear isotope commonly used in fuel in light water nuclear reactors. The fission of U-235 creates energy which is harnessed in the creation of electricity.

Urban Naturalization: an ecologically-based approach to landscape management. The purpose of urban naturalization is to restore environmental integrity to the urban landscape.

Vulnerability Score: a score made using the Assessment Report to assign vulnerability scores in around wellheads. Scores are highest closest to the well and where the vulnerability is high.

Vulnerable Areas: one of the following:
(a) significant groundwater recharge area;
(b) highly vulnerable aquifer;
(c) surface water intake protection zone; or
(d) wellhead protection area.

Wellhead Protection Area (WHPA): an area of land surrounding a well where human activities may need to be regulated to protect the quality and quantity of groundwater that supplies that well.

Wildland Fire: a fire occurring on land that has not been cultivated (wilderness)

APPENDIX A: OFFICIAL PLAN ANALYSIS

A Official Plan Analysis

As part of the report, a thorough official plan review was conducted. The results of this review can be found on the supplemental disk.

A.1 Counties

Three counties have geographic boundaries that extend into the Cataraqui Region. These counties include: The County of Frontenac, The United Counties of Leeds and Grenville, and the County of Lennox and Addington.

A.1.1 County of Frontenac

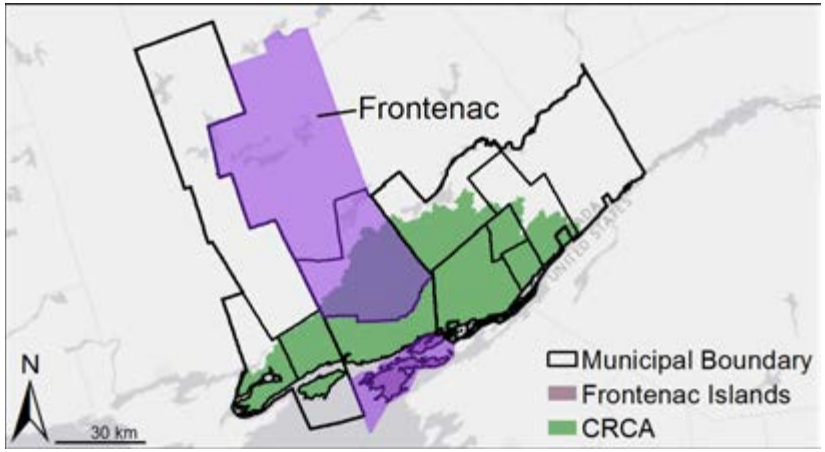

Figure A.1: Location of Frontenac County within the Cataraqui Region.

The County of Frontenac extends north from the City of Kingston to Renfrew County and south to Wolfe Island and the United States border. The County covers about 3,300 square kilometres but has a population of approximately 26,600.

The area contains four lower-tier municipalities including: the Township of North Frontenac, the Township of Central Frontenac, the Township of South Frontenac, and the Township of Frontenac Islands. The County is characterized by a predominantly rural landscape with many small communities, hamlets and villages dotting the countryside.

The County boasts some of the most beautiful natural features found in Ontario. It includes approximately one thousand lakes, two Provincial Parks (Frontenac and Bon Echo) and many significant rivers and woodlands within its boundaries. The County is also home to a portion of the Rideau Canal system, which is designated as a UNESCO World Heritage Site. Furthermore, the County contains sections of the Frontenac Arch Biosphere Reserve, one of Canada's sixteen biosphere reserves designated under UNESCO's Man and Biosphere Programme.

The County's Final Draft Official Plan was adopted on October 29th, 2014. It is still awaiting final approval by the Ministry of Municipal Affairs and Housing.

Atmospheric Temperature

The County of Frontenac is largely a rural County. It is therefore less susceptible to the impacts of rising atmospheric

temperatures in urban areas (Urban Heat Islands). However, additional direct effects of rising atmospheric temperatures are not discussed.

Extreme Weather Events

Section 7.3 contains policies relating to natural and human-made hazard lands. Development is restricted on and adjacent to these lands. This includes redirecting development to areas outside of the Great Lakes – St. Lawrence River System, large inland lakes, rivers, streams and other water bodies which are impacted by flooding hazards, erosion hazards and/or dynamic beach hazards. Additionally, development is not permitted in areas that would be rendered inaccessible to people and vehicles due to these hazards. Further policies restrict development in a floodway, regardless of whether the area of inundation contains high points of land not subject to flooding. Institutional or sensitive land uses are not permitted in hazard areas, including emergency services and uses associated with the disposal, manufacturing, or storage of hazardous substances.

Development of hazard lands is only permitted if the public safety risk is minor, could be mitigated in accordance with provincial standards, and where proper flood proofing, protection works standards, and access standards are applied. There must also be access by vehicles and people during times of emergency and the new development must not present any new hazards or aggravate the existing ones. Lastly, it must be shown that the development will result in no adverse environmental impacts.

Some development and site alterations may be permitted if the use by nature must be located in a hazard area, or passive non-structural uses that do not affect flood flows.

Natural Heritage

Section 3 of the Plan deals with growth management. The Township of South Frontenac is expected to handle 70% of the new permanent population growth in the County. The lack of full municipal water and wastewater services in the County constrains the County's ability to promote density and to direct new development into settlement areas. Accordingly, rural areas will continue to be a significant venue for new residential development. This poses a risk for increased greenland consumption in the future.

To protect valuable natural heritage features from the increasing pressures of rural growth, the County recognizes a distinct natural heritage system. This system identifies and protects significant natural heritage features in the Region. Policies in Section 7.1 restrict development that would negatively impact:

- provincial and other significant wetlands, woodlands, and valleylands;
- significant wildlife and fish habitats;
- Lake Trout lakes;
- endangered and threatened species;
- ANSIs, and;
- waterfront areas designated in the Special Policy Areas.

This includes the creation of Lake Management Plans.

This section also includes policies that require the local townships to include official plan policies ensuring that developments and site alterations are not permitted on or adjacent to these significant natural features. They also require policies ensuring that new significant natural features are identified and protected in the future.

The Plan also contains policies that seek to protect and preserve the County's natural heritage and eco-tourism destinations. A restrictive policy framework is used for development and land stewardship to promote the long-term viability of these natural areas.

Section 7.1 also includes policies that require the preparation of an Environmental Impact Study (EIS). Where appropriate, an EIS helps prove that no negative environmental impact will occur when developing in or adjacent to environmentally sensitive areas.

Agriculture

Section 2.1 of the Plan addresses development of land designated for agricultural use. Policies are in place to restrict development on prime agricultural land. It also directs local townships to include policies for the identification and protection of prime agricultural lands. These policies fail, however, to consider the long-term anticipated impacts of climate change.

Public Health

Section 4.1 addresses public health through transportation policies. The County recognizes that public and active modes of transportation offer key benefits to public health. These benefits may include air quality improvements (due to decreased GHG emissions) and increased opportunities for physical activity. As such, the County encourages the development of transit-supportive communities and the clustering of transit-supportive uses such as schools, businesses, and health facilities. They also encourage the creation and expansion of active transportation networks, including recreational trails to facilitate walking and cycling.

While specific, these policies fail to address long-term public health risks due to climate change.

Infrastructure

Outlined in Section 4, the County recognizes that it is the responsibility of local municipalities to plan, construct, and maintain most public infrastructure. However, the County will continue to work with municipalities to provide adequate infrastructure to accommodate future growth.

Following from the Public Health section, the County encourages transit-supportive communities and uses, and the expansion of active transportation networks. Stormwater Management Plans are required for new developments to control flooding and erosion, and to protect water quality and aquatic habitat. When reviewing development proposals, the County directs approval authorities to encourage the retention of existing tree cover or natural vegetation and the provision of significant grassed and natural areas to facilitate absorption of surface water into the ground.

Finally, the Plan encourages the application of reduce, reuse and recycle principles to reduce solid waste disposal needs and increase the lifespan of landfill sites. This includes the creation of a region-wide Waste Management Plan to address recycling, diversion, collection, and disposal practices for present and future requirements.

These infrastructure policies address the provision or improvement of infrastructure, but fail to consider long-term effects of climate change.

Potable Water Resources

Section 7.2 contains policies relating to the protection, conservation, and management of water resources. This includes policies that:

- ensure groundwater quality and quantity will not be negatively impacted by development;

- contribute and promote a culture of water conservation;
- establish sector-specific targets for water use reductions, and;
- show leadership by considering water conservation and efficiency within its municipal culture and decision making.

With regard to servicing, Section 4.2 states that the County shall facilitate the preparation, implementation and monitoring of Source Water Protection Plans. The County will work with the local townships to apply land-use controls to ensure long-term protection of water sources. Additionally, the County will conduct a region-wide review of villages and hamlets that could require water servicing systems in the future.

Further, a Settlement Area boundary expansion shall require a Township Official Plan amendment. As none of the Settlement Areas in the County have full municipal services, a Settlement Area Capability Study is required. The new Settlement Area must adequately accommodate new development without having negative impacts on groundwater used for drinking purposes and/or the ability of soils in the area to assimilate effluent.

Policies regarding potable water resources are comprehensive, considering current and future needs. They fail, however, to address the increased risk of groundwater depletion and contamination due to climate change.

Energy

Section 2.1.4 contains policies related to renewable energy. The County and the Townships are encouraged to work collaboratively to assist in green energy initiatives such as municipal solar installation, energy conservation, community power, and other related projects. The County will also support the creation of a Community Energy Plan to encourage local energy production and increase community capacity with renewable energy. Finally, the County will promote energy conservation to the public and will seek opportunities to facilitate conservation. While not explicitly linked to climate change, these policies offer strong support for land uses associated with green energy production and conservation.

Summary of Climate Change Adaptation Policies

The Frontenac County Official Plan generally offers a strong policy framework with regard to natural heritage, potable water resources, energy, and planning in hazard areas. This includes a comprehensive natural heritage system, source water protection, and support for land uses associated with green energy production and conservation. Further, the County uses a restrictive policy approach towards regulating development near environmentally sensitive and hazard areas. This approach effectively controls the type and location of new development and site alterations, but it does not account for the anticipated impacts of climate change.

The Plan contains policies that are broad and directive to the four local townships. Many of these policies are general and open to interpretation, making implementation difficult. After the County OP is approved, it is important for the township OPs to undergo a conformity exercise to ensure consistency with the County Plan.

Many of the identified policies fail to directly target objectives related to climate change adaptation. Rather, they target alternative objectives such as economic growth. Lacking a direct link to climate change, these policies are insufficient.

Policies directly addressing climate change adaptation should be incorporated into the County Official Plan. These policies

should be directive and contain requirements to be fulfilled by the Township and County, rather than those that simply encourage policy objectives.

A.1.2 United Counties of Leeds and Grenville

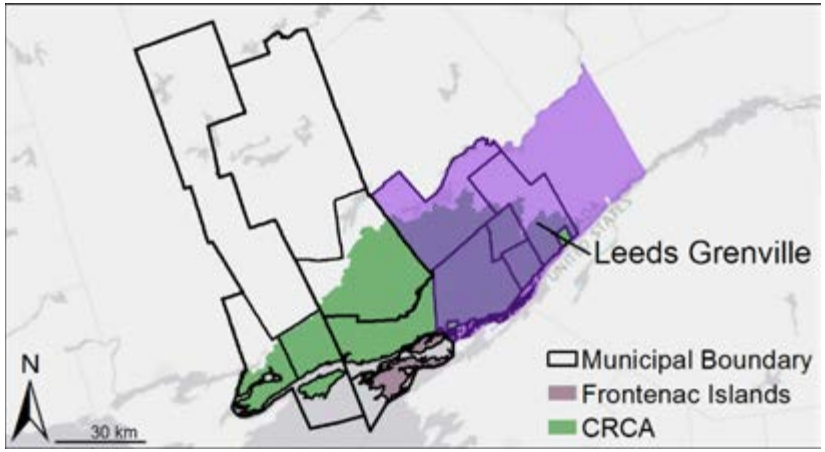

Figure A.2: Location of the United Counties of Leeds and Grenville within the Cataraqui Region.

The United Counties of Leeds and Grenville represent the easternmost portions of the Cataraqui Region. The Counties extend along the St. Lawrence River from Gananoque to Prescott, and northward to Westport, Smiths Falls, and Kemptville. Only the Southwest portion of the Counties is included within CRCA jurisdiction, from Brockville to Westport and to the southwest. The Counties cover about 3,400 square kilometres and had a 2011 population of about 99,000.

The area contains fifteen member municipalities and three partner communities: the Towns of Gananoque and Prescott, and the City of Brockville. The area is rich in natural and cultural heritage including the St. Lawrence River and the 1000 Islands Region and a portion of the Rideau Canal UNESCO World Heritage Site. The Official Plan for the Counties of Leeds and Grenville was adopted by Council in July 2015 and is awaiting approval by the Minister of Municipal Affairs.

Atmospheric Temperature

The Plan does not contain any policies that directly address atmospheric temperature.

Extreme Weather Events

The Plan employs a restrictive land use approach to address extreme weather events. Section 5.2.2 sets the standard for new development, directing it away from areas at risk of flooding and erosion, or other hazardous lands. Additionally, Section 5.2.3 directs development away from areas with hazardous forest types, which are prone to wildland fires.

Development and site alteration are permitted on hazard lands and flood hazard areas, but the development must adhere to flood proofing standards and it must be demonstrated that there will be no adverse environmental impacts.

These land use policies represent good practice for development in or near hazard areas. However, as the effects of climate change become more apparent, these policies will need to directly address the expected increased frequency and intensity of extreme weather events in the Cataraqui Region.

Natural Heritage

The United Counties of Leeds and Grenville have a rich and extensive natural heritage system. Section 4.2 contains policies that protect these valuable natural resources. Development and site alteration are restricted for:

- ANSIs;

- provincially significant wetlands, woodlands, and valleylands;
- endangered and threatened species habitats;
- fish habitats, and;
- watercourses and waterbodies, and adjacent lands

Section 4.3 establishes a region-wide natural heritage system. This promotes connections between key natural features, including those that cross multiple municipal boundaries. In collaboration with the local municipalities, the Counties will prepare a refined Natural Heritage System Strategy before the next official plan review to more accurately identify natural heritage system components. An EIS is required when any major development or site alteration is proposed within or adjacent to lands identified as part of the Natural Heritage System.

While these policies provide a good foundation for the protection of natural heritage features, they do not address direct effects of climate change.

Agriculture

The Counties are home to a large amount of agricultural land. Under Section 3.2, prime agricultural land is protected from fragmentation, development, and land uses unrelated to agriculture. Additionally, any lands deemed suitable for agricultural uses will be protected for long-term use. A minimum lot size of 40 hectares is in place for new lots to protect against future fragmentation.

Section 2.6 notes that local food production can be supported by minimizing land use conflicts and supporting on-farm diversified uses, such as agri-tourism and value-added agricultural products. However, proposed on-farm diversified uses must effectively co-exist with surrounding uses and not negatively impact surrounding agricultural lands.

These policies are effective in protecting key agricultural lands while supporting local food production. They fail, however, to include a direct link to climate change.

Public Health

The Counties have taken action to promote public health and healthy lifestyles through active modes of transportation. Section 1.1.5 notes how this can come in many forms, including through the development of an integrated and connected trail, parks, and open space system.

As previously discussed, the Plan seeks to decrease public health risks by directing new development away from hazardous areas. These include areas prone to flooding, erosion, and dynamic beach hazards due to an increased frequency and intensity of extreme weather events.

Section 2.3.1 encourages local municipalities to establish land use patterns based on density and mixed land uses. This will minimize negative impacts to air quality and promote energy efficiency. Additionally, Section 6.6 contains innovative policy allowing activities such as tree planting, landscaping and naturalization on municipal property as a method of improving air quality.

Finally, the Plan notes in Section 1.1.5 that it is important to maintain a high quality of life through the protection of natural resources, including water resources that supply drinking water. The Counties have implemented several policies under Section 4 regarding the protection of these valuable features. These are discussed further in the potable water section below.

Infrastructure

Under Section 4.4.1, the Plan requires the use of stormwater management facilities on-site and/or downstream of new

developments to mitigate negative impacts from development on stormwater quantity and quality. The Counties may consider the establishment of sector-specific targets for water use reductions and targets for on-site retention of stormwater within their stormwater management plan. Additionally, in Section 6.3.2 they promote the use of stormwater management best practices to manage the risks to human health, safety, and property damage.

To safeguard critical infrastructure, Section 5.2.2 addresses the location of sensitive institutional uses in relation to hazard lands. Hospitals, long term care homes, retirement homes, pre-schools, school nurseries, day cares, and schools are all prohibited within hazard areas.

Potable Water Resources

Water resources and source water protection are addressed in Section 4.4, wherein policies are intended to preserve water quality and quantity throughout the Region. Similar to the CRCA, the Counties employ a watershed approach to the protection, improvement, and restoration of water quality and quantity. This may include the preparation of watershed and sub-watershed studies, or a Lake Impact Assessment for shoreline development. The plan also promotes a culture of water conservation and the efficient and sustainable use of water resources.

The Counties also require local municipal OPs to implement restrictions on development and site alteration to protect all municipal drinking water supplies and designated vulnerable areas. They must improve or restore vulnerable and sensitive surface and ground water features and their hydrologic functions, in accordance with the significant threat policies of the applicable Source Protection Plan.

While these policies support the protection of valuable potable water resources, they do not address direct effects of climate change. Some effects include: increased risk of eutrophication and acidification, groundwater depletion, and increased risk of contamination.

Energy

The Plan promotes energy conservation and the development of alternative sources of energy. Section 5.3.1 states that wherever practical and feasible, methane or other GHG emissions from waste management systems will be captured and used locally as an alternative energy source. Opportunities for other renewable energy initiatives at waste disposal sites will be supported. Section 6.6 encourages the design and development of green buildings and developments that conserve energy. Finally, Section 2.3.1 promotes long-term prosperity of settlement areas through energy conservation and efficiency.

The Plan's energy policies offer strong support for renewable and alternative sources of energy. They also enable the development of energy efficient buildings and developments. They lack, however, a direct link to the effects of climate change such as increased demand for energy and increased stress on existing energy systems.

Summary of Climate Change Adaptation Policies

The United Counties of Leeds and Grenville Official Plan implements a restrictive policy approach to growth management and the protection of natural heritage. Many land use policies direct development away from sensitive lands or hazardous areas. This approach serves multiple purposes, including:

- protection of natural and ecological resources, including endangered species and their habitats, potable water, and prime agricultural land;
- protection of public health and safety; and
- protection of critical or sensitive infrastructure.

Lacking a direct link to the effects of climate change, however, these policies offer limited support for adaptation. Section 6.6 of the plan attempts to address this missing link with specific sustainability policies, including policies for energy efficiency and conservation, air quality improvement, and climate change adaptation. For example, a unique policy allows tree planting, landscaping and naturalization initiatives on municipal property to improve air quality. Another policy requires that upgrades to municipal infrastructure must consider the impacts of climate change, including those associated with extreme weather events. While these policies strongly promote adaptation strategies for energy and air quality, similar policies must be woven into other sections of the plan to address topics such as natural heritage, agriculture, and potable water resources.

Direct effects and adaptation strategies for climate change should be considered in all sections of the Official Plan.

A.1.3 County of Lennox and Addington

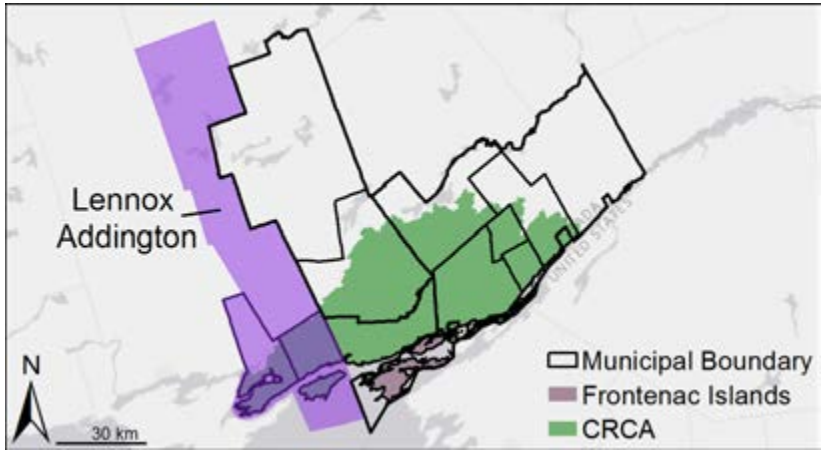

Figure A.3: Location of the County of Lennox and Addington within the Cataraqui Region.

The County of Lennox and Addington extends along Lake Ontario between Western Kingston and Greater Napanee, and northward to Renfrew County. Only the Southern portion of the County is under CRCA jurisdiction, which includes portions of Loyalist Township and the Town of Greater Napanee. The County had a 2011 population of about 42,000. This total is expected to grow by 22 percent by 2036, most of which will be concentrated in the Southern townships. The County is primarily rural, containing a mix of farmland, open spaces, forests, and lakes. The County's Official Plan was adopted on September 30, 2015 and focuses primarily on land use planning matters that transcend township boundaries.

Figure A.4: Lennox & Addington Museum and Archives (County of Lennox & Addington, 2015).

Atmospheric Temperature

The Plan does not contain any policies that directly address atmospheric temperature.

Extreme Weather Events

The County addresses extreme weather events through policies that direct development away from hazardous lands – areas which are at a greater risk of flooding, erosion, or dynamic beach hazards. Specifically, Section D6.1 directs development away from:

- hazardous lands adjacent to Lake Ontario; and
- hazardous lands adjacent to other rivers, streams, and inland lakes.

Further, Section D6.3 restricts development and site alteration for any area that would be inaccessible to people or vehicles during flooding, erosion or dynamic beach hazards, and in any floodway. The Plan also contains policies addressing the potential for increased occurrences of wildland fires. Section D6.7 directs development away from areas consisting of forest types which are considered hazardous for wildland fires.

It is important to note that these policies only consider existing areas identified as hazardous. The Plan does not account for new hazard areas due to more frequent extreme weather events.

Natural Heritage

The Cataraqui Region is projected to experience habitat fragmentation and a loss of biodiversity due to climate change. Policies in Section B of the Plan set intensification targets and focus development within settlement areas. These policies protect natural heritage features against development. The County is also committed to protecting natural heritage features through the creation of a natural heritage system. Under Section D1.9, the County will establish a natural heritage system within three years of the approval of this Plan. Further, Sections D1.2 to D1.8 restrict development and site alteration on lands adjacent to natural heritage features, including: wetlands, valleylands, woodlands, ANSIs, significant fish and wildlife habitats, habitats of endangered or threatened species, and Lake Trout lakes. Where required, an EIS shall be prepared to show that there will be no negative impacts to these features or their ecological functions.

Agriculture

Section C3 contains policies for agricultural areas; it protects prime agricultural areas from fragmentation, development, and land uses unrelated to agriculture. On-farm diversified uses are encouraged, but must be compatible with and not hinder surrounding agricultural operations. Finally, non-agricultural uses may be permitted in agricultural areas subject to certain criteria. This process includes an official plan amendment, and it must be shown that: a) the land does not comprise a

specialty crop, b) appropriate minimum distance separation is respected, c) there is a planning need, and d) there are no suitable alternative lands available.

Public Health

The Plan addresses public health indirectly through policies for growth management. In Section B, the County promotes compact, transit-supportive development through intensification targets. Additionally, Section E2.2.9 encourages local municipalities to develop interconnected networks of active transportation routes. These policies lack a direct link to reduced air quality and increased opportunities for active transportation due to climate change.

Further, the Plan contains a special policy section addressing karst topography. The formation of karst is controlled by climatic and weather conditions, making it unstable and unsuitable for most types of development. In Section D6.6, the County has identified areas of potential development constraint due to karst. In the interest of public health and safety, development is generally directed away from these areas unless it can be shown that the risk to public safety is minor or can be mitigated.

Infrastructure

Climate change in the Region is expected cause more frequent and extreme weather events. As such, critical infrastructure is at risk of more rapid deterioration or significant damage. In Section D6.5 of the Plan, the County prohibits the development of certain critical infrastructure and land uses in hazardous lands. These include:

- institutional uses (i.e. hospitals, schools);
- emergency services (i.e. fire, police stations); and
- uses associated with the disposal, manufacturing, treatment, or storage of hazardous substances.

The County has also established policies for stormwater management. Section D2.4 notes that stormwater management practices should minimize or prevent increases to stormwater volumes and contaminant loads, and maintain or increase the extent of vegetative and pervious surfaces. It also promotes stormwater management best practices such as stormwater attenuation, re-use, and Low Impact Development (LID).

Finally, the Plan contains broad policies for waste management. Section F9 provides for appropriate waste management facilities to accommodate present and future needs. It also promotes objectives for the reduction, re-use, and recycling of waste.

The County's OP includes appropriate policies for the management of critical infrastructure, stormwater, and waste. These policies, however, fail to consider the projected impacts of climate change in the Cataraqui Region.

Potable Water Resources

Policies in Section D2.1 protect, improve, or restore the quality and quantity of the County's potable water resources. Using the watershed scale, development and site alteration are restricted to protect municipal drinking water supplies and designated vulnerable areas. These are identified in Source Protection Plans and include Wellhead Protection Areas (WHPA) and Intake Protection Zones (IPZ). Further, the County promotes planning for the efficient and sustainable use of water resources.

While these policies offer protection for existing potable water resources, they fail to consider the projected impacts of climate change. This includes increased stress on water resources, increased risk of acidification and eutrophication, and increased risk of contamination due to agricultural activities.

Energy

The Plan includes general policy in Section B13 that ensures infrastructure, electricity generation facilities, and public service facilities are provided in an efficient manner that accounts for the impacts of climate change. Section F5.1 encourages local municipalities to identify specific Community Improvement Project Areas, wherein a primary objective is to promote energy efficiency and sound environmental design. While these policies generally promote energy efficiency, they fail to address the impacts of climate change directly.

Summary of Climate Change Adaptation Policies

As stated in Section 4, one of the primary purposes of the County of Lennox and Addington Official Plan is to:

> "Establish a broad, upper tier policy framework that provides guidance to local municipalities in the preparation of updated local Official Plans, Official Plan Amendments, and zoning by-laws."

The County has adopted a restrictive policy approach. This approach guides development and site alteration away from hazardous lands, natural heritage features, prime agricultural lands, and potable water resources. While these policies effectively manage present issues, they fail to account for the long-term effects of climate change.

Most policies are not directly supportive of or linked to climate change adaptation. Instead, land use policies are focused on the County's goals for growth management and economic development. Where policies supportive of climate change adaptation do exist, most simply encourage local municipalities rather than set a mandate at the county level. For example, Section E2.2.9 encourages local municipalities to develop interconnected networks of active transportation routes. By failing to mandate specific land use practices, this section lacks the "teeth" for successful implementation.

Many policies are broad, which may lead to misinterpretation or poor implementation at the township level. Specific policies for climate change adaptation are necessary to ensure the long-term vitality of the County.

A.2 Townships

The geographic extent of the Cataraqui Region includes eight distinct townships as well as the Frontenac Islands. For the purposes of this report, a representative sample of four townships was taken and their Official Plans were reviewed. These four townships include: The Township of South Frontenac, the Township of Leeds and the Thousand Islands, the Township of Athens, and the Town of Greater Napanee.

A.2.1 Town of Greater Napanee

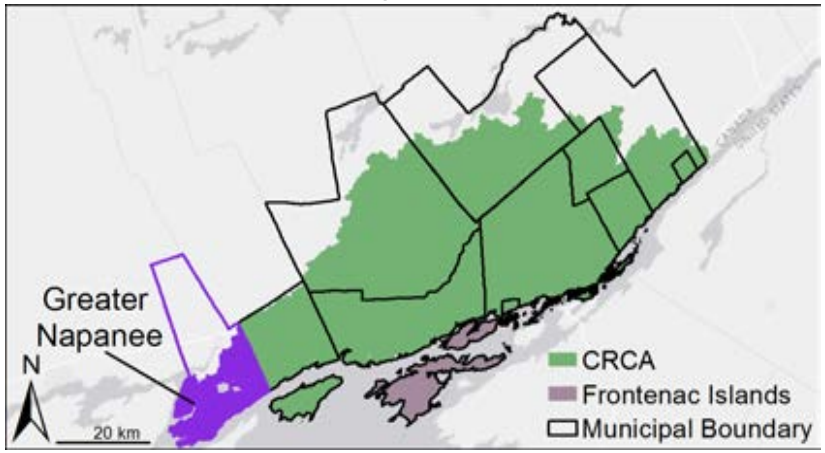

Figure A.5: Location of the Town of Greater Napanee within the Cataraqui Region.

The Town of Greater Napanee is located in the Southwest of the Cataraqui Region. Only the land south of the Bay of Quinte and the Napanee River is part of the Cataraqui Region - the area to the north is under the jurisdiction of the Quinte Conservation Authority. The current version of the Official Plan is consolidated as of May 2014 and was written by the Kingston office of IBI Group.

Figure A.6: Napanee River in the Town of Napanee (The Town of Greater Napanee, 2014).

Atmospheric Temperature

As a direct result of climate change there will be an increase in average temperatures in both the summer and winter months. Currently, Section 3.10.1.1 addresses the increase in air temperature through the promotion of a tree planting program on town roads; creating more shade in the summer months, and reducing heat strain on residents.

Extreme Weather Events

Greater Napanee's Official Plan addresses the increasing amounts of extreme weather events through policies that direct development away from areas prone to flooding or erosion, steep slopes, and dynamic beaches. These policies refer to 1:100 year flood lines as the boundary of development where flood mapping has been completed, and 30 metres from the high water mark for any waterbody where no flood map exists.

Natural Heritage

The Plan acknowledges natural heritage in a general sense. Areas of Natural and Scientific Interest (ANSI), endangered and threatened species, significant wetlands, and environmentally sensitive areas are all protected from development using buffer zones. Development is permitted in some of these areas, however, provided that it promotes the preservation and conservation of the feature.

Agriculture

The Greater Napanee area has significant agricultural features that are protected under the Plan. As per Section 4.3.2, areas designated as agricultural land under the *Provincial Policy Statement* are to be preserved for the purpose of long-term food production. This policy does not consider the anticipated long-term impacts of climate change.

Public Health

Public health policies that are relevant to climate change can be split into two categories: pollution and open space.

With regard to pollution there are policies that prohibit development on contaminated sites until the hazard has been remediated. Other policies promote the correction and prevention of air, water, and land pollution while prohibiting the development new pollution sources.

Regarding open space, the Plan promotes the creation of linear open space systems that can be used by pedestrians and cyclists. These systems should be designed to link various activity centres such as schools, commercial areas, and recreation zones.

Infrastructure

Greater Napanee encourages the use of linked transportation systems to facilitate easier intermodal access, primarily through cycling and walking. Furthermore, it is specified that the facilities that make up the public transportation network should be designed to minimally impact the environment and community. Notably, Section 4.6.6.2 directs the Council to use alternative engineering and road standards without the need for official plan amendments.

Water Resources

The conservation and protection of potable water resources, both surface and groundwater, is addressed directly and at great length. There are several policies mandating the Town to participate in watershed studies with the local conservation authority or the Ministry of the Environment and Climate Change. The findings of these studies are also to be incorporated as required through an official plan amendment.

Greater Napanee also has strict rules with respect to water protection and development proposals. Developments larger than one hectare must provide stormwater management strategies that do not adversely affect nutrient loading, contribute to contamination of, or change water levels in nearby waterbodies. Developments adjacent to waterbodies must also protect the shoreline, vegetation, water quality, and soil. In both of these cases the Conservation Authority must also be consulted.

Finally, the Plan also includes regulations related to manure storage facilities, ensuring the facility does not impact water resources.

Energy

The Plan contains few policies regarding energy and climate change. However, Section 7.2.1 promotes development of green energy and refers to the *Ontario Green Energy Act* for additional details.

Summary of Climate Change Adaptation Policies

The Town of Greater Napanee Official Plan has numerous policies that support climate change adaptation. Many of the policies are open-ended and provide guidance without being too restrictive. This allows some flexibility as the Town and the Cataraqui Region continue to learn about the effects of climate change. It is also clear that the plan prioritizes potable water resources and environmentally sensitive areas. These are generally addressed by directing development away from sensitive areas.

Additionally, the plan has significant guiding policies for active transportation, sustainable sites, and reducing residents' ecological footprints.

Most notably, "Part 8 – Sustainability" addresses climate change directly and sets out the Town's sustainability goals. This section is very progressive and may be used as a model in other parts of the Region. While there are some policy gaps to be filled, The Town of Greater Napanee is well positioned to adapt to climate change.

A.2.2 Township of Athens

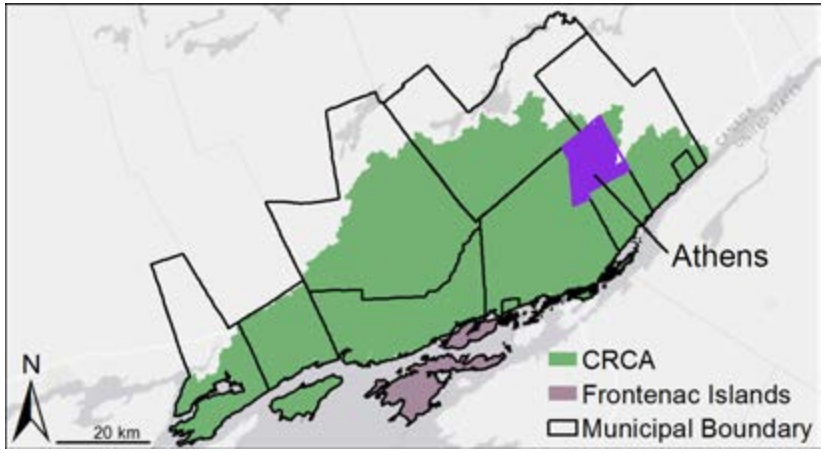

Figure A.7: Location of the Township of Athens within the Cataraqui Region.

The Township of Athens is located in the Northeast portion of the Cataraqui Region. The Township has about 3,000 residents, most of whom reside in the villages of Athens and Charleston. The Township boasts several natural features such as Charleston Lake, a cold-water lake home to Lake Trout, and part of the Frontenac Arch Biosphere, a UNESCO world biosphere reserve. The Official Plan is set to guide planning into 2030, when the forecasted population will have risen to about 3,500. The current version of the Official Plan is consolidated as of July 2012 and was prepared by Novatech Engineering Consultants.

Atmospheric Temperature

The Plan does not contain any policies that directly address atmospheric temperature.

Extreme Weather Events

The Plan addresses extreme weather events through policies relating to both natural and man-made hazards. Applicable

policies are found in a variety of sections of the Plan, including those regarding setbacks, development approvals, recreation, and agriculture. The issues of erosion and flooding are given the most emphasis, and Environmental Impact Assessments are stressed as an important mitigation tool.

Natural Heritage

The Township of Athens has an extensive natural heritage system containing unique natural features. The importance of these features is reflected in the objectives of the Plan, whereby significant natural heritage features are to be protected from development-related impacts. Most of the relevant policies are related to water: waterfront development and setbacks, water quality, water conservation, and water species are all addressed.

The Plan provides special consideration for Charleston Lake, one of the few cold-water lakes in the Region with lake trout. Riparian habitats are recognized as important and are managed through setback policies that restrict adjacent land uses and development intensity.

Finally, the Plan provides for the protection of threatened species and their habitats. Policies requiring Environmental Impact Studies help to map and address pertinent ecological information that may not be known or accessible to the general public.

Agriculture

While the Township of Athens has a long history of agriculture, it no longer represents a significant proportion of employment in the area. As such, agriculture is not emphasized in the Official Plan. The diversification of agricultural practices is prioritized, although only in relation to other agricultural policies. Policies that preserve agricultural land are in place, but are not prominent. These policies do not account for direct effects of climate change.

Public Health

While public health concerns are considered as a test in assessing development proposals, the issue of public health in relation to climate change is not uniquely discussed. In general, public health risks are addressed through policies that direct development away from areas associated with natural or man-made hazards.

Policies addressing air and water quality are not explicitly linked with climate change adaptation. Instead, these policies are linked to other objectives such as ground water supply, ecological preservation, and responsible development adjacent to waterbodies.

Infrastructure

Infrastructure is limited in the Township. Municipal servicing does not exist and it is unlikely to be built in the near future. However, policies are included that direct development to designated settlement areas (a predicted 60% of new lots). If the Township experiences population growth beyond their projections, this will help to ensure the feasibility of municipal water and sewer servicing. Larger developments may have community water and sewer services, but policies regarding preferred servicing options are not specific. Additionally, minimum lot sizes are required due to servicing needs.

Waste management is a pressing issue for the Township. It is difficult to regulate and can pose dangers to the public and the environment. Communal servicing, for five lots or more, must be municipally regulated, which poses problems for the municipality and the land owners.

While the Plan's infrastructure policies address the provision and maintenance of critical infrastructure, they do not consider the direct effects of climate change.

Potable Water Resources

Due to the lack of municipal servicing in the township, potable water policies address issues such as drainage, stormwater management, and setbacks from key water sources. These issues are addressed on a case-by-case basis by the appropriate approval authority. Minimum lot sizes are enforced to ensure appropriate water quality and quantity, and water-intensive land uses are not permitted. These policies protect valuable potable water resources, but do not address long-term direct effect of climate change.

Energy

The Plan provides meaningful policy to support energy conservation and efficiency. In the review of planning applications, it encourages the development of plans that employ techniques such as building and lot orientation, building design, and vegetation buffering. At a larger scale, alternative and renewable energy systems are supported to reduce the Township's carbon footprint.

Other

Recreational and eco-tourism are both important economic drivers for the Region. A changing climate presents significant challenges to the preservation of natural features that support these industries. While policies supporting recreation and tourism are found in numerous areas of the Plan (commercial, economic, and community improvement sections), these policies do not address the long-term effects of climate change.

Summary of Climate Change Adaptation Policies

The Township of Athens Official Plan contains strong policies for the protection of the Township's valuable natural heritage features. Policies for the protection of agricultural land are also in place, but are not prominent due to decreasing agricultural activity in the Township. While natural heritage features and agricultural land are protected from development-related impacts, there is no consideration for the long-term impacts of climate change.

The Plan also provides meaningful policy support for energy conservation and efficiency. In reviewing planning applications, the Township encourages plans that employ techniques such as building and lot orientation, building design, and vegetation buffering to advance energy objectives. At a larger scale, the Plan also supports alternative and renewable energy systems.

Public health risks in relation to climate change are not discussed. Rather, policies addressing air and water quality advance alternative objectives such as ground water supply, ecological preservation, and responsible development adjacent to waterbodies. Policies regulating development near hazard areas are included in several sections of the Plan but are not linked to climate change.

In general, few land use policies address the long-term effects of climate change in a meaningful way; many policies are focused on present conditions. As it stands, the Township of Athens Official Plan provides little land use policy support for climate change adaptation.

A.2.3 Township of Leeds and the Thousand Islands

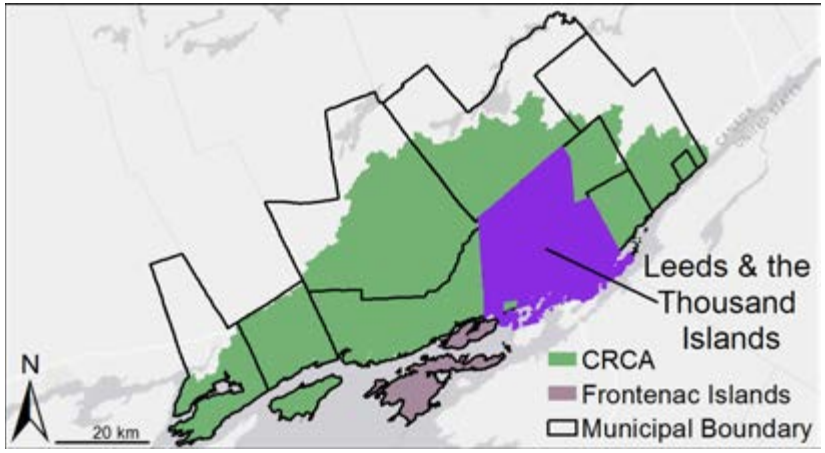

Figure A.8: Location of the Township of Leeds and the Thousand Islands within the Cataraqui Region.

The Township of Leeds and the Thousand Islands is located in the Eastern portion of the Cataraqui Region. It extends over about 640 square kilometres from Gananoque to Mallorytown, and from the St. Lawrence River to the Township of Rideau Lakes. A total of about 9,300 people live in the Township. While primarily rural, it also offers several historic villages such as Lansdowne, Seeley's Bay, and Lyndhurst. As the name suggests, the Township includes a significant portion of the St. Lawrence River's Thousand Islands. It also includes a large portion of the Frontenac Arch Biosphere Reserve, which is designated under UNESCO's Man and Biosphere Programme.

The current version of the Official Plan was prepared by J.L. Richards & Associates. It is consolidated as of March 2012, and is set to guide planning to the year 2023.

Figure A.9: Thousand Islands International Bridge (United Counties of Leeds & Grenville, 2015).

Atmospheric Temperature

The Plan does not contain any policies that directly address atmospheric temperature.

Extreme Weather Events

The Plan addresses both natural and human-made hazards in Section 5.5. Generally, development is not permitted within these areas. Flooding and erosion are identified as known natural hazards. In accordance with CRCA recommendations, flooding hazards are defined using the 1:100 year floodplain whereas erosion hazards are defined using the 3 to 1 stable slope plus a six metre allowance. Known human-made hazards such as abandoned mines and mineral resource operations are also identified.

The policies in this section are general and do not consider the effects of climate change. They do not address how an increased frequency and severity of extreme weather events will alter or create new natural hazard areas.

Natural Heritage

Described in Section 5.3, the Township recognizes a Natural Heritage System. This System includes natural features which are important for their environmental and social legacy in the natural landscape. Through the Natural Heritage System, the Plan offers long-term protection and conservation of these features. Natural heritage features are divided into two distinct categories.

Natural Heritage A:

- provincially significant wetlands; and
- significant habitat of endangered and threatened species.

Natural Heritage B:

- approved ANSIs;
- fish habitat;
- locally significant wetlands; and
- environmental protection.

The Plan regulates development within and adjacent to these areas. Development and site alteration are not permitted in Natural Heritage A designations. It may be permitted in Natural Heritage B designations, however, provided that it can be demonstrated that there will be no negative impact to the features of their ecological functions.

Section 4.15 recognizes the National and Provincial Parks within the Township. These include St. Lawrence Islands National Park and Charleston Lake Provincial Park. While the use and development of these parks does not fall under the Township's authority, the Plan identifies a need for connections between the natural heritage values of the parks and the larger ecosystem. This will be accomplished through the careful consideration of development and land uses in areas immediately surrounding the parks.

Pursuant to Section 4.28, the Township may request the preparation of an EIS where development or site alteration are proposed. An EIS is an important tool allowing the Township to better understand the potential impacts of the development on natural heritage features. This measure provides an additional level of screening and protection for the Township's valuable natural heritage resources.

Finally, Section 5.9.3 is a special policy section for highly sensitive Lake Trout lakes. Two lakes within the Township are identified as having the physical characteristics required to support Lake Trout: Charleston Lake and Red Horse Lake. New lot creation is not permitted within 300 metres of these lakes.

The Plan provides strong long-term protection for natural heritage features such as those identified in the Natural Heritage System. However, these policies fail to consider the anticipated impacts of climate change.

Agriculture

Agricultural resources are valued throughout the Plan. Pursuant to Section 5.2, land under the agricultural designation will generally be preserved for long-term agricultural use. The intent of the agricultural designation is to protect productive agricultural land from incompatible uses and fragmentation. Diverse uses are permitted on agricultural lands, including those related to value-added agricultural products such as custom meat shops or pick-your-own operations. Further, the Plan requires an OP amendment to change the designation from agriculture to a different land use.

While agricultural lands in the Township are protected for long-term use, the official plan policies described above do not account for the impacts of climate change.

Public health

Few policies for public health exist in the Plan. Section 4.6.2 supports the development of linkages between recreational trails, villages and hamlets, tourist attractions, and other points of interest. In theory, this links indirectly to climate change through increased opportunities for active transportation. It should be noted, however, that this forms part of the Township's economic policy. It supports economic growth with a focus on tourism rather than public health in a changing climate.

Infrastructure

Under Section 3.3.12, one of the primary objectives of the Plan is the effective provision of infrastructure. In Section 4.21, policies for roads generally direct new development to existing serviced roads. With the exception of the Village of Lansdowne, all other development in the municipality is currently serviced by private individual or communal water and waste systems. There are currently no plans for this to change. Finally, Section 5.7 addresses waste management. Development and land uses near or within any current or past waste management site is regulated by the Ministry of Environment.

These policies discuss only the provision of infrastructure and services in the Township. They fail to consider the impacts of climate change.

Potable Water Resources

As discussed above, the Village of Lansdowne is the only area in the Township that uses municipal water and sewer servicing. Under Section 4.23.1, and to ensure the protection of Lansdowne's public water supply, the Township will ensure that measures identified in the 2002 Wellhead Protection Study are implemented as soon as possible.

The Township encourages new development to occur by registered plan of subdivision or through the consent process. New developments will not be approved unless appropriate technical studies can demonstrate that a sufficient supply of water and sewage disposal capacity exists. Finally, under Section 4.5.1 the Township requires all lots that are to be developed on private individual services to have sufficient area and frontage to protect groundwater quality.

Policies in this section provide general, long-term protection for the Township's potable water resources. The Plan fails, however, to account for the impacts of climate change.

Energy

Alternative and renewable energy systems are terms defined in the glossary of the Plan. However, the Plan contains no supporting policies or objectives.

Summary of Climate Change Adaptation Policies

The current version of the Township of Leeds and the Thousand Islands Official Plan provides general development and land use planning policies. The Plan recognizes the Township's valuable natural heritage features and includes policies to protect them in the long term. It also includes meaningful policies for the protection of productive agricultural land, potable water resources, and against natural or human-made hazards. However, these polices do not consider the anticipated long-term impacts of climate change.

The Plan lacks policies relating to public health risks, and energy management. While Section 4.6.2 supports the development of linkages between points of interest (i.e.

recreational trails, villages and hamlets, etc.), this policy is linked to the Township's economic objectives. Further, while alternative and renewable energy systems are defined terms in the glossary, there are no supporting policies or objectives.

Climate change, or the anticipated long-term impacts of climate change, are not addressed or considered at any point in the Plan. As such, land use policies in the Plan do not provide sufficient support for climate change adaptation.

A.2.4 Township of South Frontenac

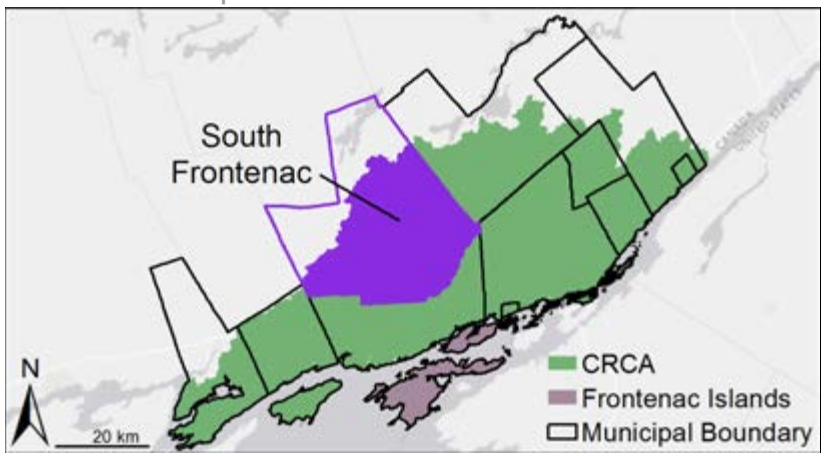

Figure A.10: Location of the Township of South Frontenac within the Cataraqui Region.

The Township of South Frontenac borders the City of Kingston to the north, and is one of four townships in Frontenac County. It has the smallest land area of the three northern townships at about 972 square kilometres, but has the largest population at about 18,000 (Government of Canada, 2011). The Township enjoys a rural character, with villages spread amongst many lakes, farms, and wooded areas.

The Township of South Frontenac Official Plan was adopted by Council in 2000, and approved by the Minister of Municipal Affairs and Housing in 2002. The Plan is currently being updated. The latest draft version was reviewed for this report, which is up to date as of June 2, 2015.

Atmospheric Temperature

The Plan does not contain any policies that directly address atmospheric temperature.

Extreme Weather Events

The Plan addresses extreme weather events through policies that direct development away from natural hazard lands. Pursuant to Section 6.21, these lands are identified as being at a higher risk of flooding and erosion, having steep slopes or organic soils, or having other physical limitations. Further, development is directed away from areas with hazardous forest types, which are susceptible to wildland fire. While these policies effectively consider present conditions, they do not link directly to the effects of climate change. They fail to consider the projected increased frequency of extreme weather events and the potential for new or expanded hazard lands.

Natural Heritage Features

As stated in Section 4.1, the Township's natural heritage is considered its predominant asset. Preserving and enhancing the Township's environmental quality is a primary goal, and planning decisions are to be made on an ecosystem basis. Under Section 5.2, the Environmental Protection designation is applied to preserve key features of the Township's natural heritage system. These features include wetlands, lakes and watercourses, and the habitats of threatened or endangered species. The Plan also identifies Environmentally Sensitive Areas – lands having unique natural or scientific features which may experience negative environmental impacts due to

development or site alterations. These lands include ANSIs, significant fish or wildlife habitats, and significant woodlands or valleylands. Development is generally directed away from these areas unless an EIS shows that no negative environmental impacts will occur.

The Township has one of the highest concentrations of inland Lake Trout lakes in Ontario. Lake Trout require a very specific quality of lake to survive. As such, the Township has included a section specific to the protection of Lake Trout habitat. Section 5.2.8 requires the preparation of an EIS for any development or site alteration within 30m of the high water mark of a Lake Trout lake. Additionally, any development on or adjacent to a Lake Trout lake is subject to site plan control. These policies ensure that development does not negatively impact water quality or otherwise affect Lake Trout habitat.

These policies offer strong protection for the Township's natural heritage features from development and site alteration. They fail, however, to account for the direct effects of climate change.

Agriculture

Under Section 4.3, the Agricultural and Rural Goal seeks to preserve the Township's established rural character and agricultural identity. Using the Agricultural designation (Section 5.1), lands identified as agriculturally productive are protected from fragmentation and the development of non-agricultural uses. These policies do not directly address the effects of climate change, such as changes to soil quality and food insecurity.

Public Health

As previously discussed, the Plan controls and directs development away from natural hazard lands. Development activity on these lands puts public health and safety at risk. Pursuant to Section 4.6, the Township's goal is to ensure that public health and safety is not jeopardized due to development on these lands. The Plan does not discuss other climate change related health effects, such as reduced air quality or increased opportunities for active transportation.

Infrastructure

Pursuant to Section 4.8, it is the objective of the Township to ensure the adequate provision of physical and community services. This is partially addressed through Section 5.6, wherein lot creation is directed to settlement areas where municipal servicing already exists. As per Section 6.18, the updating of infrastructure may also be accomplished through a Community Improvement Plan. While the Plan recognizes the ongoing need for adequate infrastructure, it does not address how climate change will effect existing infrastructure or the future provision of infrastructure.

Potable Water Resources

The Plan contains few policies relating to potable water resources. Section 6.10 will only permit lot creation in non-serviced areas if there is sufficient groundwater capacity to accommodate the proposed development. The objective of this policy is to ensure an adequate supply of potable water for proposed developments. However, there are no further policies that protect existing potable water resources or address future threats to potable water due to climate change.

Energy

Included in the Township's Natural Heritage Goal is an objective to reduce reliance on conventional energy systems by encouraging alternative energy systems. This is supported in Section 5.1.1 by permitting secondary uses, such as alternative energy generation facilities, on lands under the

agricultural designation. There are no additional policies supporting alternative energy generation or energy efficiency.

Summary of Climate Change Adaptation Policies

The Township of South Frontenac Official Plan has strong policies addressing natural hazard areas and natural heritage features. Extreme weather events are addressed through policies directing development away from natural hazard lands. Development is also directed away from natural heritage areas to ensure their protection in the long-term. While these policies effectively address present conditions, they are not linked directly to climate change adaptation. Instead, they are focused on other general economic or environmental objectives.

Policies relating to other climate change impact themes are very general and fail to account for the projected impacts of climate change. The Plan does not address anticipated changes in atmospheric temperature or consider climate change-related health effects. Agriculturally productive lands are protected from fragmentation and non-agricultural uses, but associated policies do not consider the direct effects of climate change.

The Township recognizes the need adequate infrastructure but does not consider how infrastructure will be affected by climate change. Lot creation is restricted in non-serviced areas to ensure a sufficient supply of groundwater. However, there are no further policies that protect existing potable water resources or address future threats to potable water due to climate change. Lastly, the Plan contains an objective to reduce reliance on conventional energy systems by encouraging alternative energy systems. However, there are no additional policies supporting this objective.

In its current state, the Plan does not contain adequate land use policies for adaptation to climate change.

A.3 Separated Municipalities

Three separated municipalities are located within the boundaries of the Cataraqui Region. These separated municipalities include: the City of Kingston, the City of Brockville and the Town of Gananoque.

A.3.1 City of Brockville

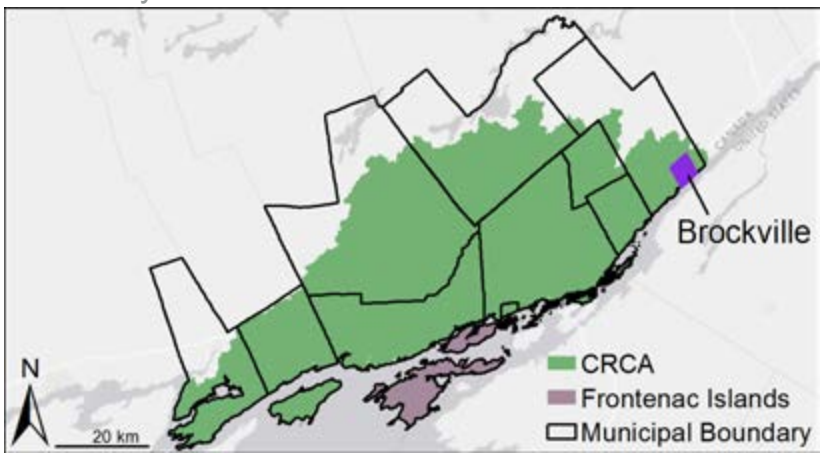

Figure A.11: Location of Brockville within the Cataraqui Region.

Brockville is a separated municipality of about 22,000 residents (Statistics Canada, 2012) located in the Northeastern portion of the Cataraqui Region. It is situated on the St. Lawrence River, and is surrounded by the Township of Elizabethtown-Kitley in the United Counties of Leeds and Grenville. Brockville's current Official Plan was approved by the Ministry of Municipal Affairs and Housing in February 2012. The plan, which guides land use planning within Brockville until 2031, is heavily driven by sustainability

principles and is organized around the following four strategic planning themes (Brockville, 2012):

- "A Sustainable, Healthy and Vital City"
- An Economically Strong and Diverse City
- A High Quality of City Services and Amenities
- A Well Planned and Responsive City

Figure A.12: Aerial view of Brockville (Green Door B&B, 2015).

Atmospheric Temperature

Brockville's Official Plan contains policies that address atmospheric temperature directly through sustainable neighbourhood development and green building or site design. Sections 3.4.1.1 and 3.4.1.2 promote the creation of innovative green spaces (such as green roofs) that will reduce the Urban Heat Island effect. Policies in other sections of the plan promote energy efficient buildings and enhanced greenspaces in the City.

Extreme Weather Events

The Plan addresses natural hazards in Section 3.7.1. Development and site alteration are directed away from hazard areas - lands which are at an elevated risk of environmental hazards such as flooding and erosion. Where development in hazard areas is necessary, appropriate minimum protection standards (such as floodproofing) must be met.

Section 3.6.3 contains policies that seek to reduce the potential impacts of flooding and erosion by enhancing vegetation along watercourses. Additionally, this section requires appropriate setbacks for development and site alteration adjacent to watercourses.

Finally, Section 5.5 (5) requires utilities to be buried underground where feasible and reasonable. This links indirectly to the expected increase in ice and windstorm frequency.

Natural Heritage

The protection of significant natural features is listed as a primary policy objective under the goal of enhancing and conserving the natural environment. Section 3.6.5 directs development and site alteration away from significant wetlands, woodlands, and valleylands, significant habitat of threatened or endangered species, and fish habitats. Delineated natural heritage features shall be protected long-term, and may be refined or expanded subject to an EIS. Furthermore, the City encourages the conservation and replacement of trees wherever possible and appropriate. While these policies offer strong protection for significant natural features, they fail to link to the direct effects of climate change.

Agriculture

The City of Brockville does not include significant agricultural land areas. Under the "Sustainable, Healthy and Vital City" theme objectives, however, the Plan lists urban agriculture as a topic to be explored. Additionally, Section 4.10.2 allows for agricultural and related uses in the Urban Reserve Area, although in the long term this area is designated for development. These policies are general and do not link directly to the effects of climate change or adaptation strategies.

Public Health

Policies in Section 3.7.2 directly address climate change from a public health perspective. Under the subheading of "Air Quality & Climate Change", this section includes both mitigation and adaptation strategies. The City will endeavour to enhance the urban tree inventory in an effort to improve air quality and reduce energy consumption. Additionally, the City promotes transit-supportive and compact urban form. This further promotes public health by reducing the number of vehicle emissions and supporting active modes of transportation.

There are also many policies that promote the creation or expansion of open spaces and trail networks. These offer residents increased opportunities for outdoor recreation and active transportation.

Infrastructure

The City recognizes the need to provide effective and adequate infrastructure to accommodate present and future needs. Section 5 addresses the provision of infrastructure at length, with separate subsections for roads, transit, water and sewer, waste, and utilities. The Plan does not, however, address how climate change will impact existing infrastructure or the future provision of infrastructure.

Potable Water Resources

The Plan contains strong policies for the protection of potable water resources, including aquifers and groundwater. Section 3.6.2 acknowledges:

> "As groundwater and aquifer contamination is extremely difficult and costly to rectify, prevention of contamination is the most realistic strategy."

While this does not link directly to climate change, the policies within the section represent effective adaptation strategies. The City promotes water use efficiency and conservation through the design and development of buildings, community programs, and by showing leadership in municipal culture. These policies primarily address water quantity. Effects of climate change that affect water quality, such as acidification, are not addressed.

Energy

The City acknowledges that "green" or renewable energy is becoming increasingly important. Section 3.3.3 encourages and facilitates green energy projects at all scales and for both the public and private realms. These policies are generally linked to economic goals rather than climate change adaptation. Other policies target energy efficiency and conservation, primarily through sustainable and green design principles. Sections 3.4.1.1 and 3.4.1.2 encourage green building design and neighbourhood development by promoting the Leadership in Energy and Environmental Design (LEED) certification. Again, these policies lack a direct link to climate change.

Summary of Climate Change Adaptation Policies

The City of Brockville Official Plan consists of many broad policies that address the City's objectives for sustainable growth. Most policies do not provide direct adaptation strategies to address the effects of climate change; rather, they only address existing issues. For example, Sections 3.4.1.1 and 3.4.1.2 promote the creation of innovative green spaces (such as green roofs) that will reduce the Urban Heat Island effect. These policies do address a direct effect of climate change, but fail to consider how the Urban Heat Island effect may be exacerbated under climate change conditions.

Section 3.7.2 directly addresses climate change from a public health perspective. Including both mitigation and adaptation strategies, this section endeavours to enhance the urban tree inventory in an effort to improve air quality and reduce energy consumption. Additionally, the City promotes transit-supportive and compact urban form to reduce harmful vehicle emissions.

Policies relating to other climate change impact themes generally fail to link directly to climate change. The Plan addresses extreme weather events through policies that direct development away from natural hazard areas. However, it does not account for increased frequency or severity of these events. Natural heritage features and potable water resources are protected in the long-term, but there is no consideration of how these features may be affected by climate change. Finally, Section 3.3.3 encourages and facilitates green energy projects at all scales. However, these policies are linked to economic objectives rather than climate change adaptation.

With the knowledge that these issues and others will intensify in a changing climate, the City should modify these policies to better link with climate change.

A.3.2 Town of Gananoque

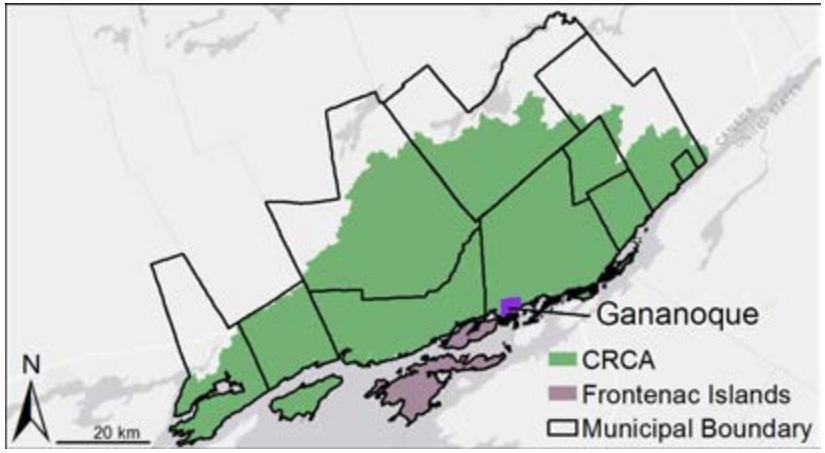

Figure A.13: Location of the Town of Gananoque within the Cataraqui Region.

The Town of Gananoque is the smallest of the separated cities in the Cataraqui Region, covering only about seven square kilometres. As of 2011, about 5,200 people live in Gananoque. The Town is divided by the Gananoque River and borders the Saint Lawrence River to the south. The current version of the Official Plan was published in 2009 by Stantec Consulting Limited and will guide Gananoque into 2029.

Atmospheric Temperature

The Cataraqui Region will experience increased temperatures year-round. In urban areas, this translates into an intensified Urban Heat Island effect. The Gananoque Official Plan contains no policies directly addressing this issue. Instead, Section 3.2.2.11 makes an indirect link by stressing the many benefits of street trees. Most notably, street trees are important in the reduction of heating and cooling costs. At a large scale this is a viable strategy to calm the Urban Heat Island effect in a warming climate.

Figure A.14: Downtown Gananoque and marina (Terry Serson, 2015).

Extreme Weather Events

Land use policies in the Plan that address extreme weather are mostly related to flooding and erosion. Planning for flooding and erosion is very important in Gananoque; the St. Lawrence and Gananoque Rivers increase the potential for such events. Section 4.1.6 addresses these issues by requiring stormwater management plans for some forms of new development. It does not, however, address the expected increased frequency of extreme weather events. This policy is general and not directly linked to climate change adaptation.

Natural Heritage

Policies regarding the preservation and conservation of natural heritage features are not directly linked to climate change adaptation. Due to its waterfront location, Gananoque's policies are instead focused on the preservation and protection of native and endangered species and their habitats. Species identified as threatened or endangered in Gananoque include: Pugnose Shiner (fish), Butternut tree, Ginseng, Broad Beech Fern, Stinkpot Turtle, and Black Rat Snake. Policies regarding ANSIs, wetlands, and valleylands are omitted due to the absence of such features in the Town.

Figure A.15: Broad Beech Fern (Ontario Ministry of Natural Resources and Forestry, 2015).

Agriculture

There is currently no land in the Town's jurisdiction designated for agricultural purposes. The Plan does, however, allow for agricultural and forestry activities on lands designated as rural. The majority of rural lands are not serviced by the municipality and are planned to remain as rural or recreational lands. Due to the lack of agricultural activities in the Town, the Plan does not directly address the impacts of climate change on agricultural lands.

Public Health

Section 3.7 of the Plan contains policies that restrict development on lands that pose a threat to public health and safety. Lands identified as hazardous are those which are subject to flooding and erosion, unstable slopes and organic

soils, or that are environmentally contaminated. The Plan sets aside safely developable lands in section 5.3.3, promoting residential infill on lots that are already serviced and considered safe for development.

Public health policies are general and do not link to climate change. The Plan fails to include meaningful policies regarding air quality and the increased potential for hazard lands due to climate change.

Infrastructure

Infrastructure is addressed at length throughout the OP. The Town recognizes a need to ensure effective infrastructure is provided on an on-going basis. Infrastructure is to be provided in a manner that ensures the protection of the environment. While the Plan recognizes the need for infrastructure improvements, it does not address how climate change will impact existing infrastructure or the future provision of infrastructure.

Potable Water Resources

Water resource policy in the Plan addresses water quality and quantity. Due to abundant nearby water sources, most of the policy is focused on preserving water quality rather than quantity. Watershed preservation is promoted in sections 4.1.4 and 4.1.5 in conjunction with the CRCA. These policies are general and do not address the expected increased stress on potable water resources due to climate change.

Energy

The Plan's energy policies promote both renewable energy sources (primarily solar and wind) and improving energy efficiency in new and existing developments. Several wind and solar farms already exist in the Cataraqui Region and have been proven effective where there is appropriate land and money available. Sections 4.1.8.1 and 4.1.8.2 encourage the use of wind and solar energy. Provisions are included for these energy systems at a variety of scales (from small residential to large industrial), subject to appropriate zoning, site-plan, or special study requirements.

Summary of Climate Change Adaptation Policies

The Town of Gananoque Official Plan provides effective general policy to protect endangered species, shield residents against hazardous lands, and promote both energy efficiency and the use of renewable sources of energy. However, the term *climate change* and the association between climate change and applicable policies is not evident.

Infrastructure is addressed at length throughout the Plan. While the Town recognizes the need to provide adequate infrastructure on an on-going basis, it does not address how climate change will impact existing infrastructure or the future provision of infrastructure.

Abundant nearby potable water resources are protected in Sections 4.1.4 and 4.1.5 under policies for watershed preservation. These policies account for existing conditions, and do not consider the anticipated long-term effects of climate change.

The Plan promotes both renewable energy sources (primarily wind and solar) and improving energy efficiency in new and existing developments. Several wind and solar farms already exist in the Cataraqui Region, and provisions for these energy systems are included at a variety of scales (from small residential to large industrial).

The Town of Gananoque Official Plan provides effective general land use policies for a number of topics. However, these policies fail to consider the long-term anticipated impacts of climate change. In its current state, the Plan does not

provide sufficient land use policy support for climate change adaptation.

A.3.3 City of Kingston

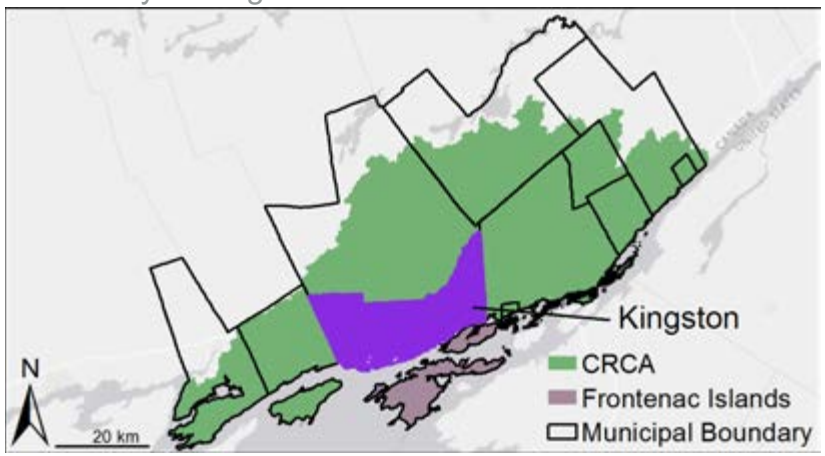

Figure A.16: Location of Kingston within the Cataraqui Region.

The City of Kingston is located in the South-central portion of the Cataraqui Region where the St. Lawrence River meets Lake Ontario. Covering nearly 475 square kilometres, the entire municipality is within the Cataraqui Region. The majority of the Region's population lives in Kingston, which had a 2011 population of about 160,000. The City is known for its dense urban core and heritage character.

The current version of the Official Plan was approved in 2010. However, the Plan is currently under review. The second draft (released October 5, 2015) of this review was used for the analysis in this report.

Figure A.17: Kingston City Hall, Springer Market Square (Tourism Kingston, 2015).

Atmospheric Temperature

As a direct result of climate change there will be an increase in year-round average temperatures. This is particularly important in City of Kingston urban microclimate. Section 2.1.1.c requires innovative energy systems and building practices, including techniques to reduce the effects of urban summer heat. Section 6.2.1 promotes design and orientation of new developments that maximize passive solar gains and minimize heat loss from wind.

Sections 6.1.27 and 6.1.28 recognize that trees are an important resource, providing shade and many other benefits in an urban setting. The City will protect and manage the urban forest. Further, Section 6.2.2 promotes landscaping and tree planting programs to help moderate both summer and winter micro-climatic conditions.

While these policies are good practices, they do not link directly to the conditions of a changing climate.

Extreme Weather Events

The Cataraqui Region will experience an increased frequency and severity of extreme weather events, including 100-year wind storms, due to climate change. The Plan addresses extreme weather events directly in Section 2.10.1, wherein to improve resiliency the City will consider the potential impacts of climate change and extreme weather events when:

- planning for infrastructure;
- assessing new development; and
- assessing risks associated with natural hazards.

The Plan also contains policies controlling development within natural hazard areas or areas more vulnerable to extreme weather events. These areas include, but are not limited to: floodplains, unstable slopes and soils, erosion hazards, karst, hazardous forest types for wildland fire, and human-made hazard areas. Section 5 generally prohibits development in these areas. Some development or site alteration may be permitted, subject to appropriate technical studies, mitigation measures, and consultation with the CRCA or other authorities. Further, the City will consider potential impacts of climate change that may increase risk associated with natural hazards when planning and developing public works, facilities, and infrastructure.

Natural Heritage

Natural heritage systems face uncertainty with climate change. Effects such as warming temperatures and changes to precipitation volume or frequency have the potential to damage and weaken the Region's valuable natural heritage features. Section 6.1 of the Plan regulates natural heritage features by grouping them into three categories:

Natural Heritage Features and Areas "A"

- Include provincially and locally significant wetlands, coastal wetlands, ANSIs, fish habitat and riparian corridors, and significant habitat of threatened and endangered species; and
- No development or site alteration is permitted.

Natural Heritage Features and Areas "B"

- Include significant woodlands and valleylands, significant habitat, unevaluated wetlands, other coastal wetlands, linkages, and corridors; and
- Development and site alteration are not permitted unless it can be demonstrated that there will be no negative impacts on the natural heritage features or their ecological functions.

Species at Risk

- Include habitats of threatened or endangered species, fish habitat, habitats of aquatic species at risk; and
- Development and site alteration are not permitted except in accordance with provincial or federal requirements.

These development restrictions apply both to identified natural heritage areas and adjacent lands. Further, Section 6.1.10 stipulates that no development will be permitted in these areas unless it is demonstrated that there will be no negative impacts. While these policies provide a good foundation for the protection of natural heritage features, they do not address the direct effects of climate change.

Agriculture

The Plan has a number of policies promoting agriculture in both urban and rural contexts. In an urban context, Policy 3.2.8 states:

> "Community-based initiatives such as community gardens, other forms of urban agriculture, and tree planting projects are permitted in all land use designations, subject to site by site evaluation."

Additionally, Section 3.1.1.1 encourages secondary uses including agriculture and community gardens in hydro corridors where it is compatible with surrounding land uses.

For rural areas, Section 3.12 restricts development and permitted uses to protect prime agricultural lands. Few non-agricultural uses are permitted, such as very limited residential and mineral aggregate extraction uses. Accessory uses, secondary farm occupations, and other non-farm related uses are no longer permitted within prime agricultural lands. Further, there are few ways that agricultural land can be re-designated.

Generally, policies in the Plan are structured to encourage urban agriculture within the urban boundary and to preserve prime agricultural land in rural areas. However, none of these policies are specifically designed to address the impacts of climate change on agriculture.

Public Health

Section 5 of the Plan is devoted to health and safety. The City acknowledges the role of climate change in increasing the risk associated with natural hazards.

Pursuant to Section 5.1, the City will review environmental hazards and consider the potential impacts of climate change in the planning and development of public works and facilities or infrastructure. Further, Section 5.4 requires separation or regulation of land uses to minimize potential health and safety threats. The City will consider the potential impacts of climate change in addressing the risk associated with natural hazards.

The Plan also includes a new section regarding wildland fires which directs development outside of lands that have hazardous forest types for wildland fire.

In crafting the latest edition of the Official Plan, the City has recognized the importance of modifying land use policies to account for the effects of a changing climate.

Infrastructure

Under Section 4, the City's goal is to provide infrastructure in an orderly, environmentally sound, and fiscally prudent manner. The City will promote compact development and a mix of land uses within the urban boundary. This will maximize the use of existing infrastructure and reduce the need for additional infrastructure.

In accordance with Section 4.5.1, the City will consider the impacts of climate change when co-ordinating and providing utilities to new developments. Section 4.6 promotes sustainable forms of transportation, encouraging walking, cycling, and transit. The City will improve connections between these modes of transportation through improved amenities, urban design, and other means. Through these efforts, the City can reduce reliance on automobiles while using existing infrastructure more efficiently.

Finally, Section 10A.3 recognizes the importance of renewing or replacing some of the City's oldest infrastructure. It does not, however, address how climate change will affect these or other infrastructure.

Potable Water Resources

This theme can be split into two categories: source water protection and potable water infrastructure.

Source water protection through land use planning is somewhat unique because the bulk of provisions that protect source water come from the *Clean Water Act* rather than the *Planning Act.* Section 6.3 of the Kingston OP divides source water into three categories of protection area:

- Wellhead Protection Areas (WHPA);
- Intake Protection Zones (IPZ); and
- Highly Vulnerable Aquifers and Significant Groundwater Recharge Areas.

Within these areas, developments must incorporate measures to mitigate and manage any risk posed to source water. There are no policies, however, that describe how protection areas may be affected due to climate change.

Municipal water and sewage infrastructure is addressed in Section 4.2. Upgrades and expansions to the existing municipal water and sewage system are to be done in an environmentally sound manner. Where feasible, the City will continue to separate sanitary and storm sewers where combined sewers currently exist. These policies are general, and do not describe how climate change will affect municipal water and sewage infrastructure.

Energy

Section 6.2 addresses energy. This section establishes a clear link between the impacts of climate change and the need for energy conservation, efficiency, and green energy production. It supports the *Kingston Climate Action Plan*, which targets a reduction in the community's GHG emissions and energy consumption. It is important to note, however, that this plan focuses on mitigation strategies rather than land use adaptation strategies.

There are many additional policies promoting green energy systems (including active and passive solar, wind, and geothermal), and design techniques for energy conservation and efficiency. However, few are land use policies and in some cases the City has little control. For example, under the *Green Energy Act* the City is not the approval authority for commercial wind or solar energy projects. Instead, the Kingston OP acts as an enabling document, ensuring that there are few restrictions to the installation, operation, or maintenance of green energy systems. There are no policies that discuss climate change and energy systems in a land use planning context.

Summary of Climate Change Adaptation Policies

The City of Kingston Official Plan contains many policies that link to climate change adaptation. Notably, policies relating to natural hazard areas, public health, infrastructure, and energy all recognize or consider the role of climate change. These policies offer little beyond consideration. However, as the City intends to continue investigating the impacts of climate change and adapt to them accordingly.

The Plan has a number of policies promoting agricultural activity and protecting agricultural lands. In urban areas, Section 3.1.1.1 encourages secondary uses including agriculture and community gardens in hydro corridors. In rural areas, Section 3.12 restricts development and permitted uses to protect prime agricultural lands. While these types of policies may represent best practice in their own right, they are not specifically targeted at climate change adaptation.

Many of the identified policies are enabling rather than directive. Language such as "encourage", "should", and

“intends” limits the strength of these policies by simply permitting, not requiring. These policies could be strengthened by incorporating language such as “shall”, “must”, and “conform”. For example, Section 4.6.1 could be re-written: “[…]the City *shall* foster sustainability within the community[…].”

The City of Kingston Official Plan is progressive, and has started to incorporate visions and strategies designed specifically for adaptation to climate change. Currently, however, the Plan does not provide sufficient support for climate change adaptation.

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APPENDIX B: PUBLIC EVENT

B Public Event

On Wednesday, November 4, 2015, the Cataraqui Region Conservation Authority hosted a public event from 3:00 P.M. to 8:30 P.M. at the Portsmouth Olympic Harbour in Kingston, Ontario. The focus of the event was adapting to climate change in the Cataraqui Region. The event included an open house and exhibits, two thirty-minute presentations and one ten-minute presentation by the project group, and presentations from other speakers. Chris St. Clair, author and Weather Network host, was the keynote speaker.

Figure B.1: Project group exhibit.

Members of the project group were present from 3:00 P.M. to 7:00 P.M. at the booth to explain the purpose and process of the project course to the public.

Members of the project group presented at 3:30 P.M. and 5:30 P.M. The presentation included a ten-minute speaking portion, fifteen-minute community development activity, and five minute debrief of the activity. The purpose of the presentations was to explain who we were, what we were working on, and our progress as a project group. The focus of the presentations was

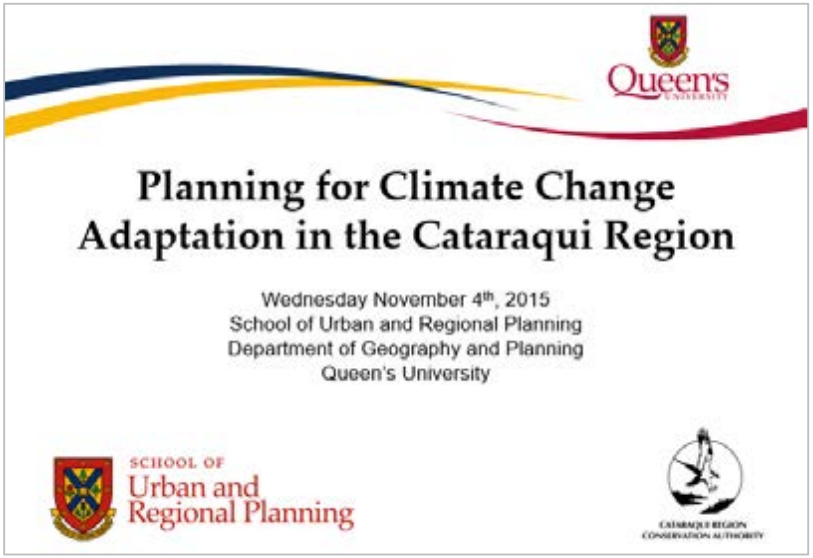

Figure B.2: Public event PowerPoint.

to explain how land use planning can be used to adapt to the impacts of climate change in the Cataraqui Region.

The ten-minute speaking portion of the thirty-minute presentation included an introduction, an overview of the locally anticipated impacts of climate change, and an example of how land use planning can be used to adapt to these impacts.

Figure B.3: Ryan Snowball explaining the local impacts of climate change.

The community development activity was designed to engage the public during the event. The purpose of the activity was to show the public that municipalities currently plan with the assumption that the environment will remain static in the future. However, the environment will change as the impacts of climate change occur. As such, it is important that municipalities begin to adapt to climate change through municipal documents and the development application process.

One member explained the community development activity to the public. The public was to design a new community called the Town of Surpsville based on the Town of Surpsville Official Plan and a checklist of community attributes. The public was then split into several groups and a facilitator was assigned to each group.

Figure B.4: Megan Rueckwald providing an example of climate change and land use planning.

Each group was provided with a map of Surpsville, the Official Plan of the Town of Surpsville, development features, a checklist to develop the community, markers, and glue. Each facilitator explained the general rules of the Official Plan to their group. The general rules were that: no buildings or structures were permitted within the 100-year floodplain, no buildings or structures were permitted within 30 metres of the protected wetlands, and that the Old Growth Forest was to remain as a natural area for the foreseeable future. The following attributes

were provided to the group: ten new residential buildings, one hospital, one school, one grocery store, one soccer field, one office park/commercial land, agricultural land, one stormwater management pond, lake trout habitat, and trees. Each group developed Surpsville with the guidance of their facilitator.

Figure B.5: Daniel Kucharczuk introducing the community development activity .

Concluding the activity, one member provided a short debrief. The purpose of the debrief was to show the groups that they had planned the Town of Surpsville assuming the environment would remain static in the future. However, as can be seen from Map 1 and 2 of the Town of Surpsville, climate change is expected to have significant impacts in the area. For example, the 100-year floodplain had moved farther inland from increased precipitation and extreme weather events. As such, any development just beyond the floodplain would likely be in danger of flooding.

Figure B.6: Map 1 of the Town of Surpsville.

Figure B.7: Map 2 of the Town of Surpsville.

Therefore, the overall purpose of the activity was to explain to the public that municipalities need to begin to consider and plan for the local, anticipated impacts of climate change so that municipalities can better adapt to these impacts in the future.

Figure B.8: Andrew Carr facilitating community development activity.

Figure B.9: Ryan Snowball and Megan Rueckwald facilitating community development activity.

Figure B.10: Andrew Carr debriefing public after community development activity.

Members of the project group also presented at 7:00 P.M. Similar to the thirty-minute presentations, the ten-minute presentation included an introduction, an overview of the locally anticipated impacts of climate change, and an example of how land use planning can be used to adapt to these. The purpose of the presentation was also to explain who we are, what we are working on, and our progress as a project group. Concluding the ten-minute presentation, a member of the project group introduced keynote speaker Chris St. Clair.

In the opinion of the project group, the public event was a success. The public appeared very receptive of the community development activity and very engaged in the question and answer period concluding the two thirty-minute presentations.

Figure B.11: Spencer Skidmore introducing the project.

Figure B.12: The project group with Chris St. Clair.

B.1 Links to News Articles

The following is a list of news articles and videos that report on the public event:

- Kingston Region Dailies, "Community groups team up to adapt to climate change locally": http://www.kingstonregion.com/news-story/6109499-community-groups-team-up-to-adapt-to-climate-change-locally/
- Station14, "Preparing for Climate Change": http://www.station14.ca/video.html?id=3333

B.2 Poster Displays

On the following pages the posters that were created by the project group and displayed at the public event are provided.

Planning for Climate Change Adaptation in the Cataraqui Region

Anticipated Impacts of Climate Change on the Cataraqui Region:

- Increased Annual Atmospheric Temperature
- More Variable & Extreme Local Weather Events
- Changes to Agriculture & Food Production
- Public Health Risks
- Greater Stress on Water Resources
- Vulnerability of Energy Systems
- Stressed/ Vulnerable Ecosystems & Wildlife
- Damage to Public & Private Infrastructure

OUR QUESTION:

Are the current land use planning policies in the Cataraqui Region supportive of climate change adaptation?

Cataraqui Region

Land Use Planning: the process of protecting and improving the living, production and recreation environments in a community through the proper use and development of land.

In Ontario, municipalities outline their land use planning goals, objectives and policies within an Official Plan.

Official Plans are primarily the documents we are evaluating.

Climate Change Adaptation: actions that prepare for changes that are occurring, or are likely to occur, in the future.

Supportive Climate Change Adaptation in Land Use Planning = Regulating and arranging the structure and function of the land and the built environment in a community to ensure it is prepared for changes that will occur as a result of climate change.

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Stage #1: Official Plan Review

Score each Official Plan on the basis of how well it supports climate change adaptation

Poor? Excellent? Fair?

Evaluation criteria:

- **How many impacts** of climate change does the Official Plan address?
- How general are the policies relating to climate change adaptation? Are they written in a way that makes their **implementation discretionary and open to interpretation**, or are they **directive, leaving little uncertainty about when, how and where they should be applied?**

Identify policies that relate to climate change and its anticipated impacts in the Cataraqui Region

Examples:

"The City promotes landscaping and tree planting programs that help to moderate summer and winter micro-climatic conditions". *- City of Kingston Official Plan, s. 6.2.2*	**Addresses increase in local atmospheric temperature**
"The City may apply certain conditions to site plan approval... site plan design elements include... iv) Permeable surfaces to reduce stormwater runoff". *- City of Brockville Official Plan, s. 6.4.6(6)*	**Addresses increase in extreme local weather events**
"Proposed development in areas identified... as having 'Very High Sensitivity' to groundwater quantity & quality, will require supporting reports". *-Township of South Frontenac Official Plan, s. 6.10*	**Addresses greater stress on water resources**

Official Plans Reviewed:

Separated Municipalities
- City of Kingston*
- City of Brockville
- Town of Gananoque

Counties
- County of Frontenac*
- The United Counties of Leeds & Grenville*
- County of Lennox & Addington*

Townships
- Township of South Frontenac*
- Township of Leeds & the Thousand Islands
- Township of Athens
- Town of Greater Napanee

*Official Plan still under review or in draft

Stage #2: Identification of "Best Practices"

- **What land use planning strategies have other regions implemented to adapt to climate change?**
- **Are these land use planning strategies appropriate for the Cataraqui Region?**


Green roofs cool buildings, reducing stress on energy resources during heat waves


Buried utilities are not at risk of being damaged in ice storms


Bioswales help filter and manage storm water runoff


Street trees help lessen hot temperatures in urban areas in the summer

Stage #3: Provide Recommendations

Identify GOALS, OBJECTIVES and POLICIES local municipalities should implement into their Official Plans in order to adequately prepare for the impacts of climate change.

The suggested approaches will:
- Comply with Ontario planning legislation.
- Be feasible and effective.
- Enhance the existing social, environmental and economic conditions in the Region.

Planning for Climate Change Adaptation in the Cataraqui Region

Project Background:

The project team is comprised of 11 students from the School of Urban and Regional Planning at Queen's University. For our captstone project, we have been contracted by the Cataraqui Region Conservation Authority to complete a report on climate change adaptation in the Cataraqui Region. Our final report is expected to be completed by December 2015. We will be presenting our findings to the Conservation Authority at that time.

To provide us with comments about the project, please contacts us at 825surp@gmail.com

The project team: (top row, from left to right) Dr. John Meligrana (faculty supervisor); Spencer Skidmore; Daniel Kucharczuk; Jim Avram; Eric Joyal; Graham Rathwell; Matthew Marsili; (bottom row, from left to right) Rob McRae (project coach, Cataraqui Region Conservation Authority); Ryan Snowball; Megan Rueckwald; Andrew Carr; Amy Shanks; Ashley Taylor.

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