

Climate Change Strategy

June 2016



**KAWARTHA
CONSERVATION**

Discover • Protect • Restore

About Kawartha Conservation

Who we are

We are a watershed-based organization that uses planning, stewardship, science, and conservation lands management to protect and sustain outstanding water quality and quantity supported by healthy landscapes.

Why is watershed management important?

Abundant, clean water is the lifeblood of the Kawarthas. It is essential for our quality of life, health, and continued prosperity. It supplies our drinking water, maintains property values, sustains an agricultural industry, and contributes to a tourism-based economy that relies on recreational boating, fishing, and swimming. Our programs and services promote an integrated watershed approach that balance human, environmental, and economic needs.

The community we support

We focus our programs and services within the natural boundaries of the Kawartha watershed, which extend from Lake Scugog in the southwest and Pigeon Lake in the east, to Balsam Lake in the northwest and Crystal Lake in the northeast – a total of 2,563 square kilometers.

Our history and governance

In 1979, we were established by our municipal partners under the *Ontario Conservation Authorities Act*.

The natural boundaries of our watershed overlap the six municipalities that govern Kawartha Conservation through representation on our Board of Directors. Our municipal partners include the City of Kawartha Lakes, Region of Durham, Township of Scugog, Township of Brock, Municipality of Clarington, Municipality of Trent Lakes, and Township of Cavan Monaghan.



**KAWARTHA
CONSERVATION**

Discover • Protect • Restore

Kawartha Conservation

277 Kenrei Road, Lindsay ON K9V 4R1

T: 705.328.2271 F: 705.328.2286

GenInfo@KawarthaConservation.com

KawarthaConservation.com

Acknowledgements

This document was developed by a multidisciplinary team of professionals at Kawartha Conservation, including:

Rob Messervey	Chief Administrative Officer
Mark Majchrowski	Director, Watershed Management
Dave Pridham	Manager, Technical and Stewardship Services
Greg Bunker	Stewardship Outreach Technician
Jayme Hughes	Marketing and Communications Specialist
Jessie James	Conservation Areas Coordinator
Beverly Saunders	Resources Planner
Holly Shipclark	Stewardship Coordinator
Iryna Shulyarenko	Hydrologist
Rob Stavinga	Watershed Resources Technician
Brett Tregunno	Aquatic Biologist

Executive Summary

Kawartha Conservation is a watershed management agency delivering local services and programs that protect and manage our water and other natural resources. Our vision for the future is **“a sustainable watershed with clean and abundant water and natural resources assured for future generations.”** As a changing climate puts this statement at risk, we recognize that the response to this challenge must become a part of our core business. We are committed to taking immediate actions, demonstrating leadership, and supporting our communities and partners in dealing with climate change mitigation and adaptation.

There is a strong consensus in the international scientific community that “human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.” (*Climate Change 2014: Synthesis Report*). Furthermore, it is expected that “... continued high emissions would lead to mostly negative impacts for biodiversity, ecosystem services and economic development and amplify risks for livelihoods and for food and human security.”

This Climate Change Strategy is our response to this uneasy challenge. Building on our mandate, our responsibilities and our expertise, Kawartha Conservation is embracing climate change as another challenge to be addressed in watershed management. We recognize that it is critical to incorporate climate change adaptation into existing policies and programs, and prioritize actions that have co-benefits for mitigation and adaptation.

The strategies in this document have been developed by a multidisciplinary team of experts and reviewed by our Climate Change Strategy Advisory Group. Strategies fall under the goals outlined in our *Strategic Plan 2012-2016* and are also supported by a number of proposed strategic actions.

The goal of this Climate Change Strategy is **“to increase the resiliency of our watershed and communities in order to adapt to and evolve with the changing climate.”** The strategies and actions in this document are based on the principles of Integrated Watershed Management and collaboration with watershed partners. They are developed on the basis of local knowledge and will be integrated into our core operations. As an adaptive approach is one of our guiding principles, we realize that modifications of the proposed actions or additional actions may be needed to tailor our response to the changing conditions.

Following Kawartha Conservation’s strategic goals, climate change actions are grouped into three streams that reflect our mandate and responsibilities: **Protecting, Conserving and Restoring**, and **Discovering**.

A category **Focusing on our Business Operations** was added to reflect our business goals and commitments in mitigating and adapting to climate change.



PROTECTING

GOAL: *Ensure that people, properties and communities are sufficiently protected in conditions of changing climate*

WHY IT IS IMPORTANT: *Implementing recommendations will ensure a high degree of protection from flooding, erosion, and low water conditions for local residents, private and public property, and infrastructure. Natural hazard planning and proactive preventive measures will reduce risks and provide cost saving for municipalities and the public*

- Enhance our knowledge of future flooding and erosion hazards
- Update planning policies and procedures to implement the enhanced understanding of natural hazards
- Enhance stormwater management practices to mitigate increased runoff
- Enhance Kawartha Conservation's Flood Forecasting and Warning system
- Support municipalities in improving flood emergency response
- Further enhance low water/drought conditions monitoring and response
- Encourage member municipalities to develop low water response planning

CONSERVING AND RESTORING

GOAL: *Increase watershed resistance to climate change and ability to mitigate it through conservation, restoration, and improvement of natural ecosystems*

WHY IT IS IMPORTANT: *Implementing recommendations will enhance local ability to adapt to changing climate conditions through further development of green infrastructure. The actions will support mitigation of climate change by increasing the watershed's capacity to sequester greenhouse gases by protecting water quality and quantity and natural heritage features*

- Increase ecosystem resilience and our watershed's ability to capture greenhouse gases by protecting its natural features through the planning and regulation process
- Maintain existing and develop new programs that preserve and improve our watershed's natural features
- Develop a comprehensive aquatic natural heritage program to identify and integrate climate change adaptation and mitigation opportunities
- Maintain and improve the health of local watercourses and their aquatic communities by implementing targeted programs, projects, and actions
- Provide watershed stewardship leadership through education, outreach, and increased awareness
- Allocate stewardship resources based on natural heritage systems and potential runoff reduction and mitigation
- Develop stewardship programs and projects that target rural, urban, and shoreline landowners
- Incorporate climate change considerations into conservation lands management
- Build public awareness of the changing climate and challenges it brings



DISCOVERING

GOAL: *Enhance our knowledge of our watershed's natural environment and its response to a changing climate for informed decision-making*

WHY IT IS IMPORTANT: *Implementing recommendations will improve our knowledge of watershed resources and our understanding as to how they may be affected by a changing climate. It will provide a basis for more informed planning, decision making and development of proactive actions*

- Enhance existing watershed monitoring network
- Develop an aquatic natural heritage monitoring program to track the status of sensitive aquatic habitats and communities
- Continue enhancing our knowledge on how climate change will impact watershed resources

FOCUSING ON OUR BUSINESS OPERATIONS

GOAL: *Reduce our corporate carbon footprint by developing a business culture of conservation, using best practices and solutions*

WHY IT IS IMPORTANT: *Implementation of actions will assist in a reduction of our corporate footprint, demonstrate our corporate culture of conservation and provide possible cost savings to our business operations*

- Enhance and promote corporate culture of conservation in order to reduce corporate carbon footprint

Upon endorsement of the Climate Change Strategy by our Board of Directors we will move to the implementation phase. Implementation of strategies and actions will commence immediately in accordance with our approved work plans. They will also be included into the *Kawartha Conservation Strategic Plan 2017-2021*.

Recommended actions will be prioritized for implementation. Some actions and programs are already established; programs will continue to integrate climate change considerations within their goals and objectives. Other actions may require significant effort or additional funds for implementation. For those actions, plans will be developed and possible funding opportunities will be considered and used.

Many decisions and actions will require consensus at various levels of government. Partnerships will be developed with partner agencies and watershed stakeholders that reflect climate change mitigation and adaptation efforts.

As adaptive management is our principle, the strategies and actions will be reviewed and modified where necessary. Implementation of the *Kawartha Conservation Climate Change Strategy* will be reported to the Board of Directors. In addition, the public will be informed of our progress through the various communication mechanisms utilized by Kawartha Conservation.



Table of Contents

About Kawartha Conservation.....	i
Acknowledgements	iii
Executive Summary	v
List of Tables	ix
List of Figures.....	ix
Acronyms.....	x
1.0 Introduction.....	1
2.0 Changing Climate and its Challenges	2
3.0 Kawartha Conservation Climate Strategy Framework.....	6
3.1 Our Mission.....	6
3.2 Goals and Objectives.....	8
3.3 Guiding Principles	9
3.4 The Working Process.....	10
3.5 Communicating Our Strategy.....	14
4.0 Responding to the Changing Climate	15
4.1 Protecting.....	16
4.2 Conserving and Restoring	19
4.3 Discovering.....	23
4.4 Focusing on Our Business Operations	25
5.0 Moving Ahead.....	26
References / Bibliography	28
Appendix 1.0 Vulnerability Assessment	29



List of Tables

Table 3.1 Program Areas Vulnerability - Summary..... 11

List of Figures

Figure 2.1: Long-term Yearly Minimum, Maximum, and Average Temperatures and their Trends for the Lindsay Frost Climate Station (Environment Canada), 1975–2006. 3

Figure 2.2: Long-term Yearly Total Precipitation and its Trend for Lindsay, Using Data from the Lindsay Frost Climate Station (Environment Canada) and Ken Reid Conservation Area (Kawartha Conservation), 1975–2014..... 4

Figure 3.1: Milestone Framework (adapted from ICLEI Canada (2011)) 10



Acronyms

CO ₂	Carbon dioxide
IPCC	Intergovernmental Panel on Climate Change
LID	Low impact development
MNRF	Ministry of Natural Resources and Forestry
MOECC	Ministry of the Environment and Climate Change
NGO	Non-Governmental Organization
OLWR	Ontario Low Water Response
PGMN	Provincial Groundwater Monitoring Network
TSW	Trent-Severn Waterway



1.0 Introduction

Kawartha Conservation is a watershed management agency delivering local services and programs that protect and manage our water and other natural resources. Our vision for the future is **“a sustainable watershed with clean and abundant water and natural resources assured for future generations.”** As a changing climate puts this statement at risk, we recognize that the response to this challenge must become a part of our core business. We are committed to taking immediate actions, demonstrating leadership, and supporting our communities and partners in dealing with climate change mitigation and adaptation.

As discussed within the Kawartha Conservation Climate Change Background paper (Kawartha Conservation, 2015) climate change is one of the most urgent challenges of our time. The scientific community has agreed that “human influence on the climate change is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.” (*Climate Change 2014: Synthesis Report*). Furthermore, it is expected that “... continued high emissions would lead to mostly negative impacts for biodiversity, ecosystem services, and economic development and amplify risks for livelihoods and for food and human security.”

This Climate Change Strategy is our response to this daunting challenge. The document defines Kawartha Conservation’s role in adapting to and mitigating the expected changes and provides recommendations and directions on local adaptations and mitigation actions. It is built on our strengths in adaptive watershed management and leadership in applying sustainability at the local level. It outlines proactive strategic directions to address the impacts of climate change and provide a planning framework for local climate change adaptation and mitigation.

The goal of the Strategy is **“to increase the resiliency of our watershed and communities in order to adapt to and evolve with a changing climate.”** The actions are based on the principles of Integrated Watershed Management and collaboration with watershed partners. They are developed on the basis of local knowledge and will be integrated into Kawartha Conservation’s core operations.

2.0 Changing Climate and its Challenges

There is a strong consensus in the international scientific community that the impacts of climate change are already being felt. Warmer winters, less snow, hotter summers, and increasing numbers of damaging precipitation events and wind storms are being observed during recent decades. The World Meteorological Organization has recently confirmed that the first 15 years of the 21st century have been the warmest on record, with 2014 being the hottest ever observed (World Meteorological Organization, 2015).

...Climate change will amplify existing risk and create new risks for natural and human systems. Increasing magnitude of warming increases the likelihood of severe, pervasive and irreversible impacts for people, species and ecosystems.
IPCC 2014 - Synthesis

The following changes in climate and weather in Ontario, including the Kawartha Conservation watershed, have been observed and are expected to intensify:

- A warming trend in air temperature, especially noticeable in winter;
- An increased number of intense and extreme precipitation events; and
- An increased number of extreme weather events.

The annual average air temperature in Canada has warmed by 1.5°C over the period 1950 to 2010 (Bush, Loder, James, Mortsch, & Cohen, 2014). Recent analysis shows that 2011 and 2012 were 1.5 °C and 1.9 °C warmer than the reference period (the 1961 to 1990 average), and 2010 still stands as the warmest year on record in Canada, at 3.0 °C above normal (Environment Canada, 2011). Daily minimum temperatures have been rising faster than daily maximum temperatures over the period 1950 to 2010. Warming is generally observed in all seasons, with the greatest warming occurring in winter and spring. In Ontario, the increase in average temperature during the last 60 years has varied from about 1.3 °C in the west to very little increase in the southeast near Lake Ontario (Environment Canada, 2011).

Local data confirm the above-mentioned findings. The analysis of long-term daily minimum, daily maximum, and yearly average temperatures recorded by the Lindsay Frost climate station (Environment Canada) from 1975 to 2006 confirm that all three datasets exhibit the rising trends, while the most obvious increase is detected for the daily minimum temperatures (Figure 2.1).

Warming of the Earth's surface and atmosphere results in changes in evaporation and precipitation, as well as in atmospheric circulation patterns that influences the geographical distribution of rain. Warmer temperatures lead to greater potential evaporation of surface water, thus increasing the potential for surface drying and increasing the amount of moisture in the air. Because warmer air can hold more moisture, more intense precipitation events are often the result.

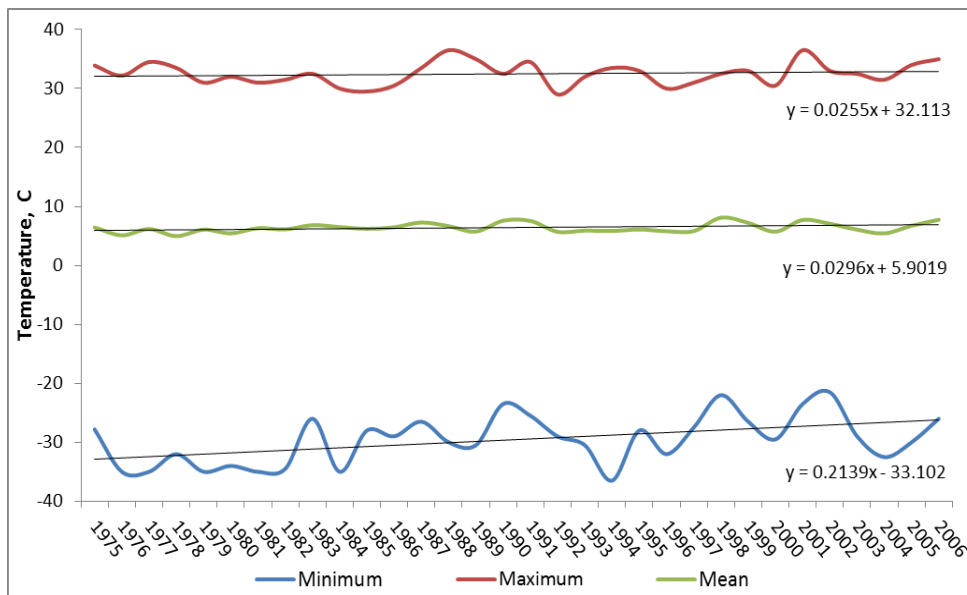


Figure 2.1: Long-term Yearly Minimum, Maximum, and Average Temperatures and their Trends for the Lindsay Frost Climate Station (Environment Canada), 1975–2006.

Research demonstrates that Canada has generally become wetter in recent decades; an increase in annual precipitation of about 16% over the period 1950 to 2010 has been detected (Mekis & Vincent, 2011). At most stations, total seasonal precipitation has increased in spring and fall, while many sites show declining winter precipitation. The observed decrease in total winter precipitation is mainly due to the decrease in winter snowfall, while winter rainfall has not changed significantly (Mekis & Vincent, 2011). The shift in winter precipitation type has been determined, with decreasing snowfall and increasing rainfall, as would be expected with warming temperatures.

Undertaken analysis of precipitation data for the Lindsay climate station has yielded similar results. As Figure 2.2 confirms, an increasing trend in yearly precipitation amounts over the period 1975 to 2006 has been detected.

In a changing climate, extreme temperatures and precipitation will also change as a result of shifts in mean conditions and/or as a result of changes in variability. For example, warming is expected to be accompanied by a decrease in cold extremes and an increase in hot extremes. It is also expected that the global hydrological cycle will intensify with continued global warming, leading to an increasing intensity of both wet and dry extremes and associated hazards such as floods and droughts (Bush, Loder, James, Mortsch, & Cohen, 2014). An extreme event, by definition, is rare – making analysis and prediction of changes in extreme events challenging.

These changes are already affecting components of the hydrological cycle (precipitation, runoff, and evapotranspiration). We must become much more prepared to manage significant changes in water availability and distribution.

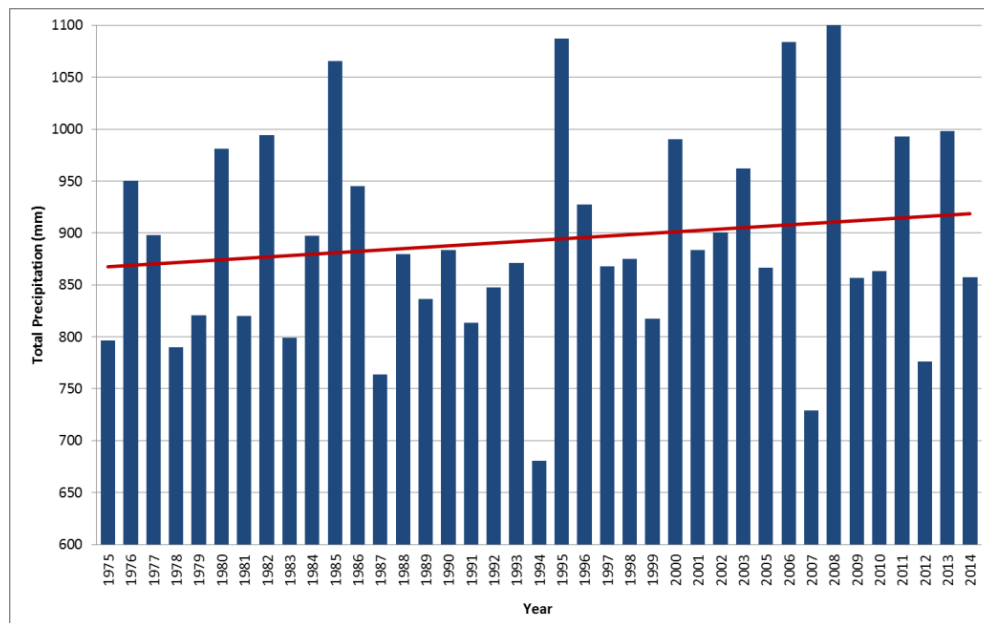


Figure 2.2: Long-term Yearly Total Precipitation and its Trend for Lindsay, Using Data from the Lindsay Frost Climate Station (Environment Canada) and Ken Reid Conservation Area (Kawartha Conservation), 1975–2014.

Relevant Changes

- Changes in precipitation patterns increase winter and yearly spring runoff, bringing greater threats of mid-winter and spring flooding, similar to events observed on the Burnt and Gull rivers in 2013 and 2014.
- The spring freshet occurs earlier and is generally lower.
- Summer and fall low flows are lower and last longer. Over the last 15 years, our watershed has experienced low water conditions in 1999, 2000, 2001, 2005, 2007, and 2012.
- More intense precipitation increases the occurrence of flooding events, especially in urban areas, with the most significant including Peterborough in 2002 and 2004; Toronto in 2005, 2013, and 2014; Burlington in 2012; and Hamilton in 2014.

As more pollutants enter watercourses and water bodies with increased precipitation runoff, water quality parameters and water temperature are changing. This allows harmful bacteria and algae, such as blue-green algae, to thrive.



Flooding on the Gull River (Shadow Lake), 2013

Changes in weather and climate affect our economy and society. The agriculture industry must adapt to the new conditions, adopting new crop varieties that are resistant to more frequent droughts and higher temperatures during the growing season, as well as soil conservation practices geared to minimizing erosion during sudden high precipitation events. As the local tourism industry relies heavily on stable water levels and clean water, there will be increasing problems as summer water levels are more difficult to maintain. The period of ice cover for lakes and other water bodies is progressively reduced, water quality is impacted, and fish communities are affected by increased water temperatures and a longer growing season for aquatic vegetation.



Blue-green algae outbreak, Sturgeon Lake, 2012

The future climate will place new stresses on the health of watershed residents. Both benefits and challenges come from climate changes, however, negative impacts prevail. Factors affecting human health include heat waves, smog episodes, an increased number of severe weather events, and a greater opportunity for insect-borne diseases as West Nile virus, Lyme disease, and other disorders to spread north.

The changing climate brings changes to the aquatic and terrestrial components of the ecosystem. Observations of fish populations in southern Ontario, including our watershed, are indicating a shift from cold and coolwater species to more warmwater species. Lower water levels in the lakes and lower groundwater levels are damaging wetlands. Invasive species are benefiting from climate change and expanding their presence in the ecosystem, putting pressure on native plants and animals.

3.0 Kawartha Conservation Climate Strategy Framework

3.1 Our Mission

As a local watershed management agency, Kawartha Conservation delivers services and programs that protect and manage water and other natural resources within our watershed. We promote watershed-based partnerships and we have demonstrated successful examples of collaboration with community stakeholders, non-governmental organizations, partner agencies, and provincial and municipal governments in a variety of programs and projects. An Integrated Watershed Management approach that balances human, environmental, and economic needs in an area defined by watershed boundaries is our guiding principle. This approach allows multiple issues and objectives to be addressed and enables planning in a very complex and uncertain environment.

Kawartha Conservation is delegated by the Ministry of Natural Resources and Forestry to comment on municipal plans and applications under the *Planning Act*, 1990 to ensure conformity with the natural hazard policies of the *Provincial Policy Statement*, 2014. Through regulations in the *Conservation Authorities Act*, 1990 we regulate development in areas prone to water-related hazards (such as shorelines, flood plains, wetlands, and hazardous lands) for impacts to control of the hazards (e.g., flooding, erosion, pollution, and conservation of land) and for interference with watercourses or wetlands. Also, we are responsible for flood forecasting and warning within our watershed.

As a leader in environmental protection and resources management, we already undertake a wide array of climate change oriented actions that relate to our mandate and responsibilities, including but not limited by the following:

- Undertaking and constantly enhancing monitoring that assists in establishing a baseline state of the natural resources in our watershed, including waters lands and aquatic communities. Through watershed and lake management plans, as well as data collection done in a variety of federal, provincial, and municipal partnerships, we have accumulated a wide range of scientific information and local knowledge that will support climate change decisions.
- Improving ability to protect the public from flood hazards through developing and updating flood plain mapping.
- Leading the Ontario Low Water Response Program within the watershed.
- Building local ecosystem resilience through programs, projects, and partnerships that aim to preserve, restore and enhance **green infrastructure***. For the purpose of this document **green infrastructure** is defined as natural and living features and elements of an ecosystem. It does not include renewable energy infrastructure.

We own and manage 1,250 hectares of lands that include forests, wetlands, and significant natural habitat and continue increasing ownership.

***Green infrastructure** as defined on page 7

Green infrastructure is an approach to water management that protects, restores, or mimics the natural cycle. Green infrastructure is effective, economical, and enhances community safety and quality of life. It means planting trees and restoring wetlands, rather than removing contaminants through costly water treatment processes. It means choosing water efficiency instead of building a new water supply system. It means restoring flood plains instead of building taller levees. Green infrastructure incorporates the natural environment and can include environmentally engineered systems to provide clean water, conserve ecosystem values and functions, and provide a wide array of benefits to people and wildlife. Green infrastructure solutions can be applied on different scales, from the house or building level, to the broader landscape level. At the largest scale, the preservation and restoration of natural landscapes (such as forests, flood plains and wetlands) are critical components of green infrastructure. On the local level, green infrastructure practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems (American Rivers, 2014).

Our *Climate Change Strategy* focuses on natural and living features and elements of green infrastructure. It does not include renewable energy infrastructure.



Example of a bioretention retrofit of a median in a parking lot, Port Perry

Our **BlueScaping program** is community-focused outreach that promotes innovative, lot-level stormwater management measures to address urban stormwater issues. Through workshops, residents learn about stormwater landscaping and what they can do on their properties: rain gardens, soakaway pits, and permeable paving are just a few examples. We have also developed steering committees with municipalities and community groups to guide program efforts such as selecting BlueScaping demonstration sites in public, high profile locations, and to help deliver programs that raise urban stormwater awareness among youth. Our steering committees have also identified the need to engage developers, who we will engage as we continue to develop and broaden our efforts.

- Developing natural heritage and biodiversity by utilizing the Kawartha’s Naturally Connected natural heritage system that links natural heritage features and areas by natural corridors protecting healthy biodiversity and ecosystem resiliency from impacts related to climate change.
- Delivering programs that support afforestation and private land stewardship, and supporting climate change mitigation and adaptation. As an example, our Tree Seedling distribution program provides low-cost tree seedlings to watershed landowners.

3.2 Goals and Objectives

This Climate Change Strategy outlines proactive strategic directions to address the impacts of climate change and provides a planning framework for local climate change adaption and mitigation. The overall goal of the Strategy is

To increase the resiliency of our watershed and communities in order to adapt to and evolve with a changing climate

In achieving the overall goal, the following will be accomplished:

- Ensuring sustainability of our watershed in a changing climate and increasing its adaptive capacity
- Working with watershed agencies and the public to implement measures to respond to a changing climate
- Establishing our leadership role in watershed management with regards to climate change.

Objectives of our Climate Change Strategy are:

- Define strategies and actions that will help prepare watershed resources to adapt to climate change
- Define our roles and responsibilities in adaptation to and mitigation of climate change in conjunction with partners roles and responsibilities
- Identify key climate considerations for planning and policy decisions
- Inform Kawartha Conservation’s upcoming Strategic Plan (2017-2020) as well as annual business planning
- Promote awareness of effects of climate change.

Resilience is the capacity of social, economic and environmental systems to cope with a hazardous event or trend, responding in ways that maintain their essential function, identity and structure

Adapted from IPCC, 2014

3.3 Guiding Principles

This Climate Change Strategy is built on our strengths in adaptive watershed management and leadership in applying sustainability at the local level. The actions are based on the principles of Integrated Watershed Management and collaboration with watershed partners. They will be developed on the basis of local knowledge and integrated into our core operations.

The following principles guide this Climate Change Strategy:

- Integrated Watershed Management is our guiding approach
- Further development and enhancement of the watershed's **green infrastructure**, including the **BlueScaping*** program, is recognized as a key approach in building an ecosystem's resilience and improving its ability to mitigate climate change and adapt to it. For the purpose of this document, **green infrastructure** is defined as natural and living features and elements of an ecosystem. It does not include renewable energy infrastructure.
- Collaboration with many stakeholders such as municipal partners, government agencies, business and agricultural communities, non-governmental organizations, and landowners is fundamental to planning and implementing actions to deal with climate change
- Climate change response strategies and actions are built upon strategic actions of our Strategic Plan 2012-2016 and other documents
- Integration of the proposed actions into our existing operations is a priority thereby limiting financial implications
- The development of new programs is recommended in some cases. Implementation of those programs will depend on funding availability, including grants, donations, partnerships
- Where possible, proposed actions are to address both mitigation and adaptation of climate change
- "No-regrets" actions, focused on improving the resilience of natural systems and public safety, regardless of the eventual climate change outcomes, are a priority
- The actions are to be developed based on science, local knowledge, and local data
- Adaptive management will be used to allow for flexibility in delivering programs and services, in light of climate change.

Adaptation is the process of adjustment to actual or expected climate and its effects
IPCC, 2014 – Impacts

Mitigation (of climate change) is human intervention to reduce the sources or enhance the sinks of greenhouse gases
IPCC, 2014 - Impacts

* *BlueScaping Program* as defined on page 7

3.4 The Working Process

Development of this Climate Change Strategy has generally followed the milestone process described in *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation* (ICLEI Canada (2011)). The following steps (named milestones) are identified in the document: *Initiate, Research, Plan, Implement* and *Monitor/Review* (Fig. 3.1). The document is focused on the context of municipal governance; therefore the methodology has been revised to address a Conservation Authority context. Some of these milestones have been completed, as the milestone Plan includes the completion of this Strategy.

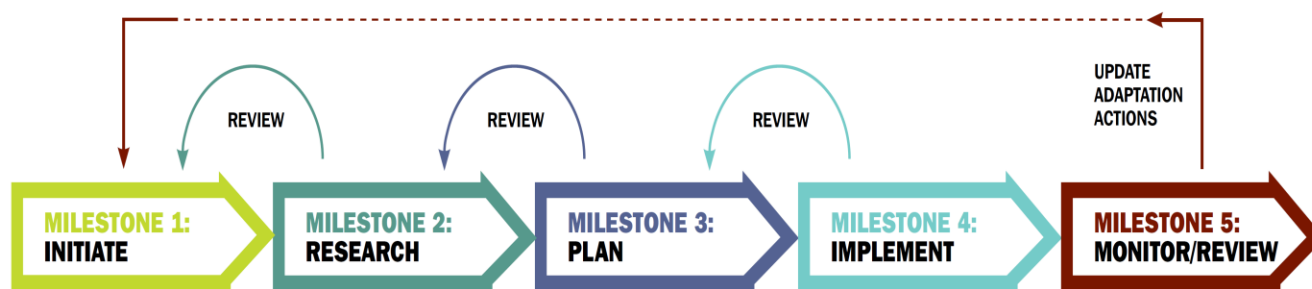


Figure 3.1: Milestone Framework (adapted from ICLEI Canada (2011))

Milestone 1: Initiate

The purpose of Milestone 1 is to initiate the planning process and build support for the project. Through the project planning phase an Internal Climate Change Strategy Team was set up that included Rob Messervey, Mark Majchrowski, Dave Pridham, and Iryna Shulyarenko. The framework of the project (project charter) was developed; goal, objectives and guiding principles of the Strategy document were established at this phase. Our main program areas that would be impacted by the projected changes were identified.

Milestone 2: Research

The purpose of Milestone 2 is to research the issue. At this phase we have researched **climate change and its potential impacts to ecosystem and society**. The extensive literature review, consultations with other team members and analysis of the available environmental data was conducted and the background paper *Changing Climate – a Challenge and an Opportunity* was developed. The document includes analysis of observed changes in weather and climate and their future projections; review of impacts of changing climate on the natural environment and society; overview of national, provincial, and local response to climate change and summarizes a framework for Strategy development.

The background paper was endorsed by our Board of Directors and following this endorsement we moved forward with development of this Climate Change Strategy.

At this phase of the project a Climate Change Strategy Advisory Group (Advisory Group) was established. The group included representatives from member municipalities, a partner Conservation Authority, and provincial ministry. Advisory Group members have provided added expertise in the field of climate change adaptation and mitigation, as well as support and guidance in developing the strategy.

In order to identify the degree of climate change impact to our program areas, a vulnerability assessment was conducted (Appendix 1.0). It was completed in several steps. The first step was to confirm affected key program areas (Appendix 1.0, Table 1) and identify future weather and climate features (Appendix 1.0, Table 2). As a next step, changes in ecosystem and society resulting from the projected weather/climate conditions were determined (Appendix 1.0, Tables 3 and 4). Once changes were identified, program areas’ *sensitivity* to the projected changes were assessed (Appendix 1.0, Table 5) and program areas’ ability to adjust to the changes (*adaptive capacity*) were evaluated (Appendix 1.0, Table 6). The last step was a *vulnerability assessment*, where High, Medium and Low scores were assigned to program areas based on their sensitivity to climate change and adaptive capacity (Table 3.1 and Appendix 1, Table 7 and 8).

Vulnerability assessment was conducted by the Kawartha Conservation staff members that have extensive expertise and are involved to a high degree in identified program areas.

Table 3.1 Program Areas Vulnerability - Summary

<i>Program Areas</i>	<i>Vulnerability Score</i>
<i>Protecting</i>	
Natural Hazard Protection	High
Planning and Regulation	High
Flood Forecasting and Warning	High
Low Water Response	High
<i>Conserving and Restoring</i>	
Natural Heritage – Terrestrial	Low
Natural Heritage – Aquatic	Low
Conservation Lands	High
Urban Stewardship	Medium
Rural Lands Stewardship	Medium
Shoreline Stewardship	High
<i>Discovering</i>	
Monitoring	High
Research and Innovative Approaches	Medium
Education and Outreach	Low
<i>Kawartha Conservation Business Practices</i>	
Daily Business Operations	High
Facility & Fleet Management	High
Public and Partners Engagement	Medium

Note: This table is a representation of our program's ability (vulnerability) to deal with changes in climate. It is not a representation of the vulnerability of the environmental resource to changes in climate.

Milestone 3: Plan

The purpose of the planning milestone was to **establish adaptation and mitigation recommendations** within this Climate Change Strategy. During this phase strategies were developed that address different program areas. Each strategy is supported by adaptation and mitigation recommendations for actions. Recommendations emphasized modifications of existing programs, thereby limiting financial implications. The development of new programs was recommended in some cases, however financial implications were not considered at this stage. Review of the Draft Climate Change Strategy was undertaken by the Advisory Group

Milestone 4: Implement

At the implement milestone we will be seeking **collaboration from municipal and provincial partners, and the community to implement the recommendations identified in this Strategy.** This milestone will be initiated upon endorsement of the Strategy by Kawartha Conservation Board of Directors. Tools needed in this milestone include development of programs and projects, training, internal and external communications, marketing, and consultation. It is intended that outputs will include support and approval from our municipal partners, identification of specific implementation tools and strong community engagement and partnership. In order to ensure that this Climate Change Strategy is implemented, recommendations will be reviewed during the annual budget development process. Specific climate change project funding should be identified in the budget so that the commitment to implementation is understood.

Milestone 5: Monitor and Review

The purpose of the final milestone is to assess the progress made towards meeting the goals and recommendations as set out in this Strategy. Additionally, the Strategy, through this milestone will be revised to address new scientific information, lessons learned, and effectiveness of recommendations. This milestone will be ongoing and flexible (adaptive management). It is recommended that a comprehensive review of the Strategy be undertaken every 5 years.

3.5 Communicating Our Strategy

In order to build support for the strategies and associated actions outlined in this Climate Change Strategy, a great deal of communication with partners, stakeholders, and the communities in our watershed will be necessary. Communicating the projected changes to our climate and the specific impacts that these changes will have locally, as well as outreach to educate our communities and partners on the actions and associated resources that are required to achieve our goals will be of crucial importance.

Messaging linking climate change impacts to our environment, our health, as well as our economy will be utilized to reinforce the widespread importance and co-benefits of both mitigation and adaptation efforts. Communication of the Strategy will also help to position us as a local leader on the topic of climate change. Examples of necessary communications efforts include: development of useful tools for our staff and partners to utilize when communicating with various audiences, media relations efforts, the integration of climate change messaging into our education programming, and ensuring our online presence reflects the integration of climate change adaptation and mitigation across all of our program areas.

We will develop a comprehensive Communications Plan for communicating the Climate Change Strategy which will identify target audiences, potential barriers and solutions for these barriers, key messages, specific communication tools and timelines, as well as reporting mechanisms for measuring the success of our communications efforts. Communications actions will be built into the implementation phase of the overall Climate Change Strategy in order to maximize effectiveness.

4.0 Responding to the Changing Climate

Building on our mandate, our responsibilities, and our experience, we are embracing **climate change as another challenge to be addressed in watershed management**. We recognize that it is critical to incorporate climate change adaptation into existing policies and programs, prioritizing actions that have co-benefits for mitigation and adaptation.

The following are **climate change strategies**, as developed by the multidisciplinary team at Kawartha Conservation and reviewed by the Climate Change Strategy Advisory Group. Strategies fall under our goals as outlined in the *Kawartha Conservation Strategic Plan 2012-2016* and supported by a number of proposed strategic actions. As an adaptive approach is one of our guiding principles, we realize that modifications of proposed actions or additional actions may be needed to tailor our response to the situation.

Following our strategic goals, climate change actions are grouped in three streams that reflect our mandate and responsibilities: *Protecting, Conserving and Restoring*, and *Discovering*. An additional category '*Focusing on Our Business Operation*' has been added to reflect how we, as a corporative body address climate change mitigation and adaptation through our operations and business activity.



*Clockwise from top left: shoreline naturalization at **Garnet Graham Park**, Fenelon Falls; low impact development project; surveying High Water Marks for flood plain mapping project; installation of the all-weather precipitation gauge, Indian Point Provincial Park*

4.1 Protecting

GOAL: Ensure that people, properties and communities are sufficiently protected in conditions of a changing climate

WHY IT IS IMPORTANT: Implementing recommendations will ensure a high degree of protection from flooding, erosion and low water conditions for local residents, private and public property and infrastructure. Natural hazard planning and proactive preventive measures will reduce risks and provide cost saving for municipalities and the public

Strategy	Actions	Department	Partners
Enhance our knowledge of future flooding and erosion hazard	<ul style="list-style-type: none"> Complete flood risk assessment to determine the need for updated flood plain mapping and policies to accommodate changes in climate Based on the risk assessment completed, develop or update where required flood plain mapping Complete a geotechnical assessment to evaluate the erosion which would incorporate impacts of climate change (e.g. change in ice cover, low soil moisture, unpredictable temperature fluctuations, etc.) Upgrade and refine digital elevation data to improve planning review process 	<ul style="list-style-type: none"> Planning Environmental Monitoring 	<ul style="list-style-type: none"> Ministry of Natural Resources and Forestry Member municipalities Partner Conservation Authorities
Update planning policies and procedures to implement the enhanced understanding of natural hazards	<ul style="list-style-type: none"> Update flood hazards planning and regulation policies accordingly. This will include: (a) updating our policy manual, (b) consultations with MNRF and the public, (c) having the policies approved by the Board of Directors, and (d) communicating updated policies to relevant audiences Review and improve where needed internal protocols for application review. Develop staff and resources capacity to implement new policies. Continue streamlining the permitting and planning process with member municipalities and partner agencies. 	<ul style="list-style-type: none"> Planning 	<ul style="list-style-type: none"> Ministry of Natural Resources and Forestry Member municipalities Trent-Severn Waterway Local building and development communities Partner Conservation Authorities
Enhance storm water	<ul style="list-style-type: none"> Encourage and assist member municipalities in updating design 	<ul style="list-style-type: none"> Planning 	<ul style="list-style-type: none"> Ministry of Natural

<p>management practices to mitigate increased runoff</p>	<p>standards for infrastructure, stormwater facilities, and major and minor drainage systems to address more frequent, high intensity flow events.</p> <ul style="list-style-type: none"> Promote development of green infrastructure as a tool to enhance stormwater management and protect communities from adverse weather and climate changes such as increased runoff, deterioration of water quality, heat stress Integrate Low Impact Development (LID) practices into planning process Develop LID planning and regulation policies and procedures. This will include: (a) developing policy manual, (b) extensive consultations with MNRF, MOECC and the public, and (c) having the policies approved by the board of directors. Develop the LID Planning and Design Guidelines for the Kawartha Conservation jurisdiction Promote retrofitting of the existing stormwater systems Develop LID retrofit demonstration sites on municipal properties in urban centres. Employ new and emerging technologies in real-time monitoring and flood forecasting. 	<ul style="list-style-type: none"> Stewardship 	<p>Resources and Forestry</p> <ul style="list-style-type: none"> Ministry of the Environment and Climate Change Member municipalities Local building and development community Partner Conservation Authorities
<p>Support municipalities in improving flood emergency response</p>	<ul style="list-style-type: none"> Continue supporting member municipalities in development of flood emergency response plans Incorporate updated and new flood plain mapping into Municipal Emergency Plans that will enhance flood response Continue enhancing communication protocol for flood emergency to ensure seamless information flow and exchange 	<ul style="list-style-type: none"> Environmental Monitoring 	<ul style="list-style-type: none"> Member municipalities Ministry of Natural Resources and Forestry Trent-Severn Waterway Partner Conservation Authorities
<p>Further enhance low water/drought conditions monitoring and response</p>	<ul style="list-style-type: none"> Improve low water conditions monitoring by including additional representative sites Implement the low water groundwater indicators for the PGMN wells (as per MOECC protocol) 	<ul style="list-style-type: none"> Environmental Monitoring Communication and Marketing 	<ul style="list-style-type: none"> Ministry of Natural Resources and Forestry Ministry of the Environment and Climate

	<ul style="list-style-type: none"> • Update the OLWR Background Report bi-annually and use information collected when conditions warrant 	<ul style="list-style-type: none"> • Stewardship 	<p>Change</p> <ul style="list-style-type: none"> • Member municipalities
<p>Encourage member municipalities to develop low water response planning</p>	<ul style="list-style-type: none"> • Promote low water/drought conditions as natural hazards that require coordinated and planned response • Develop Kawartha Conservation Low Water Response action plan that can be easily employed when conditions warrant • Encourage member-municipalities to develop low water/drought emergency response plan • Utilize best management practices to plan response to the low water and drought conditions 		<ul style="list-style-type: none"> • Partner Conservation Authorities • Representatives of local tourism, business, agricultural communities

4.2 Conserving and Restoring

GOAL: Increase watershed resistance to climate change and ability to mitigate it through conservation, restoration and improvement natural ecosystems

WHY IT IS IMPORTANT: Implementing recommendations will enhance local ability to adapt to changing climate conditions through further development of *green infrastructure*. The actions will support mitigation of climate change by increasing the watershed's capacity to sequester greenhouse gases by protecting water quality and quantity and natural heritage features

Strategy	Actions	Department	Partners
Increase ecosystem resilience and watershed's ability to capture carbon dioxide (CO₂) and other greenhouse gases by protecting its natural features through the planning and regulation process	<ul style="list-style-type: none"> • Develop and implement a Natural Heritage Strategy for the watershed • Anticipate and address environmental issues • Support and assist municipalities in development and implementation of tree conservation by-laws • While enhancing natural heritage systems, focus on connecting green spaces, and riparian and shoreline areas 	<ul style="list-style-type: none"> • Environment Monitoring • Planning • Stewardship 	<ul style="list-style-type: none"> • Member municipalities • Ministry of Natural Resources and Forestry • Kawartha's Naturally Connected
Maintain existing and develop new programs that preserve and improve watershed's natural features	<ul style="list-style-type: none"> • Continue developing watershed-wide reforestation program; use native species for reforestation projects • Monitor changes in climate for resource-related impacts and develop adaptation strategies • Develop partnerships and support initiatives that increase ecosystem resilience and support watershed's natural health 	<ul style="list-style-type: none"> • Stewardship • Environmental Monitoring 	<ul style="list-style-type: none"> • Provincial, corporate and non-governments organizations and agencies
Develop a comprehensive aquatic natural heritage program	<ul style="list-style-type: none"> • Conduct review of existing aquatic heritage program and identify opportunities to enhance integration into planning and regulations, stewardship, environmental monitoring, and 	<ul style="list-style-type: none"> • Environmental Monitoring • Planning 	<ul style="list-style-type: none"> • Member municipalities

<p>to identify and integrate climate change adaptation and mitigation opportunities</p>	<p>communications departments</p>	<ul style="list-style-type: none"> • Stewardship 	
<p>Maintain and improve health of local watercourses and their aquatic communities by implementing targeted programs, projects and actions</p>	<ul style="list-style-type: none"> • Develop a program to remove/mitigate watershed and in-stream features that contribute to stream warming, and install/maintain features that contribute to stream cooling. • Develop a program to remove/mitigate in-stream features that isolate/fragment sensitive aquatic habitats and communities 	<ul style="list-style-type: none"> • Environment Monitoring • Stewardship 	<ul style="list-style-type: none"> • Ministry of Natural Resources and Forestry • Ministry of the Environment and Climate Change • Ministry of Transportation • Member municipalities • Partner Conservation Authorities • Local landowners • Academia
<p>Provide watershed stewardship leadership through education, outreach, and increased awareness</p>	<ul style="list-style-type: none"> • Continue working with watershed landowners promoting best management practices targeted to the audience: rural, urban and shoreline landowners. • Continue to reach out to local landowners through local events, direct contacts campaigns, educational and promotional events • Continue to deliver the seedling distribution program; support the development of a volunteer planting network • Continue to partner with Forests Ontario to steer local delivery of the 50 Million Tree Program, the Durham 5 Million Tree Program and any other similar initiatives • Develop and implement a low cost plant distribution program for stewardship projects • Maintain existing and develop new partnerships delivering 	<ul style="list-style-type: none"> • Stewardship • Communication and Marketing 	<ul style="list-style-type: none"> • Ministry of Natural Resources and Forestry • Ontario Soil and Crop Improvement Association • NGOs such as but not limited to: Ducks Unlimited, 4H, Ontario Woodlot Association, Farms at Work, Forests Ontario • Member municipalities • Partner Conservation Authorities

	projects that increase watershed resiliency		
Allocate stewardship resources based on natural heritage systems and potential runoff reduction and mitigation	<ul style="list-style-type: none"> • Create stewardship prioritization mapping tool for terrestrial and aquatic stewardship combining natural heritage system and stormwater considerations (permeability, level of development, existing stormwater infrastructure). Use the tool to make resource allocation decisions and promote the use of the tool to implementation partners. • Develop and administer a watershed-wide landowner cost sharing program in which the level of funding is determined in part by level of priority for the project type on each property 	<ul style="list-style-type: none"> • Environmental Monitoring • Stewardship 	<ul style="list-style-type: none"> • Kawartha's Naturally Connected • Member municipalities • Ministry of the Environment and Climate Change • Partner Conservation Authorities
Develop and deliver targeted programs and projects for rural, urban and shoreline landowners	<ul style="list-style-type: none"> • Seek out opportunities to pilot, demonstrate and showcase innovative technology, land and runoff management practices that increase watershed resiliency (e.g. nutrient management, erosion control, LID sites) • Provide urban landowners with information promoting appropriate best management practices such as increasing permeability, managing urban forests, <i>BlueScaping*</i> (which is Kawartha Conservation's program branding that focuses on implementation of low impact development practices), and shoreline naturalization • Partner with organizations that support large scale urban planting projects (i.e. TD Tree Days) • Continue to reach out to shoreline communities through local events and direct landowner contact (Blue Canoe) linking landowners to resources and information • Develop and maintain demonstration sites that showcase shoreline erosion control and rehabilitation techniques • Continue implementing actions as identified within Lake Environmental Management Plans that will help increase 	<ul style="list-style-type: none"> • Stewardship • Communication and Marketing 	<ul style="list-style-type: none"> • Member municipalities • Possible funders • Local landowners

	watershed resiliency to climate change		
Incorporate climate change considerations into conservation lands management	<ul style="list-style-type: none"> • Make sustainability a guiding principle in further conservation land development. Continue managing and enhancing our conservation lands planning for the changing climate • Support healthy lifestyle choices and help offset the negative effects of climate change on human health by offering watershed’s residents high-quality recreational opportunities in our conservation areas • Continue further land securement focusing on enhancing our existing Conservation Areas and areas vulnerable to flooding and erosion • Developing new and maintaining existing trails, consider future climate and ecosystem changes • Maintain forest canopy by planting trees which are better suited to longer growing seasons • Develop and implement list of species for adaptation in conservation areas • Plan for increased need for conservation lands maintenance that will result from the changing weather conditions 	<ul style="list-style-type: none"> • Conservation Lands • Stewardship 	<ul style="list-style-type: none"> • Member Municipalities • NGOs such as but not limited to: Ontario Heritage Trust, Nature Conservancy of Canada, Ducks Unlimited Canada, Oak Ridges Moraine Land Trust. • Partner Conservation Authorities
Build public awareness of changing climate and challenges it brings	<ul style="list-style-type: none"> • Develop educational programs targeting youth to increase environmental awareness, including climate change challenges. This will help to foster a generation willing to accept the lifestyle adjustments for mitigation and adaption • Develop educational materials focused on climate change and its effects within the watershed 	<ul style="list-style-type: none"> • Environmental Monitoring • Stewardship • Communication and Marketing 	<ul style="list-style-type: none"> • Conservation Ontario • Partner Conservation Authorities

4.3 Discovering

GOAL: Enhance our knowledge of our watershed’s natural environment and its response to a changing climate for informed decision-making

WHY IT IS IMPORTANT: Implementing recommendations will improve our knowledge of watershed resources and our understanding as to how they may be affected by changing climate. It will provide a basis for more informed planning, decision making and development of proactive actions

Strategy	Actions	Department	Partners
Enhance existing watershed monitoring network	<ul style="list-style-type: none"> Evaluate existing watershed monitoring network Assess how current monitoring addresses the current and future information needs. Identify information gaps Develop comprehensive Watershed Monitoring Strategy that takes into consideration monitoring, required to recognize changes in ecosystem as a result of changing climate Establish partnerships and pursue cost-sharing approaches in developing new monitoring locations 	<ul style="list-style-type: none"> Environmental Monitoring 	<ul style="list-style-type: none"> Ministry of Natural Resources and Forestry Ministry of the Environment and Climate Change Member municipalities Partner Conservation Authorities
Develop an aquatic natural heritage monitoring program to track status of watershed’s aquatic habitats and communities	<ul style="list-style-type: none"> Develop an aquatic natural heritage monitoring program to track status of sensitive aquatic habitats and communities Integrate sensitive community monitoring into existing benthic macroinvertebrate monitoring program Develop a program to monitor status of coldwater habitat and sensitive fish communities in coldwater streams Evaluate existing coldwater streams water temperature monitoring program to determine if spatial and temporal coverage is sufficient to detect changes due to climate change Develop a program to track status of sensitive fish communities in coldwater streams. Develop a program to track status of coldwater habitat in lakes 	<ul style="list-style-type: none"> Environmental Monitoring Conservation Lands 	<ul style="list-style-type: none"> Ministry of Natural Resources and Forestry Ministry of the Environment and Climate Change Department of Fisheries and Oceans of Canada Ontario Waterways (TSW) Partner Conservation Authorities Member municipalities

	<ul style="list-style-type: none"> • Develop a monitoring program for conservation areas wetlands in order to establish benchmark conditions and effects on wetlands and wetland species • Develop species at risk monitoring program for conservation areas 		<ul style="list-style-type: none"> • Local landowners • Academia
<p>Continue enhancing our knowledge how climate change will impact watershed resources</p>	<ul style="list-style-type: none"> • Estimate vulnerability of watershed’s water resources under the changing climate conditions • Conduct research to identify vulnerable aquatic ecosystems, anticipated changes associated with climate change, and acceptable mitigation/adaptation approaches • Continue to evaluate changes in terrestrial ecosystems and adjust mitigation and adaptation actions 	<ul style="list-style-type: none"> • Environmental Monitoring 	<ul style="list-style-type: none"> • Ministry of Natural Resources and Forestry • Ministry of the Environment and Climate Change • Department of Fisheries and Oceans of Canada • Partner Conservation Authorities • Academia

4.4 Focusing on Our Business Operations

GOAL: Reduce our corporate carbon footprint by developing a business culture of conservation, using best practices and solutions

WHY IT IS IMPORTANT: Implementation of actions will assist in a reduction of our corporate footprint, demonstrate our corporate culture of conservation and provide possible cost savings to our business operations

Strategy	Actions	Department	Partners
<p>Enhance and promote corporate culture of conservation in order to reduce business carbon footprint</p>	<ul style="list-style-type: none"> • Assess our corporate performance in energy, water use and waste production; identify opportunities to reduce wasted resources • Develop and implement immediate actions to improve our corporate performance and decrease our footprint • Develop long-term recommendations on further improving our performance, focusing on most efficient and emerging technologies in transportation, energy and water use. The best energy, heat and water efficient solutions will be considered to improve our corporate performance and decrease our footprint • Develop and implement waste management plan, including comprehensive recycling program and composting of organic waste 	<ul style="list-style-type: none"> • All departments 	<ul style="list-style-type: none"> • Member municipalities • Partner Conservation Authorities

5.0 Moving Ahead

Upon endorsement of this Climate Change Strategy by our Board of Directors we will move to the implementation phase. Implementation of strategies and actions will commence immediately in accordance with our work plans. They will also be included into the Kawartha Conservation Strategic Plan 2017-2021.

Recommended actions will be prioritized based on several criteria including but not limited to:

- Impact of the action
- Feasibility of implementation in the short, medium and long term
- Level of effort and resources required to implement the action
- Implication of not implementing the recommended action
- Availability of alternative or additional sources of funding where additional costs are required
- Capacity to continue providing the required level of service to the public, member municipalities and partner agencies

Some projects and programs recommended within this document are already being implemented, often with climate change considerations being a significant impetus in their development. Current flood plain mapping efforts, Blue Canoe and **BlueScaping** projects are examples of such watershed initiatives. Provincially, Conservation Authorities work with several Ministries in the Low Water Response Program and have been delegated with the leadership of local response activities. Other initiatives, such as the development of a regional natural heritage system, will provide a basis for identifying best options for protecting and enhancing **green infrastructure**.

Other recommended strategies and actions, such as streamlining of the planning process, natural hazard mapping, watershed reforestation or educational program have been initiated. Best management practices now recommended to landowners as good stewardship actions also convey messages about climate change adaptation. Those programs will continue to develop, enhancing our watershed's natural resources and its ability to mitigate and adapt to climate change.

Several actions recommended in this strategy will require significant effort and/or additional funds for implementation. Updating stormwater management standards, the retrofit of existing stormwater management facilities and development of a flood forecasting model are examples of long-term projects. Investment in a more comprehensive watershed monitoring network, including weather, surface water, aquifer recharge, aquatic and terrestrial monitoring is required to quantify climate change impacts and to evaluate adaptation measures and will also require significant support.

For specific projects or program areas that are not currently in place or which will require an investment of funds and resources to implement, plans will be developed to determine costing estimates to fund the work. Alternative funding opportunities will also be identified. As both provincial and federal governments are becoming proactive on the climate change issue, we anticipate that funding to support mitigation and adaptation efforts by conservation authorities and municipalities might become available in the near future.

Many decisions and actions require consensus at various government levels. Collaboration with partner agencies and watershed stakeholders that reflect climate change mitigation and adaptation efforts will be integral. As

adaptive management is a key when considering climate change, the strategies and actions will be reviewed and modified where necessary. A comprehensive review and update will take place every five years in conjunction with our review.

An annual summary and evaluation of program accomplishments relative to this strategy will be provided to our Board of Directors. In addition, the watershed community will be informed of our progress through various communication mechanisms.

References / Bibliography

American Rivers. (2014). *What is Green Infrastructure?* Retrieved from:

<http://www.americanrivers.org/initiatives/pollution/green-infrastructure/what-is-green-infrastructure/#sthash.FWPpEqWp.dpuf>

Bush, E.J., Loder, J.W., James, T.S., Mortsch, L.D. & Cohen, S.J. (2014). An Overview of Canada's Changing Climate; in *Canada in a Changing Climate: Sector Perspectives on Impacts and Adaptation*, (ed.) F.J. Warren & D.S. Lemmen. Government of Canada. Ottawa: Retrieved from

http://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/assess/2014/pdf/Chapter2-Overview_Eng.pdf

Environment Canada. (2011). *Environment Canada: Climate Trend and Variation Bulletins*. Retrieved from

<http://ec.gc.ca/adsc-cmda/default.asp?lang=En&n=4A21B114-1>

ICLEI Canada (2011). *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation*. ICLEI Canada, Toronto, ON.

IPCC (2014). *Climate Change 2014: Impacts, Adaptation and Vulnerability. Summaries, Frequently Asked questions, and Cross-Chapter Boxes. A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field C.B., V.R. Barros, D.J. Dokken, K.J. Match, M.D. Monstrandrea, T.E. Bilalr, M. Chatterjee, K.L. Ebi, Y.O. Estrade, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. World Meteorological Organization, Geneva, Switzerland.

IPCC (2014). *Climate Change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team R.K.Pachauri and L.A.Mayer (eds.)]. IPCC, Geneva, Switzerland.

Kawartha Conservation (2015). *Changing Climate – A Challenge and an Opportunity*. Lindsay, Ontario.

Kawartha Conservation (2012). *Strategic Plan 2012-2016*. Lindsay, Ontario.

Mekis, É. & Vincent, L.A. (2011). An overview of the second generation adjusted daily precipitation dataset for trend analysis in Canada. *Atmosphere-Ocean (v2)*, 163-177. Retrieved from

<http://www.tandfonline.com/doi/abs/10.1080/07055900.2011.583910>

SENE Consultants (2013). *Durham Region's Future Climate (2040-2049)*. SENE Consultants, Richmond Hills, ON.

Appendix 1.0 Vulnerability Assessment

In order to identify degree of impact of climate change to the Kawartha Conservation program areas, a program areas vulnerability assessment was conducted. This analysis was completed in several consecutive steps as seen in the figure below (Figure 1). Each following step relied on the results of the previous step – the assessment process and tables supporting the vulnerability assessment are presented in the text below.

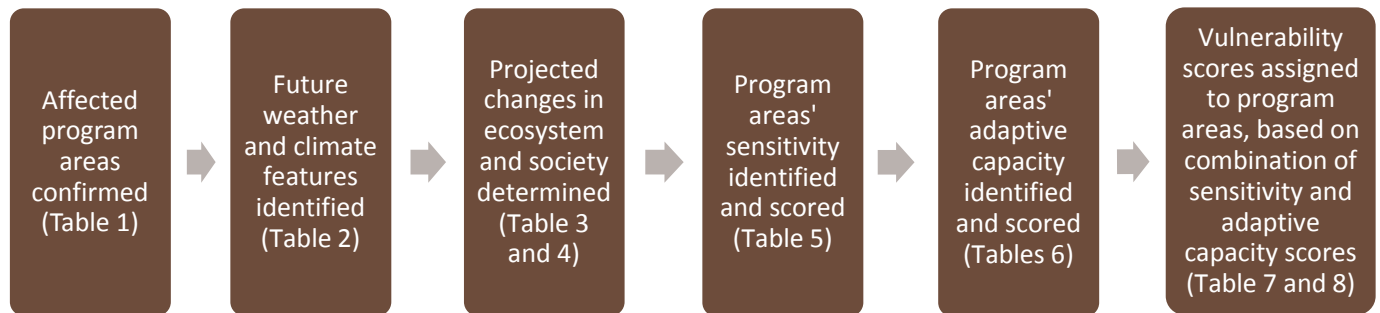


Figure 1. Vulnerability assessment process

The first step in the vulnerability assessment was to confirm affected key program areas. Sixteen program areas were identified, grouped by Kawartha Conservation’s strategic goals **Protecting, Conserving and Restoring**, and **Discovering** (see Table 1). A category called **Focusing on our Business Operations** was added to reflect our business goals and commitments in mitigating and adapting to climate change.

The second step involved the identification of future weather and climate features, based on literature review and local climate projections (Table 2) A primary source for these features was *Durham Region’s Future Climate (2040-2049)* prepared by SENES Consultants, 2013.

Changes in ecosystem and society resulting from the projected weather/climate conditions were determined (Tables 3- Possible Impact on Watershed Resources and Table 4 – Possible Impact on Society and Economics) as step three.

Once these changes were identified, program areas’ sensitivity to the projected changes was assessed based on the sensitivity scoring criteria described in Table 5. Program areas’ ability of to adjust to the changes (adaptive capacity) were evaluated based on criteria defined in Table 6. These tables were adapted from the Municipal Climate Adaptation Guide. Modifications were made to the scoring to make criteria more relevant to our program areas and provide tangible benchmarks when evaluating our program vulnerability to climate change.

The last step and end result was a vulnerability assessment, where High, Medium and Low scores were assigned to program areas based on its determined sensitivity to the climate change and its adaptive capacity. Table 7 indicates the matrix result of Table 5 (sensitivity of program area to climate change) and Table 6 (adaptive capacity of the program area). Table 8 identifies the scoring matrix applied to our program areas based on the potential impacts.

Table 1. Kawartha Conservation – Program Areas

<i>Strategic Goal</i>	<i>Program Areas</i>
Protecting	Natural Hazard Protection
	Planning and Regulation
	Flood Forecasting and Warning
	Low Water Response
Conserving and restoring	Natural Heritage – Terrestrial
	Natural Heritage – Aquatic
	Conservation Lands
	Urban Stewardship
	Rural Lands Stewardship
	Shoreline Stewardship
Discovering	Monitoring
	Research and Innovative Approaches
	Education and Outreach
Kawartha Conservation Business Practices	Daily Business Operations
	Facility & Fleet Management
	Public and Partners Engagement

Table 2. Changes Expected in Climate Parameters and Weather Pattern (adapted from SENES Consultants (2013))

Climate Parameter	Expected changes in the parameter	Expected change in weather / climate
Temperature		
Extreme Heat	<ul style="list-style-type: none"> Increased average maximum daily temperature Increased extreme maximum temperature Increased number of days per year with temperature >30°C 	<ul style="list-style-type: none"> Increased average air temperature Especially sharp increase in winter temperatures, both extremes and averages Reduced snow cover – in depth, area, and duration Change in ice cover regime Increased number of freezing-thaw cycles Unpredictable temperature changes (early /late frost and heat) Increased evapotranspiration Increased risk of drought Increased number of frost free days Increased growing season Longer and stronger heat waves Increased humidex
Extreme Cold	<ul style="list-style-type: none"> Increased average minimum daily temperature Increased extreme minimum temperature Decreased number of days per year with temperature < -10°C Decrease number of days per year with minimum <0°C (frost days) Increase number of freeze-thaw cycles 	
Wind Chill	<ul style="list-style-type: none"> Increase of extreme daily temperature Decrease number of days per year with temperature <-20°C 	
Degree Days	<ul style="list-style-type: none"> Increased number of degree days per year with temperature > 24°C (air conditioning required) Increased number of degree days per year with temperature > 0°C Decreased number of degree days per year < 0°C (heating required) 	
Humidex	<ul style="list-style-type: none"> Increased maximum temperature Increased average number of days per year with temperature >40°C 	
Precipitation		
Extreme Precipitation	<ul style="list-style-type: none"> Increased maximum one-day precipitation Increased number of days per year with daily precipitation >25mm Increased annual total precipitation (mm) 	<ul style="list-style-type: none"> Increase in high intensity rain events Increase in winter precipitation, particularly rain amounts Decreased snow cover Decrease in maximum amount of snow during the snowstorms Possible decrease in summer precipitation Increased frequency of ice storms
Extreme Rainfall	<ul style="list-style-type: none"> Increased maximum daily precipitation Increased number of days per year with precipitation > 25mm 	
Extreme Snowfall	<ul style="list-style-type: none"> Decreased maximum daily snowfall Decreased number of days per year with snowfall > 5 cm 	
Strong Winds and Violent Storms		
Potential for Violent Storms	<ul style="list-style-type: none"> Increased number of days with high lightning potential per year Increased number of days per year potential for storms and tornadoes 	<ul style="list-style-type: none"> Increased number of violent storms

Table 3. Possible Impact on Watershed Resources

Water Resources		Water Quality	Aquatic		Terrestrial
Surface Water	Ground Water		Lakes	Tributaries	
Temperature Related Changes					
<p>Changes in watercourse flow and hydrological regime including:</p> <ul style="list-style-type: none"> • Earlier and lower spring freshet • Summer and fall low flows and water levels are lower and last longer • Increased loss of water due to increased evaporation • Soil moisture may increase by as much as 80% during winter, but decrease by as much as 30% in summer and autumn • Increased frequency of low water/drought conditions • Decrease in water levels (lakes and tributaries) 	<ul style="list-style-type: none"> • Decreased groundwater recharge, with shallow aquifers being especially affected in short-term perspective • Decreased groundwater levels • Increased demand, especially in summer time • Decreased groundwater input to the streams, lakes, and wetlands especially in summer time • Possible increase of groundwater recharge in winter time 	<ul style="list-style-type: none"> • Increased water temperature in rivers and lakes • Change in water chemistry parameter • Higher concentration of nutrients and contaminants • Possible increase in development of toxic algae 	<ul style="list-style-type: none"> • Increase in exotic/invasive species presence • Reduction in deep coldwater habitat and reduction in thermocline • Increase in warmwater species productivity • Decrease in cool/cold water species productivity • Increased risk of fish die-offs due to reduced oxygen content • Changes in lacustrine wetland habitat • Changes in species diversity and fish population health as a result of reduced oxygen content 	<ul style="list-style-type: none"> • Increase in exotic/invasive species presence • Decrease in cool/cold water habitat and species productivity • Increase warmwater habitat and warmwater species productivity • Reduced volume of habitat during low-flow conditions • Changes in riverine and palustrine wetland habita 	<ul style="list-style-type: none"> • Change in species range both flora and fauna • Increase in insects and disease outbreaks • Increase in invasive species • Increase in disease in flora and fauna • Increase in plant pests both native and non native • Loss of wetlands and wetland species • Loss of species at risk due to vulnerability • Loss of species diversity • Loss of mature forest canopy • Increased productivity of various flora and fauna species

Precipitation Related Changes					
<ul style="list-style-type: none"> Increased frequency and magnitude of high water levels and flows following extreme precipitation events (flash floods), summer-fall Increased frequency of rain events in winter (rain-on-snow events), which can cause extra high runoff, increased water levels and possible flooding 		<ul style="list-style-type: none"> Deteriorated water quality following high intensity precipitation events as a result of increased stormwater runoff 	<ul style="list-style-type: none"> Increased erosion/sedimentation 	<ul style="list-style-type: none"> Increased erosion/sedimentation 	<ul style="list-style-type: none"> Changes to types of precipitation (i.e. ice storms) negatively impacting forest cover Changes in agricultural drainage practices may further undermine wetland areas Change in upland vs. lowland distribution Potential increase in wetland area Loss of tree cover protection of some species from increased potential for freeze thaw cycle
Wind and Violent Storms Related Changes					
<ul style="list-style-type: none"> Increased storm surge on Kawartha Lakes Increased erosion (riverine and lakeshore) 				<ul style="list-style-type: none"> Possible blockage/changing of migration routes 	<ul style="list-style-type: none"> Loss of tree cover, mature trees (species dependent) Urban tree canopy loss and resulting impacts to infrastructure

Table 4. Possible Impact on Society and Economics

Agricultural	Recreational	Shoreline Living	Urban
Temperature Related Impacts			
<ul style="list-style-type: none"> • Longer growing seasons • Increased productivity because of warmer temperature • Possibility of growing new crops • Possibility of exploring new markets as demands from outside of Canada may grow • Decreased moisture stress • Crop damage from extreme heat • Increased weed grows • Diseases and insects outbreaks • Less effective pesticides and herbicides 	<ul style="list-style-type: none"> • Decrease in winter recreation activities, including ice fishing, snowmobiling and skiing • Deteriorating water quality and increased aquatic vegetation will negatively impact local tourism • Difficulties in using the TSW for recreational boating because of lower WLs and intensified growing of aquatic plants • Possible increase of warm-water fishery • Expansion of the tourism season early in spring and later in fall 	<ul style="list-style-type: none"> • Loss of enjoyment of shoreline properties because of low water levels and aquatic growth problems • Increased shoreline erosion • Difficulties in water supply (where domestic water supply comes from the lake) • Loss of the property values • Spread of invasive plants and insects potentially harmful for humans 	<ul style="list-style-type: none"> • Increased heat stress • Decreases air quality • Increased demand for electricity in summer time (air conditioning) • Decreased demand for gas/electricity for heating in winter time • Increased pressure on water supply systems as demand for water (lawn/gardens irrigation) grows • Decreased local recreational opportunity • Spread of invasive plants and insects potentially harmful for humans
Precipitation Related Impacts			
<ul style="list-style-type: none"> • Crops loss because of possible drought conditions • Increased need for irrigation • Decrease in water resources available for irrigation and livestock watering • Increased erosion as a result of high intensity precipitation events 	<ul style="list-style-type: none"> • Decreased recreational opportunity following high intensity precipitation event because of high flows, degraded water quality, erosion 	<ul style="list-style-type: none"> • Increased possibility of shoreline flooding • Increased shoreline erosion as a result of high intensity precipitation events 	<ul style="list-style-type: none"> • Increased risk of flooding in flood-prone areas • Increased risk of winter flooding • Development of new flood-prone areas • Increased risk of erosion • Less snow removal
Violent Storms Impacts			
<ul style="list-style-type: none"> • Crop damages a result of violent storms 	<ul style="list-style-type: none"> • Limitation of recreational activities because of hazardous conditions during and following storms 	<ul style="list-style-type: none"> • Increased risk of storm surge • Increased risk of shoreline erosion 	<ul style="list-style-type: none"> • Increased risk of electricity loss because of storms • Increased damage to the urban forest • Increased cost of emergency response for municipalities • Increased risk of property damages and personal injuries

Table 5. Sensitivity Score: How Sensitive is the Program to the Changes in Climate?

Will a program be affected by changes in climate?

	As per Municipal Climate Adaptation Guide ICLEI Canada (2011)	Adjusted to Kawartha Conservation business
S1	No. Functionality will stay the same	No change in program is anticipated
S2	Unlikely. Functionality will likely stay the same	Unlikely. Program will likely stay the same
S3	Functionality is likely to get worse	Yes. Change in program will likely happen, require minor modifications
S4	Functionality will get worse	Yes. Program will not function as it is expected at its current format and require moderate modifications
S5	Yes. Functionality will become unmanageable	Yes. Program will become non-functional and will require major modification (amendment) or termination

Table 6. Adaptive Capacity: Can the Program Area Adjust With a Minimal Cost and Disruption?

	As per Municipal Climate Adaptation Guide ICLEI Canada (2011)	Adjusted to Kawartha Conservation business
AC1	No. Will require substantial cost (\$\$\$\$) and staff intervention	\$50+ K in capital or operational; 2-3 additional staff units, partners will have to change their function as a result
AC2	No. Will require significant cost (\$\$\$\$) and staff intervention	\$20-50 K in capital budget; 1 staff unit, partners will be affected
AC3	May be. Will require some cost (\$\$\$) and staff intervention	\$10-20 K; ½ of a staff unit, partners may be affected
AC4	Yes. But will require some slight cost (\$\$) and staff intervention	\$5-10 K; existing staff, up to 10% of increase in staff time
AC5	Yes. No to little cost (\$) and staff intervention are necessary	\$0-5 K; existing staff, < 10% of increase in staff time

Table 7. Sensitivity and Adaptive Capacity Matrix and Vulnerability Score

	S1	S2	S3	S4	S5	Vulnerability Score	
AC5	V1	V1	V2	V3	V3	V1	Low Vulnerability
AC4	V1	V2	V2	V3	V3	V2	Medium-Low Vulnerability
AC3	V2	V2	V3	V4	V4	V3	Medium Vulnerability
AC2	V2	V2	V3	V4	V5	V4	Medium-High Vulnerability
AC1	V2	V2	V4	V5	V5	V5	High Vulnerability

Table 8. Sensitivity, Adaptive Capacity and Vulnerability Assessment – Kawartha Conservation Program Areas

Impacts	Protecting												Conserving and Restoring																							
	Natural Hazard Protection			Planning and Regulation			Flood Forecasting and Warning			Low Water Response			Natural Heritage – Terrestrial			Natural Heritage - Aquatic			Conservation Lands			Urban Stewardship			Rural Lands Stewardship			Shoreline Stewardship								
	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V			
Change in ice cover regime	S3	AC4	V2	S1	AC5	V1	S3	AC5	V2	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Change in a watercourse flow and hydrological regime	S4	AC2	V4	S4	AC2	V4	S4	AC2	V4	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increased risk of winter flooding	S3	AC5	V2	S3	AC5	V2	S4	AC2	V4	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S3	AC3	V3	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increased risk of flash flooding	S3	AC5	V2	S3	AC2	V3	S4	AC2	V4	S1	AC5	V1	S2	AC5	V1	S3	AC5	V2	S3	AC3	V3	S4	AC3	V4	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increased erosion	S4	AC2	V4	S4	AC2	V4	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S3	AC5	V2	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3	S4	AC3	V4			
Increased risk of drought/low water conditions	S2	AC5	V1	S2	AC4	V2	S2	AC5	V1	S4	AC2	V4	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Decreased summer/fall water levels (lakes and watercourses)	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S4	AC2	V4	S2	AC5	V1	S3	AC5	V2	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increased and more competitive demand for water	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S4	AC2	V4	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S3	AC3	V3	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Decrease in soil moisture	S2	AC5	V1	S3	AC4	V2	S1	AC5	V1	S3	AC4	V2	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Decrease in groundwater levels	S2	AC5	V1	S3	AC4	V2	S1	AC5	V1	S5	AC2	V5	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Change /decrease in wetlands and wetland species	S3	AC5	V2	S3	AC4	V2	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increase in water temperature	S2	AC5	V1	S3	AC4	V2	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Change in water chemistry parameters	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC4	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Deterioration of water quality	S2	AC5	V1	S3	AC4	V2	S1	AC5	V1	S1	AC3	V2	S2	AC5	V1	S3	AC5	V2	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Change in fish community composition (toward warm-water community)	S2	AC5	V1	S3	AC4	V2	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increase of growing season	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S3	AC3	V3	S1	AC5	V1	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3			
Unpredictable temperature fluctuation	S3	AC4	V2	S3	AC4	V2	S1	AC5	V1	S1	AC5	V1	S3	AC6	V2	S2	AC6	V2	S3	AC3	V3	S3	AC5	V2	S3	AC5	V2	S3	AC5	V2	S3	AC5	V2			
Change in species range both flora and fauna	S2	AC5	V1	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S3	AC5	V2	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1			
Increase in invasive/exotic species presents	S2	AC5	V1	S3	AC5	V2	S3	AC5	V1	S1	AC5	V1	S3	AC4	V2	S1	AC5	V1	S4	AC2	V4	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3			
Increase in insects and disease outbreaks	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S3	AC4	V2	S1	AC5	V1	S4	AC2	V4	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3	S3	AC3	V3			
Loss of species at risk due to vulnerability; loss of diversity	S1	AC5	V1	S3	AC5	V2	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1	S3	AC4	V2	S3	AC4	V2	S3	AC4	V2			
Negative impact to the forest because of violent storms	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S3	AC3	V3	S3	AC4	V2	S3	AC4	V2	S3	AC4	V2	S3	AC4	V2			

Table 8 - Continued. Sensitivity, Adaptive Capacity and Vulnerability Assessment – Kawartha Conservation Program Areas

Impacts	Discovering									Kawartha Conservation Business Practices								
	Monitoring			Research and Innovative Approaches			Education and Outreach			Daily Business Operations			Facility & Fleet Management			Public and Partners Engagement		
	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V	S	AC	V
Change in ice cover regime	S4	AC3	V4	S2	AC5	V1	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1
Change in a watercourse flow and hydrological regime	S4	AC2	V4	S2	AC5	V1	S2	AC5	V1	S2	AC3	V3	S1	AC5	V1	S2	AC5	V1
Increased risk of winter flooding	S4	AC2	V4	S2	AC5	V1	S2	AC5	V1	S4	AC3	V3	S1	AC5	V1	S3	AC4	V2
Increased risk of flash flooding	S4	AC2	V4	S3	AC3	V3	S2	AC5	V1	S4	AC3	V3	S1	AC5	V1	S3	AC4	V2
Increased erosion	S1	AC5	V1	S2	AC4	V2	S2	AC5	V1	S3	AC5	V2	S2	AC4	V2	S1	AC5	V1
Increased risk of drought/low water conditions	S2	AC3	V2	S3	AC3	V3	S2	AC5	V1	S4	AC3	V4	S2	AC4	V2	S3	AC3	V3
Decreased summer/fall water levels (lakes and watercourses)	S2	AC5	V1	S2	AC4	V2	S2	AC5	V1	S2	AC4	V2	S1	AC5	V1	S2	AC5	V1
Increased and more competitive demand for water	S2	AC3	V2	S2	AC4	V2	S2	AC5	V1	S4	AC3	V4	S4	AC2	V4	S3	AC3	V3
Decrease in soil moisture	S1	AC5	V1	S2	AC4	V2	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Decrease in groundwater levels	S3	AC3	V3	S3	AC3	V3	S2	AC5	V1	S4	AC3	V4	S4	AC2	V4	S3	AC3	V3
Change /decrease in wetlands and wetland species	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S3	AC3	V4
Increase in water temperature	S3	AC3	V3	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S1	AC5	V1
Change in water chemistry parameters	S1	AC5	V1	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1
Deterioration of water quality	S3	AC3	V3	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1
Change in fish community composition (toward warm-water community)	S4	AC2	V4	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1	S2	AC5	V1
Increase of growing season	S1	AC5	V1	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S3	AC4	V2	S2	AC5	V1
Unpredictable temperature fluctuation (episodes of late frost/early heat)	S2	AC6	V2	S3	AC3	V3	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S1	AC5	V1
Change in species range both flora and fauna	S4	AC2	V4	S3	AC3	V3	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increase in invasive/exotic species presents	S4	AC2	V4	S2	AC4	V2	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1
Increase in insects and disease outbreaks	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S3	AC4	V2	S3	AC4	V2	S1	AC5	V1
Loss of species at risk due to vulnerability; loss of species diversity	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S2	AC5	V1	S1	AC5	V1	S1	AC5	V1
Negative impact to the forest because of violent storms	S2	AC5	V1	S1	AC5	V1	S2	AC5	V1	S3	AC4	V2	S4	AC2	V4	S1	AC5	V1

