CITY OF BARRIE

CLIMATE CHANGE ADAPTATION STRATEGY

2017

ACKNOWLEDGEMENTS

Climate change and adaptation are interdisciplinary by nature, and many stakeholders need to be involved in order to develop a holistic response to future climate conditions. The City of Barrie Climate Change Adaptation Strategy is a culmination of efforts from the Mayor and City Council, the Adaptation Team, Stakeholder Advisory Group, City staff, and other key stakeholders in the community. The insights provided by these groups helped to develop goals and actions that were inclusive, comprehensive, and representative of the community of Barrie.

The City would like to take this opportunity to thank everyone who contributed to the development of the Adaptation Strategy. Thank you for your efforts in making Barrie more resilient to the impacts of climate change.

CLIMATE CHANGE ADAPTATION STRATEGY

CITY OF BARRIE

EXECUTIVE SUMMARY

While climate change is being experienced across the globe, the impacts on natural and human systems are being felt at the local level. According to the Intergovernmental Panel on Climate Change, scientific evidence for warming of the climate system is now considered unequivocal. More frequent and extreme weather events, increasing summer temperatures, changes to freeze-thaw cycles, and prolonged heatwaves are only some of the changes being experienced in cities across central Ontario.

The City of Barrie recognizes the threat that climate change poses, both to its community and to City operations. While the City is already undertaking mitigation efforts to reduce greenhouse gas emissions, adaptation efforts are also needed to increase local resilience to the consequences of climate change. The purpose of the Climate Change Adaptation Strategy is to mainstream adaptation actions into City operations and to reduce the risks climate change poses to Barrie's physical, economic, social, and ecological systems.

The development of this Strategy was guided by ICLEI Canada's Building Adaptive and Resilient Communities Program, a 5-Milestone adaptation planning framework for local governments. The planning process was complimented by extensive cross-departmental and community engagement. This ensured that impacts and actions identified were a priority both to the City as well as to the community as a whole.

Following research on local climate projections, over 60 climate change impacts were initially identified for the City of Barrie. Risk and vulnerability assessments were then conducted to prioritize climate change impacts, resulting in 28 impacts being brought forward into the planning stage. From there, the City brainstormed actions it could take in order to adapt. This process was completed through several methods, including surveys distributed to City departments, several brainstorming workshops, and conducting a national best practice review. Following analysis by the Project Team, a total of 59 actions were selected as priority 'Must Do' for this Strategy.

These actions align with the seven goals of the Strategy, which outline the high-level intentions that Barrie will strive towards:

- Maintain Public Health and Safety
- Minimize Risks to Buildings and Properties
- Strengthen Infrastructure Resilience
- Help Local Businesses and the Tourism Industry Adapt to Changing Conditions
- Protect Biodiversity and Enhance Ecosystem Functions
- Minimize Disruption to Corporate Services
- Build Community Resilience

To ensure that prioritized actions are implemented promptly and effectively, a preliminary implementation schedule was developed for each action. This schedule will act as a framework for the City to follow in the coming years to ensure actions are carried through. The preliminary implementation schedule can be found in Appendix A. Recognizing the uncertainty present within the adaptation planning process, the schedule is intentionally flexible, and can be updated based on changes in available data, funds, or staff time.

The Strategy ensures that the City of Barrie is doing what is necessary to adapt to the effects of climate change in a sustainable and efficient way, based on best available climate science and local anecdotal knowledge. Throughout the implementation of the Strategy, the City will continue to build collaborative relationships with the community, and mainstream adaptation considerations into everyday operations.

MESSAGE FROM THE MAYOR

On behalf of City Council, I am pleased to present to you the City of Barrie Climate Change Adaptation Strategy. The City has developed this strategy to adapt to anticipated climatic change, which will help to minimize the severity of the resulting impacts.

Barrie is noticing changing weather patterns that lead to physical, ecological and financial impacts to our community, infrastructure, homes, and natural spaces. The goal of the strategy is to build community resilience to reduce the risks inherent in climate change, and take advantage of opportunities associated with current and future impacts of climate change. The strategy contains seven over-arching goals and outlines numerous actions to achieve resiliency.

Barrie is committed to providing its residents with opportunities to enjoy an enhanced and secure quality of life in a prosperous and ecologically sustainable community. We have a responsibility to anticipate and prepare for potential impacts of climate change on our community. This strategy is our commitment that we will take action in the face of uncertainty.

- Mayor Jeff Lehman

GLOSSARY

Adaptation	Includes any initiatives or actions in response to actual or projected climate change impacts and which reduce the effects of climate change on built, natural and social systems.
Adaptive Capacity	The ability of built, natural and social systems to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
Baseline	A climatological baseline is a reference period, typically three decades (or 30 years), that is used to compare fluctuations of climate between one period and another. Baselines can also be called references or reference periods.
Climate	The weather of a place averaged over a period of time, often 30 years. Climate information includes the statistical weather information that tells us about the normal weather, as well as the range of weather extremes for a location.
Climate Change	Climate change refers to changes in long-term weather patterns caused by natural phenomena and human activities that alter the chemical composition of the atmosphere through the build-up of greenhouse gases which trap heat and reflect it back to the earth's surface.
Climate Change Scenario	A climate change scenario is the difference between a future climate scenario and the current climate. It is a simplified representation of future climate based on comprehensive scientific analyses of the potential consequences of anthropogenic climate change. It is meant to be a plausible representation of the future emission amounts based on a coherent and consistent set of assumptions about driving forces (such as demographic and socioeconomic development, technological change) and their key relationships.
Extreme Weather Event	A meteorological event that is rare at a place and time of year, such as an intense storm, tornado, hail storm, flood or heat wave, and is beyond the normal range of activity. An extreme weather event would normally occur very rarely or fall into the tenth percentile of probability.
Global Climate Models (GCM)	Global Climate Models are based on physical laws and physically-based empirical relationships and are mathematical representations of the atmosphere, ocean, ice caps and land surface processes. They are therefore the only tools that estimate changes in climate due to increased greenhouse gases for a large number of climate variables in a physically-consistent manner.
Greenhouse Gas (GHG) Emissions	Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation, emitted by the Earth's surface, the atmosphere itself, and by clouds. Water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and chlorofluorocarbons (CFCs) are the six primary greenhouse gases in the Earth's atmosphere in order of abundance.

Heatwave	Environment Canada issues heatwave warnings for central and southern Ontario when two consecutive days of daytime maximum temperatures are expected to reach 31°C or when two consecutive days of humidex values reach 40°C or more.
Impact	The effects of existing or forecast changes in climate on built, natural, and human systems. One can distinguish between potential impacts (impacts that may occur given a projected change in climate, without considering adaptation) and residual impacts (impacts of climate change that would occur after adaptation)
Maladaptation	Maladaptation is a process that results in increased vulnerability to climate variability and change, directly or indirectly, and/or significantly undermines capacities or opportunities for present and future adaptation. One characteristic of maladaptation is any adaptation action that increases greenhouse gas emissions, as it would increase the likelihood that further adaptation to climate change will be required in the future
Mitigation	The promotion of policy, regulatory and project-based measures that contribute to the stabilization or reduction of greenhouse gas concentrations in the atmosphere. Renewable energy programs, energy efficiency frameworks and substitution of fossil fuels are examples of climate change mitigation measures.
Resilience	The capacity of a system, community or society exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.
Weather	The day-to-day state of the atmosphere, and its short-term variation in minutes to weeks.

ACRONYMS

BARC	Building Adaptive and Resilient Communities
SAG	Stakeholder Advisory Group
CGCM2	Coupled Global Climate Model
AR	Assessment Report

THE PLANNING TEAM

PROJECT TEAM

The Project Team consisted of members from the City of Barrie, ICLEI Canada, and Lura Consulting. The Project Team lead the development of the Adaptation Strategy by providing research and consultation, collecting outputs from the Adaptation Team, and synthesizing information into the final draft of the Strategy.

Sherry Diemert, Manager of Infrastructure Planning, Infrastructure and Growth Management Division - Engineering Department, City of Barrie

Katie Thompson, Risk Management Official, Infrastructure and Growth Management Division - Engineering Department, City of Barrie

Michaël Houle, Adaptation and Resilience Project Coordinator, ICLEI Canada

Ewa Jackson, Manager, ICLEI Canada

Hana Lapp, Adaptation and Resilience Planner, ICLEI Canada

Leya Barry, Adaptation and Resilience Project Coordinator, ICLEI Canada

Leah Winter, Project Coordinator, Lura Consulting

Jeff Garkowski, Senior Planner & Project Manager, Lura Consulting

Susan Hall, Vice President, Lura Consulting

ADAPTATION TEAM

The Adaptation Team was the core group contributing to the adaptation planning effort in the City of Barrie. The Team provided overall strategic direction for the project and input into the risk and vulnerability assessments, as well as other key steps such as the development and final endorsement of the Plan.

Merwan Kalyaniwalla, Manager of Policy Planning, Infrastructure and Growth Management Division - Planning Services Department

Scott Lamantia, Senior Communications Advisor, Access Barrie Portfolio

Ken Lin, Operations Project Coordinator, Infrastructure and Growth Management Division - Roads, Parks and Fleet Department

Gary Matthie, Senior Development Services Technologist, Infrastructure and Growth Management Division - Engineering Department - Development Services Branch

Diane Moreau, Supervisor of Compliance and Technical Support, Infrastructure and Growth Management Division - Environmental Services Department

Lesley O'May-Dodge, Policy and Standards Technologist, Infrastructure and Growth Management Division - Engineering Department

Kevin Rankin, Forestry Supervisor, Infrastructure and Growth Management Division - Roads, Parks and Fleet Department

Susan Rockey, Business Development Officer, Invest Barrie

Edward Terry, Planner, Infrastructure and Growth Management Division- Planning Services Department

Barry Thompson, Manager of Energy Management, Infrastructure and Growth Management Division - Facilities and Transit Department

Kelly Walker-Prince, Landfill Operations Supervisor, Infrastructure and Growth Management Division - Environmental Services Department - Environmental Operations Branch

Jeff Weber, Manager of Prevention and CEMC Deputy Fire Chief, Community and Corporate Services Division - Barrie Fire and Emergency Services Department

STAKEHOLDER ADVISORY GROUP

The Stakeholder Advisory Group provided sector-specific knowledge, input, and advice from a community perspective at different steps of the adaptation planning process. The group provided a broad range of perspectives and various expertise from the Barrie community.

Peter Bursztyn, Environmental Advisory Committee

Mike Fox, Transition Barrie/Living Green Barrie

Morgan Levison, Simcoe Muskoka District Health Unit

Aileen MacMillan, Tourism Barrie/Explore Lake Simcoe Sustainable Tourism

Mike McCann, Ward 10 Councilor

Alan McNair, Brereton Field Naturalists

Geri Poisson, Environmental Advisory Committee

Clinton Reynolds, Environmental Advisory Committee

Craig Stevens, Downtown Barrie BIA

Sean Stewart, Canadian Red Cross-Simcoe Muskoka Branch

Glenn Switzer, Nottawasaga Valley Conservation Authority

Bill Thompson, Lake Simcoe Region Conservation Authority

Kathleen Trainor, Tourism Barrie/Explore Lake Simcoe Sustainable Tourism

Marina Whelan, Simcoe Muskoka District Health Unit

Gayle Wood, Nottawasaga Valley Conservation Authority

INTRODUCTION

BARRIE'S COMMITMENT TO CLIMATE CHANGE

The City of Barrie is committed to providing residents with opportunities to enjoy an enhanced and secure quality of life in a prosperous and ecologically sustainable community. This commitment is reflected in several measures the City has already taken to become more sustainable in the face of climate change. In 2001, the City of Barrie committed to the Partners for Climate Protection Program, a network of more than 126 Canadian municipal governments who have committed to reducing greenhouse gases and acting on climate change. In 2006, the City developed their Green House Gas Inventory and Community Energy Plan, which outlines the historical impact of Barrie's operations on greenhouse gas (GHG) emissions, and how it intends to take action by setting GHG reduction targets. Further efforts were made towards sustainable energy and GHG reductions in October 2012, when City Council adopted the Energy Management Plan (2012-2017). This plan is intended to help the City meet the Provincial reporting requirements established under the Green Energy and Economy Act, as well as reduce energy consumption within facilities. The City will be implementing projects over 6 years that will save the Corporation over four million in energy costs.

Responding to climate change is a two-part approach. While reducing greenhouse gas emissions is important to address the root causes of climate change, adaptation is also important in addressing the symptoms. Developing a Climate Change Adaptation Strategy was identified as a strategic project for the City, following the development of the City's Framework for a Climate Change Strategy from December 2015 and a

THE CITY OF BARRIE'S CLIMATE CHANGE MITIGATION ACTIVITIES

- ✓ "Barrie in a Changing Climate" Workshop (2010)
- ✓ Municipal Stormwater Management Discussion Group (2011)
- ✓ Energy Management Group (2013)
- ✓ "Run it Right" (Water and Energy Audit) Facility Optimization Program (2015)
- ✓ "Save Adam" Energy Awareness Program
- ✓ Adoption of LEED silver as a standard for new buildings
- ✓ Solar Panels on Operations Centre Roof
- ✓ Green Roof on the City's Water Treatment Plant
- ✓ Landfill Gas Collection System
- ✓ Waste Water Treatment Biogas Utilization Upgrades
- ✓ Greening the City's Fleet
- ✓ Battery Charging Stations for Electric Vehicles
- ✓ LED Streetlight Conversion Project
- ✓ Multi-Model Active Transportation Master Plan
- ✓ Sidewalk Infill and Bicycle Lane Construction Project
- ✓ Traffic Control Signal Coordination

conference hosted by the City in May of 2015 entitled Building Municipal Resilience in Central Ontario. The take home message from the event was that climate change is here, and collaborative action must be taken now to help our communities become more resilient to climate change impacts. The development of the Adaptation Strategy will help coordinate decision-making and planning efforts to reduce vulnerabilities to climate change, while building resilience across City operations.

CLIMATE ADAPTATION 101

Climate change refers to changes in long-term weather patterns caused by natural phenomena and human activities. There exist two complementary and synergistic approaches to dealing with climate change: mitigation and adaptation.

Mitigation refers to the implementation of policy, regulatory and project-based measures that contribute to the stabilization or reduction of greenhouse gas concentrations in the atmosphere. These include anti-idling by-laws, using regulatory options for promoting green roofs, and transitioning to low-carbon energy sources. However, the effects of climate change are wide ranging and will require a diversity of responses. While mitigation efforts work to contain the long-term impacts of global warming, adaptation measures are needed to address the climate change impacts that are already happening. Adaptation is not meant to replace or undermine mitigation efforts, rather adaptation complements local government efforts to protect and improve their long-term sustainability.

Climate change adaptation refers to any initiative or action that seeks to reduce the vulnerability of social, ecological, physical, and economic systems to changing climate conditions.

The National Roundtable on the Environment and Economy estimated that every dollar spent on adaptation can yield anywhere from $9-$38 in avoided damages.[1] Adaptation efforts may focus on changing individual behaviour, updating municipal by-laws and policies, enhancing the capacity of physical infrastructure developing education and outreach programs, improving ecological services, or reducing impacts on vulnerable populations.

It is important to recognize that adaptation is not a new concept. Municipalities have been adapting to changing climate conditions for decades. However, the rate of these changes is increasing and requires more anticipatory action as the past is no longer a reliable predictor of the future. As such, decisions, actions, and attitudes need to be adjusted in order to reduce harm and take advantage of new opportunities that arise.

ADAPTATION = managing the unavoidable

MITIGATION = avoiding the unmanageable

ROLE OF LOCAL GOVERNMENT IN ADAPTATION

Local governments are well positioned to respond to climate change as they are the level of government closest to residents, and are on the front lines of response efforts when impacts hit. As such, local governments are in a position to target adaptation efforts to their local circumstances and to the unique set of impacts and challenges they face. They also have the tools and mechanisms that are needed to respond to and prepare for the impacts of climate change.

There are five key local action mechanisms available to local governments that can be utilized to drive local action on climate change in a preventative way (see Exhibit 1).

These local action mechanisms outline the different ways a municipality can take action on climate change adaptation through a combination of tangible measures that generate direct outputs and supporting measures that assist in institutionalizing climate change adaptation.

Exhibit 1: Local Government Action Mechanisms

LAND USE AND URBAN PLANNING

A key role of local government is to manage local places in a coordinated, planned way that reflects the community's shared vision of a safe and sustainable place to live.

LICENSING AND REGULATION

Local governments set the local regulatory framework through assessments and approval processes, the use of surcharges and rebates, and the enforcement of bylaws to implement and enforce adaptive policies.

LEADERSHIP AND AWARENESS

Local governments are in close contact with community organizations, businesses, residents and other stakeholders. The influence that results from this contact can be used to develop a shared understanding and encourage community-wide responses to climate change.

COMMUNITY ENGAGEMENT AND SERVICE DELIVERY

Local governments are committed to protecting the health, safety, and well-being of residents, while ensuring opportunities for active civic participation. They do this by delivering services to the community and through programs, partnerships, and projects.

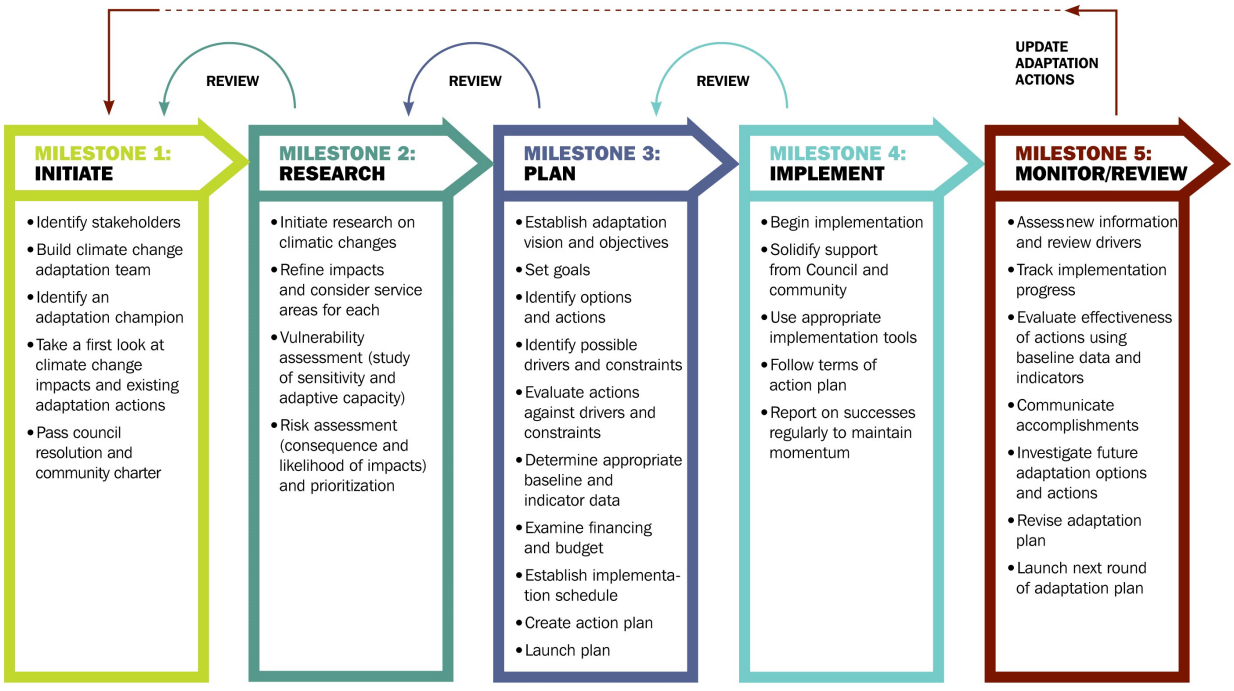
OPERATIONS AND WORKFORCE

As responsible corporate citizens, local governments can act as leaders in climate adaptation by ensuring climate change considerations are integrated into the services they deliver, the management of public spaces and buildings, and workforce development programs (through training and educational campaigns).

ABOUT THE BUILDING ADAPTIVE AND RESILIENT COMMUNITIES (BARC) PROGRAM

The Building Adaptive and Resilient Communities (BARC) Program was developed by ICLEI Canada following the release of Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation in 2010. The BARC Program provides a framework and protocol guiding municipalities through a comprehensive planning methodology that includes research and climate impact assessment methods, plan development, action-setting processes, implementation planning, and monitoring and review strategies (see Exhibit 2). ICLEI's BARC Framework is a proven methodology that has been applied by municipalities across the country including (but not limited to): Hamilton (ON), Windsor (ON), Oakville (ON), Fredericton (NB), Red Deer (AB), Calgary (AB), Edmonton (AB), Iqaluit (NU), and District of North Vancouver (BC).

Exhibit 2: BARC Milestone Framework



CLIMATE SCIENCE

Climate change is defined as any change in global or regional climate patterns. While the Earth's climate has naturally fluctuated for millions of years, changes in climate from the mid-to-late 20th century onwards are largely attributed to increased levels of atmospheric carbon dioxide produced by burning fossil fuels.

The Intergovernmental Panel on Climate Change (IPCC) recently published its Fifth Assessment Report in 2014. This report, one of the most comprehensive and up to date publications regarding scientific, technical, and socio-economic information concerning climate change, concluded that the warming of the climate system is unequivocal, and that the observed changes are unprecedented. In the Northern Hemisphere, 1983–2012 was the warmest 30-year period of the last 1400 years.

While annual temperatures may fluctuate, long-term climate analysis shows that air temperatures are warming across the globe. This warming trend not only influences annual and seasonal air temperatures: a warmer climate spurs the evaporation of water from land and sea and allows the atmosphere to hold more moisture—thus setting the stage for more extreme precipitation. In fact, the atmosphere's water-holding capacity increases by about 7 percent for every 1°C rise in temperature.

At the same time, most regions facing warming temperatures are experiencing shorter winters and more precipitation is falling as rain and less as snow, therefore increasing the risk of freezing rain events. Whether precipitation falls as rain or snow, these extremes can heighten the risk of flood, and cause economic, ecological, and social disruptions for communities that are unprepared to cope.

CLIMATE CHANGE IN CANADA

According to recent studies, Canada has been warming at roughly double the global average over the last six decades. This means that an increase of 2°C in average temperatures globally could mean that Canada could see a change of 3 - 4°C[2]. Over the past half-century, Canada has already experienced an increase in temperatures, altered precipitation patterns, and an increase in the frequency, intensity, and duration of extreme weather events. These changes are expected to continue, with implications for future vulnerability.

Between 1950 and 2010, Canada's annual temperatures increased by 1.5°C.[3] Recent analysis shows that 2011 and 2012 were 1.5°C and 1.9°C warmer than the reference period (1961-1990 average) [4]. 2016 now stands as the warmest year on record globally, with some areas in Canada's northwest experiencing 3.0°C above normal temperatures.[5]

National trends in precipitation, though more difficult to assess, indicate that on average, Canada has become wetter over the past half century with an increase of approximately 12%[6]. There have also been significant increases in the number of intense precipitation events at the regional level. A 1-in-25-year storm* today is likely to become a 1-in-5-year storm by mid-century, while a 1-in-100-year storm today is expected to become a 1-in-50 or 1-in-25-year storm by 2050.[7]

CLIMATE CHANGE PROJECTIONS FOR BARRIE

The City of Barrie is already experiencing the impacts of climate change, including the ice storm in April 2016, extreme cold temperatures in 2015, and the wind storm in 2015. These recent events have highlighted the need to be prepared for ongoing challenges, especially as Barrie's climate will continue to change over the next century.

Projecting future climate conditions requires historical weather station data in the City of Barrie as well as an ensemble of climate models, which provide the best available scientific assessment of how future social and economic conditions will influence the climate system in Barrie. While it is not possible to anticipate future climate changes with absolute certainty, climate change scenarios create plausible representations of future climate conditions. These conditions are based on assumptions of future atmospheric composition and on an understanding of the effects of increased atmospheric concentrations of greenhouse gases (GHG), particulates, and other pollutants.

The climate data presented for the City of Barrie is based on global climate models and emission scenarios defined by the Intergovernmental Panel on Climate Change (IPCC), drawing from both the Fourth Assessment Report (AR4) for temperature and precipitation data and the Fifth Assessment Report (AR5) for extreme weather data. Please see Appendix B for more detailed climate projections for the City of Barrie.

* The term "1-in-25 year storm" is meant to simplify the probability of occurrence in any given year. Said differently, a "1-in-25 year storm" statistically has a 4% chance of occurrence in any given year and can happen multiple times in a year or for multiple years in a row.

Exhibit 3: Summary of Projected Climate Changes in Barrie

Temperature 	• The mean, annual temperature between 1971 – 2000 was 6°C. Barrie can expect to see an annual increase in mean temperature of approximately 1.5°C by 2020, 3°C by 2050, and 4.7°C by 2080 • Greatest warming will occur in the spring and summer • Increase in the number of hot days (days >30°C) from 4 days per year between 1971-2000, 15 days per year by 2020, 28 days per year by 2050, and 49 days by 2080. • Heatwaves projected to become more frequent and prolonged • Increased surface warming of lakes, rivers, and streams • Greater variability in winter temperatures, including more freeze/ thaw events
Precipitation 	• Annual increase in precipitation by 26.8 mm in 2020, 72.9 mm by 2050, and 106.3 mm by 2080 • Increase in precipitation in the winter, spring, and fall • Decrease in precipitation in summer • Decrease in annual snowfall, with more winter precipitation falling as rain instead of snow • Increased incidents of freezing rain
Extreme Events 	• Increase in the intensity, duration, and frequency of extreme rainfall events • Historically rare extreme rain events will occur almost twice as often by mid-century • Increased occurrences of storm events (ice storms, thunderstorms, etc.)

IMPACTS AND ISSUES

PHYSICAL IMPLICATIONS

The impacts of climate change will affect a variety of physical systems in the City of Barrie. From the built environment, to parks, transportation, and energy systems. More frequent and extreme weather events will increase maintenance requirements, replacements costs, and the potential loss of assets throughout the community. Increased precipitation will have a direct impact on stormwater and transportation infrastructure (e.g. stormwater pond capacity, road washouts, etc). Freezing rain and more frequent freeze-thaw cycles present challenges to the physical and green infrastructure in Barrie. Historic or cultural sites are also at risk of damage or deterioration due to storms, erosion, flooding, and wind.

SOCIAL IMPLICATIONS

Expected climate impacts will have both direct and indirect effects on the complex social systems in the City of Barrie. Extreme weather events, air quality concerns, extreme heat and cold, as well as the spread of vector and rodent born disease will directly impact residents. Extreme heat has been linked to psychological stress and physical aggression or violence.[8] Communities also need to prepare for the emotional stress that arises when people experience weather-related disasters.[9]

ECOLOGICAL IMPLICATIONS

Biodiversity refers to the variety of species and ecosystems and the ecological processes of which they are a part. These ecological systems have a significant influence on Canada's natural capital and its ability to deliver services which in turn contribute to human health and well-being as well as the productivity of a wide range of economic sectors.[10] Ontario's ecosystems are already under stress as a result of human activities, the movement of native and non-native species, fires, and the spread of insects and disease, all of which will be exacerbated by climate change. Warmer winters, longer summers, and decreased annual precipitation have led to lower water levels, warmer water temperatures, and reduced availability of soil moisture in forests and agricultural land.[11] These changes are having an effect on shoreline integrity, species distribution, erosion, water quality, habitats for fish and wildlife, and the proliferation of invasive species.

ECONOMIC IMPLICATIONS

The climate is already changing and industrial processes, fixed assets (e.g. buildings), and commodities will be directly (and indirectly) affected.[12] While the magnitude of these impacts is difficult to predict, the effect of extreme weather and longer term changes in temperature and precipitation is undeniable. Economic losses from extreme weather events, changes to the production, price, and demand for goods and services, as well as impacts to several economic sectors, such as energy, tourism, recreation, freshwater fisheries, and transportation, are all likely to occur within the short and medium term.[13] Residents and citizens will also be affected as insurance premiums rise and damage to properties and homes is likely to increase as a result of extreme weather events. Local businesses could experience operational losses, business continuity issues, and disruptions to essential services (e.g. power, telecommunications) which are relied upon to deliver products and services to the local community.

It is important to understand the impacts of climate change on the local economy in order to build awareness and engagement from the business community and to enhance resilience within local economic sectors. While there may be certain opportunities that could arise, particularly in tourism related industries, it is important to proactively plan for the impacts (and opportunities) of climate change. To enable action, governments and business alike must embed adaptation within existing risk-management mechanisms and processes and work collectively to improve the adaptive capacity of the local economic sectors in Barrie.[14]

CLIMATE CHANGE IMPACTS

EXTREME HEAT & COLD

1 Enhanced urban heat island effect (hotter temperatures, stress on air quality) from warmer summer temperatures
2 Cold-related health and safety issues among vulnerable populations due to more extreme cold days in winter
3 Heat-related health and safety issues amongst vulnerable populations due to more extreme heat days in summer
4 Freezing of water service lines and water mains due to extreme cold temperatures
5 Reduced productivity of City staff during hot days

INVASIVE SPECIES

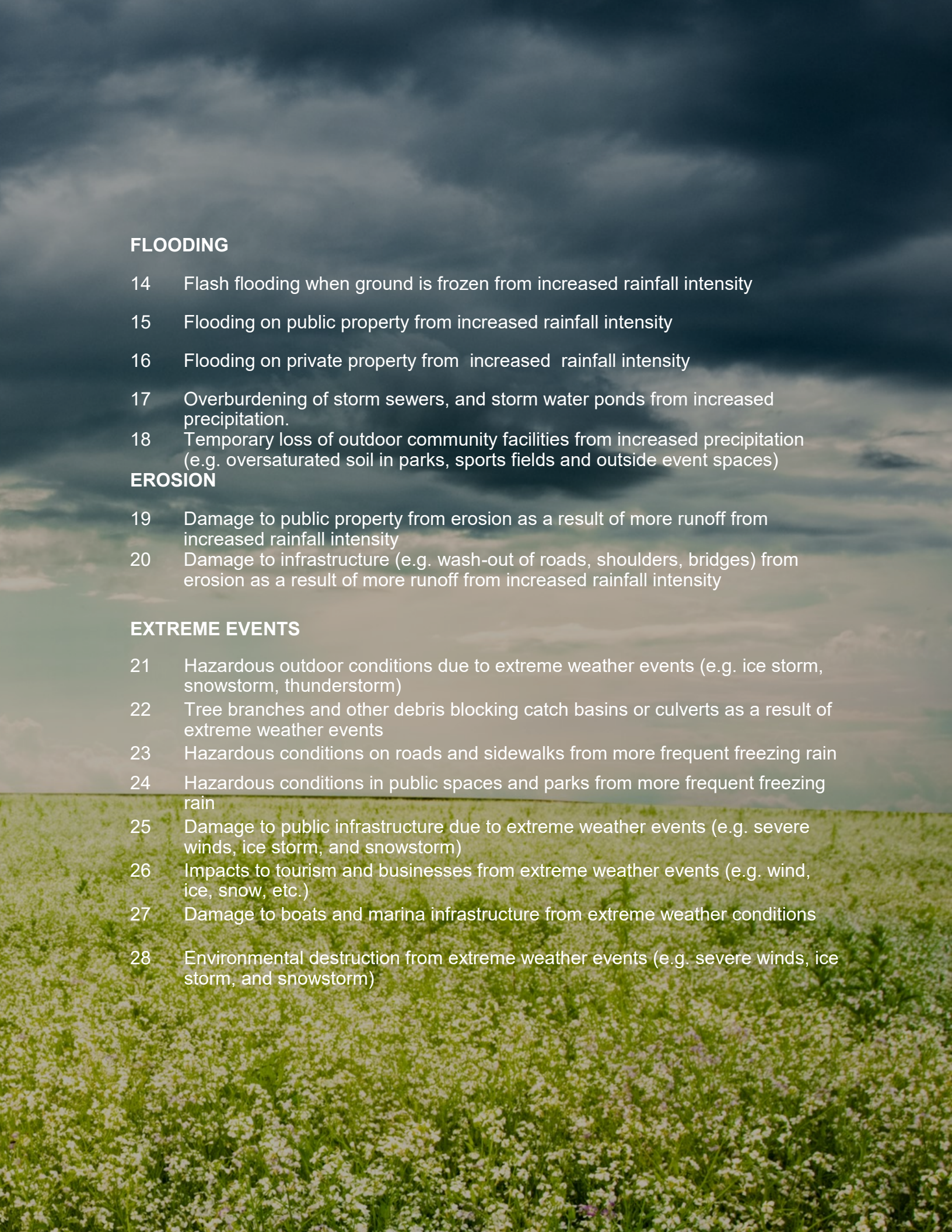
6 More frequent and rapid spread of invasive species due to more favourable climatic conditions

WATER QUALITY

7 Negative impacts to water quality from improper functioning or overburdened stormwater ponds
8 More beach closures due to bacteria or other water quality concerns as a result of warmer water

TEMPERATURE VARIABILITY IN SHOULDER SEASONS

9 Damage to private property (e.g. building foundation, landscaping) from more frequent freezing and thawing cycles
10 Damage to roads and sidewalks (e.g. wear and tear, cracks, potholes) from more frequent freeze-thaw cycles
11 Malfunctioning stormwater ponds from more frequent freezing thawing
12 Overburdening of the storm sewer system resulting in surcharge and runoff from rapid snowmelts
13 Water quality concerns resulting from increased use of road salt due to more frequent freezing rain events.



FLOODING

14 Flash flooding when ground is frozen from increased rainfall intensity

15 Flooding on public property from increased rainfall intensity

16 Flooding on private property from increased rainfall intensity

17 Overburdening of storm sewers, and storm water ponds from increased precipitation.

18 Temporary loss of outdoor community facilities from increased precipitation (e.g. oversaturated soil in parks, sports fields and outside event spaces)

EROSION

19 Damage to public property from erosion as a result of more runoff from increased rainfall intensity

20 Damage to infrastructure (e.g. wash-out of roads, shoulders, bridges) from erosion as a result of more runoff from increased rainfall intensity

EXTREME EVENTS

21 Hazardous outdoor conditions due to extreme weather events (e.g. ice storm, snowstorm, thunderstorm)

22 Tree branches and other debris blocking catch basins or culverts as a result of extreme weather events

23 Hazardous conditions on roads and sidewalks from more frequent freezing rain

24 Hazardous conditions in public spaces and parks from more frequent freezing rain

25 Damage to public infrastructure due to extreme weather events (e.g. severe winds, ice storm, and snowstorm)

26 Impacts to tourism and businesses from extreme weather events (e.g. wind, ice, snow, etc.)

27 Damage to boats and marina infrastructure from extreme weather conditions

28 Environmental destruction from extreme weather events (e.g. severe winds, ice storm, and snowstorm)

OUR APPROACH

Guided by the BARC methodology, the Adaptation Strategy was developed through extensive collaboration with City departments and community stakeholders. The Strategy itself is intentionally flexible to accommodate any changes resulting from the uncertainty inherently present in the adaptation planning process. The Strategy is intended to be regularly monitored and updated as new information and resources become available.

SHAPING OUR STRATEGY THROUGH STAKEHOLDER ENGAGEMENT

A key component of developing the Climate Change Adaptation Strategy was engagement with a range of stakeholders and audiences in Barrie. By using and building upon the knowledge and expertise of Council, City Staff, and local stakeholders and partners, the Strategy is reflective of the needs and priorities of the Barrie community as we move towards a new climate reality.

A Climate Adaptation Team was established to provide strategic direction and technical support to the Project Team over the course of developing the Strategy. The Adaptation Team was comprised of cross-departmental staff members from the City of Barrie with a diversity of expertise and experience with the management of infrastructure, public communications, natural resources, economic development, parks and community recreation, tourism, and emergency services. Five workshops were held over several months which enabled staff to contribute to

the vision and goals of the Strategy, and help to identify climate change impacts, risks and vulnerabilities to the City, as well as adaptation actions. The involvement of the Climate Adaptation Team helped to ensure the Strategy aligns with departmental functions, and supports corporate objectives.

A Stakeholder Advisory Group (SAG) was formed to provide an ongoing forum for advice, feedback, and guidance from a broader community perspective to the Adaptation Team at key points during the planning process. The role of the SAG was to provide sector-specific knowledge and input, while acting as champions for the project.

The SAG consisted of representatives from:

- Brereton Field Naturalists
- Canadian Red Cross-Simcoe Muskoka Branch
- City of Barrie Environmental Advisory Committee
- Downtown Barrie BIA
- Lake Simcoe Region Conservation Authority
- Nottawasaga Valley Conservation Authority
- Simcoe Muskoka District Health Unit
- Tourism Barrie
- Transition Barrie/Living Green Barrie

Over the course of two workshops and an online survey, the SAG shared their feedback and ideas, with a unique perspective on leveraging community partnerships in the implementation of the Strategy.

The collaborative planning approach also included engagement with the broader public through a series of pop-up engagement events held across the City during August and September 2016 , an online survey, and a public open house. Community members shared their input on the local effects of climate change and actions to be taken to become more resilient. The themes and concepts shared by the community helped to inform the Strategy and were used to gauge their understanding of climate change. For a detailed summary of community engagement activities and outcomes, see Appendix D.

The City recognizes that the successful implementation of the Strategy will depend on the collective efforts of City staff, residents, businesses, and partner organizations throughout Barrie.

VULNERABILITY ASSESSMENT

The Adaptation Team conducted a vulnerability assessment for each impact statement to determine the areas in which the City should focus its effort. Vulnerability refers to the susceptibility of a given City department to harm arising from climate change impacts. It is a function of a department's sensitivity to climate change and its capacity to adapt to climate change impacts. The matrix by which vulnerability rankings were determined is presented in Exhibit 4. Additional details on the vulnerability assessment results and methodology is provided in Appendix C.

SENSITIVITY

To determine sensitivity, the Adaptation Team looked at each impact statement and assessed whether it would affect the ability of a City department to function or operate normally. To answer this question, the Adaptation Team considered the current state of a department and how it would be affected if this impact was to occur today. Considerations included current pressures faced by the department that might increase sensitivity, and any conditions that would affect different departments' ability to manage each impact. Sensitivity was ranked on a scale of 1 (low) to 5 (high).

ADAPTIVE CAPACITY

To measure adaptive capacity, the Adaptation Team assessed how well departments could cope with projected climate impacts. The Adaptation Team considered plans, policies, programs, initiatives, and regulations that are already in place to mitigate certain issues. Rankings are based on the costs and intensity of staff intervention that would be required to respond to a given impact. Adaptive capacity was ranked on a scale of 1 (high) to 5 (low). City departments which cannot accommodate changes and impacts have a low adaptive capacity.

VULNERABILITY

By combining Sensitivity and Adaptive Capacity, the vulnerability ranking of each primary City department was identified. Departments with high sensitivity and low adaptive capacity are considered highly vulnerable; those with low sensitivity and high adaptive capacity have low vulnerability; and those service areas that have both medium sensitivity and medium adaptive capacity have a medium vulnerability.

Exhibit 4: Vulnerability Matrix

Adaptive Capacity Low ↓ High	Sensitivity: Low → High				
	S1	S2	S3	S4	S5
AC1	V2	V2	V4	V5	V5
AC2	V2	V2	V3	V4	V5
AC3	V2	V2	V3	V4	V4
AC4	V1	V2	V2	V3	V3
AC5	V1	V1	V2	V3	V3

RISK ASSESSMENT

Using the results from the vulnerability assessment, the Adaptation Team then conducted a risk assessment on impacts with a vulnerably ranking of (V2) or higher, for a total of 68 impacts. Risk is defined as the combination of an event's likelihood and its associated consequences.

LIKELIHOOD

Based on projected climate data and local observations, the Adaptation Team discussed both the likelihood of the climatic change occurring (i.e. increased temperature), as well as the likelihood of occurrence of the associated impacts (i.e. health impacts for vulnerable populations). A likelihood rating from 1 to 5 was assigned to each impact, where 1 is "rare" and 5 is "almost certain".

CONSEQUENCE

The Adaptation Team then looked at the consequences of the 68 impacts against 12 consequence criteria. A consequence ranking from 1 to 5 was assigned for each criterion, where 1 is "negligible" and 5 is "catastrophic." For each impact, total consequence scores for the social, economic, and environmental factors were calculated, as well as an overall consequence score for all three categories. Consequence scores and likelihood were then multiplied to obtain a risk ranking.

Based on the results of the vulnerability and risk assessments, the Adaptation Team identified 28 impacts as priorities. Impacts were prioritized based on the total social, economic, and environmental consequence scores, the cumulative risk ranking, and the vulnerability scores. Impacts that were assigned a major or catastrophic consequence rating in any of the 12 consequence criteria were also prioritized.

The list of 28 impacts was then presented to the Stakeholder Advisory Group to be further reviewed and vetted by members of the community. The SAG focused specifically on the consequence criteria scores for the risk assessment and provided their knowledge and expertise of the impacts as members of the community. These results were incorporated into the Adaptation Team's risk assessment and helped the City determine where to focus its efforts in order to prepare both the Corporation and the community for the changing climate. See Appendix C for the results and methodology of the risk assessments.

Exhibit 5: Risk Assessment Consequence Criteria

SOCIAL FACTORS	ECONOMIC FACTORS	ENVIRONMENTAL FACTORS
Public Health & Safety	Property Damage	Air
Displacement	Local Economy and Growth	Water
Loss of Livelihood	Community Livability	Soil & Vegetation
Cultural Aspects	Public Administration	Ecosystem Function

PRIORITIZATION OF ACTIONS

Adaptation planning typically involves five phases: awareness-raising; research and assessment; planning; implementation; and monitoring and review. This process is outlined in ICLEI Canada's Building Adaptive and Resilient Communities (BARC) framework and has been utilized in the development of this Climate Change Adaptation Strategy. Action prioritization typically occurs within the planning phase, following the completion of the vulnerability and risk assessments.

There are a variety of types of adaptation actions that can be used to respond to climate change impacts. Actions can include activities that are taken before an impact is observed (anticipatory) or after an impact has occurred (reactive).[15] Both anticipatory and reactive actions can be planned (i.e. the result of deliberate policy decisions), however reactive adaptation can also occur spontaneously (i.e. without planning).

Workshops were held with the Stakeholder Advisory Group, Adaptation Team, and surveys were sent to other key municipal staff to brainstorm action to prepare for and mitigate the risks associated with the prioritized impacts. This list of actions was then refined by the Adaptation Team. A total of 146 actions were identified by the Stakeholder Advisory Group and the Adaptation Team. All actions were then further evaluated by the Consulting Team using criteria adapted from the *Canadian Communities' Guidebook for Adaptation to Climate Change*, which is included in Exhibit 6.

The purpose of this evaluation was to provide insights into the trade-offs between different responses, the urgency of responses, and the availability of resources (both financial and institutional) for implementation.[16] Each action was evaluated based on a series of sustainability, effectiveness, risk and uncertainty, opportunity, and implementation considerations and was assigned a low, medium, or high score (1-3) for each criteria.

Exhibit 6: Action Prioritization Criteria

		1 (LOW)	2 (MEDIUM)	3 (HIGH)
SUSTAINABILITY	*Mitigation co-benefits*	Could result in increased GHG emissions	Not likely to affect GHG emissions	Could reduce GHG emissions
	Equity	Benefits only to some people	Benefits to many people	Significant benefits to many people
	Implementation Cost	Cost is high relative to cost of inaction	Cost is moderate relative to cost of inaction	Cost is low relative to cost of inaction
EFFECTIVENESS	*Robustness*	Effective for a narrow range of plausible future scenarios	Effective across many plausible future scenarios	Effective across a wide range of plausible future scenarios
RISK AND UNCERTAINTY	*Urgency*	Impacts are likely to occur in the longer term	Impacts are likely in the near to mid term	Impacts are already occurring
OPPORTUNITY	*Ancillary Benefits*	Will contribute little to other goals and programs in the community	Will contribute somewhat to other goals and programs in the community	Will contribute significantly to other goals and programs in the community
	No Regret	Will have little or no benefit if climate change impacts do not occur	Will have some benefits regardless of actual climate change impacts	Will result in significant benefits regardless of actual climate change impacts
	Window of Opportunity	There is no window currently	A window of opportunity could be created	A window of opportunity exists to implement
IMPLEMENTATION	*Public (or political) Acceptability*	Could face some public or political opposition	Not likely to receive much public or political attention	Likely to receive public/ political support
	Funding Sources	Additional funding sources are required but have not been identified	Additional funding sources may be required	Funding is available or not required
	Capacity (information, technical, staff, resources)	Current capacity is insufficient and gaps cannot be easily addressed	Gaps exist in one or more areas but can likely be addressed	Current capacity is sufficient to implement the action
	Institutional	Implementation requires coordination with, or action by, other jurisdictions	Implementation may require external approval/ coordination	Implementation is within local control

Using the cumulative scores for each action, an overall Action Evaluation Score (from 12-36) was assigned. This score was then compared against the final risk score for the climate impact that each action was meant to address. The lowest possible score was 12, as zero was not an available score in each of the categories. The result was a list of actions that fell into three categories: must do (28-36), monitor (20-27), or investigate further (12 -19). See Exhibit 7.

Thirty-nine actions were identified as Must Do and were pulled forward as priority actions. A strategic gap analysis was then conducted to ensure that all priority impacts were addressed and any funding or implementation opportunities were accounted for. An additional 11 actions were identified through this analysis. The Consulting Team then worked with City staff to integrate the feedback that was received through the pop-up engagement events and the public open house. An additional nine actions were added to the Strategy based on feedback that was received which resulted in a total of 59 actions. The full list of priority actions is outlined in the Actions section of the Strategy.

Exhibit 7: Prioritization Matrix

RISK SCORE

ACTION EVALUATON SCORE	Low Risk	Medium-Low risk	Medium Risk	Medium-High Risk	High Risk
Low (12-19)	Investigate further	Investigate further	Investigate further	Monitor	Monitor
Medium (20-27)	Investigate further	Monitor	Monitor	Monitor	Must Do
High (28-36)	Monitor	Monitor	Must Do	Must Do	Must Do

VISION, GOALS, AND ACTIONS

ENGAGING THE PUBLIC

In December 2016, a Public Open House was held at City Hall to introduce the public to the City's draft Climate Change Adaptation Strategy. The purpose of the open house was to seek feedback on the overall vision, goals, guiding principles and proposed actions of the Strategy. For more information on how the public was consulted in the developed of the Strategy please see the Community Engagement Summary Report in Appendix D.

VISION

Barrie will adapt to changing climate conditions and embrace new opportunities to remain a vibrant, healthy, and sustainable waterfront community.

MISSION

The City of Barrie will demonstrate leadership by taking progressive and innovative steps to achieve the vision of the Climate Change Adaptation Strategy. We have a responsibility to anticipate and prepare for potential impacts of climate change on our community. The City is committed to taking action in the face of uncertainty.

GUIDING PRINCIPLES

The City of Barrie will work in **collaboration with internal and external stakeholders**. This will help us to better prepare Barrie for potential impacts of climate change by taking a broader look at how the community will be impacted and how it can prepare.

The City of Barrie will take an **inclusive and coordinated approach** as a corporation to adapt to climate change at the City. Climate change is not a department; each and every department has a role in preparing for and adapting to climate change. All departments will work together in a collaborative and coordinated approach.

The City of Barrie will **integrate climate change considerations** into ongoing business decisions of the City. Potential impacts of climate change are broad and preparing for those changes needs to be considered in all decisions, across all departments. This will allow the City to keep climate change top-of-mind and commonplace in our ongoing efforts to adapt to changing conditions.

The City of Barrie will **leverage community partnerships** to allow the City and community organizations to work towards common goals and mandates. Many stakeholders have a role in adapting to climate change and a shared mandate to do so; the City will work together with community organizations to take collective action on preparing for climate change impacts that affect us all.

The City of Barrie will recognize and leverage the great work that the City and other community partners are doing to adapt to climate change. The City is not starting from scratch and it will **build on the successes already achieved** and will work to improve and enhance the work that is already underway. By building on existing initiatives, the City will make best use of existing resources.

The City of Barrie will continue to **provide a high quality of service** to its citizens as it adapts to climate change. Maintaining what is valuable to the community in the face of a changing climate is a key consideration in this Strategy.

The City of Barrie will work to **build awareness of climate change and educate citizens** on what climate change means for them and how they can prepare. We all have a role in preparing and adapting to climate change. Small actions by many can go a long way.

The City of Barrie will **be fluid and adjust our approaches** as things change and new data becomes available. The actions and the impacts in the Climate Adaptation Strategy are not set in stone; they will be continually reviewed and updated to reflect current conditions as climate change occurs in Barrie.

The City of Barrie will take a **holistic approach** to preparing for climate change **to maximize the co-benefits** of actions to achieve multiple sustainability goals.

The City of Barrie will **demonstrate innovation** in its approaches to assess potential climate impacts and prepare for them. As more information becomes available and as technologies change, the City will stay at the forefront to best serve the Barrie community.

GOALS AND ACTIONS

A series of seven goals were developed by the Adaptation Team and Stakeholder Advisory Group to guide the development of the City's actions. The Goals represent the physical, social, economic, and ecological implications of climate change. Actions have been organized according to these overarching goals. An additional set of cross-cutting actions have been included in their own section.

CROSS CUTTING ACTIONS

GOAL 1: MAINTAIN PUBLIC HEALTH AND SAFETY

GOAL 2: MINIMIZE RISKS TO BUILDINGS AND PROPERTIES

GOAL 3: STRENGTHEN INFRASTRUCTURE RESILIENCE

GOAL 4: HELP LOCAL BUSINESSES AND THE TOURISM INDUSTRY ADAPT TO CHANGING CONDITIONS

GOAL 5: PROTECT BIODIVERSITY AND ENHANCE ECOSYSTEM FUNCTIONS

GOAL 6: MINIMIZE DISRUPTION TO COMMUNITY SERVICES

GOAL 7: BUILD COMMUNITY RESILIENCE

CROSS CUTTING ACTIONS

Cross cutting actions are actions that are applicable across a variety of Goals. For this Strategy, these actions primarily refer to integrating climate change considerations into existing plans, policies, and frameworks. Factoring climate change into Barrie's programs, plans, and policies is one of the most important ways the City can contribute to adaptation, while also supporting the planning and decision making processes.

Integrating climate change across the corporation provides a more sustainable, effective, and efficient uses of resources. Rather than designing and managing climate policies separately from ongoing activities, integrating actions allows adaptation to be looked at holistically.

CROSS CUTTING ACTIONS

CC.1 Incorporate climate change into the City’s Official Plan.

CC.2 Integrate climate change considerations into Barrie's existing plans and policies (e.g. Multi-Modal Transportation Plan, Transportation Master Plan, Emergency Management Plan, etc.)

CC.3 Develop education initiatives to lead and encourage awareness of climate change for Barrie residents, businesses, and City staff. When possible, integrate these initiatives into existing programs and communications.

GOAL 1: MAINTAIN PUBLIC HEALTH AND SAFETY

Climate change comes with great public health and safety concerns. Over the coming decades, Barrie will experience more severe and potentially threatening weather and climate phenomena such as extreme heat, extreme cold, and freezing rain events. As well, impacts due to vector-borne diseases (e.g. West Nile and Lyme disease) are expected to increase in the future and have direct implications for the health and safety of residents. Everyone will be affected by climate change, but vulnerable communities in Barrie including children, the elderly, and homeless, those with special existing health conditions may be particularly affected. In the face of a changing climate, the City of Barrie is committed to maintaining the health, safety, and wellness of the whole community.

GOAL 1 ACTIONS

1.1 Improve communications to the public regarding road conditions and safety during extreme weather events.

1.2 Continue working towards blue flag certifications for all Barrie beaches.

1.3 Communicate beach closures or swimming advisories to the public.

1.4 Support the continued implementation of Barrie's Geese Management Program.

1.5 Require adherence to the Threshold Limit Values (TLVs) for Heat Stress and Heat Strain recommended by the Ministry of Labour (via safety talks, education and training of staff) to reduce heat stress and maintain productivity.

1.6 Partner with Simcoe Muskoka District Health Unit to address climate change considerations in food-security communications and programming.

1.7 Consider impacts and risks of increased disease vectors in design of stormwater infrastructure (e.g. avoiding ponding/standing water).

GOAL 2: MINIMIZE RISKS TO BUILDINGS AND PROPERTIES

In recent years, the City of Barrie has experienced increased incidences of basement flooding, cracked building foundations, and damaged landscapes. The impacts have come as a result of changing climate conditions, which have manifested as more frequent extreme weather events, overland flooding, and changes to freeze thaw cycles. These changing conditions will affect the ways in which buildings and landscapes are designed, constructed, managed, and maintained. The City of Barrie is dedicated to minimizing risks from climate change to buildings and properties in order to protect public health and safety, and reduce costs incurred by property owners.

GOAL 2 ACTIONS

2.1 Support the promotion and marketing of Barrie's Sanitary Sewer Inflow Reduction Rebate (SSIRR) program to improve uptake of storm water best management practices.

2.2 Develop an education and incentive program to promote lot level storm water controls (e.g. rain barrels, rain gardens, down spout disconnections, etc.).

2.3 Evaluate and recommend opportunities for increased storm water management during park redesign and in new parks to reduce flooding risk.

2.4 Promote higher building standards which reflect newest climate projections by updating by-laws, development guidelines, and zoning regulations.

GOAL 3: STRENGTHEN INFRASTRUCTURE RESILIENCE

Recent climate events have offered insight into what continued changes might mean for Barrie's infrastructure: increased intensity of rainfall, runoff, and erosion leading to wash-outs on roads, shoulders, and bridges; more frequent freeze-thaw cycles, soil instability, and ground movement causing damage to roads, sidewalks, and underground infrastructure; and more extreme weather events leading to direct physical damage to infrastructure.

Recognizing that climate change will put additional stress on Barrie's critical green and grey infrastructure, the City is committed to strengthening the resilience of its infrastructure systems to climate change and other non-climatic factors (e.g. land-use changes, population growth, aging infrastructure) to prevent disruptions of essential services and ensure the safety of the community.

GOAL 3 ACTIONS

3.1 Increase staff and/or resources to repair potholes.

3.2 Increase natural and forested areas within sub-watersheds with high surcharge and runoff.

3.3 Increase low impact development technologies throughout the City and update engineering policy and standards accordingly.

3.4 Explore possibilities of incorporating storm water management measures along existing developed watercourses to reduce system surcharge and overflow where required.

3.5 Develop and implement a plan to regularly update the design Intensity Duration Frequency (IDF) curve to reflect the geographic areas of the municipality.

3.6 Update the inflow and infiltration reduction program as required.

3.7 Develop and implement a comprehensive maintenance and inspection program and manual for storm water works.

3.8 Enforce the site alteration by-law including erosion and siltation requirements.

3.9 Conduct storm water drainage area inspections to identify areas of potential risk for debris blockage and dams.

3.10 Develop an inspection policy for high risk infrastructure to identify any damage from events.

3.11 Investigate and apply methods of incorporating climate change considerations into infrastructure (grey, green, and urban forests) asset management.

3.12 Develop a policy for regularly updating infrastructure design and retrofit standards repairs to reflect new climate change projections and green infrastructure technologies.

3.13 Investigate and explore opportunities to collect and recycle water and storm water for further use in future buildings and developments.

3.14 Update engineering policy and standards to consider new and emerging green technologies to manage storm water in new developments.

3.15 Explore the possibility of a storm water utility in Barrie to manage and operate storm water infrastructure.

3.16 Upsize storm water infrastructure as part of renewal (where possible).

GOAL 4: HELP LOCAL BUSINESSES AND THE TOURISM INDUSTRY ADAPT TO CHANGING CONDITIONS

Climate change can pose significant risks to businesses, not only for their operations, but also to their suppliers, employees, customers, and people living in the areas in which they operate. The City of Barrie will help local businesses and the tourism industry in adapting to climate changes in order to ensure their continuity of operations, improve their ability to reduce and manage risk, and build and maintain a positive and proactive reputation within the community.

GOAL 4 ACTIONS

4.1 Improve communications to local businesses on their role in the maintenance of sidewalks and appropriate application rates or best management practices (outlined in the Smart About Salt Program) during freezing rain or snow events.

4.2 Assess new opportunities for different forms of business and tourism as a result of a changing climate.

4.3 Provide guidance to local business on how to maintain business continuity (e.g. supply chain) during extreme weather events.

4.4 Establish a local best practice network (e.g. business continuity, green business practices, adaptation measures) for businesses to build resiliency.

GOAL 5: PROTECT BIODIVERSITY AND ENHANCE ECOSYSTEM FUNCTIONS

Climate change affects ecosystems directly by creating favorable climatic conditions for the spread of invasive species, causing environmental damage due to extreme weather events, while simultaneously interacting with other human stressors. The increase in rainfall intensity leading to overburdened stormwater ponds, or the increased frequency of winter events requiring the use of de-icing substances are a few of the many examples where added stress will have cascading effects on water quality and ecosystem functions. Acknowledging the intrinsic value of ecosystems and their contributions to the quality of life in Barrie, the City will take steps to further protect and enhance ecosystems functions and services.

GOAL 5 ACTIONS

5.1 Collect data on the urban canopy to develop baseline information and direction for a future Urban Forest Management Plan.

5.2 Develop municipal by-laws, standards, and permitting processes to advocate/enhance green space, green roofs, and tree canopy on private and public properties.

5.3 Develop an Urban Forest Management Plan with specific greening strategies for areas of the City where tree canopy/greenspace is low.

5.4 Support the identification and mapping of invasive species as part of the Urban Forest Strategy.

5.5 Develop partnerships and funding strategies to control non-native invasive species.

5.6 Increase education and communication to public about invasive species (e.g. dog strangling vine, garlic mustard, round goby, zebra mussels, and quagga mussels).

5.7 Promote the planting of native vegetation along lakes, creeks and ravines to reduce erosion risk, maintenance needs, and enhance local biodiversity.

5.8 Support the implementation of the Smart About Salt program to reduce salt used by the City, businesses and residents.

GOAL 6: MINIMIZE DISRUPTION TO COMMUNITY SERVICES

The more frequent occurrence of extreme weather has the potential to hinder people's routines and day-to-day activities, while posing safety-related risks to those driving or utilizing outdoor recreational spaces such as waterfront and community park pathways. Recognizing that the ability of the City to efficiently deliver services to the residents will be under pressure due to changing climatic conditions, the City of Barrie will take measures to ensure that the needs of the community are met, and any disruption to core services are minimized.

GOAL 6 ACTIONS

6.1 Develop a communication tool (e.g. an app) which tells residents the plowing/sanding/salting status of roads in order to better plan routes for driving in hazardous conditions.

6.2 Mandate the use of snow tires on all City vehicles during winter months.

6.3 Encourage the pre-treatment of roads (using brine or alternatives) to reduce the amount of salt used during freezing rain/snow events.

6.4 Continue to implement winter control measures (snow removal and de-icing) on waterfront park and community park pathways and parking lots.

6.5 Ensure communication plans are in place between departments (e.g. Environmental operations, Roads, Parks, and Fleer, Facilities) to provide efficient clean-up after an extreme weather event.

6.6 Develop strategies to reduce wind pressure (e.g. tree planting, pedestrian sheltering, etc.) especially around the marina and on north/south roads.

6.7 Increase preventative maintenance and inspection of trees on public property (e.g. tree pruning, removal of diseased/hazardous trees, proactive planting) in order to reduce damage caused by extreme weather events to the urban forest.

6.8 Expand Barrie's Road Weather Information System (RWIS), and use of road pucks to monitor road conditions to enhance winter maintenance actions.

6.9 Develop teleworking and other alternative work arrangements (e.g. Stay-at-home days/shifted/flex) that eliminate commuting during extreme weather events and hazardous road conditions.

GOAL 7: BUILD COMMUNITY RESILIENCE

Climate change poses a variety of risks to the community, ranging from flooding, to extreme heat and cold, to habitat loss, and property damage. To ensure that the City of Barrie is able to withstand and recover from the impacts of climate change it is important to build and maintain the community's resilience. Building community resilience in the context of this Strategy refers to actions that can be taken by the City to support residents and citizens in order to improve local adaptive capacity and reduce risks.

GOAL 7 ACTIONS

7.1 Develop outreach programs to teach residents what they can do to reduce snowmelt flooding on their property (e.g. removing snow from around their foundations, clearing debris from catch basins, etc.)

7.2 Conduct education and outreach to developers to encourage the use of Low Impact Development technologies.

7.3 Encourage residents to plant gardens with native species that provide habitat and enhance local biodiversity.

7.4 Encourage natural and constructed shade and cooling structures on public and private property.

7.5 Support ongoing community initiatives that address extreme heat and cold such as Barrie's Out of the Cold Program.

7.6 Create naturalized and edible landscapes on City land using existing resources.

7.7 Develop communications campaign with messaging to residents on lot-level resiliency actions (e.g. green roofs, shade structures, rain gardens, etc.).

7.8 Continue with active tree planting and preservation, community partnerships, and naturalization programs as outlined in the Urban Forest Strategy.

IMPLEMENTATION

The City of Barrie has made strides in adaptation through the development of the Climate Change Adaptation Strategy. However, it is through implementation of the strategy that the city will improve its adaptive capacity. To ensure the implementation is prompt and effective, a preliminary implementation schedule was developed.

The implementation schedule is intended to be a living document, and will be further refined into an implementation plan by the City as it continues with the implementation phase of Milestones Four (Implementation) and Five (Monitoring and Review) of ICLEI's BARC Framework. Updates may be made to accommodate changes in policies, staff or financial resources, and unexpected extreme weather events. This flexibility will ensure the City is not constrained to certain parameters should new opportunities for implementation arise.

In order to ensure that the actions outlined in this strategy are implemented in line with the vision for the City of Barrie, a series of guiding principles for implementation were developed.

- **Sustainable:** Wherever possible, actions should enhance mitigation efforts, and should not be maladaptive or unsustainable.
- **Effective:** Those actions which are effective for a wide range of plausible future scenarios should be prioritized.
- **Integrated:** Wherever possible, implemented actions should contribute to other goals and/or programs in the community.
- **Inclusive:** Implementing actions should involve multiple city government departments, stakeholders, and community partners.
- **Iterative:** The implementation of actions should be informed, adjusted, or refined as new information becomes available or circumstances change.

IMPLEMENTATION SCHEDULE

The preliminary implementation schedule was developed to identify and allocate resources required to implement priority actions. Alongside every priority action, the Implementation Schedule includes:

- Identification of the primary responsible City department for each adaptation action
- Identification of opportunities to integrate actions into already exiting municipal plans, policies, or actions, as well as actions that exist in other plans and policies
- Identification of key internal and external partnerships required to support implementation
- Timeframes for implementation of each action

- Assessment of costs associated with the implementation of each action
- Foreseen amount of effort required to implement each action
- Identification of the frequency of the action (i.e. is it a ‘one off’ or is it an ongoing action)

The implementation schedule also recognizes existing actions that are either already planned or currently underway, and which address the impacts identified in the Strategy.

While these actions may exist in other existing plans and policies, they were included in the Climate Change Adaptation Strategy as means to recognize the efforts the City is already undertaking to increase its adaptive capacity. The preliminary implementation schedule is presented in Appendix A.

IMPLEMENTATION TOOLS

In Milestone Four (Implementation) of the

BARC Framework, the City of Barrie will identify appropriate implementation tools to complement each priority action to ensure they are successfully applied. Utilizing a variety of tools to achieve an action will help to improve the likelihood of success, provide new opportunities for outreach and engagement, and foster long-term sustainability by integrating multiple streams of support. These tools will be used at various times, and will represent different ways the City can go about implementing each action. Implementation tools include, but are not limited to:

Communications and marketing tools: The City can utilize different mediums of communication and outreach, ranging from visual (e.g. infographics, advertisements) to written media (e.g. government publications, brochures, websites), to oral communication (e.g. group dialogue and presentations). Both internal and external communication will help, among other things, with public awareness and community buy-in.

Municipal policy tools: The City can utilize policy-based implementation, such as land use planning tools (e.g. zoning, covenants and easements, design guidelines), municipal bylaws and subsidy programs. These tools can provide policy frameworks and generate new compliance requirements supportive of the City's adaptation actions.

Education and training tools: The City can utilize both internal training of municipal staff, as well as external public education sessions on specific adaptation actions. These activities can help support implementation by increasing the knowledge and capacity of internal staff and the public to contribute to community adaptation and implementation.

Pilots and demonstration: The City can utilize pilot or demonstration sites to test run an action before implementing it across the municipality. These smaller scale initiatives can help determine the price of implementation and the degree of success in terms of its desired results.

MONITORING AND REVIEW

Monitoring and review is an important part of the adaptation planning process. It provides an opportunity to examine the lessons learned throughout the development and implementation of the adaptation actions outlined in this Strategy and assess whether the context of the risks and vulnerabilities has changed. These insights can then be integrated into future adaptation strategies.

Tracking progress is an important part of the monitoring and review process as it enables the City to assess whether the actions outlined in this Strategy are producing the desired results. It also provides an opportunity to communicate accomplishments and celebrate the successes of the City's adaptation efforts.

A formal review of the Climate Change Adaptation Strategy is planned to occur every five years, with a Climate Change Adaptation Strategy implementation update to council occurring on an annual basis once implementation begins.

INDICATORS

To ensure the successful implementation of the City's Climate Change Adaptation Strategy a series of high level indicators have been recommended to track progress over time. These indicators are outlined in Appendix E and are meant to measure the success of the overall Climate Adaptation Strategy and provide insights into how the City is preparing for, and responding to the impacts of climate change.

NEXT STEPS

The focus of 2017/2018 will be to develop an implementation plan and beginning implementation of some quick win actions. The implementation plan will outline the details of how the City is going to achieve the high level actions outlined in the strategy, identify community partners, and determine how we will report back on the implementation of the adaptation plan. Collaboration and partnerships will be key to the successful implementation of the adaptation actions. The City will also continue to work with the Health Unit, and local Conservation Authorities on the development of their strategies.

APPENDIX A: IMPLEMENTATION SCHEDULE

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
CC.1	Incorporate climate change into the Official Plan.	Planning	Official Plan; Sustainable Development Strategy Action Plan
CC.2	Integrate climate change considerations into Barrie's existing plans and policies (e.g. Multi-Modal Transportation Plan, Transportation Master Plan, Emergency Management Plan, etc.)	All	All
CC.3	Develop education initiatives to lead and encourage awareness of climate change for Barrie residents, businesses, and City staff. When possible, integrate these initiatives into existing programs and communications.	Engineering and Access Barrie	Climate Change Adaptation Plan; Energy Plans; Emergency Management Plans
1.1	Improve communications to the public regarding road conditions and safety during extreme weather events.	Roads Parks and Fleet	Emergency Management Plan
1.2	Continue working towards blue flag certifications for all Barrie's beaches.	Corporate Facilities	Waterfront and Marina Strategic Plan
1.3	Communicate beach closures or swimming advisories to the public.	Corporate Facilities	Waterfront and Marina Strategic Plan
1.4	Support the continued implementation of Barrie's Geese Management Program.	Corporate Facilities	Geese Management Program
1.5	Require adherence to the Threshold Limit Values (TLVs) for Heat Stress and Heat Strain recommended by the Ministry of Labour (via safety talks, education and training of staff) to reduce heat stress and maintain productivity.	Human Resources	Health and Safety Policies

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
	$	Low	Short-term	Ongoing
Active Transportation Working Group, Emergency Management Working Group	$	Medium	Medium-term	One-off
	$-$$$	Medium	Short to Medium-term	Recurrent
Media, Police	$	Low	Short-term	Ongoing
Private marinas; Businesses (i.e. boat and other watercraft rental businesses); Tourism Barrie; Simcoe Muskoka District Health Unit	$	Low	Short-term	Ongoing
Simcoe Muskoka District Health Unit; Media	$	Low	Short-term	Ongoing
	$	Low	Short-term	Ongoing
Ministry of Labour	$	Low	Short-term	Ongoing

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
1.6	Partner with Simcoe Muskoka District Health Unit to address climate change considerations in food-security communications and programming.	Engineering-Parks Planning & Road, Parks, Fleet- Parks Operations	Parks and Recreation Master Plan, Official Plan
1.7	Consider impacts and risks of increased disease vectors in design of storm water infrastructure (e.g. avoiding ponding/standing water).	Engineering	Comprehensive Stormwater Management Master Plan
2.1	Support the promotion and marketing of Barrie's Sanitary Sewer Inflow Reduction Rebate (SSIRR) program to improve uptake of storm water best management practices.	Engineering-Infrastructure Planning	Sanitary Sewer Inflow Reduction Rebate (SSIRR) program
2.2	Develop an education and incentive program to promote lot level storm water controls (e.g. rain barrels, rain gardens, down spout disconnections etc.,)	Engineering	Comprehensive Stormwater Management Master Plan
2.3	Evaluate and recommend opportunities for increased storm water management during park redesign and in new parks to reduce flooding risk.	Engineering	Comprehensive Stormwater Management Master Plan; Parks and Recreation Strategic Master Plan; Parks standards
2.4	Promote higher building standards which reflect newest climate projections by updating by-laws, development guidelines, and zoning regulations.	Planning, Building and By-law	
3.1	Increase staff and/or resources to repair potholes.	Roads Parks and Fleet - Roads	Asset Management Plans, and Operations and Maintenance practices
3.2	Increase natural/forested areas within sub watersheds with high surcharge and runoff.	Engineering	Comprehensive Stormwater Management Master Plan; Urban Forestry Strategy
3.3	Increase low impact development technologies throughout the City and update engineering policy and standards accordingly.	Engineering	City of Barrie Built Boundary Community Improvement Plan & other improvement plans; Intensification Area Urban Design Guidelines; Parks and Recreation Strategic Master Plan; Comprehensive Stormwater Management Master Plan; Urban Forestry Strategy

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
Simcoe Muskoka District Health Unit, Simcoe County Food Partners Alliance, Simcoe County Farm Fresh Marketing Association	$	Low	Medium-term	Recurrent
Simcoe Muskoka District Health Unit	$	Low	Short-term	Recurrent
	$	Low	Short-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority	$$	Medium	Medium-term	One-off
	$$	Medium	Short-term	Recurrent
Ministry of Municipal Affairs and Housing	$$	Medium	Short to medium-term	One-off
	$$-$$$	Medium	Short-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority	$$-$$$	High	Medium-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Community organizations; Local businesses	$$-$$$	High	Short-term	Recurrent

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
3.4	Explore possibilities of developing smaller detention facilities upstream along existing developed watercourses to reduce system surcharge and overflow as required.	Engineering	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines
3.5	Develop and implement a plan to regularly update the design IDF curve to reflect the geographic areas of the municipality and changing climate parameters.	Engineering	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines
3.6	Update the inflow and infiltration reduction program as required.	Engineering- Infrastructure Planning	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines; Sanitary Sewage Collection System Policies and Design Guidelines; Inflow Reduction Rebate (SSIRR) program
3.7	Develop and implement a comprehensive maintenance and inspection program and manual for storm water works.	Roads Parks and Fleet	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines; System-Wide Environmental Compliance Approval
3.8	Enforce the site alteration by-law including erosion and siltation requirements.	Environmental Operations and Engineering	Comprehensive Stormwater Management Master Plan; Site Alteration By-Law
3.9	Conduct storm water drainage area inspections to identify areas of potential risk for debris blockage and dams.	Roads, Parks, Fleet	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines
3.10	Develop inspection policy for high risk infrastructure to identify any damage from events.	Engineering- Corporate Asset Management	Asset Management Plan
3.11	Investigate and apply methods of incorporating climate change considerations into infrastructure (grey, green, and urban forests) asset management.	Engineering- Corporate Asset Management and/ or Parks- Forestry	Asset Management Plan; Urban Forest Management Plan;
3.12	Develop a policy for regularly updating infrastructure design standards and repairs to reflect new climate change projections and green infrastructure technologies	Engineering – Corporate Asset Management	Engineering Design guidelines (e.g. storm/sanitary, etc.)

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
	$$	Medium	Short-term	Ongoing
	$$	Medium	Short-term	Ongoing
	$$	Medium	Short-term	Recurrent
	$	Low	Short-term	Ongoing
	$	Low	Short-term	Ongoing
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority	$$	Medium	Short-term	Ongoing
	$-$$	Medium	Short to medium-term	One-off
Federation of Canadian Municipalities (FCM)	$$	Medium	Short to medium-term	One-off
	$	Medium	Short to medium-terms	One-off

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
3.13	Investigate and explore opportunities to collect and recycle water and storm water for further use in future buildings and developments.	Engineering	Sustainable Development Strategy
3.14	Update Engineering policy and standards to consider new and emerging green technologies to manage storm water in new developments.	Engineering	
3.15	Explore possibility of storm water utility in Barrie to manage and operate storm water infrastructure.	Engineering	Stormwater Master Plan
3.16	Upsize storm water infrastructure as part of renewal (where possible)	Engineering	Comprehensive Stormwater Management Master Plan; Storm Drainage & Stormwater Management Policies & Design Guidelines
4.1	Improve communications to local businesses on their role in the maintenance of sidewalks and appropriate application rates or best management practices (outlined in the Smart About Salt Program) during freezing rain or snow events.	Economic Development	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan
4.2	Assess new opportunities for different forms of tourism as a result of a changing climate.	Business Development	
4.3	Provide guidance to local business on how to maintain business continuity (e.g. supply chain) during extreme weather events.	Business Development	
4.4	Establish a local best practice network (e.g. business continuity, green business practices, adaptation measures) for businesses.	Business Development	
5.1	Collect data on the urban canopy to develop baseline information and direction for a future Urban Forest Management Plan.	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
	$-$$$	Medium	Medium-long term	Re-current
Ministry of Environment and Climate Change; Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority	$-$$$			
	$-$$	Medium	Short to medium-term	One-off
	$$$	High	Long-term	Recurrent
Business Improvement Area (BIA)	$	Low	Short-term	Ongoing
Tourism Barrie (Explore Lake Simcoe Project); Ministry of Natural Resources and Forestry	$	Low	Short-term	One-off
Downtown Barrie Business Association; Local businesses; Tourism Barrie; Private marinas	$	Low	Short-term	Recurrent
Georgian College, ventureLAB, Small Business Centre of Barrie - Simcoe County and Orillia Tourism Barrie (Explore Lake Simcoe Project)	$	Low	Short-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Georgian College Simcoe Muskoka District Health Unit	$$	Medium	Short-term	Ongoing

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
5.2	Develop municipal by-laws, standards, and permitting processes to advocate/enhance green space, green roofs, and tree canopy on private and public properties.	Planning and By-law	Urban Forest Strategy
5.3	Develop an Urban Forest Management Plan with specific greening strategies for areas of the City where tree canopy/ greenspace is low.	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy
5.4	Support the identification and mapping of invasive species as part of the Urban Forest Strategy.	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy
5.5	Develop partnerships and funding strategies to control non-native invasive species.	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy
5.6	Increase education and communication to public about invasive species (e.g. dog strangling vine, garlic mustard, round goby, zebra mussels, and quagga mussels).	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy
5.7	Promote the planting of native vegetation along lakes, creeks and ravines to reduce erosion risk, maintenance needs, and enhance local biodiversity.	Engineering – Parks Planning and Roads, Parks, Fleet - Parks	Comprehensive Stormwater Management Master Plan; Urban Forestry Strategy; Waterfront & Marina Strategic Plan; Parks and Recreation Strategic Master Plans
5.8	Support the implementation of the Smart About Salt program to reduce salt used by the City, businesses and residents.	Engineering - Source Water Protection	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan; Source Water Protection Plan
6.1	Develop a communication tool (e.g. an app) which tells residents the plowing/sanding/salting status of roads in order to better plan routes for driving in hazardous conditions.	Roads, Parks, Fleet	Winter Operations Plan; Winter Control Program

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
	$	Low	Short-term	Recurrent
	$$	Medium	Short-term	Ongoing
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Georgian College	$$	Medium	Short-term	Ongoing
Ontario Invasive Plant Council; Local interest groups	$	Low	Short-term	Ongoing
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Community organizations	$	Low	Short-term	Ongoing
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Community organizations	$	Low	Short-term	Recurrent
Downtown Barrie Business Association; Local businesses; Tourism Barrie (Explore Lake Simcoe Project)	$	Low	Medium-term	Ongoing
Georgian College Ministry of Transportation Ontario; Ontario Good Roads Association	$-$$	Medium	Short-term	One-off

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
6.2	Mandate the use of snow tires on all City vehicles during winter months.	Access Barrie	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan; Source Protection Plan
6.3	Encourage the pre-treatment of roads (using brine or alternatives) to reduce the amount of salt used during freezing rain/snow events.	Roads, Parks, Fleet	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan
6.4	Continue to implement winter control measures (snow removal and de-icing) on waterfront park and community park pathways and parking lots.	Roads Parks and Fleet	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan
6.5	Ensure communication plans are in place between departments (e.g. Environmental operations, Roads, Parks, and Fleer, Facilities) to provide efficient clean-up after an extreme weather event.	All	Emergency Management Plan
6.6	Develop strategies to reduce wind pressure (e.g. tree planting, pedestrian sheltering, etc) especially around the marina and on north/south roads.	Corporate Facilities	Urban Forest Strategy; Waterfront and Marina Strategic Plan
6.7	Increase preventative maintenance and inspection of trees on public property (e.g. tree pruning, removal of diseased/ hazardous trees, proactive planting) in order to reduce damage to the urban forest caused by extreme weather events.	Roads, Parks, Fleet	Urban Forest Strategy; Tree Protection Policy
6.8	Expand Barrie's Road Weather Information System (RWIS) and use of road pucks to monitor road conditions to enhance maintenance actions.	Roads, Parks, and Fleet	Winter Operations Plan; Winter Control Program; Salt Optimization Strategy; Salt Management Plan
6.9	Develop teleworking and other alternative work arrangements (e.g. Stay-at-home days/shifted/ flex) that eliminate commuting during extreme weather events and hazardous road conditions.	Human Resources	

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
Ontario Good Roads Association	$	Low	Short-term	One-off
Source Protection Region; Ontario Good Roads Association	$	Low	Short-term	Ongoing
	$	Low	Short-term	Ongoing
	$	Low	Short-term	One-off
Private marinas; Boat (and other watercraft) rental businesses; Tourism Barrie; Community organizations	$$	Medium	Short-term	Recurrent
	$$	Medium	Short-term	Recurrent
	$$	Medium	Short to medium-terms	One-off
	$	Low	Short-term	One-off

ACTION NUMBER	ACTION	LEAD DEPARTMENT(S)	ASSOCIATED MUNICIPAL PLANS/POLICIES/STRATEGIES
7.1	Develop outreach program to teach residents what they can do to reduce snowmelt flooding on their property (e.g. removing snow from around their foundations, clearing debris from catch basins, etc.)	Emergency Management Group	Comprehensive Stormwater Management Master Plan
7.2	Conduct education and outreach to developers to encourage the use of Low Impact Development technologies.	Engineering-Development Services Planning	City of Barrie Built Boundary Community Improvement Plan & other improvement plans; Intensification Area Urban Design Guidelines; Comprehensive Stormwater Management Master Plan
7.3	Encourage residents to plant gardens with native species that provide habitat and enhance local biodiversity.	Engineering-Parks Planning & Road, Parks, Fleet- Parks Operations	Parks & Recreation Strategic Master Plan, Community Garden Policy, Comprehensive Stormwater Management Master Plan, Commemorative Program
7.4	Encourage natural and constructed shade, cooling structures and spaces (e.g. recreational/sprinkler community water parks) on public and private property.	Engineering—Parks Planning	City of Barrie Built Boundary Community Improvement Plan & other improvement plans; Intensification Area Urban Design Guidelines; Parks and Recreation Strategic Master Plan; Parks standards
7.5	Support ongoing community initiatives that address extreme heat and cold such as Barrie's Out of the Cold Program.	Access Barrie	Emergency Management Plan
7.6	Create naturalized and edible landscapes on City land using existing resources.	Roads, Parks and Fleet	Parks & Recreation Strategic Master Plan, Boulevard Garden Policy
7.7	Develop communications campaign with messaging to residents on lot-level resiliency actions (e.g. green roofs, shade structures, rain gardens, etc.).	Engineering	Comprehensive Stormwater Management Master Plan
7.8	Continue with active tree planting, community partnerships, and naturalization programs as outlined in the Urban Forest Strategy.	Roads Parks and Fleet-Parks (Forestry)	Urban Forest Strategy

POTENTIAL PARTNERS	ESTIMATED COST ($, $$, $$$)	LEVEL OF EFFORT (low, medium, high)	DURATION	FREQUENCY
Public Health, Media	$$	Low	Short-term	One-off with recurrent promotion
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority	$	Low	Short-term	Ongoing
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority, Barrie Garden Club	$	Low	Short-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Downtown Barrie Business Association; Tourism Barrie; Community organizations; Simcoe Muskoka District Health Unit	$	Low	Short-term	Recurrent
Community organizations (e.g. local churches); Simcoe Muskoka District Health Unit	$	Low	Short-term	Recurrent
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority, Barrie Garden Club, Fruit Share Barrie; Community Organizations	$$ - $$$	High	Medium-term	One-off
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority, Ministry of Environment and Climate Change	$	Low	Short-term	One-off
Nottawasaga Valley Conservation Authority; Lake Simcoe Region Conservation Authority; Community organizations	$-$$$	Medium	Short to medium-term	Ongoing

APPENDIX B: CLIMATE PROJECTION DATA FOR THE CITY OF BARRIE

TEMPERATURE

Annual and seasonal temperatures in the City of Barrie are expected to rise. The Canadian Climate Change Data and Scenarios (CCDS) tool provides information from a weather station located just outside the City of Barrie (Shanty Bay). The data uses a baseline of 1971-2000, and depicts projected temperature change (not actual temperature) from both A2 (high) and B1 (low) scenarios. See Chapter 5: Emissions Scenarios of the IPCC Fourth Assessment Report: Summary for Policy Makers for more information on scenarios.

Projections are based on increases from the temperature baseline, which is the mean air temperature from 1971-2000. For Barrie, the annual mean temperature over this period was **6.5°C**. The projections to 2020, 2050, and 2080 reflect the expected future temperature, in degrees Celsius, from the annual and seasonal baselines.

In a high emission scenario (A2), the City of Barrie can expect to experience an average annual temperature change of **1.5°C** in the 2020s, **3°C** in the 2050s, and **4.7°C** in the 2080s from baseline.

Exhibit 8: Baseline Mean Temperatures (1971-2000) for Station Shanty Bay (44.40N 79.63W)
(All figures are positive, unless noted otherwise)

	Annual	Winter	Spring	Summer	Autumn
°C	**6.5°C**	-6.5°C	5.3°C	18.7°C	8.5°C

Exhibit 9: High Emissions Scenario (A2) Projected Seasonal Temperature Change for Station Shanty Bay (44.40N 79.63W)

AR4 (2007) - CGCM3T47 (Mean) - SR-A2 (baseline: 1971 - 2000)

	2020s	**2050s**	**2080s**
Winter	1.6°C	3.3°C	4.4°C
Spring	1.6°C	3.0°C	4.7°C
Summer	1.4C	2.9°C	4.8°C
Autumn	1.3°C	2.8°C	4.6°C
Annual	**1.5°C**	**3.0°C**	**4.7°C**

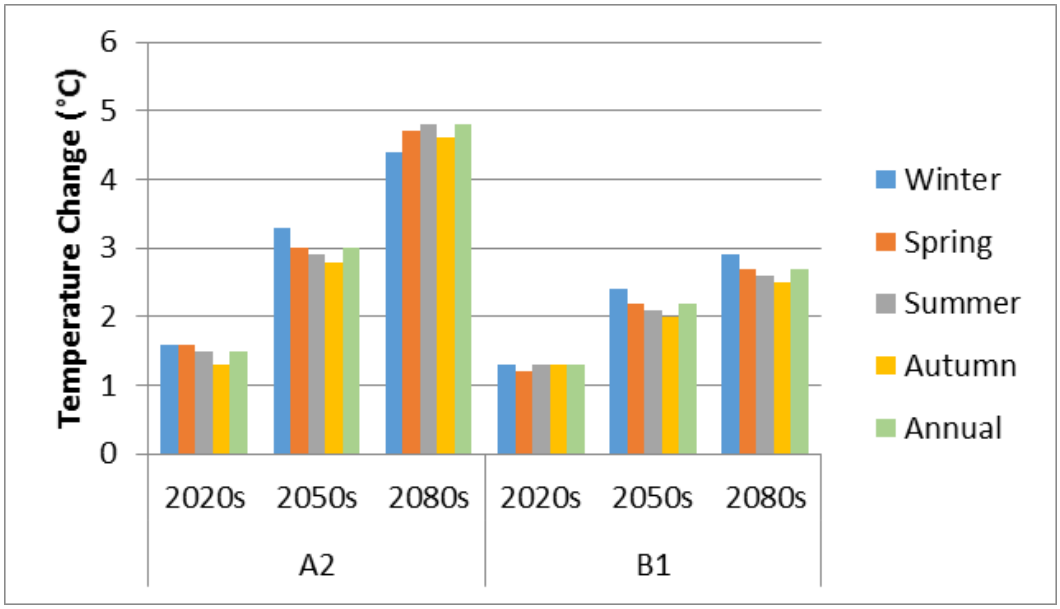
Exhibit 10: Low Emissions Scenario (B1) Projected Seasonal Temperature Change for Station Shanty Bay (44.40N 79.63W)

AR4 (2007) - GCGCM3T47 (Mean) - SR-B1 (baseline: 1971-2000)

	2020s	**2050s**	**2080s**
Winter	1.3°C	2.4°C	2.9°C
Spring	1.2°C	2.2°C	2.7°C
Summer	1.3°C	2.1°C	2.6°C
Autumn	1.3°C	2.0°C	2.5°C
Annual	**1.3°C**	**2.2°C**	**2.7°C**

Exhibit 11: Projected Temperature Change for Station Shanty Bay (44.40N 79.63W)

AR4 (2007) - GCGCM3T47 (Mean) - SR-B1 & A2 (baseline: 1971-2000; projection start: 2011)



HOT DAYS

Annual and seasonal temperatures in the City of Barrie are expected to rise. The Canadian Climate Change Data and Scenarios (CCDS) tool provides information from a weather station located just outside the City of Barrie (Shanty Bay). The data uses a baseline of 1971-2000, and depicts projected temperature change (not actual temperature) from both A2 (high) and B1 (low) scenarios. See Chapter 5: Emissions Scenarios of the IPCC Fourth Assessment Report: Summary for Policy Makers for more information on scenarios.

Projections are based on increases from the temperature baseline, which is the mean air temperature from 1971-2000. For Barrie, the annual mean temperature over this period was **6.5°C**. The projections to 2020, 2050, and 2080 reflect the expected future temperature, in degrees Celsius, from the annual and seasonal baselines.

In a high emission scenario (A2), the City of Barrie can expect to experience an average annual temperature change of **1.5°C** in the 2020s, **3°C** in the 2050s, and **4.7°C** in the 2080s from baseline.

Exhibit 12: Projected number of days with extreme temperature for Station Shanty Bay (44.40N 79.63W)

AR4 (2007) - GCGCM3T47 (Mean) - SR-B1 & A2 (baseline: 1971-2000)

	A2			B1		
	Days with Maximum Temperature >30°C	Days with Maximum Temperature >35°C	Days with Maximum Temperature <-10°C	Days with Maximum Temperature >30°C	Days with Maximum Temperature >35°C	Days with Maximum Temperature <-10°C
1971-2000	4	0	11	4	0	11
2020s	15	0	8	15	0	8
2050s	28	2	6	19	0	7
2080s	49	5	4	25	2	6

PRECIPITATION

Precipitation in the City of Barrie is expected to rise in congruence with the provincial changes observed in the AR5 data above, with some decreases in precipitation during the summer months. The Canadian Climate Change Data and Scenarios (CCDS) tool provides information from a weather station located just outside the City of Barrie (Shanty Bay). The data uses a baseline of 1971-2000, and depicts projected precipitation change (not total precipitation) from both A2 (high) and B1 (low) scenarios.

Projections are based on increases from the precipitation baseline, which is the average amount of precipitation from 1971-2000. For Barrie, the annual precipitation average over this period was 962.9 mm. The projections to 2020, 2050, and 2080 reflect the projected amount of precipitation, in millimeters, from the annual and seasonal baselines.

In a high emission scenario (A2), the City of Barrie can expect to experience an average annual precipitation increase of 26.8 mm in the 2020s, 72.9 mm in the 2050s, and 106.3 mm in the 2080s from baseline.

Exhibit 13: Baseline Mean Precipitation (1971-2000) for Station Shanty Bay (44.40N 79.63W)

	Annual	Winter	Spring	Summer	Autumn
Millimeters (mm)	**962.9**	236.2	203.9	253.6	269.2

*Exhibit 14: High Emissions Scenario (A2) Projected Seasonal Precipitation Change for Station Shanty Bay (44.40N 79.63W)**

AR4 (2007) - CGCM3T47 (Mean) - SR-A2 (baseline: 1971 - 2000)

	2020s	**2050s**	**2080s**
Winter	21.6 mm	43.4 mm	67.9 mm
Spring	9.6 mm	25.8 mm	43.7 mm
Summer	(-)7.1 mm	(-) 14.2 mm	(-) 12.1 mm
Autumn	2.6 mm	17.8 mm	6.9 mm
Annual	**26.8 mm**	**72.9 mm**	**106.3 mm**

* All figures are positive, unless noted otherwise.

Exhibit 15: Low Emissions Scenario (B1) Projected Seasonal Precipitation Change for Station Shanty Bay (44.40N 79.63W)*

AR4 (2007) - CGCM3T47 (Mean) - SR-B1 (baseline: 1971 - 2000)

	2020s	**2050s**	**2080s**
Winter	11 mm	25.3 mm	33.1 mm
Spring	9.1 mm	18.4 mm	25.3 mm
Summer	(-)6.4 mm	(-) 7.2 mm	(-) 10.5 mm
Autumn	5.8 mm	5.7 mm	10.2 mm
Annual	**19.6 mm**	**42.2 mm**	**58.3 mm**

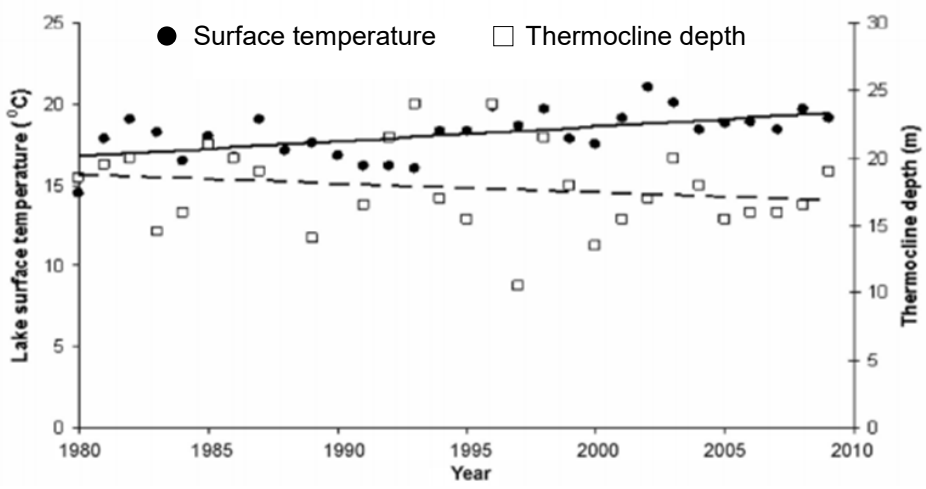
* All figures are positive, unless noted otherwise.

WATER LEVELS AND WATER TEMPERATURE

The City of Barrie is located on the Western shore of Lake Simcoe, Southern Ontario's largest interior lake. With air temperatures in the area projected to increase up to 2.7°C according to the low emissions scenario and 4.7°C for the high emissions scenario (by 2080s), lake water temperatures are also expected to rise.

A study conducted by the Ontario Ministry of Natural Resources measured surface water temperatures and thermocline depths at weather station K42 in Kempenfelt Bay, Lake Simcoe. It found that between 1980 and 2009, the surface water temperature in Lake Simcoe increased by approximately 2°C.[17]

Exhibit 16: Changes in surface water temperatures (°C) and thermocline depths (m) at station K42 in Kempenfelt Bay, Lake Simcoe from 1980 to 2009.[18]



This same study also concluded that by 2100, surface water temperatures in Lake Simcoe could increase by 2.4°C, with the greatest difference between present and future water temperatures occurring within the epilimnion (the top, warmest layer of water in the lake). Temperatures in the hypolimnion (bottom, coldest layer of water in the lake) are projected to increase by 0.6°C by the year 2100.[19]

Exhibit 16 (above) depicts the estimated temperature profile for Kempenfelt Bay under current and future climate conditions. These projections are based on the Canadian Global Climate Model 2 (CGCM2) under the AR4 A2 high emissions scenario and the temperature profile model developed within the study.

As a result of these changing temperatures, Lake Simcoe could experience a variety of climate change-related impacts, such as a shorter winter season, reduced ice cover and ice quality, increased number of invasive species, degraded fish habitats, algae blooms, and more.[20]

HEAVY OR EXTREME RAIN

Extreme and heavy rain events are expected to become more intense and more frequent.[21] The Institute for Catastrophic Loss Reduction (ICLR) has developed a tool that assists users in developing and updating intensity, duration, and frequency (IDF) curves using precipitation data from existing Environment Canada hydro-meteorological stations. Available precipitation data is integrated with predictions obtained from Global Climate Models to assess the impacts of climate change on IDF curves. GCM models developed for IPCC Assessment Report (AR5) are used to provide future climate scenarios for the various Representative Concentration Pathways (RCPs).

Projections are based on increases from the precipitation intensity rate baseline, which is the average amount of precipitation/h from 1979-2007. Exhibit 17 and 18 display the baseline precipitation intensity rates. Exhibits 19-24 depict the projected precipitation intensity rates for RCP8.5 in the 2020s, 2050s, and 2080s. The data is for Station Barrie WPCC.

Exhibit 17: Baseline Precipitation Intensity Rates (mm/h) (1979-2007) for Station Barrie WPCC (44.38N 79.69W)

T (years)	2	5	10	25	50	100
5 min	102.34	131.66	151.07	175.60	193.80	211.86
10 min	73.94	98.09	114.08	134.29	149.28	164.16
15 min	61.02	81.52	95.09	112.23	124.95	137.58
30 min	39.05	51.44	59.64	70.01	77.70	85.34
1 h	22.85	29.92	34.60	40.51	44.90	49.26
2 h	13.98	19.56	23.26	27.93	31.39	34.83
6 h	6.33	8.71	10.29	12.28	13.75	15.22
12 h	3.50	4.70	5.50	6.51	7.26	8.00
24 h	2.02	2.74	3.21	3.81	4.26	4.70

Exhibit 18: Baseline Precipitation Intensity Rates (mm/h) (1979-2007) for Station Barrie WPCC (44.38N 79.69W)

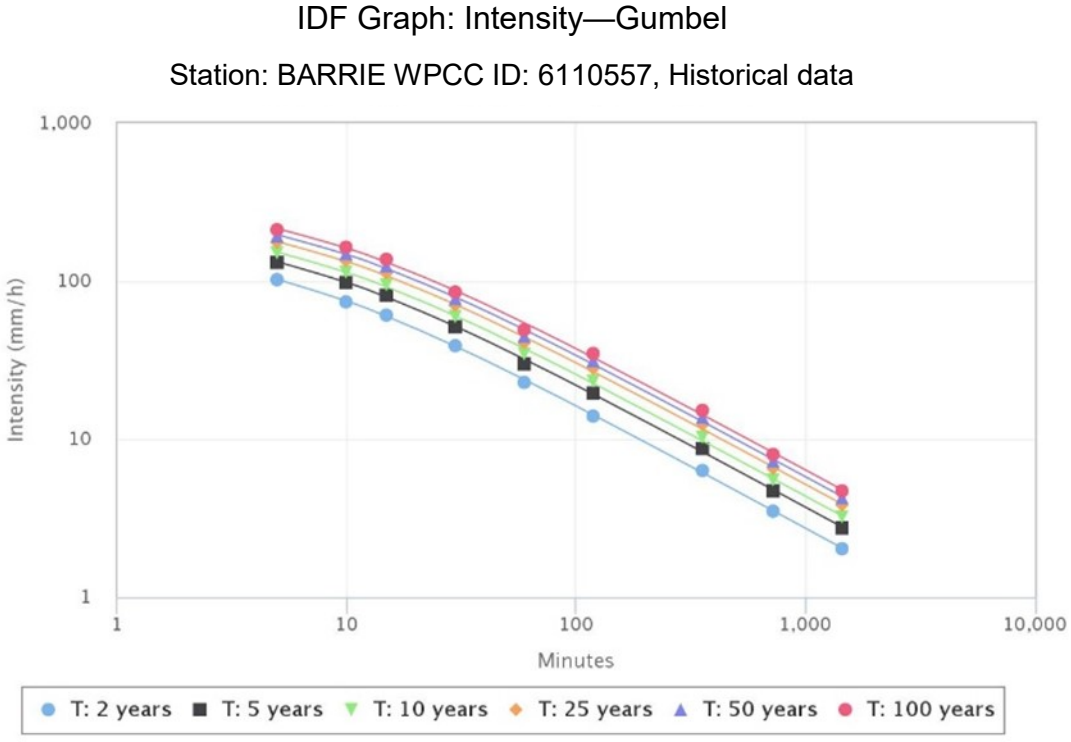


Exhibit 19: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5(baseline: 1979 - 2007; projection start: 2011-2040)

T (years)	2	5	10	25	50	100
5 min	116.14	150.29	171.62	197.41	216.35	235.32
10 min	85.45	113.44	131.01	152.25	167.86	183.49
15 min	70.79	94.54	109.45	127.48	140.72	153.98
30 min	44.88	59.32	68.33	79.23	87.24	95.25
1 h	26.18	34.41	39.55	45.77	50.34	54.91
2 h	16.64	23.11	27.17	32.08	35.69	39.30
6 h	7.46	10.22	11.95	14.05	15.58	17.12
12 h	4.07	5.47	6.35	7.41	8.18	8.96
24 h	2.36	3.19	3.72	4.35	4.81	5.27

Exhibit 20: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5(baseline: 1979 - 2007; projection start: 2011-2040)

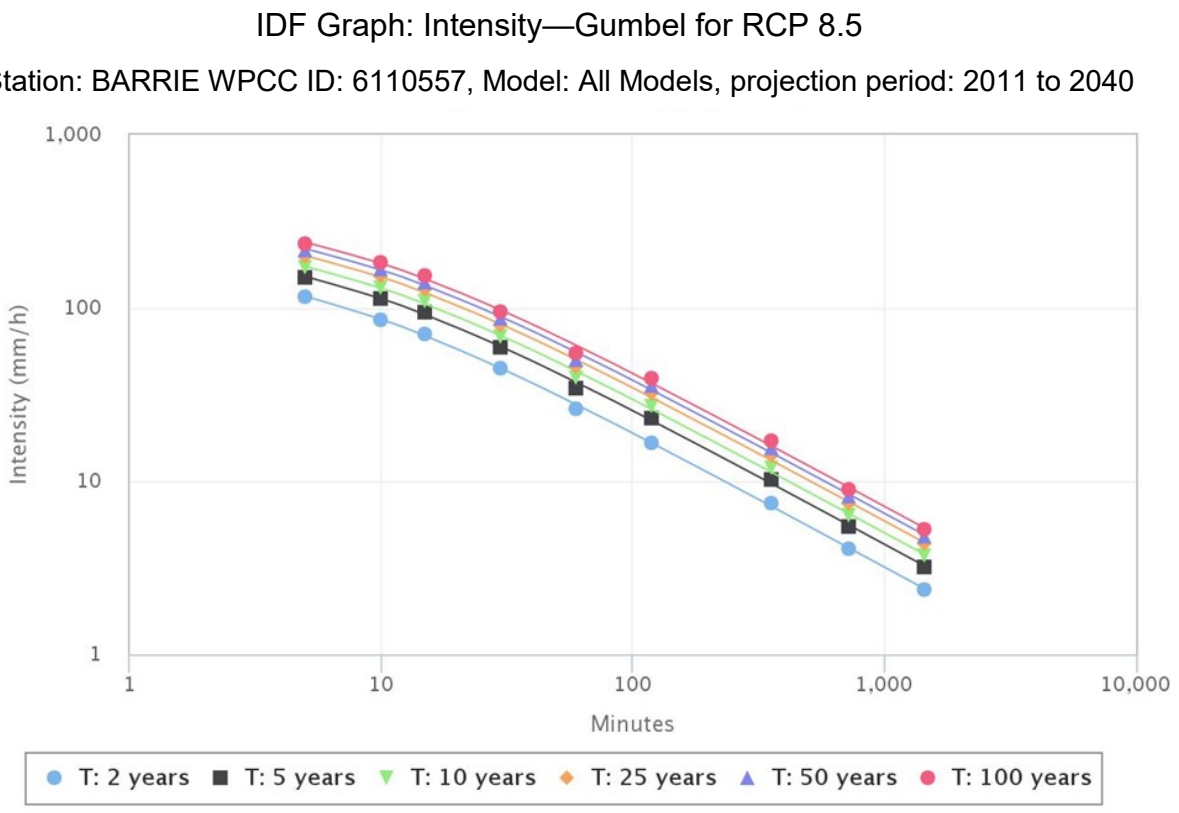


Exhibit 21: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5(baseline: 1979 - 2007; projection start: 2041-2070)

T (years)	2	5	10	25	50	100
5 min	128.22	161.00	184.95	215.20	238.25	261.66
10 min	95.26	122.26	142.00	166.91	185.89	205.18
15 min	79.11	102.03	118.77	139.91	156.02	172.39
30 min	49.99	63.84	73.97	86.75	96.49	106.38
1 h	29.09	36.99	42.77	50.06	55.62	61.26
2 h	18.91	25.15	29.71	35.47	39.86	44.31
6 h	8.43	11.09	13.04	15.49	17.36	19.26
12 h	4.56	5.91	6.89	8.14	9.08	10.05
24 h	2.66	3.46	4.04	4.78	5.34	5.92

Exhibit 22: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5(baseline: 1979 - 2007; projection start: 2041-2070)

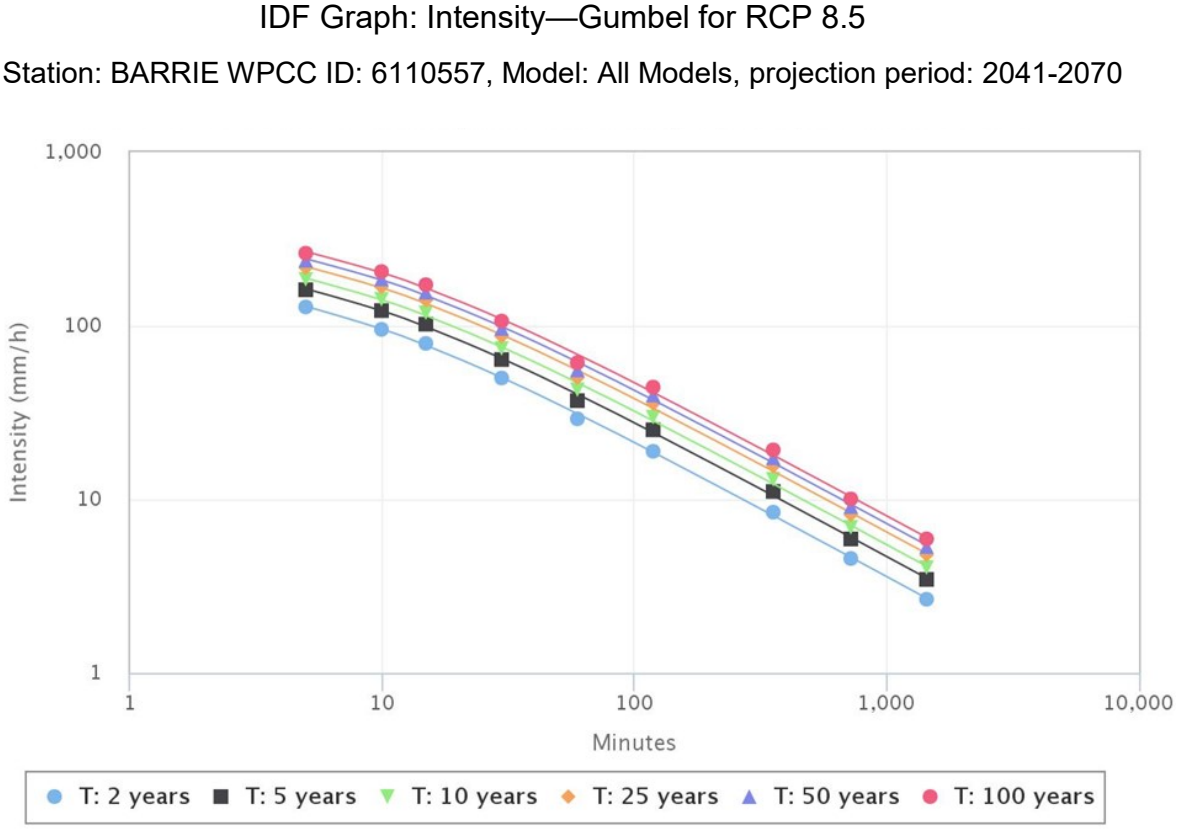


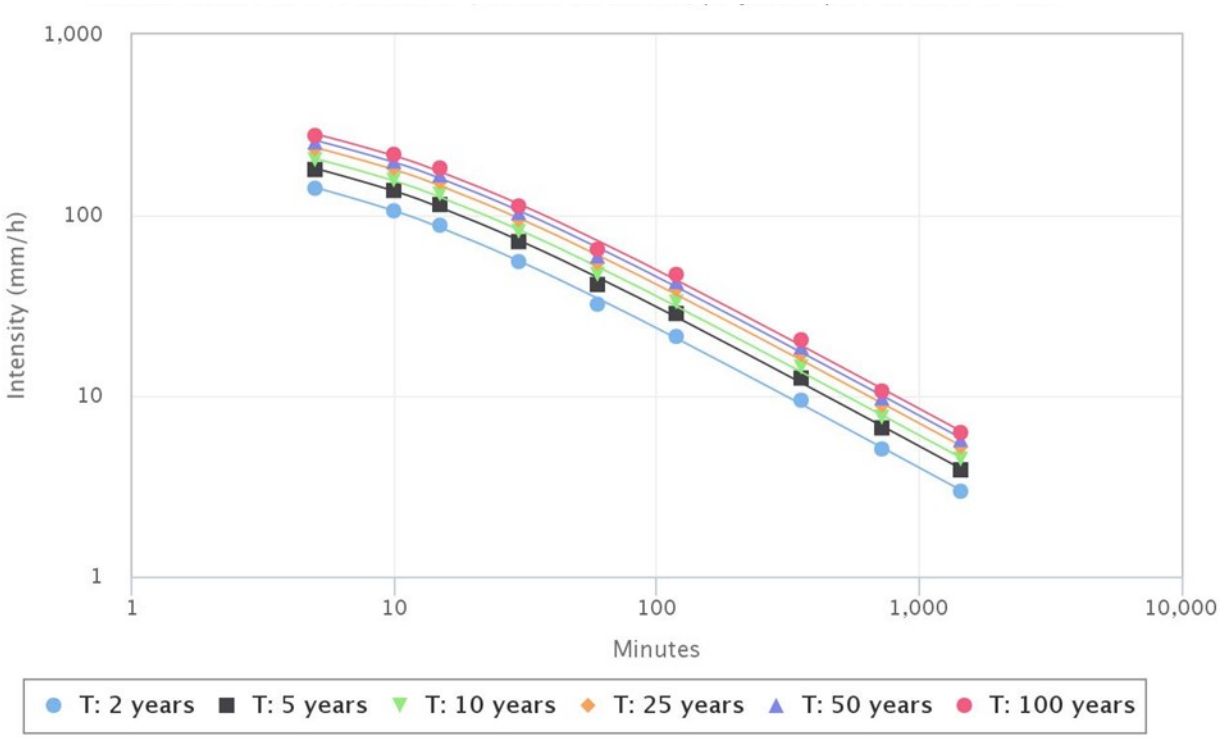
Exhibit 23: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5 (baseline: 1979 - 2007; projection start: 2071-2100)

T (years)	2	5	10	25	50	100
5 min	140.91	178.93	202.57	232.52	254.60	276.06
10 min	105.71	137.03	156.50	181.18	199.37	217.04
15 min	87.98	114.56	131.08	152.02	167.46	182.46
30 min	55.35	71.42	81.41	94.07	103.40	112.47
1 h	32.15	41.32	47.02	54.24	59.56	64.74
2 h	21.32	28.56	33.06	38.77	42.97	47.06
6 h	9.46	12.55	14.47	16.90	18.69	20.43
12 h	5.08	6.65	7.62	8.85	9.76	10.64
24 h	2.97	3.89	4.47	5.20	5.74	6.27

Exhibit 24: Precipitation Intensity Rates (mm/h) for Station Barrie WPCC (44.38N 79.69W)

AR5 (2014) – Ensemble Model – RCP8.5 (baseline: 1979 - 2007; projection start: 2071-2100)



APPENDIX C: RISK AND VULNERABILITY ASSESSMENT OUTCOMES

Milestone Two of the BARC Framework involves developing impacts statements which detail the ways in which climate change will affect a municipality's physical, economic, social, and ecological systems. These impacts are then run through a risk and vulnerability assessment in order to prioritize the areas in which the City should focus its efforts. Below are the risk and vulnerability results of the 27 priority impacts for the City of Barrie that were brought forward into the planning phase. A justification for why the impact was brought forward into the planning phase is also provided.

VULNERABILITY ASSESSMENT

A vulnerability assessment necessitates an understanding of both biophysical and socioeconomic implications as the focus is more on understanding the processes involved with climate change impacts and the factors that influence sensitivity and adaptive capacity. This understanding will assist with the development of suitable adaptation actions later in Task Three.

SENSITIVITY ASSESSMENT

In order to determine how sensitive the primary departments are to projected impacts, the Adaptation Team discussed the following questions:

- What is the level of exposure of the primary department's ''assets'' to the impact?
- How would the primary department be affected by these changes if they occurred today?
- Is the primary department already subject to any existing stress?

The Team then assigned a value (out of 5) representing the sensitivity of each primary department to the climate change impacts. See Exhibit 25 for a more detailed Sensitivity Scale.

Exhibit 25: Sensitivity Ranking Scale

Ranking	Definition
S1	Functionality will stay the same
S2	Functionality will likely stay the same
S3	Functionality is likely to get worse
S4	Functionality will get worse
S5	Functionality will become unmanageable

ADAPTIVE CAPACITY

The Adaptation Team then used the information from the sensitivity assessment to frame the linkages between the climatic change, the effect on the primary department, and whether that department can adapt to those changes. Based on that information, the Adaptation Team then assessed the adaptive capacity of the department to accommodate these changes with little or no cost or disruption.

In order to determine how adaptive the primary departments are to projected impacts, the Adaptation Team discussed the following questions:

- What is the ability of the built, natural, or human systems in the community to accommodate to changes, moderate potential damages, take advantage of opportunities, or to cope with consequences?
- What are current actions, plans, and policies in place that might help mitigate the impacts?
- What are the links between the climatic change, the effect on the department (sensitivity) and its capacity to adapt?

The Adaptation then assigned a value (out of 5) representing the adaptive capacity of each primary department to the impact. See Exhibit 26 for a more detailed Adaptive Capacity Scale.

Exhibit 26: Adaptive Capacity Ranking Scale

Ranking	Definition
AC1	Substantial costs and staff intervention ($$$$$)
AC2	Significant costs and staff intervention ($$$$)
AC3	Some costs and staff intervention ($$$)
AC4	Some slight costs and staff intervention ($$)
AC5	Little or no costs and staff intervention ($)

Exhibit 27 depicts the Vulnerability Matrix used to rank the sensitivity and adaptive capacity of the City of Barrie to the 28 priority impacts. Using the results from the sensitivity and adaptive capacity assessment, a vulnerability score was assigned to each impact. City departments with high sensitivity and low adaptive capacity are highly vulnerable; those with low sensitivity and high adaptive capacity have low vulnerability; and those service areas that have both high sensitivity and high adaptive capacity have a medium vulnerability.

Exhibit 27: Vulnerability Matrix

		Sensitivity: Low ➔ High				
		S1	S2	S3	S4	S5
Adaptive Capacity Low ↓ High	AC1	V2	V2	V4	V5	V5
	AC2	V2	V2	V3	V4	V5
	AC3	V2	V2	V3	V4	V4
	AC4	V1	V2	V2	V3	V3
	AC5	V1	V1	V2	V3	V3

RISK ASSESSMENT

Risk is the combination of an event's likelihood and its consequences – risk therefore equals the probability of a climate impact multiplied by the consequence of that event. Using the results from the vulnerability assessment, along with research on projected climatic changes, the Adaptation Team estimated the consequence and likelihood of each impact.

LIKELIHOOD

To determine the likelihood of each impact, the Adaptation Team discussed the following questions:

Based on the best available climate science and current observations, what is the probably of the climatic change occurring and what is the likelihood of the impact occurring?

The Adaptation Team then assigned a value (out of 5). See Exhibit 28 for a more detailed Likelihood Scale.

Exhibit 28: Likelihood Ranking Scale

Likelihood Ranking	Impact
Almost Certain (5)	Could occur several times per year
Likely (4)	May arise about once per year
Possible (3)	May arise once in 10 years
Unlikely (2)	May arise once in 10 years to 25 years
Rare (1)	Unlikely during the next 25 years

Consequences

After assigning a likelihood rating for each impact, the Adaptation Team assigned a value (out of 5) for each consequence criteria.

The original BARC risk assessment methodology was modified to include an assessment of consequence against an additional 7 consequence criteria. The Consulting Team worked with the City Project Lead to develop the additional criteria to ensure its applicability to the City of Barrie. See Exhibit 29 for the full list of social, economic and environmental consequence criteria that were used.

Exhibit 29: Social, Economic, and Environmental Consequence Criteria

CONSEQUENCE RATING	SOCIAL FACTORS			
	Public Health & Safety	Displacement	Loss of Livelihood	Cultural Aspects
Catastrophic	Large number of fatalities or serious injuries, or permanent illness	Large number of permanently displaced people on a widespread scale	Large disturbances leading to permanent changes in people's normal routines and way of life	Unprecedented loss of cultural identity (i.e. traditions and customary practices) across the wider community (i.e. cancellation of flagship annual event)
	5	5	5	5
Major	Isolated instances of fatalities or serious injuries, or long-term illness	Isolated instances of permanently displaced people on a widespread scale	Large disturbances leading to prolonged changes in people's normal routines and way of life	Significant loss of cultural identity (i.e. traditions and customary practices) for multiple social groups
	4	4	4	4
Moderate	Small number of injuries or cases of illness	Isolated instances of temporary displaced people on a widespread scale	Moderate disturbances leading to short-term changes in people's normal routines and way of life	Moderate impact on cultural identity (i.e. traditions and customary practices) for multiple social groups
	3	3	3	3
Minor	Near misses or minor injuries	Isolated instances of temporary displaced people in localized areas	Minor and short-term changes to people's normal routines and way of life	Minor impact on cultural identity (i.e. traditions and customary practices) for a small number of social groups
	2	2	2	2
Negligible	Appearance of a threat but no actual harm	Appearance of a threat but no actual displacement	No changes to people's normal routine and way of life	Appearance of a threat but no actual impact on cultural identity (i.e. traditions and customary practices)
	1	1	1	1

CONSEQUENCE RATING	ECONOMIC FACTORS			
	Property Damage	Local Economy & Growth	Community Livability	Public Administration
Catastrophic	Catastrophic damage and costs incurred by the owner ($$$$$)	City-scale decline leading to widespread business failure, loss of employment and hardship	Permanent decline in services, causing the city to be seen as very unattractive, moribund, and unable to support the community	Public administration would fall into decay and cease to be effective
	5	5	5	5
Major	Major damage and costs incurred by the owner ($$$$)	City-scale stagnation such that businesses are unable to thrive	Widespread and severe decline in services and quality of life within the community	Pubic administration would struggle to remain effective and would be in danger of failing
	4	4	4	4
Moderate	Moderate damage and costs incurred by the owner ($$$)	Isolated areas of reduction in economic performance relative to current forecasts	Isolated but noticeable examples of decline in services	Public administration would be under severe pressure on several fronts
	3	3	3	3
Minor	Minor damage and costs incurred by the owner ($$)	Inconveniences that cause minor shortfall relative to current forecasts	There would be minor areas in which the community is unable to maintain its current services	There would be minor instances of public administration being under more than usual stress
	2	2	2	2
Negligible	No damage and costs incurred by the owner ($)	No real impact to the local economy and growth	No real pressure on current services	No real stress on public administration
	1	1	1	1

CONSEQUENCE RATING	ENVIRONMENTAL FACTORS			
	Air	Water	Soil & Vegetation	Ecosystem Function
Catastrophic	Very frequent periods of reduced air quality.	Irreversible, widespread reduction in water quality/ quantity	Irreversible, widespread impacts to soil or vegetation	Major and widespread loss of ecological functions and irrecoverable damage
	5	5	5	5
Major	Considerable increase in periods of reduced air quality in the medium term	Major, widespread reduction in water quality/ quantity in the medium/long -term	Major, widespread impacts on soil or vegetation in the medium/long-term	Severe and widespread loss of ecological functions and damage that could be reversed with intensive efforts
	4	4	4	4
Moderate	Moderate increase in periods of reduced air quality in the short/ medium term	Moderate, widespread reduction in water quality/ quantity in the short/ medium-term	Moderate, widespread impacts on soil or vegetation in the short/ medium-term	Isolated but moderate instances of damage to the ecosystem that could be reversed with intensive efforts
	3	3	3	3
Minor	Minor increase in periods of reduced air quality in the short term	Minor, localized reduction in water quality/quantity in the short-term	Minor, localized impacts on soil or vegetation in the short-term	Isolated but minor instances of damage to the ecosystem that could be reversed
	2	2	2	2
Negligible	Appearance of a threat but no real impact to air quality	Appearance of threat but no real reduction in water quality/quantity	Appearance of threat but no real impacts on soil or vegetation	Appearance of a threat but no real damage to the ecosystem and its functions
	1	1	1	1

The following exhibit documents the vulnerability and risk scores of the 28 priority impact statements assessed by the Adaptation Team.

Exhibit 30: Risk and Vulnerability Assessment Results

IMPACT NUMBER	IMPACT STATEMENT	RISK SPECTRUM	RISK SCORE (OVERALL)	CONSEQUENCE SCORE
1	Enhanced urban heat island effect (hotter temperatures, stress on air quality) from warmer summer temperatures	Medium	155	31
2	Cold-related health and safety issues among vulnerable populations due to more extreme cold days in winter	Medium-Low	120	24
3	Heat-related health and safety issues amongst vulnerable populations due to more extreme heat days in summer	Medium	160	32
4	Freezing of water service lines and water mains due to extreme cold temperatures	Medium-Low	106	26.5
5	Reduced productivity of City staff during hot days	Medium-Low	97.5	19.5
6	More frequent and rapid spread of invasive species due to more favorable climatic conditions.	Low	85.75	24.5
7	Negative impacts to water quality from improper functioning or overburdened stormwater ponds	Medium-Low	110	22
8	More beach closures due to bacteria or other water quality concerns as a result of warmer water	Medium-Low	120	24
9	Damage to private property (e.g. building foundation, landscaping) from more frequent freeze-thaw cycles	Medium-Low	108	27
10	Damage to roads and sidewalks (e.g. wear and tear, cracks, potholes) from more frequent freeze -thaw cycles	Medium	140	28
11	Malfunctioning stormwater ponds from more frequent freezing and thawing	Medium-Low	90	30
12	Overburdening of the storm sewer system resulting in surcharge and runoff from rapid snowmelts	Medium	150	30

LIKELIHOOD SCORE	VULNERABILITY SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	JUSTIFICATION FOR PLANNING
5	V3	S3	AC3	Moderate to significant risk to the society, the economy and the environment
5	V3	S4	AC4	Significant risk to public health & safety
5	V2	-S3	AC4	Significant risk to the social and economic factors.
4	V5	S4	AC1	Significant risk to properties
5	V4	S4	AC3	Moderate risk to the economy
3.5	-	-	-	Significant risk to soil & vegetation, and ecosystem functions
5	V5	S5	AC1	Significant risk to water resources
5	V3	S1	AC3	Moderate risk to society and the economy
4	V3	S4	AC5	Significant risk to properties
5	V4	S4	AC2	Moderate risk to society and the economy
3	V5	S5	AC1	Significant risk to properties
5	V4	S4	AC3	Significant risk to the economy and moderate risk to the environment

IMPACT NUMBER	IMPACT STATEMENT	RISK SPECTRUM	RISK SCORE (OVERALL)	CONSEQUENCE SCORE
13	Increased use of salt for road management due to an increase in freezing rain causing water quality concerns	Medium	150	30
14	Flash flooding when ground is frozen from increased rainfall intensity	Medium	128	32
15	Flooding on public property from increased rainfall intensity	Medium-Low	105	21
16	Flooding on private property from increased rainfall intensity	Medium	128	32
17	Overburdening of storm sewers, and stormwater ponds from increased precipitation	Medium-High	187.5	37.5
18	Temporary loss of outdoor community facilities from increased precipitation (e.g. oversaturated soil in parks, sports fields and outside event spaces)	Medium-Low	117.5	23.5
19	Damage to public property from erosion as a result of more runoff from increased rainfall intensity	Medium-High	185	36.5
20	Damage to infrastructure (e.g. wash -out of roads, shoulders, bridges) from erosion as a result of more runoff from increased rainfall intensity	Medium-High	182.5	36.5
21	Hazardous outdoor conditions due to extreme weather events (e.g. ice storm, snowstorm, thunderstorm)	Medium-Low	120	30
22	Tree branches and other debris blocking catch basins or culverts as a result of extreme weather events	Medium-Low	80	20
23	Hazardous conditions on roads and sidewalks from more frequent freezing rain	High	202.5	40.5
24	Hazardous conditions in public spaces and parks from more frequent freezing rain	Medium-Low	94	23.5

LIKELIHOOD SCORE	VULNERABILITY SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	JUSTIFICATION FOR PLANNING
5	V4	S4	AC2	Significant risk to the environment and moderate risk to the economy
4	V2	S2	AC4	Significant risk to the economy and moderate risk to the environment
5	V5	S4	AC1	Significant risk to water resources
4	V2	S3	AC5	Moderate risk to the society and the economy
5	V5	S5	AC2	Significant risk to the society, the economy, and the environment
5	V4	S4	AC2	Moderate risk to the society and the economy
5	V2	S3	AC4	Significant risk to public health & safety, and properties
5	V2	S3	AC4	Significant risk to the society, the economy, and the environment
4	V3	S3	AC2	Significant risk to public health & safety, and moderate risk to the economy
4	V5	S5	AC2	Significant risk to public health & safety
5	V4	S4	AC2	Significant risk to the society, the economy, and the environment
4	V5	S4	AC1	Significant risk to properties

IMPACT NUMBER	IMPACT STATEMENT	RISK SPECTRUM	RISK SCORE (OVERALL)	CONSEQUENCE SCORE
25	Damage to public infrastructure due to extreme weather events (e.g. severe winds, ice storm, and snowstorm)	Medium-High	187.5	37.5
26	Impacts to tourism and businesses from extreme weather events (e.g. wind, ice, snow, etc.)	Medium	155	31
27	Damage to boats and marina infrastructure from extreme weather conditions	Medium	124	31
28	Environmental destruction from extreme weather events (e.g. severe winds, ice storm, and snowstorm)	Medium	118	29.5

LIKELIHOOD SCORE	VULNERABILITY SCORE	SENSITIVITY SCORE	ADAPTIVE CAPACITY SCORE	JUSTIFICATION FOR PLANNING
5	V5	S4	AC1	Significant risk to the society, the economy, and the environment
5	V5	S4	AC2	Significant risk to the society and the economy
4	V4	S4	AC3	Significant risk to the society, the economy, and the environment
4	V5	S4	AC1	Moderate risk to the economy and the environment

APPENDIX D: COMMUNITY ENGAGEMENT SUMMARY REPORT

Engaging the Barrie community is an important part of developing the Climate Change Adaption Strategy. This Community Engagement Summary Report outlines the various activities and tools that were used to support the development of the Climate Change Adaptation Strategy and summarizes the input received.

COMMUNITY ENGAGEMENT

Three main audiences were engaged during the planning process: the City of Barrie (staff and Council), key stakeholder organizations (the Stakeholder Advisory Group), and the general public (local community members, residents, and businesses). A description of the activities used to engage these audiences is described below.

CLIMATE ADAPTATION TEAM

A Climate Adaptation Team was established to provide strategic direction and technical support to the Project Team over the course of developing the Strategy. The Adaptation Team was comprised of cross-departmental staff members from the City of Barrie with a diversity of expertise and experience with the management of infrastructure, public communications, natural resources, economic development, parks and community recreation, tourism, and emergency services.

Five workshops were held over several months which enabled staff to contribute to the vision and goals of the Strategy, and help to identify climate change impacts, risks and vulnerabilities to the City, and adaptation actions. The involvement of the Climate Adaptation Team helped to ensure the Strategy aligns with staff expertise and local knowledge, departmental functions, and supports corporate objectives.

STAKEHOLDER ADVISORY GROUP

A Stakeholder Advisory Group (SAG) was formed to provide an ongoing forum for advice, feedback, and guidance to the City of Barrie at key points during the planning process from a broader community perspective. The role of the SAG was to provide sector-specific knowledge and input, while acting as champions for the project. The SAG consisted of representatives from:

- Brereton Field Naturalists
- Canadian Red Cross-Simcoe Muskoka Branch
- City of Barrie Environmental Advisory Committee
- Downtown Barrie BIA
- Lake Simcoe Region Conservation Authority
- Nottawasaga Valley Conservation Authority
- Simcoe Muskoka District Health Unit
- Tourism Barrie
- Transition Barrie/Living Green Barrie
- City Council

The Project Team met with the SAG in-person two times (September and October 2016) over the course of the project. SAG members were also encouraged to provide feedback on the draft Strategy document either through email or an online survey.

The objectives of the first SAG meeting on September 21, 2016 were to: introduce the Project Team and SAG members; provide an introduction and overview of the project scope and timeline; review the SAG Terms of Reference and role; identify and discuss climate change impacts on the City of Barrie; and brainstorm preliminary plan directions.

The themes that emerged from the impacts generated during the meeting included: natural environment, public health, tourism and recreation, local economy, lake and water, extreme weather, transportation, infrastructure, and social impacts.

The objectives of the second SAG meeting were to: provide an update on project progress; provide an overview of the results of the climate change impact identification and assessment of vulnerabilities process; conduct a risk assessment of climate change impacts affecting the City from a social, economic, and environmental perspective; identify potential actions for the City to consider to address climate change impacts; discuss roles for external partners in addressing climate change impacts on the City's operations; and present and discuss next steps for completion of the Climate Change Adaptation Strategy.

PUBLIC ENGAGEMENT

The broader public was encouraged to participate in the development of the Climate Change Adaptation Strategy through various events.

POP-UP ENGAGEMENT EVENTS

During the early stages of the project, community members were asked to share their input on the local effects of climate change and actions to be taken to become more climate-ready. This was done through a series of pop-up engagement events held across the City during August and September 2016 (see table below). The objectives of these engagement events were:

To build awareness of climate change impacts and risks to the community (i.e., impacts to the built environment, natural environment, social environment, and economic environment); and

To obtain input on climate change/extreme weather impacts and potential adaptation measures to be considered in developing the Strategy.

Field Location	**Date / Time**
Rythmfest	August 12-13, 2016
East Bayfield Community Centre	September 13, 2016, 9:00am-1pm
Holly Community Centre	September 14, 2016, 9am-12pm
Georgian College	September 15,2016, 10am-2pm
Farmers Market	September 24, 2016, 8am-12pm
Barrie North Collegiate	September 26, 2016, 8am-11am

During these events, community members were asked to share their ideas and input on two key discussion questions:

- How have you felt the effects of a changing climate?
- What actions should the City take to adapt to future climate conditions?

Participants were encouraged to share their feedback through conversations with Project Team staff and by writing down comments on sticky notes and posting them on a display board. Six high-level themes were provided to assist with sparking ideas, steering the conversation, and organizing the input received. These themes were: natural environment, public health and safety, local economy and growth, community services, severe weather, and buildings and roads. The same questions asked at the pop-up events were also made available in an online survey format to expand the reach of engagement. Approximately 35 community members shared their feedback during the in-person engagement events and 30 participants completed the online survey.

Community members provided a range of responses on how they have felt the effects of a changing climate and potential adaptation actions that the City should take. Key feedback received focused on:

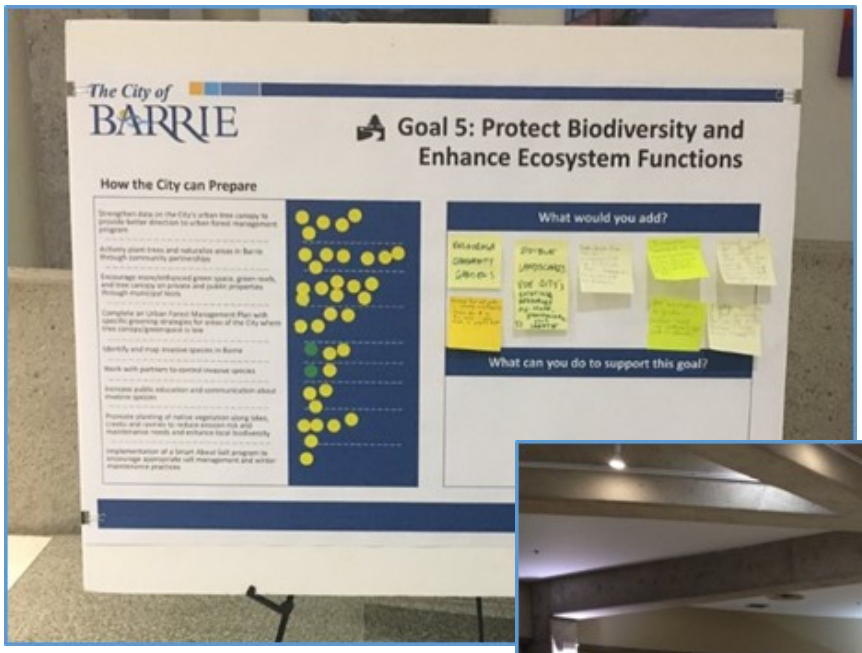
- Increasing and protecting greenspaces within the City;
- Encouraging low impact and resilient urban development;
- Promoting active and sustainable transportation;
- Increasing community food security and supporting local agriculture; and
- Providing education and incentives to Barrie residents for mitigating and adapting to climate change on a local level.

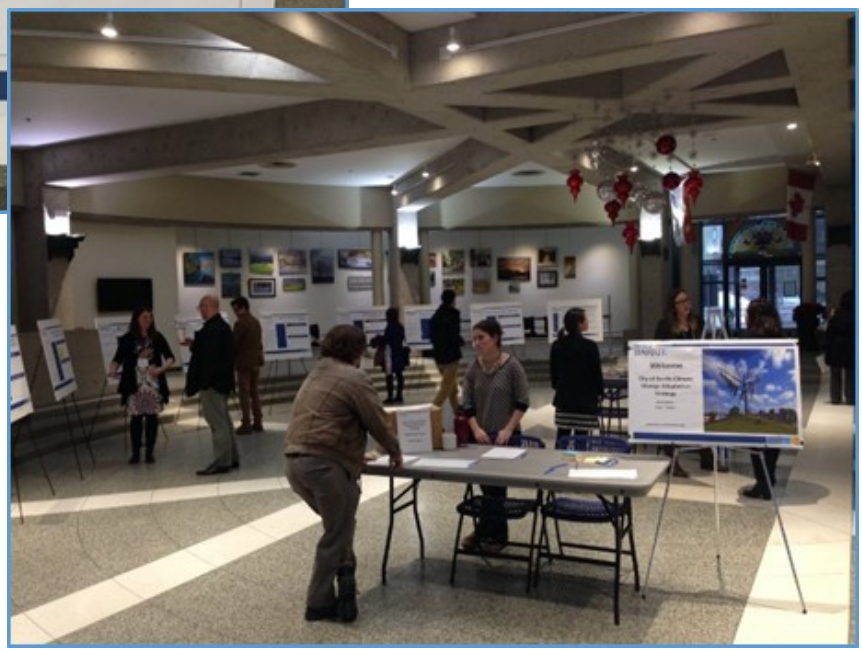
PUBLIC OPEN HOUSE

On December 7, 2016, the City of Barrie and consultant team hosted a public open house from 4:00pm – 7:00pm in the City Hall Rotunda. The purpose of the open house was to:

- Introduce/update the public on the City's draft Climate Change Adaptation Strategy;
- Seek feedback on the overall vision, goals, and guiding principles of the Strategy;
- Obtain input on priorities for implementing proposed actions;
- Seek input on the public's role in preparing for climate change; and
- Outline the next steps in the process.

A series of display boards were presented which featured components of the draft Strategy including the vision, mission statement, guiding principles, goals and actions. Background information was also presented on the adaptation planning process and projected climatic changes in Barrie. Project team members were available to speak informally with attendees and answer questions.





Participants were encouraged to provide their input on the draft Strategy directly on the display boards using sticky notes and dot stickers. A Comment Form was also distributed at the registration table for attendees to complete and submit during or following the open house. An online survey mirroring the interactive display boards was available until December 14, 2016. Approximately 35 people attended the open house, including Mayor Jeff Lehman, and 5 community members completed the online survey.

During the open house, a recurring suggestion was received from participants that the draft Vision Statement and overall Strategy should include mitigation measures and not only focus on adaptation. There was widespread support for the draft Mission Statement, specifically for the strongly worded message it conveys and the use of the term “responsibility”. A few suggestions were also provided, including emphasizing collaboration as a means to support both preparing for and adapting to climate change, focusing on inspiring communities to come together to solve arising issues.

Key feedback on the proposed actions for each of the six goal areas are included on the next page.

Please note: At the time of the Public Open House Goal 7, Building Community Resilience, had not been identified and therefore did not receive specific comment. However, the actions that have been listed in the Strategy under Goal 7 were originally captured under Goals 1-6 and therefore would have received comments and are captured in the feedback on the next page.

Goal 1: Maintain Public Health and Safety

A high level of support was expressed for encouraging more shade structures on public and private property, and developing alternative work arrangements to reduce commuting during extreme weather events. To a lesser extent, support was also received for community-focused initiatives for extreme heat and cold, as well as preventative maintenance and inspection on public property to reduce damage from extreme weather events. Additional suggestions for actions provided by participants include developing a municipal food strategy, increasing active transportation, and reducing the use of gas-powered maintenance equipment and hard surfaces in parks and around the city.

Goal 2: Minimize Risks to Buildings and Properties

Participants expressed support for the majority of proposed actions pertaining to this goal. Among the supported actions, common elements included educational programs and outreach to developers and residents regarding stormwater control, the development of rebate programs, and higher development standards. Additional suggested actions were focused on the creation of sustainable development guidelines and outreach to promote low impact and resilient development.

Goal 3: Strengthen Infrastructure Resilience

A range of support levels were expressed for the actions proposed to achieve the City's goal to strengthen infrastructure resilience. Many participants indicated support for actions relating to greening initiatives, such as increasing natural areas, plantings, and green infrastructure. Additional suggestions put forward by participants included introducing an energy retrofit loan program, including educational material in City mailings (i.e. tax bills) regarding green infrastructure, and education programs on ways to improve their household energy efficiency.

Goal 4: Help Local Businesses and the Tourism Industry Adapt to Changing Conditions

Feedback received on the proposed actions was not extensive for this theme, however several additional actions that the City could consider were provided by participants. Suggestions were related to the support of local business in undertaking green practices. Other comments were focused on local agriculture and supporting local food producing practices. It was also noted that while many tourist attractions are located outside of the City of Barrie, hundreds of Barrie residents are employed by these facilities (for example ski resorts, golf courses, fishing and boating industry). In addition, many tourist activities in and around the City revolve around water sports, fishing, beaches, outdoor festivals and events. Thus, the economic impact of climate fluctuations related to climate change will have a significant impact on economics and on employment stability for Barrie residents.

Goal 5: Protect Biodiversity and Enhance Ecosystem Functions

Levels of support received for each of the proposed actions for this goal were varied. Actions that received the most support as a priority were largely related to encouraging and supporting naturalization and urban greening strategies. Additional actions suggested by participants were largely focused on supporting local agriculture and food security through initiatives which encourage public and privately owned edible landscaping.

Goal 6: Minimize Disruptions to Corporate Services

The strongest supported action for this goal was reducing wind pressure around the City marina by increasing the tree canopy. One participant felt that mandating the use of snow tires on transit vehicles should be done through contract requirements as an additional action the City of Barrie could take towards this goal.

COMMUNICATION AND OUTREACH TOOLS

Various tools and communication channels were used to reach a broad audience of Barrie community members and encourage their participation in the development of the Climate Change Adaptation Strategy.

PROJECT WEBPAGE

A dedicated webpage on the City of Barrie's website (www.Barrie.ca/ClimateChange) was used to share information about the development of the Climate Change Adaptation Strategy, opportunities to provide feedback, and staff contact information, as well as post project documents.

SOCIAL MEDIA PROMOTION

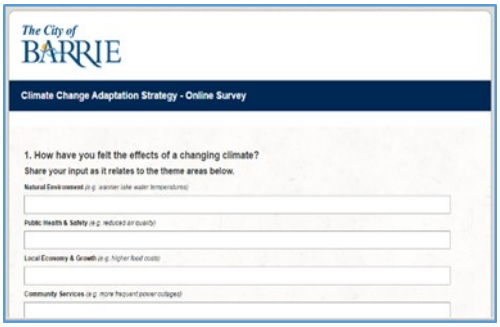
The City's established Twitter (@cityofbarrie) and Facebook accounts were used to promote the project and encourage participation. Engagement events were advertised through these channels including links to online feedback surveys.

NEWSLETTER ADVERTISEMENTS

Leveraging the reach of the City's existing communication channels, announcements were made through e-News and This Week in Barrie, a weekly publication in The Barrie Examiner, to introduce the project, encourage public participation, and advertise the pop-up engagement events, online surveys and public open house.

ONLINE SURVEYS

Online surveys were used during the community engagement process to provide an alternative format for individuals to share their ideas and input on the Strategy. The surveys mirrored the discussion questions used during the in-person engagement events (pop-up events, open house). A combined total of approximately 35 survey responses were received from community members over the course of the project.



NEXT STEPS

The Consulting Team worked with City staff to integrate the feedback that was received through the pop-up engagement events and the public open house. An additional eight actions were added to the Strategy based on feedback that was received, as well as a variety of edits and minor modifications to a selection of existing actions.

The collaborative planning approach used to develop the Climate Change Adaptation Strategy will help to ensure that Barrie's commitments are reflective of the needs and priorities of the community as we move towards a new climate reality.

The City of Barrie recognizes that the successful implementation of the Climate Change Adaptation Strategy will depend on the collective efforts of City staff, residents, businesses, and partner organizations throughout Barrie.

APPENDIX E: PROPOSED INDICATORS

The purpose of the proposed indicators is to measure the progress and effectiveness of the Adaptation Strategy overall. Adaptation indicators will support the City of Barrie by providing comparable information, and tracking progress and performance over time.

Overall, 42 possible indicators were identified. Indicators were grouped together under each Goal, and align with the prioritized actions outlined in the Adaptation Strategy. Potential data sources for each indicator has also been identified. Indicators will be evaluated based on applicability and feasibility and finalized during the development of the implementation plan.

Overarching Indicators

RECOMMENDED INDICATOR	POTENTIAL SOURCE
% of annual municipal expenditures directly related to climate change adaptation	Finance
# of plans, policies, and programs that include climate adaptation considerations	All Departments
# of priority adaptation actions implemented	All Departments
# of climate change-related public events	Access Barrie
# of external partnerships on adaptation	All Departments

Goal #1: Maintain Public Health and Safety

RECOMMENDED INDICATOR	POTENTIAL SOURCE
# of deaths during extreme heat & cold events	Royal Victoria Regional Health Centre, Simcoe Muskoka District Health Unit
# of hospitalizations during extreme heat & cold events	Royal Victoria Regional Health Centre, Simcoe Muskoka District Health Unit
# of cases of illness related to vector-borne disease/total population	Simcoe Muskoka District Health Unit
# of times freshwater tests are above maximum contaminant level	Simcoe Muskoka District Health Unit
# of beach closures per year	Simcoe Muskoka District Health Unit
# of Blue Flag certified beaches in Barrie	Blue Flag, Corporate Facilities

Goal #2: Minimize Risks to Buildings and Properties

RECOMMENDED INDICATOR	POTENTIAL SOURCE
# of households participating in the Sanitary Sewer Inflow Reduction program	Engineering
# of reported properties experiencing flooding	Service Barrie
% of total housing and development permitted in flood plain	Planning, Nottawasaga Valley Conservation Authority, Lake Simcoe Region Conservation Authority Planning
% of population living in 100 or 200-year flood plain	Planning, Nottawasaga Valley Conservation Authority, Planning
Frequency and/or cost of private insurance claims for water damage due to flooding	Legal Services Private Insurance Companies

Goal #3: Strengthen Infrastructure Resilience

RECOMMENDED INDICATOR	POTENTIAL SOURCE
# of Low Impact Development (LID) features in the City	Engineering
# of rain events that exceed design standards in a given period (e.g. 25 or 50 years)	Engineering
Annual cost of road maintenance	Road Operations, Finance
# of potholes per km of road (indicator of freeze-thaw cycles)	Road Operations
Annual cost of sewer infrastructure maintenance, repairs and new construction.	Wastewater Operations, Finance, Roads, Parks, Fleet - Road operations.
Percentage of permeable surfaces/total ground coverage	Information Technology- Geographic Information Services

Goal #4: Help Local Businesses and the Tourism Industry Adapt to Changing Conditions

RECOMMENDED INDICATOR	POTENTIAL SOURCE
# of City business's that have included climate change considerations into business continuity plans	Invest Barrie
# of City business's that have become Smart About Salt Certified	Smart About Salt Council
# of members participating in the local business best practice network	Invest Barrie
# of tourist visits to the municipality in general or to natural sites/attractions (e.g. beaches, lakes, ski hills)	Tourism Barrie
Changes to seasonal business operations (i.e. winter recreational activities)	Tourism Barrie

Goal #5: Protect Biodiversity and Enhance Ecosystem Functions

RECOMMENDED INDICATOR	POTENTIAL SOURCE
% total tree canopy cover	Parks, Information Technology- Geographic Information Services
Mortality rate of trees in public inventory	Parks
Budget allocated to green infrastructure	Finance, Engineering, Parks
# of implemented green infrastructure projects	Finance, Engineering
Change in # of invasive species	Parks
Habitat area retained, managed, restored and enhanced (total sq km)	Parks
Proximity of residents to public green spaces (e.g. public parks)	Planning, Parks

Goal #6: Minimize Disruption to Corporate Services

RECOMMENDED INDICATOR	POTENTIAL SOURCE
# of calls to Service Barrie's Customer Service Contact Centre regarding service disruptions	Service Barrie
# of weather-related transit service disruptions	Barrie Transit
# of weather-related waste collection disruptions	Environmental Operations
# of deployed winter control vehicles (e.g. plows, salters, sidewalk plows)/ snowfall or freezing rain event	Roads, Parks, and Fleet
Changes in # of anti-icing/de-icing materials used/snowfall or freezing rain event	Roads, Parks, and Fleet

Goal #7: Build Community Resilience

RECOMMENDED INDICATOR	POTENTIAL SOURCE
% total public greenspace	Parks, Planning
# of community gardens	Parks, Planning
% shade coverage in municipality (shaded area/total municipal area)	Parks, Planning

APPENDIX F: LONG LIST OF PROPOSED ACTIONS

Below are the proposed actions that were identified as either “monitor” or “investigate further” based on the action prioritization process that was completed. This list of proposed actions will be reviewed during the development of the implementation plan and at the 5-year review period to determine if they are “sub-actions” of the priority actions, should be brought forward for implementation, or updated to reflect changing conditions.

	PROPOSED ACTIONS	PRIORITY
F.1	Develop policy for marina harbour staff to respond to extreme weather conditions by relocating boats at risk of damage from wind, wave action, and debris	Monitor
F.2	Conduct vulnerability assessment on spit that breaks waves for Marina and retrofit if necessary	Monitor
F.3	Work with Tourism Barrie and the Downtown Barrie BIA to develop a strategy to help weather dependent tourism businesses and events diversify their experience offerings to not be so weather dependent.	Monitor
F.4	Develop and implement a systematic snow fencing strategy for the blown wind prone areas to avoid damage to public infrastructure	Monitor
F.5	Apply the Public, Infrastructure, Engineering, Vulnerability, Committee (PIEVC) Engineering Protocol and conduct a vulnerability assessment of grey and green infrastructure assets	Monitor
F.6	Develop complaint process through customer service protocol for residents to help document damage to public infrastructure from extreme weather events	Monitor
F.7	Increased communication between LSRCA staff (out monitoring creek flows) and City staff as to status of creek flow following extreme weather events to ensure timely maintenance and clearing of potential debris upstream of culverts.	Monitor
F.8	Encourage residents to remove debris from catch basins sewer grates/remove branches from storms when safe to do so to minimize flooding potential.	Monitor
F.9	Increase public awareness regarding citizen monitoring and clearing of catchbasins.	Monitor
F.10	Continue monitoring and assessment of culvert and catchbasin status.	Monitor
F.11	Integrate inspection of public infrastructure into the Spring Into Clean Initiative to help remove debris from catchbasins and culverts when safe to do so.	Monitor
F.12	Develop a more flexible procurement process so that it becomes easier to get contractor assistance with clean up response/recovery during or after an extreme event	Monitor
F.13	Develop policy to use Personal Protective Equipment (PPE) that reduces the impact of temperature on outdoor workers	Monitor
F.14	Develop communications strategy about service delays (e.g. garbage pickup) as a result of extreme weather conditions	Monitor

	PROPOSED ACTIONS	PRIORITY
F.15	Build enclosed walkways to reduce impact of extreme temperatures on pedestrians	Monitor
F.16	Extend hours of public buildings (e.g. library) during extreme heat events	Monitor
F.17	Implement Emergency Hydration Stations (e.g. water trucks, water stations) during extreme heat days	Monitor
F.18	Encourage a “check on your neighbour” program in cases of extreme temperatures, especially when power outages are involved.	Monitor
F.19	Research the use of construction materials that are more resilient to freezing	Monitor
F.20	Ensure that installation of water service lines and water mains are done correctly according to new service construction techniques (e.g. updated to go deeper, under grass where possible)	Monitor
F.21	Increase communication to home-owners in areas at risk to freezing pipes to open taps to maintain flow.	Monitor
F.22	Utilize municipal by-laws, standards, and permitting processes to ensure new construction and service lines are properly protected from frost penetration.	Monitor
F.23	Develop Frozen Water Pipe Policy to enhance existing programs to prevent service freezing, address vulnerable customers, and to provide temporary water access and service in the event of another pipe freeze.	Monitor
F.24	Explore possibility of anti-icing for sidewalks	Monitor
F.25	Update the City's design standards to account for a zero-infiltration scenario (e.g. increase in rainfall while ground is frozen) and increase the sewer size accordingly	Monitor
F.26	Increase the percentage of road crown to provide better drainage	Monitor
F.27	Conduct vulnerability assessment of roads to flash flooding caused by frozen ground	Monitor
F.28	Improve drainage capacity within/around existing parks to reduce soil saturation	Monitor
F.29	Use of higher drainage subsoils (reduced clay content) on future sports fields/ parks.	Monitor
F.30	Develop GIS database to map areas at risk of erosion in the City.	Monitor
F.31	Update grading and slope standards to reinforce stability	Monitor

	PROPOSED ACTIONS	PRIORITY
F.32	Spatially identify overland flow routes on GIS to share the information with key stake holders	Monitor
F.33	Develop and implement an operating maintenance plan for overland flow routes of the City	Monitor
F.34	Regularly maintain and update stabilization techniques, slope assessment requirements, surface applications, planting, and grid systems	Monitor
F.35	Increase natural plantings on erodible slopes to reduce the risk of erosion	Monitor
F.36	Overland flow routes should be designed with the attention to reduce the scour/velocity of the flow	Monitor
F.37	Implement bank stabilization techniques to prevent erosion (e.g. maintaining surrounding vegetation and plants) near stormwater ponds	Monitor
F.38	Promote the diligent use of street sweepers to reduce sediment, litter and other debris being washed into stormwater infrastructure through runoff	Monitor
F.39	Develop inventory of vulnerable stormwater infrastructure to flag for upgrades, retrofits and maintenance activities.	Monitor
F.40	Maximize the efficiency of winter maintenance to reduce the amount of salt and sand released to the environment.	Monitor
F.41	Ensure developers adhere to the Planning Services Department's Site Plan Application Manual.	Monitor
F.42	Identify flood prone areas	Monitor
F.43	Implement a "no-development" policy within the overland flow route (i.e. residential buildings)	Monitor
F.44	Explore expanding the rain gauge monitoring network to include additional stations, and new technologies to permit the monitoring of winter precipitation.	Monitor
F.45	Increase overall design capacity of stormwater ponds (e.g. larger sediment forebay, overall pond capacity, greater retention times, outlet structures) to account for changing climate conditions (e.g. freeze-thaw cycles).	Monitor
F.46	Increase expenditure for road resurfacing to address existing backlog of streets needing construction.	Monitor
F.47	Identify and understand what types of plants are hardier to changing temperature extremes. (supporting action to below)	Monitor
F.48	Update the acceptable plantings list for site plans and subdivisions to hardier varieties.	Monitor

	PROPOSED ACTIONS	PRIORITY
F.49	Explore possibilities for newer, more resilient construction materials or techniques for roads and buildings	Monitor
F.50	Educational campaign for residents and businesses to promote regular monitoring of properties for foundation damage caused by freeze/thaw	Monitor
F.51	Develop public awareness campaign for homeowners on how they can divert water and runoff away from building foundations	Monitor
F.52	Develop citizen science program in order to survey and monitor invasive species throughout Barrie.	Monitor
F.53	Develop urban heat island maps to identify vulnerable areas.	Monitor
F.54	Expand cooling centres in the City, especially in vulnerable areas	Monitor
F.54	Coordinate with Downtown Barrie Business Association to gauge interest in local business adopting an "open-door policy" during extreme cold days	Investigate Further
F.55	Eliminate rollover curbs and implement full curb and gutters to help plow operators efficiently clear the snow to improve drainage	Investigate Further
F.56	Provide alternative, indoor recreation spaces during heavy rain events to house community events	Investigate Further
F.57	Explore possibilities for newer, more resilient construction materials or techniques (e.g. pipe insulation) for stormwater infrastructure (e.g. outlet pipes)	Investigate Further
F.58	Explore possibility of installing boat washing station at Barrie Marina or hosting a mobile station during busy summer weekends to prevent the spread of invasive species in Lake Simcoe.	Investigate Further
F.59	Develop an Invasive Species Management policy.	Investigate Further

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