PREPARING FOR A changing future

Acknowledgement

The preparation of this plan was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

Canada FCM FEDERATION OF CANADIAN MUNICIPALITIES FÉDÉRATION CANADIENNE DES MUNICIPALITÉS

a glance inside # contents

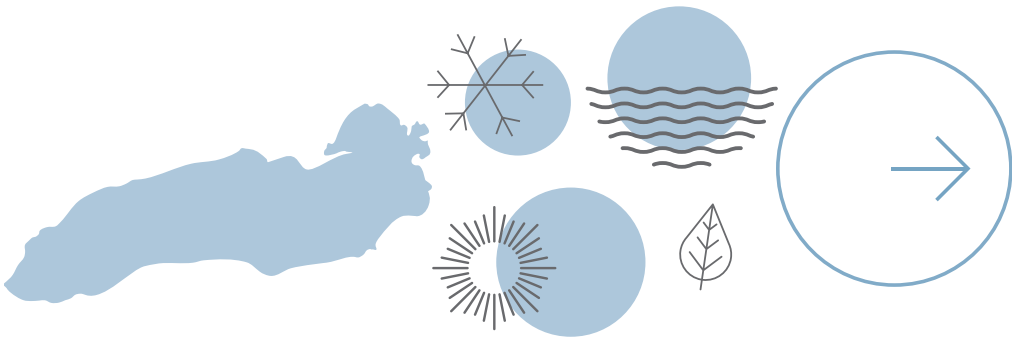
Executive Summary

Climate change is a global issue that all communities are facing. The community of St. Catharines has seen the effects of extreme weather in various forms in recent years, including high water levels on Lake Ontario, severe storms, flooding, and an increase in extreme temperatures changes.

Municipalities are on the frontlines of climate change and as such have a pivotal roles to undertake as climate change affects both municipal operations, as well as the communities they serve. Adaptation is a locally responsible and proactive way to address climate change from an economic, social, and environmental aspect. Adaptation aims to minimize or prevent negative effects of climate change from projected climate impacts on the built, natural, and social systems at the local level.

A Corporate Climate Change Adaptation Plan evaluates climate impacts, risks, and vulnerabilities the municipal government currently faces, or is expected to experience in the future, due to climate change. Understanding climate related risks and vulnerabilities that impact The Corporation of the City of St. Catharines (Corporation) will allow internal municipal operations, policies, and procedures to best align with the future climate. Positioning adaptation planning throughout the municipal government will provide proactive decision-making, climate orientated action and implementation focused on creating a climate responsible and resilient community.

To prepare for the future, the Plan contains six goals that closely follow the trends of climate projections, representing the high-level intended outcomes of the Corporate Climate Change Adaptation Plan.



Corporate Climate Change Adaptation goals

The actions proposed in this plan address the City's highest risks and vulnerabilities at the time of completing this plan. There are 28 adaptation actions that have been identified and are included in the implementation schedule of this report. The actions include departmentally focused actions, as well as corporate wide actions.

Moving towards a climate resilient future requires attainable action and monitoring of progress, which will be performed throughout the plan's implementation.

This is the first Climate Change Adaptation Plan created for the City. This Plan is intended to be a living document as adaptation best practices are continuously evolving along with climate data and context.

No. 1
Prepare for hotter summers

No. 2
Prepare for and respond to extreme weather events

No. 3
Develop a flood prevention strategy

No. 4
Improve stormwater management including the use of green infrastructure

No. 5
Prepare for high Lake Ontario water levels

No. 6
Re-think how the City addresses climate change

Glossary

a

Adaptation
Actions that minimize or prevent negative impacts of climate change. This can include either anticipatory or reactive responses to actual and projected impacts of climate change on built, natural and social systems. Adaptation maximizes and utilizes possible opportunities and benefits that arise from climate change.

Adaptive capacity
The ability of a built, natural, and social system to adapt effectively to change; cope with; or benefit from climatic change.

b

Baseline
Climatological baseline refers to a reference period. Typically, a 30-year period is used to compare variabilities of climate between one period and another.

c

Climate
The long-term average or expected weather for a location calculated over a 30-year period of weather statistics. Information collected demonstrates the normal weather including the range of extremes for a location.

Climate change
Refers to a long-term statistic over a 30-year period in weather patterns caused by both natural phenomena and human activities, resulting in chemical changes to the composition of the atmosphere as a result of greenhouse gases.

Climate impact
The effects of existing or forecast changes in climate on built, natural, and human systems. Two types of impacts to consider are 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).

Climate variability
The variations above or below a long-term average state of the climate. This variability can be due to natural internal processes within the climate system (internal variability) or to variations resulting from human-induced external forces (external variability).

Consequence Refers to the known or estimated consequences of an impact for assessing risk. The five consequence criteria that were accounted for in this plan's assessment include: public health and safety; local economy and growth; community and lifestyle; environment and sustainability; and lastly, public administration.

Corporate or corporation
For the purposes of this report the term corporate or corporation is used to reference The Corporation of the City of St. Catharines.

e

Extreme weather event
A meteorological event that is rare, such as an intense storm, drought, flood, heat wave, for a location and time of year beyond the normal range of activity. An extreme weather event would normally occur very rarely or fall into the tenth percentile of probability.

Exposure
The nature and degree to which a system is exposed to significant climate variations.

g

Greenhouse gas (GHG)

Greenhouse gases are any gas that have the property to absorb and emit infrared radiation, which contributes to trapping heat in the Earth's atmosphere. These gases can originate from both natural and anthropogenic (human-induced) sources. The six primary greenhouse gases in the Earth's atmosphere in order of abundance are water vapour (H20), carbon dioxide (C02), methane (CH4), nitrous oxide (N20), ozone (O3) and chlorofluorocarbons (CFCs). Without greenhouse gases in its atmosphere, Earth would be too cold to support life as we know it. However, too high a concentration of greenhouse gases in the atmosphere can results in a dangerous level of planetary warming.

The gases of primary concern based on the Kyoto Protocol that are closely associated with human activities are carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).

Global climate model (GCM)

A computer model that is a numerical representation of the climate system, based on equations that drive the physical, chemical, and biological properties of its components; its interactions and feedback processes; and accounts for most of its known properties.

Green infrastructure

Green infrastructure, sometimes referred to as natural infrastructure or low impact development (LID), are natural vegetative system(s) that provide a variety of benefits (economic, social and environmental). The primary role of green infrastructure is stormwater management, which provides water quantity and water quality treatment. Examples include; urban trees/forests, engineered wetlands, rain gardens, and green or blue roofs.

h

Heatwave

Environment Canada issues heatwave warnings for central and southern Ontario when two or more 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.

l

Likelihood

Referring to risk, the likelihood, is based on how recurrent the impact is likely to be. A higher likelihood is placed for more certain events that could occur several times per year, compared to an unlikely event that may arise once in 10 to 25 years.

m

Maladaptation

Maladaptation refers to action or inaction that may lead to increased risk of adverse climate-related outcomes; increased vulnerability to climate change; or diminished welfare, now or in the future. Changes could be to the built, natural, or human systems that would increase vulnerability to climate stimuli. One example of maladaptation is choosing any action that increases greenhouse gas emissions, which would increase the likelihood of further climate change.

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.

n

Natural variability

Natural variability describes short-term changes of climate that take place over months, seasons, and years. It can be due to natural variations in external forces such as changes in the sun's radiation or volcanoes. It can also be the result of variations in internal processes, such as those related to the interactions of the oceans and the atmosphere, that occur for example in the Pacific Ocean during an El Nino Event.

p

Projection (climate projection)

Projections represent the future portion of climate model simulations that reflect greenhouse gas emission scenarios. Consequently, a projection is based on assumptions such as those concerning future socioeconomic and technological developments. These may or may not be realized, and thus are subject to uncertainty.

r

Representative Concentration Pathway (RCP)

A time series of up to the year 2100 as it relates to preindustrial levels of emissions and concentrations of greenhouse gases, aerosols, chemically active gases, and land use. The word 'representative' signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. In 2014 four RCPs were selected and adopted as the basis for the climate projections used in the Fifth Assessment Report published by the International Panel on Climate Change. Representative Concentration Pathway 2.6 leads to the least warming and reflects a future shaped by aggressive and immediate efforts to drastically reduce greenhouse gas emissions. Representative Concentration Pathways 4.5 and 6.5 lie between the extreme low and high scenarios, modelling futures in which some mitigation of emissions prevents the extreme warming projected by RCP 8.5.

Resilience

The capacity of a system, community or society exposed to hazards to adapt — by resisting or changing — to reach and maintain an acceptable level of function and structure.

Risk

Risk can be considered as the combination of an event, its likelihood, and its consequences. Risk equals the probability of climate hazard multiplied by the consequence of that event.

S

Sensitivity

The degree to which a given system is directly or indirectly affected (either adversely or beneficially) by climatic conditions (i.e. temperature increases) or a specific climate change impact (i.e. increased flooding).

V

Vulnerability

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of both the sensitivity and the adaptive capacity of a given sector, system, or community.

W

Weather

The day-to-day state of the atmosphere, and its short-term variation measured in minutes to weeks.

Acronyms

BARC
Building Adaptive and Resilient Communities

This is a national program focused on resilience and adaptation delivered by the International Council for Local Environmental Initiatives. It offers a comprehensive way to respond to the impacts of climate change; develop and implement an adaptation plan; and protect the people, property, and prosperity of communities. The program holds decades of experience in the field of municipal governance to respond to the impacts of a changing climate.

FCM
Federation of Canadian Municipalities

The FCM has been the national voice of more than 2,000 municipal governments of all sizes since 1901, representing more than 90 percent of all Canadians from coast to coast. FCM advocates on behalf of municipalities for citizens' needs reflected in federal policies and programs. Year after year, FCM's work benefits every municipal government and taxpayer in Canada, with programming delivering tools to help municipalities tackle local challenges.

ICLEI
International Council for Local Environmental Initiatives

The ICLEI – Local Governments for Sustainability is a global network of more than 1,750 local and regional governments committed to sustainable urban development. Active in 100-plus countries, they influence sustainability policy and drive local action for low-emission, nature-based, equitable, resilient, and circular development. Their members and team of experts work together through peer exchange, partnerships, and capacity building to create systemic change for urban sustainability.

IPCC

Intergovernmental Panel on Climate Change

The IPCC is an international body administered by the United Nations. The group was created to assess climate science research, and it regularly issues authoritative assessment reports about the science of climate change, climate change impacts, and policy options for adaptation and mitigation.

STC

City of St. Catharines department abbreviations

CRCS
Community, Recreation and Culture Services

CSS
Corporate Support Services

EDTS
Economic Development and Tourism Services

EFES
Engineering, Facilities and Environmental Services

FMS
Financial Management Services

FS
Fire Services

LCS
Legal and Clerk Services

MW
Municipal Works

Office of the CAO
Office of the Chief Administration Officer

PBS
Planning and Building Services

Contributions

To assist with the development of the adaptation plan an internal, cross-departmental staff working group was formed. The Climate Adaptation Team contributed to and structured the adaptation planning efforts.

The team consisted of staff from various departments and backgrounds to provide a well-rounded representation of the City of St. Catharines organization. The team's primary role was to provide input; assess past and future impacts collectively; provide feedback; finalize; and adopt a Corporate Adaptation Plan, to be initiated by the various departments of the City.

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Niagara Adapts

Niagara Adapts was an initiative designed to build innovative climate solutions right here in Niagara through a partnership between Brock University and seven local municipalities in the Niagara Region. Niagara Adapts was led by academic experts who used novel approaches to the adaptation planning process by leveraging resources and expertise from municipalities in the Niagara Region and Brock University's Environmental Sustainability Research Centre (ESRC). The project supported and led collaborative climate change adaptation assessment, planning and implementation. The group formally launched in June of 2019 and is currently scheduled to conclude work in the spring of 2021. The following individuals were invaluable in collecting, researching, consulting, and analyzing the information and data presented in this final report:

Dr. Jessica Blythe, Assistant Professor

Dr. Ryan Plummer, Professor and Director to ESRC

Amanda Smits, Centre Administrator

Angela Mallette, Research Assistant

Michaela Jennings, Research Assistant

Participating municipalities include: Grimsby, Lincoln, Niagara Falls, Niagara-on-the-Lake, Pelham, St. Catharines, and Welland

External Stakeholders, Community Groups and Residents

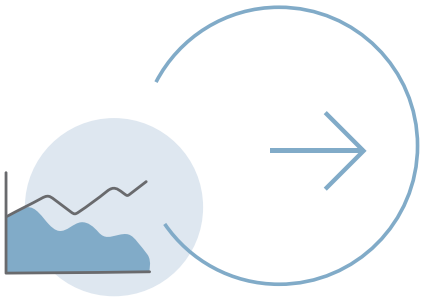
The opportunity to further engage and provide deeper insight to the adaptation planning process involved the interaction and knowledge from external stakeholders and the community. Niagara Adapts lead the community stakeholder engagement process for multiple survey and community events. This provided valuable insight into the community's vulnerabilities, and support for the plan's vision and goals. The community was also engaged through the City's engagement platforms to provide questions and impacts related to the plan, its goals and action item implementation.

Introduction

The effects of climate change, and related concerns for the future, are currently impacting individuals, communities and states across the planet. The Intergovernmental Panel on Climate Change (IPCC) is the intergovernmental body of the United Nations that provides the world with objective, scientific summaries of climate change.

The IPCC has concluded that climate warming is unequivocal and humans are the cause based on two main factors: increased greenhouse gas emissions and deforestation for agriculture production occurring globally (IPCC 2013). Average global temperatures have already risen 1 Celsius (C) above pre-industrial levels. The IPCC has researched how future global temperature increases will affect society including threats to food security, water resources, ecosystem services, and human health. The IPCC stresses the importance of minimizing global temperature increase to the greatest extent, ideally below a 1.5 C increase.

The purpose of this plan is to address the adaptive measures that can be initiated by the City of St. Catharines through an internal corporate focus. This allows the City to not only put actions in place within its scope of operations and control, but also lead by example.



Staff developed the following report as the City of St. Catharines Corporate Climate Change Adaptation Plan (the Plan). The Plan includes an implementation strategy with actions that allow St. Catharines to better prepare for the impacts of climate change and enable stronger adaptation practices.

The Plan aligns priorities and recommends necessary actions across departments of the Corporation. Climate adaptation plans are developed to reduce climate related risks and vulnerabilities as well as reduce negative future economic impacts.

Plan development background

No. 1
St. Catharines was successful in applying for a FCM grant through the Municipalities for Climate Innovation Program.

No. 2
This grant partially covered the cost of hiring a Climate Change Coordinator.

No. 3
The primary role of the position was to focus on developing a corporate adaptation plan and implement its actions.

No. 4
The long-term objective of this plan will be to integrate climate change considerations into all aspects of the municipal decision-making process.

section 1.0

Overview of climate change and science

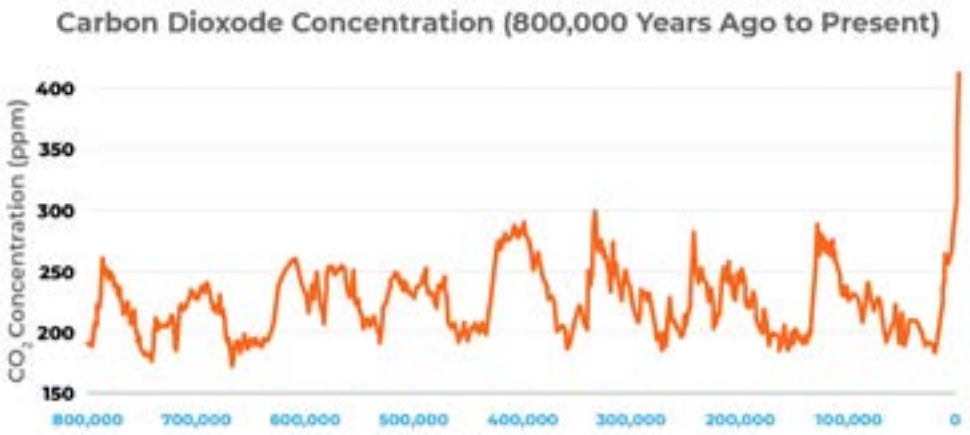
Throughout history scientists have studied the earth's climate and natural processes. It is therefore known that the earth's climate is not static, as both natural and anthropogenic factors hold influence on climate.

Earth's natural variability includes natural process and functions such as the earth's tilt and orbit around the sun, the natural cycles of seasons across the globe, volcanic eruptions, and historic levels of carbon dioxide. However, this natural climate variability does not explain the recent and sudden warming of the earth being experienced today.

Anthropogenic factors are human induced changes that have influenced the natural cycle of the planet, therefore altering the natural variability of earth. Humans have increased carbon dioxide concentration levels which has directly influenced the earth's rising temperature.

Scientists have tracked historic emission levels through a wide variety of sampling techniques, such as ice cores and tree ring samples. These sampling methods have allowed historic data to be compared to present data, such as greenhouse gas emission levels. This information informs various modelling algorithms and theories to generate future climate projections both on global and regional scales. Figure 1 demonstrates the carbon dioxide concentration levels and cycles that have taken place over the last 800,000 years.

Figure 1: Carbon Dioxide Concentration levels informed through ancient climate data from ice core and sediment core samples.
Source photo Prairie Climate Centre, 2018



1.1 Weather and climate

Municipal planning decisions are often made for short and long-term needs, which is why many different time scales need to be considered. Two terms, often used interchangeably, represent very different timescales.

Weather is the actual atmospheric condition experienced at any given time. Temperature is one measurement of weather, and has been collected globally since the 1880s. Weather data, such as precipitation, wind and temperature, allows us to look back to see what happened on a given day. This type of information, along with wind patterns, provides us with the weather forecast for the next day or week via short-term projections.

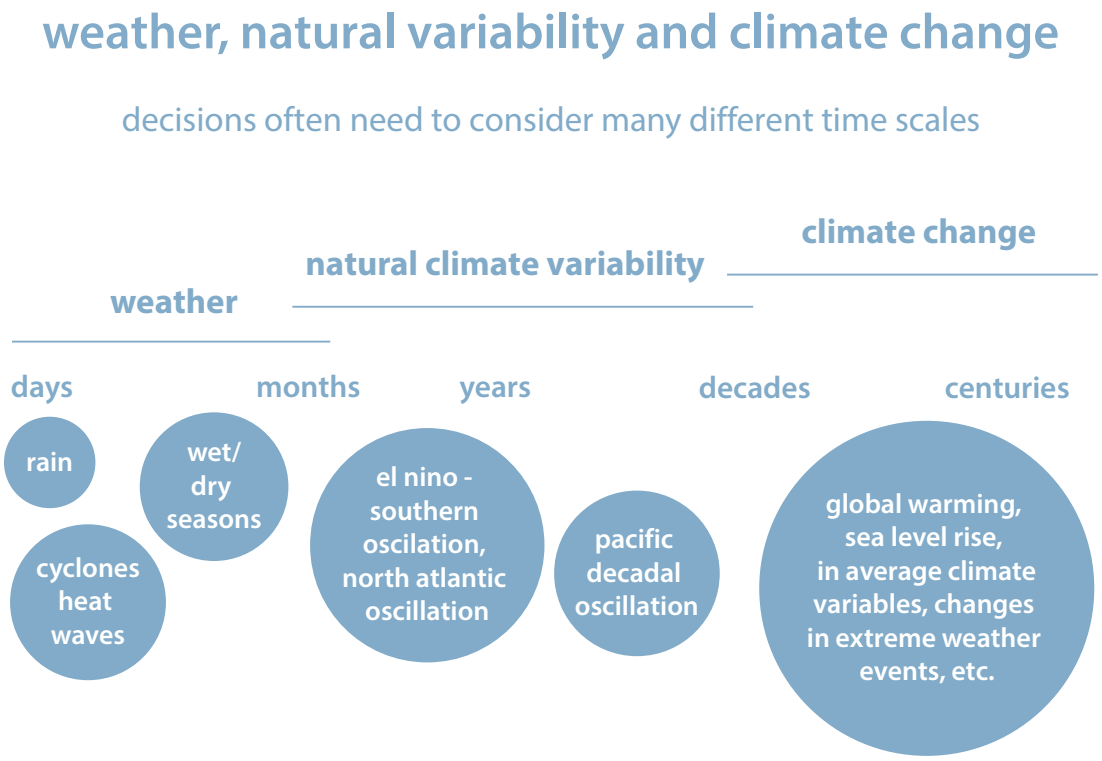
"Weather is what you get"

Climate change, on the other hand, is defined as a "long-term shift in weather conditions identified by changes in precipitation, winds and other indicators" (Canada 2019). This can hold influence over the average conditions as well as the variability, such as an extreme event. Climate data is captured and assembled as an average over a thirty-year period and is referred to as a region's typical weather. Natural causes can contribute to climate change however they are responsible for relatively short-term effects on climate.

"Climate is what you expect"

Between weather (short-term events) and climate change (long-term changes) there is what is known as climate variability or natural variability. This is often used to compare one season to another, or one year to the next. Natural climate factors, such as El Nino, El Nina, sun radiation or volcanoes, can also factor into this timescale of climate variability. Examples can include how we define as an extremely cold winter or as a mild summer. Figure 2 provides a visual representation of all three timescales.

Figure 2: Weather and climate timescales



1.2 Global context

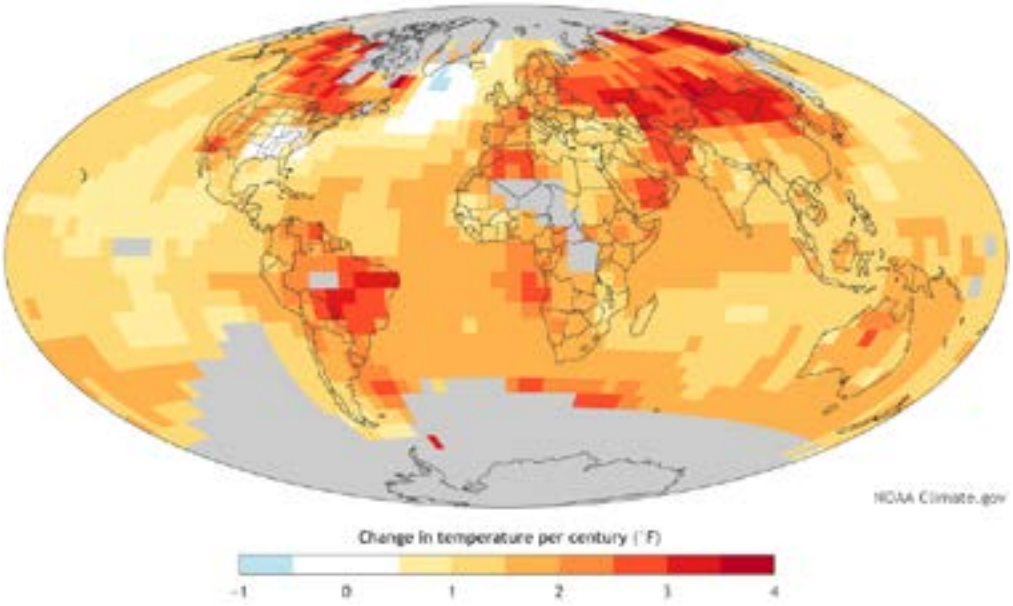
The consensus of the scientific community is that the planet is warming and that this warming is caused by human activity (J. Cook 2016). The major contributing factor of climate change is human driven through two primary areas, specifically, "the burning of fossil fuels and the conversion of land from forestry to agriculture" (J. Cook 2016).

Fossil fuels have been used since the Industrial Revolution, contributing to the release of carbon dioxide, a greenhouse gas (GHG). Within the last 30 years (1990 to 2020) global atmospheric carbon dioxide levels have increased by roughly 159 parts per million (ppm) (Lindsey 2020). When compared with 1960 level increases of 0.6 ppm per year, 2010 level increases were roughly four times higher, at 2.3 ppm per year (Lindsey 2020). The constant increase of carbon dioxide emissions has amplified earth's natural greenhouse effect. On-going greenhouse gas emissions have "the potential to warm the planet to levels that have never been experienced in the history of human civilization" (Canada 2019). See Figure 3 showing historical global temperature increases.

A rise in greenhouse gases causes not only temperatures to rise globally, it influences sea level rise, ocean acidification, and increased occurrences of catastrophic events such as wildfires. Therefore to reduce the negative impacts in the future IPCC has reported we need to limit global warming to 1.5 C. This means global greenhouse gas reductions would need to be reduced by 45 per cent below 2010 levels by 2030, and reach net zero by 2050 (IPCC 2018).

"This means the global GHG emissions must fall by 7.6 per cent every year from 2020 to 2030 to keep temperature increases to less than 1.5 C" (UNEP 2019). For "every year that GHG emissions are not zero, atmospheric GHG concentrations continue to build, increasing the risk that even incremental increases could trigger feedback loops that results in outsized and permanent damage to the climate" (Farmer 2019).

Figure 3: Global increasing temperature trend from 1900 to 2014



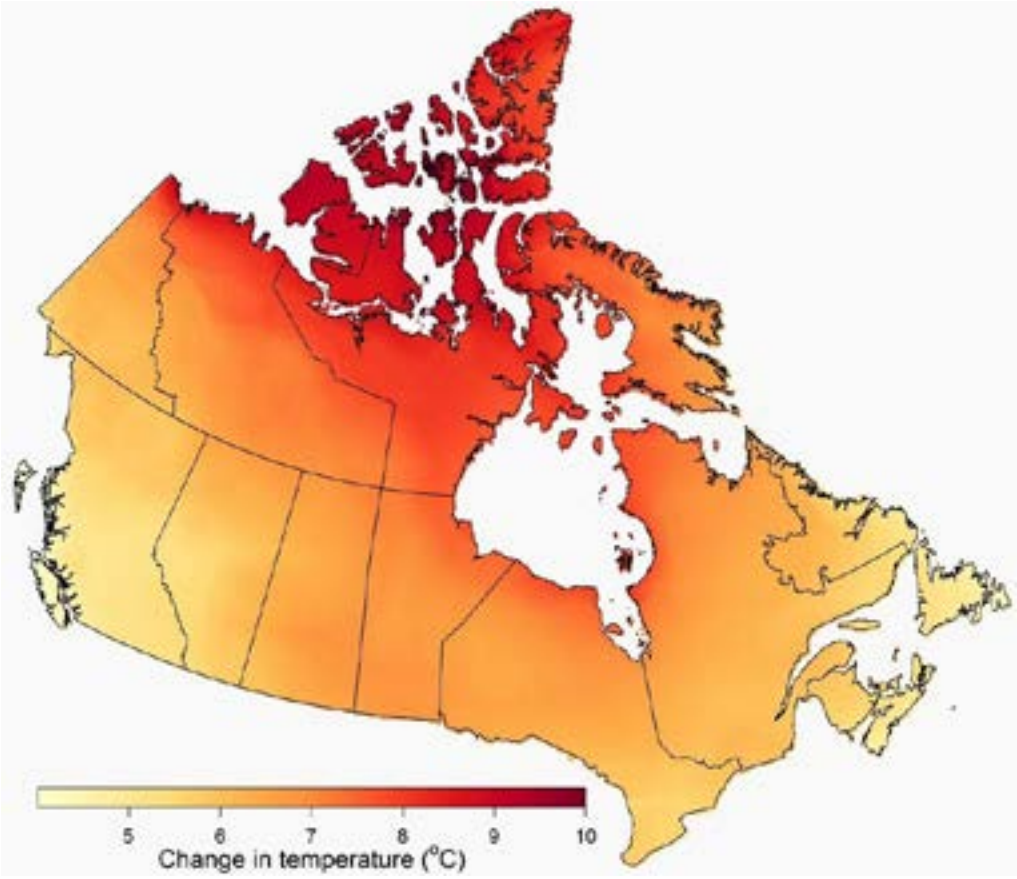
1.3 Canada's changing climate

The latest NASA data shows that 2020 has tied with 2016 for the warmest year on record globally (NASA 2021). The temperature of the earth however is not warming at the same rate across the world. It is projected that 'Canada will warm twice as fast as the global average and experience more frequent and severe weather, including heavy precipitation events' (IPCC 2013). In Canada, the mean temperature has already increased by 1.7 C from 1948 to 2016, and daily extreme temperatures, hot and cold, are projected to increase substantially (Bush 2019). See Figure 4 for Canada's projected rise in temperature.

Canada has also seen an increasing trend in precipitation. Though more difficult to assess, there has been an increase in precipitation over the past half century by 12 per cent (Bush 2019). Canada will also experience more frequent and intense extreme events such as extreme heat, extreme precipitation, windstorms, and ice storms. According to Public Safety Canada the "federal assistance offered under the Disaster Financial Assistance Arrangements has increased dramatically between 1970 and 2015, and of all weather-related expenditures, 75 per cent was estimated to be from flooding with 50 per cent of the increase related to water losses alone.' (Moudrak and Feltmate 2019).

A recent 2019 study highlighted that Canada's six highest areas of climate risk over the next 20 years are in physical infrastructure, coastal communities, Northern communities, human health and wellness, ecosystems, and fisheries (Council of Canadian Academics 2019). The study also found that three areas offer the greatest potential to adapt to the forecasted climate impacts: physical infrastructure; governance and capacity; and human health and wellness (Council of Canadian Academics 2019).

Figure 4: Canada's projected increasing temperature trend from a baseline of 1986 to 2005 forward to the end of the 21st century under the RCP 8.5.



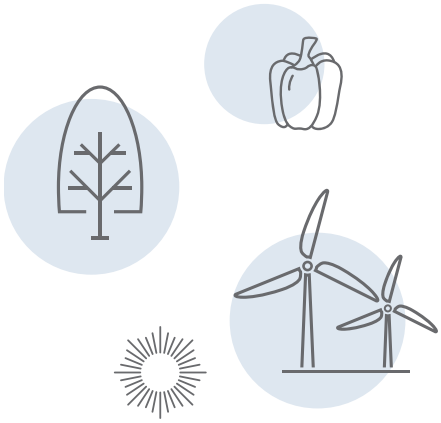
1.4 Adaptation and mitigation

Climate change mitigation and adaptation equally play a vital role in how our society will take action to reduce and respond to the effects of a changing climate. Together these actions work in partnership toward the end goal of creating a continuously improving, sustainable city. When actions interact with both areas, they often contribute to co-benefits and offer low carbon resilience solutions.

Mitigation is focused on the "actions that reduce the rate of climate change or otherwise limit or prevent greenhouse gas emissions" (IPCC 2018). The activities implemented from mitigation strategies have the goal of reducing, preventing and further removing greenhouse gases in the atmosphere to help prevent climate change. Mitigation is a global effort and all levels of government, businesses, institutions, and citizens need to take an active role.

Adaptation aims to "reduce adverse consequences of climate change and to enhance positive impacts, through private or public measures" (IPCC 2018). The actions that are proposed through adaptation planning are often prioritized on addressing the highest vulnerabilities and highest risks from a local context. This allows the actions to better address specific impacts for varying communities.

Both approaches are needed to combat climate change. Even if emissions were stopped tomorrow, the earth would experience some degree of warming that would still require adaptation action. "Since mitigation reduces the rate as well as the magnitude of warming, it also increases the time available for adaptation to a level of climate change, potentially by several decades. Delaying mitigation actions may reduce options for climate-resilient pathways in the future" (IPCC 2014).



Adaptation and Mitigation actions

Adaptation: Actions that help manage the impacts of climate change. "The locally responsible thing to do"

Adaptation: managing the unavoidable

Flood protection, Infrastructure and building design, Disaster management and business continuity, Health programs

Mitigation: Actions that reduce or prevent emissions that cause climate change. "The globally responsible thing to do"

Mitigation: avoiding the unmanageable

Sustainable transportation, Energy efficiency, Renewable energy, Fuel efficient and electric vehicles

Synergies and shared benefits

No. 1
Water and energy conservation

No. 2
Natural environment preservation (urban forestry)

No. 3
Green infrastructure

No. 4
Local food production

section 2.0

Role of governments

2.1 Federal and Provincial direction

Federally, Canada signed on to the Paris Agreement under the United National Framework on Climate Change in 2015. Canada is one of 195 countries that signed the agreement. This represents a commitment from countries to accelerate actions and investments for a sustainable low carbon future by limiting global average temperatures to well below 2 C above pre-industrial levels, and to pursue efforts to limit the increase to 1.5 C (NRCAN 2020). Canada then established a greenhouse gas reduction target — 30 per cent below 2005 by 2030 — and developed the Pan-Canadian Framework on Clean Growth and Climate Change, which aims to support Canada's transition to a low carbon future and the path forward (NRCAN 2020).

Canada's physical infrastructure is one of the country's top climate change risk areas (Council of Canadian Academics 2019). From an adaptation perspective, "in the absence of adaptation planning climate change will cost Canadian taxpayers between $21 billion and $43 billion annually by 2050" (Zerbe 2019). If plans and actions are put in place early on however, for "every dollar invested in pre-disaster adaptation actions, up to six dollars can be saved in post-disaster recovery spending" (Zerbe 2019). This stresses the importance that Canada and all levels of government need to act on adaptation planning.

In 2018, a Made-in-Ontario Environment Plan was released and carries similar messaging from the Federal government addressing climate change and adopted the same greenhouse gas reduction target to align with Canada's 2030 target. In April 2021, Prime Minister Justin Trudeau announced a 40 to 45 per cent emission reduction target by 2030 from 2005 levels.

2.2 Local context

Municipalities are at the front lines of climate change and as a result are also the ideal and potentially best-positioned governments to implement policies to protect communities and property from climate related risks (Guyadeen 2018). Municipalities understand from past events what has impacted their operations, or where the community has been most vulnerable to certain events. Learning from the past and anticipating the impacts of the future, developing an adaptation plan allows municipalities to become more active in planning for the future with less reliance on reactive measures.

"Developing climate change plans represents a municipal government's firm commitment that addressing climate change is a local priority" (Guyadeen 2018). Adaptation, however, does not end with local government, it continues to be an important effort for individuals, such as citizens and employees, businesses, and corporations of all sizes.

2.3 Green recovery, experience from COVID-19

COVID-19 exposed societies' vulnerabilities across the globe and has caused the Canadian economy to face serious challenges. However, before COVID-19, climate change economic costs were already steadily rising. With the number of events rising every year (wildfires, floods, severe storms) it has been estimated that from 2010 to 2019 total disaster costs were $14.5 billion, compared to the four previous decades' combined total of $21 billion (Canadian Institute for Climate Choices 2020).

Climate¬ change has also affected the mental and physical health of many families. A homeowner that is displaced from their home or lives in a location with unsuitable living conditions from a flooding event, for example, may experience lasting health implications.

The consideration of dealing with multiple or stacked crises, such as COVID-19 and climate change, should be top of mind. Realizing that climate change and COVID-19 response and recovery can be addressed in unison can help Canada's economy while establishing measures to build back better. More importantly, as we build new municipal infrastructure, we need to consider the idea of building smart from the start.

Climate change and COVID-19 have affected the wellbeing of many communities, groups, and individuals. Experience shows that climate change and COVID-19 have not impacted everyone equally. Greater consideration should ensure the most vulnerable are not disproportionately affected. It is important that all members of society benefit, including those that have been historically disadvantaged or marginalized, as part of a green recovery.

Green recovery aims to:

- support the flow of economic stimulus back into the local economy
- support diversity and equity;
- create sustainable jobs;
- support mental health, physical health and long-term community well-being; and
- protect and restore the natural environment while increasing biodiversity and ecological value

This means recovering smarter with stimulus funding from higher levels of government and adoption of a fair, equitable and green recovery.

2.4 St. Catharines municipal profile

St. Catharines is the largest and most predominantly urbanized lower tier municipality located in the Niagara Region. The current population is approximately 133,113 (2016 census), representing almost a third of Niagara's residents. The community of St. Catharines is 98 square kilometres (km) in area and is known as the Garden City. Throughout the city is a network of over 90 km of trails and 106 municipal parks. The City is located on the shore of Lake Ontario and has 11 km of shoreline including three municipally owned beaches. See Figure 5 for map of the Niagara Region.

It is important to note that being a lower tier municipality, some services are not within the local government's authority, therefore this plan is proposing the actions that are within the means of the Corporation and focused on lower tier municipal assets and services.

Municipal infrastructure and services within the City's control or influence include:

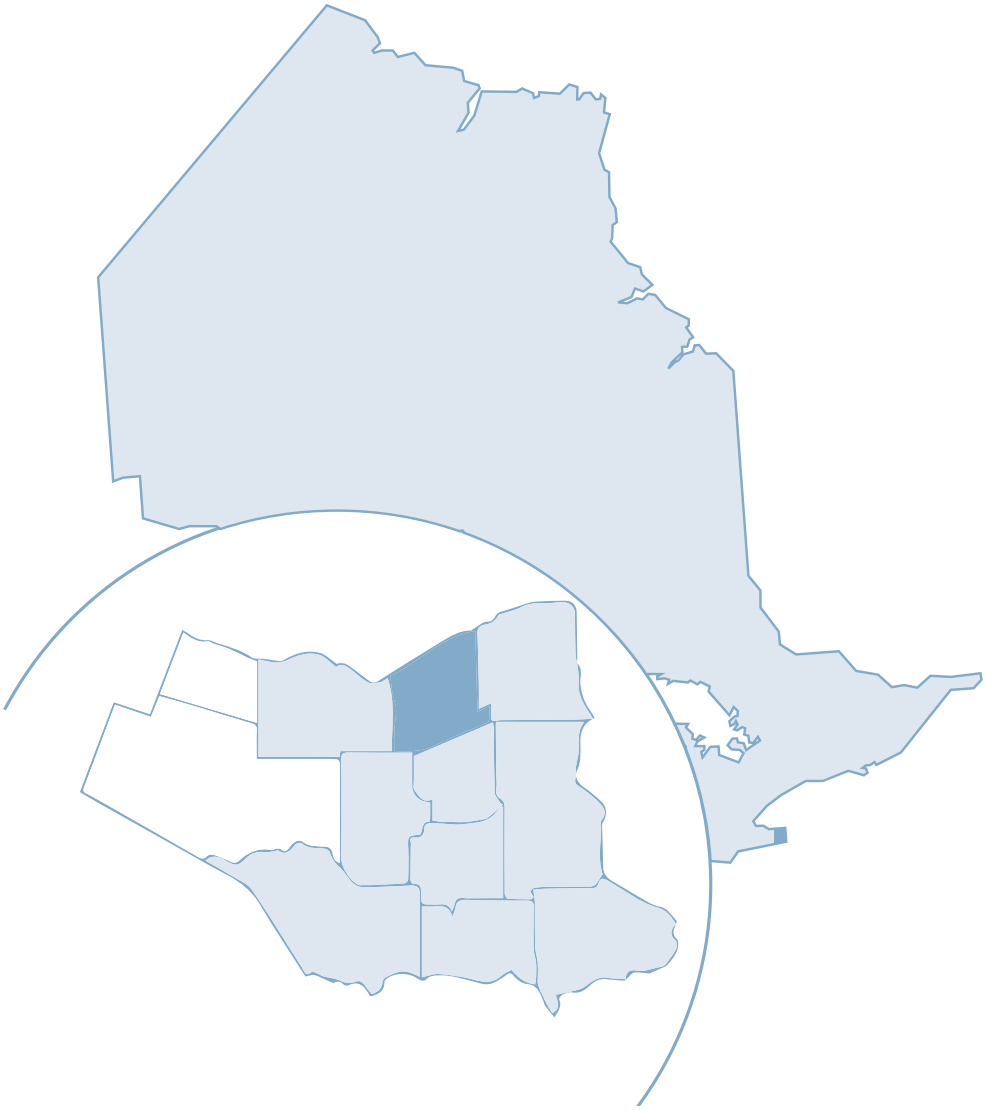
Stormwater management and flood protection; drinking water and wastewater delivery systems; public transportation (St. Catharines Transit Commission); maintenance of roads, sidewalks, and streetlight infrastructure; fire and emergency response facilities and routes; recreational and cultural facilities; parks; trails; shorelines; and other natural areas

Other critical infrastructure assets that are controlled outside of the Corporation include:

Water and wastewater treatment plants; health care provision and facilities; social services; police services and public safety; waste and recycling collection; electricity and natural gas utilities

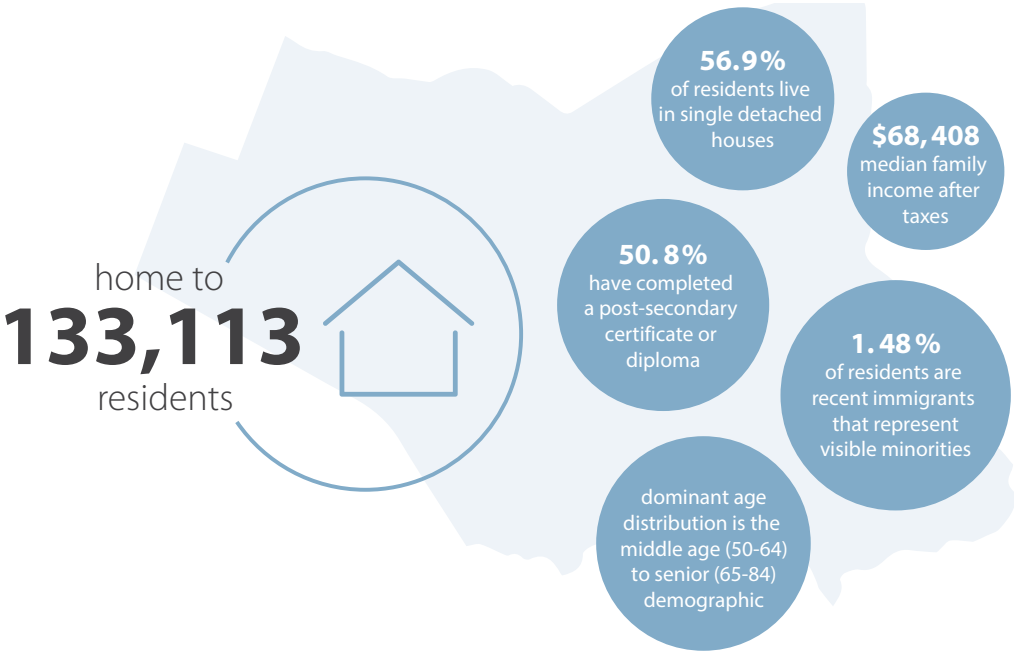
The City has continued to deliver local services in the face of increased demands on its aging infrastructure and assets. The challenge is keeping up with the demands while factoring in population growth, intensification and being cognizant of a changing local climate.

Figure 5: Map of Ontario and Niagara Region



2.5 St. Catharines community profile

Demographic Profile of St. Catharines, based on the 2016 Census



2.6 Municipal commitment to climate change action

In April 2019, St. Catharines City Council unanimously declared a Climate Emergency. The dual purposes of the declaration were to recognize the urgent need to take action to mitigate the effects of climate change and to deepen the City's commitment to protecting its economy, ecosystems, and community from climate change. St. Catharines was the 29th community in Canada to make this declaration.

In October 2019, council approved an updated Strategic Plan , including the environmental stewardship goal to "adopt innovative approaches and continue responsible community planning and decision-making that balances growth, enhances quality of life, manages emergencies, and minimizes the environmental impacts of climate change."

Other environmental initiatives that the City supports include

- Bee City of St. Catharines
- Blue Dot Community
- Ban on single use plastics at City facilities
- Member of Partners for Climate Protection Program
- Member of the Global Covenant of Mayors for Climate and Energy
- Great Lakes and St. Lawrence Cities Initiative
- Unflood Ontario

2.6.1 St. Catharines role in mitigation

The City of St. Catharines has taken an active role in establishing emission reduction targets. In October 2019 the City committed to municipal greenhouse gas emission reductions through its Energy Conservation and Demand Management Plan. The approved target in 2019 was a 40 per cent reduction in corporate greenhouse gas intensity by 2030 compared to the base year of 2011. In 2020, a newer target was approved by Council that aligns with the IPCC recommendation of limited warming to 1.5 C. See Figure 6 below. Currently, from 2011 to 2018, St. Catharines has been able to reduce its greenhouse gas intensity by 25 per cent (Figure 7).

Figure 6: 2020 adopted greenhouse gas reduction target that aligns with IPCC recommendations

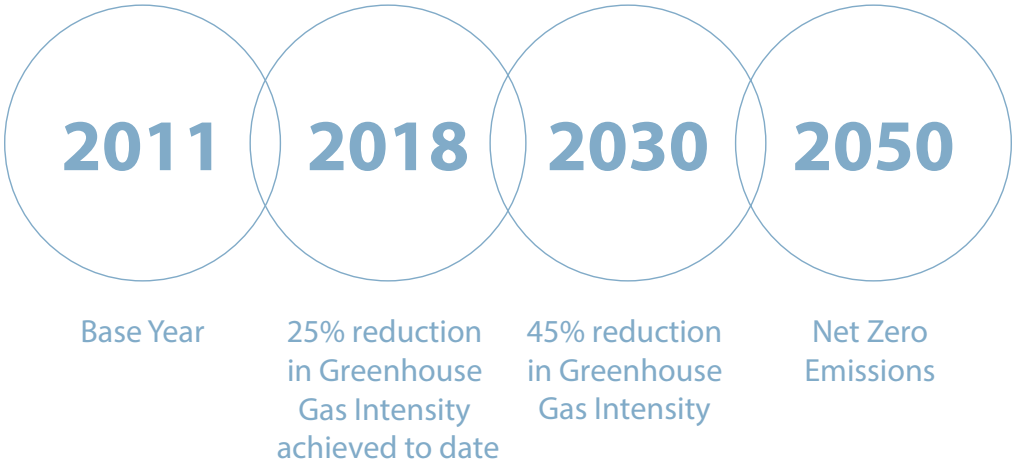
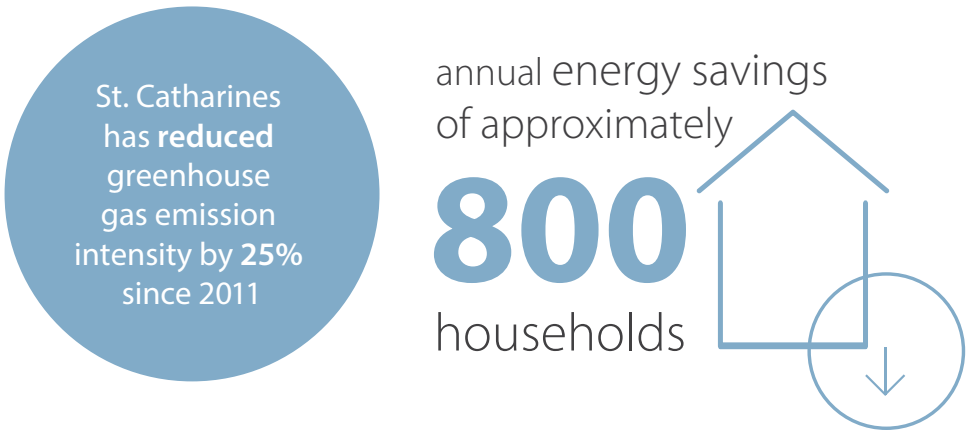


Figure 7: Greenhouse gas reductions from 2011 to 2018 achieved by the City



In 2015, Council approved a light emitting diode (LED) streetlight conversion project which provided energy and financial savings. Within three and a half years the project converted a total of 14,100 high-pressure sodium light bulbs to high-efficiency LED fixtures. In total, this reduced the City's annual energy costs on streetlights by 62 per cent and maintenance costs by as much as 60 per cent. Financially, this has equated to $720,000 in annual energy savings and $350,000 in annual maintenance savings.

For more information how the City is going to continue to reduce its energy and meet its greenhouse gas targets refer to the Energy Conservation and Demand Management Plan.

2.6.2 St. Catharines role in adaptation

The City is not a stranger to adaptation and some long-standing initiatives and programs already contribute to adaptation for residents. Examples include the annual rain barrel sale and grants through the Flood Alleviation Program (FLAP) to aid basement flood protection.

Other initiatives are more corporate focused and support stormwater management such as the permeable pavement sites located at the Lake Street Service Center and the Kiwanis Aquatic Centre, built to meet Leadership in Energy and Environmental Design (LEED) silver rating.

Some cross-cutting actions, that help both adaptation and mitigation, already in place are the:

- Bi-Annual tree give away that promotes and provides 1,000 native trees to residents to plant on private property
- Management and support of the St. Catharines Farmers Market for local food
- Community Gardens

section 3.0

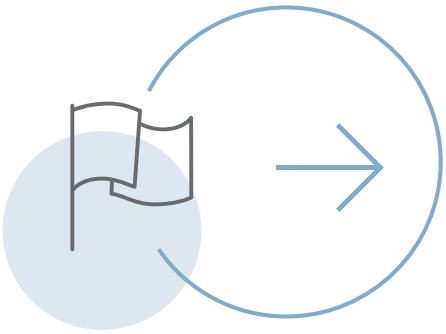
Plan development

3.1 The climate change planning process

The key elements of climate change planning relate to mitigation and adaptation planning. Each hase a five-milestone framework that has led Canadian municipalities to incorporate climate change planning and action at the regional or municipal level. Both frameworks have been created by the International Council of Local Environmental Initiatives (ICLEI) Canada.

Adaptation Planning Framework

The Niagara Adapts partnership guided participating municipalities through adaptation planning, development, and the implementation process. The Building Adaptative and Resilient Communities (BARC) framework which was created by ICLEI- Local Governments for Sustainability, was referenced as a guiding document. The following framework (Figure 8) outlines the key milestones to the adaptation planning process. For key details related to each milestone refer to **Appendix A.**



For St. Catharines, the creation of this adaptation plan has fulfilled Milestones 1 to 3 of the adaptation planning process. Council's endorsement of this plan has allowed St. Catharines to move to Milestone 4, which is the implementation phase of the framework.

Figure 8: The five key milestones for climate adaptation planning

Adaptation planning process milestones

No. 1
Initiate an adaptation effort
Timeline - Q3-Q4 2019
Status - Complete

No. 2
Research climate change impacts
Timeline - Q4 2019 - Q2 2020
Status - Complete

No. 3
Develop an adaptation plan
Timeline - Q2 2020 – Q1 2021
Status - Complete

No. 4
Implementation of the plan
After council endorsement
Status - In-progress

No. 5
Monitor and review the plan
Timeline - On-going into the future
Status - Future Action

3.2 Climate data, methodology and projections

The City of St. Catharines is already experiencing the impacts of climate change. In 2018 and 2019, St. Catharines and Niagara experienced a total of 56 extreme weather events which included freezing rain, extreme heat, severe wind, and heavy precipitation leading to basement flooding and record high water levels on Lake Ontario. These events demonstrate the need to be prepared for more frequent and severe events and the ability to adapt over the next century.

- Lake Ontario high water levels in 2017 and 2019
- Multiple freezing rain events in 2017 and 2019
- Severe wind events, example Halloween (October 31) in 2019
- Consecutive heat warnings in July of 2020

This Adaptation Plan used climate data specific to St. Catharines, which has been downscaled and collected from the Climate Atlas of Canada and ClimateData.ca (Table 1, below). There are several representative concentration pathways (RCP) that could have been used, however for the purposes of this plan and based on the recommendation of Niagara Adapts, the RCP 8.5 model, associated with the business as usual model or "high carbon" scenario, has been selected. This reflects the city's position to plan for the worst-case scenario and put in place the most appropriate and robust adaptative measures. In other words, let's prepare and plan for the worst and hope for the best.

The baseline period is defined as the recent past historical average, from 1976 to 2005, and future projections for the years 2050 and 2100 respectively. This prepares the City to look at the near future climate, as well as a long-term projections that are important for large capital investment and expenditures such as infrastructure projects with long life cycles.

Climate change projections; more heat, more precipitation, more extreme events

The three broad climate data parameters collected are temperature, precipitation, and other variables. The key trends include overall increased temperature, increased precipitation in all seasons except for summer and the increased intensity of rainfall events. Although future precipitation is less certain compared to temperature projections, an increase in temperature will accelerate evaporation and further activate the hydrologic cycle to result in more frequent and potentially more severe rainfall events (Moudrak, N.; Feltmate, B. 2019.) For more detailed climate projections for St. Catharines please refer to **Appendix B.**

Table 1: Summary of climatic change in St. Catharines

1

Change summary: average temperature increase
Anticipated Changes:

- The mean annual temperature between 1976 – 2005 (historic baseline) was 9 C. The city can expect an annual increase in mean temperature of 3 C by 2050 and an additional 3 C by 2100.
- Warming will occur across all seasons, with the fall season experiencing the highest rate of warming
- Increase in the number of hot days (days >30 C) from 13 days per year historically, to 50 days by 2050 and a total of 96 days by 2100.
- General trend of having hotter days in the future with more heatwaves in effect. The hottest day historically was 33 C. The hottest day is projected to be 37 C in 2050, and up to 41 C by 2100.
- Less freeze-thaw events from the historic 57 days, with a decrease in 11 days by 2050

2

Change summary: average annual precipitation increase
Anticipated Changes:

- Annual increase in precipitation of 163 millimetres (mm) from historic baseline to 2050 and 100mm from baseline to 2100
- Precipitation levels will increase for all seasons, except for the summer months where it will remain the same.
- The greatest increase in precipitation will occur in the winter and fall seasons.
- Trends indicate that single storm events will become more intense and extreme

3

Change summary: extreme events; heavy rain and windstorm increase

Anticipated Changes:

- Frost days will be reduced by 40 days or by a third in 2050 and reduced by two thirds by 2100.
- Ice Days (below 0 C) from the baseline of 42 days will decrease by 52 per cent for 2050, and 90 per cent by 2100.
- Increase by double and triple the amount for tropical nights above 18 C by 2050 and 2100 respectively
- Freeze-thaw days will decrease by 11 days and 22 days from baseline for 2050 and 2100, respectively.

By the 2050's St. Catharines will experience

Warmer and wetter winter

- Temperature increase of 2 C with average temperature at 0 C
- Average increase of 34 mm of winter precipitation
- Coldest day or minimum temperature will increase by 7 C, historically has been -19 C and will be -12 C for 2050
- Overall reduced home heating needs by 41 per cent
- 52 per cent decrease in ice days

Longer and wetter spring

- Last spring frost will come one week earlier in the year
- Average increase of 35 mm of spring precipitation with general trend of more heavy rainfalls
- Average spring temperature will be 9 C, an increase of 2 C from historic temperatures
- Frost free season days will increase by 20 days

Hotter summer

- More frequent heatwaves and hotter days in the future
- 37 day increase in hot days (above 30 C) for 2050, with a total of 50 days
- Up to double the incidences of nighttime temperatures above 18 C
- Increased usage and reliance on air conditioning and cooling centers

Shorter fall

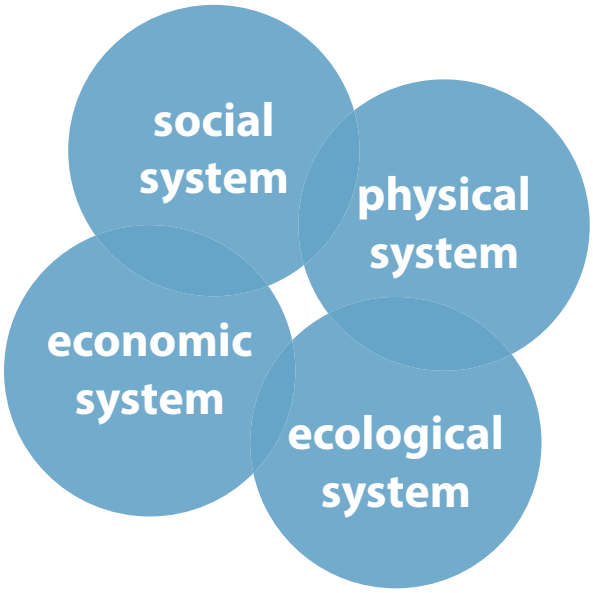
- First fall frost will take place almost two weeks later in the year.
- Average increase of 7mm of autumn precipitation
- Temperature increase of 3 C with average temperature at 14 C
- Frost days will be reduced 40 days, or by a third, in 2050

3.3 Anticipated impacts

The Climate Adaptation Team developed a list of impact statements that consider climate projections on social, physical, economic, and ecological systems (Figure 9). The intent of an impact statement is to identify the climate variable, the outcome, and the consequence as a result. For example, a rise in temperature increases the amount of days above 30 degrees Celsius, which affects the heat stress of residents and municipal staff working outdoors.

The adaptation plan identifies climatic impacts that are projected to affect the Corporation directly or indirectly. Possible opportunities were also captured in the process. The Climate Adaptation Team informed the internal corporate knowledge of how operations, programs and services could be impacted based on the most current science and data available.

Figure 9: Systems that were considered in creating climate impact statements



3.4 Vulnerability assessment

Through Niagara Adapts, researchers at Brock University and municipal staff completed a vulnerability assessment. A report was produced for each of the seven participating municipalities, which delivered valuable insight into where St. Catharines is potentially vulnerable to future climate impacts.

An online household vulnerably survey generated valuable insight on how community members are experiencing climate change and where we need to focus efforts to increase adaptive capacity. St. Catharines had a total of 340 people complete the survey.

Vulnerability refers to the susceptibility of a given region, municipality, social group, or sector to harm arising from climate change impacts. Vulnerability is a function of three criteria: exposure, sensitivity, and adaptive capacity.

The overall vulnerability index value for St. Catharines was 0.353 on a scale of 0 (highly vulnerable) to 1 (highly robust) (Blythe J 2020).This value represents the baseline for St. Catharines vulnerability.

The findings of the report demonstrate that the highest exposure in St. Catharines was community flooding and extreme heat. The areas of highest sensitivity included infrastructure, prevalence of infectious diseases, rental housing, and recent immigrants. Overall, adaptive capacity was ranked as most robust, with improvements to be made in the areas of assets and flexibility.

Other key findings from respondents of the Niagara Adapts survey include:

- 82 per cent believe climate change is impacting the community;
- 88 per cent believe humans have the capacity to address climate change;
- 19 per cent feel St. Catharines is prepared for climate change; and
- 88 per cent support municipal resources being used for climate change adaptation.

For further information please see summary information in **Appendix C** on the Vulnerability Report. For the full report please refer to the St. Catharines Climate Vulnerability Report.

Based on the findings from the Vulnerability Report, a vulnerability assessment was completed to directly classify each individual impact statement. The two assessment criteria, for sensitivity and adaptive capacity, were ranked from one to five.

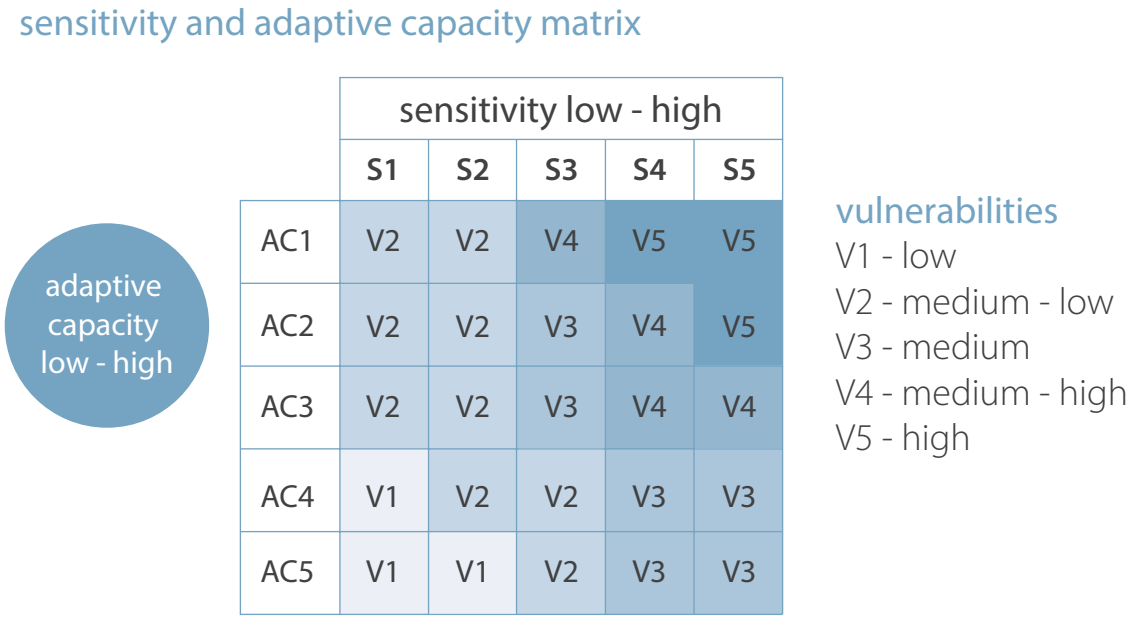
Vulnerability = Sensitivity x Adaptive Capacity

Sensitivity aims to understand how current services will be impacted by stresses, if current services are limited, or if resources are being met. An impact with low sensitivity was seen to not affect the functionality of the department, compared to a high sensitivity of continuously affecting the functionality of the department and likely to get worse.

Adaptative Capacity is measured on the projected impact and how it will affect systems within the City's service areas. An impact with low adaptative capacity was measured as requiring substantial costs and staff intervention compared to a high adaptive capacity will little to no costs or staff intervention needed.

Both sensitivity and adaptative capacity were ranked based on the findings of the Vulnerability Report. Below in Figure 10 is the matrix used to complete the vulnerability assessment for each impact statement. The results align corporate focused impact statements with a vulnerability assessment score.

Figure 10: The Vulnerability Assessment Matrix



3.5 Risk assessment

A risk assessment combines an events likelihood and its consequence to provide an indication of the overall level of risk.

For each of same impact statements that were scored under the vulnerability assessment, a risk-based scoring was undertaken from the municipal perspective. The outcome of the Risk Assessment provided an outlook and direction for the top climate risks facing St. Catharines.

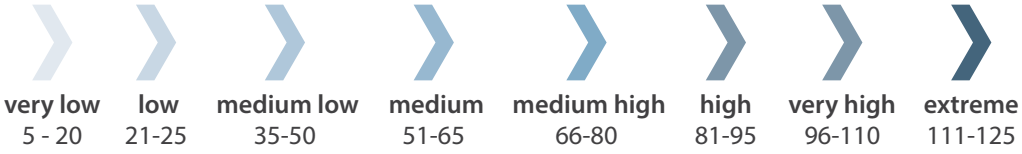
Risk= Likelihood x Consequence

Risk score (out of /125) = likelihood (#/5) x total consequence score (#/25)

The *likelihood* is based on how recurrent the impact is likely to be, for example the rise in temperature is very likely and more certain compared to the frequency of extreme events. A higher likelihood was placed for almost certain events that could occur several times per year, compared to an unlikely event that may arise once in 10 to 25 years.

Consequence refers to the known or estimated consequences of an impact. There were five consequence criteria that were accounted for in this assessment: public health and safety; local economy and growth; community and lifestyle; environment and sustainability; and lastly, public administration. Each criterion was provided a score from 1 to 5.

Figure 11: Risk spectrum



For the purposes of this report, adaptation actions were only developed for impacts that demonstrated medium to high vulnerabilities (V3 to V5) and medium to high risk scores (scores above 50). For a full list of the climate impacts please refer to **Appendix D**.

Table 2: Top 12 climate impacts for St. Catharines under four common themes

1

Summary of Change: Increase in heat

Top Climate Impacts:

- Outdoor workers and firefighters experience increased risk of heat stress and decreased productivity due to summer heat waves
- Vulnerable populations will be negatively impacted due to heat stress, in turn requiring more City services
- Ecological impacts to plants and trees from increased heat stress, leading to less growth and higher mortality

2

Summary of Change - Overall increase in precipitation

Top Climate Impacts:

- Increased spring rainfall will lead to increased combined sewer overflow events resulting in more contamination of local creeks and Lake Ontario
- Increased runoff will increase stormwater pollution and impair water quality
- High lake levels reduce the ability to use beaches and City facilities

3

Summary of Change: Increase in heavy precipitation events

Top Climate Impacts:

- More frequent flooding events affecting more residents and infrastructure
- Due to increased overland runoff there will be greater need for maintenance of storm drainage systems
- Higher Lake levels leads to increased erosion resulting in damage to shorelines and requiring increased shoreline protection

4

Summary of Change: Increase in extreme events

Top Climate Impacts:

- Increase in extreme events resulting in property damage and higher insurance risk
- Increase in extreme events causes disruption to transportation routes resulting in delays to emergency response
- Environmental damage from extreme weather events (ice storms, severe wind, snowstorms) causes infrastructure damage

section 4.0

Vision, goals and guiding principles

4.1 Engagement on vision and goals

The Plan's vision and goals received both internal and external stakeholder review through an engagement survey conducted in partnership with Niagara Adapts in December 2020. Overall, the survey received a total of 83 responses with 86 per cent 'supporting-to-strongly supporting' the Plan's vision. More information on the vision and goals engagement survey can be found in **Appendix C.**

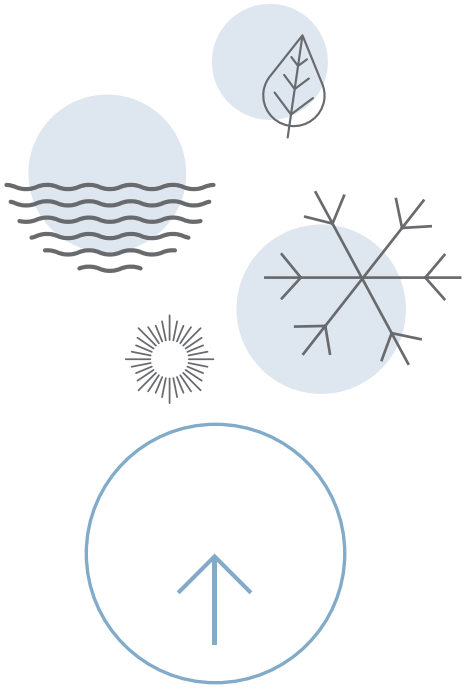
4.2 Vision

St. Catharines will mitigate and adapt to climate change through the integration of plans, policies, and procedures to ensure the City of St. Catharines takes action to remain innovative, sustainable and livable.

4.3 Mission

St. Catharines will be positioned to mitigate, respond and adapt to the local impacts of climate change, such as the rise of extreme heat, increased precipitation levels and extreme weather events.

This will be accomplished through the knowledge of anticipated climate impacts; informed decision making; and implementation of necessary actions to strengthen the City's commitment to a resilient St. Catharines.



4.4 Goals

No. 1
Prepare for hotter summers

No. 2
Prepare and respond to extreme weather events

No. 3
Develop a flood prevention strategy

No. 4
Improve stormwater management including the use of green infrastructure

No. 5
Prepare for high Lake Ontario water levels

No. 6
Re-think how the City addresses Climate Change

4.5 Guiding Principles

The City will adopt the following guiding principles towards a changing climate

1. Forward looking

The City will consider current and long-term needs and proactive adaptation measures when making decisions and provisions to better enable its assets to meet future demands, including changing demographics and populations, customer expectations, legislative requirements, technology, and environmental factors (climate change).

2. Evidence and science based

The City's climate change policy will be based on acknowledgement of certain risks and uncertainties associated with downscaled climate change projections. Therefore, the most relevant and reliable information available will form the basis of transparent decision making aimed at reducing the risks anticipated to the Corporation.

3. Risk based

The City will take a risk-based approach to prioritizing. Risk will be considered in relation to the likelihood of a climatic event occurring and the consequence of the impact to the City's assets and services. Highest-ranking risks will receive highest priority for investment and implementation.

4. Sustainable investments in climate change

The City will provide effective asset management to ensure the long-term availability and sustainability of corporate assets for infrastructure, services, and programs to achieve the best value from available capital funding resources.

5. Embrace the natural environment

The City will continue to embrace and protect its natural surroundings and build upon the opportunities provided by these assets through the enhancement of adaptation measures.

6. Continually evolving

this policy will continue to evolve and improve through ongoing evaluation of best practices, innovation, and consideration of future directions, regulations and requirements from upper levels of government.

7. Resilience based

Priority for procedures that deliver both climate change adaptation and mitigation, with consideration of maladaptation, regardless of future climate conditions to achieve the City's desired sustainable future.

8. Value based and affordable

The City will deliver the greatest value from its investment in assets respecting available funding and its customers' ability to pay.

9. Corporate integration

Promote and embrace incorporating climate change considerations into plans, policies and day-to-day business.

10. Climate leadership

Encourage and advocate for other levels of government and external stakeholders to take climate actions.

11. Collaboration with internal and external stakeholders

This will deepen the City's commitment to work collectively, across departments while enhancing external expertise in dealing with climate change.

12. Encouraging positive partnerships and alliances

Where appropriate, the City will pursue partnerships with other public, community and private sector providers to facilitate the provision of a diverse range of climate change opportunities.

section 5.0

Actions and implementation

5.1 Adaptation actions

The Plan's goals and actions were informed by the top climate impacts for St. Catharines. Adaptation actions are designed to prioritize and address the highest risks and vulnerabilities to the Corporation while considering relevance and feasibility as they pertain to the Plan's five-year timeline.

An adaptation action is any project or initiative that seeks to increase the City's adaptative capacity to climate change. The focus was to reduce the vulnerability and risk of delivering municipal services and assets; ensure overall feasibility of the City's operations; and otherwise increase the long-term safety and well-being of the community.

The adaptation plan supports actions that are already underway at the City that aid in adaptation to climate impacts, therefore not all actions included in this plan are new. There are in total 28 identified adaptation actions. The actions identify a lead department within the Corporation that will be responsible for the planning, initiation and monitoring of the adaptation action proposed.

*Please note these goals and actions are not listed in any specific order, for more details on each action reference the implementation schedule in **Appendix E**

1

Prepare for hotter summers

1. Review and assess measures in place to protect municipal staff from heat stress and maintain productivity

2. Develop a public education and awareness campaign on ways to reduce heat stress, recognize heat exhaustion and further promote City services that are offered (e.g. cooling centers)

3. Determine the area's most vulnerable to extreme heat to inform City planning, services, and programming initiatives

4. Continue to implement the Urban Forestry Management Plan and achieve the Urban Canopy Target

5. Implement and support the City of St. Catharines Horticultural Management Plan

2 Prepare and respond to extreme weather events

6 Improve communications to the public regarding health and safety updates and concerns during extreme weather events (for example,road conditions in the winter and heat alerts)

7 Ensure current mutual aid agreements are practiced and receive continuous review

8 Ensure communication plans are in place between departments (for example, environmental operations, roads, parks, facilities, and fleet) to provide efficient clean up after an extreme weather event (snow operations, fallen trees on power lines, etc.)

9 Enhance corporate business continuity to continue to deliver essential services, even though extreme weather events

10 Review and develop an inspection policy for high-risk infrastructure to identify any damage from events

3

Develop a Flood Prevention Strategy

11 Help residents take actions to protect against flooding including improved grants for protective plumbing, increased awareness, promotion and supports

12 Develop and promote homeowner awareness of stormwater best practices and flooding protection, with consideration of new programs where applicable

13 Update and review Flood Management Plans

14 Update and implement the Pollution Prevention and Control plan to reflect current best practices to reduce water pollution from combined sewer overflows

4

Improve stormwater management, including the use of green infrastructure

15 Continue to undertake rehabilitation and restoration efforts in local watercourses to reduce erosion

16 Complete the Storm System Master Servicing study

17 Encourage and promote the use of low impact development in corporate renewal projects and in new developments to increase water quality to local waterways

5

Prepare for high Lake Ontario water levels

18 Continue to enhance and maintain municipal shoreline protection by following the recommendations of the St. Catharines Shoreline Review

19 Ensure amenities at beaches and waterfront parks are above revised high lake levels and/or design features to be resilient to higher lake levels

6

Re-think how the City addresses climate change

Some of these actions do not address the top climate impacts, however, will support the City's environmental sustainability goals and improve general climate literacy

20 Establish a 'green' interdepartmental team

21 Develop a green reserve fund and seek available funding from different levels of government and non-government grants to advance climate change efforts

22 Incorporate climate change into the Corporate Asset Management Plan

23 Develop a strategy to include green infrastructure into the Corporate Asset Management Plan

24 Develop and implement a climate change lens tool

25 Develop and implement a green procurement policy

26 Regularly review climate projections and incorporate considerations into corporate plans, policies, and procedures

27 Promote the updated environmental considerations to developers included in the new Community Improvement Plan

28 Use partnerships to address climate change considerations in food-security communications and programming such as community gardens

section 6.0

Monitoring and review

6.1 Proposed indicators and monitoring

Monitoring the goals and actions of this Plan will allow the City to track general progress as well as adaptation accomplishments.

To track progress, the development of indicators and key performance metrics are required to ensure the adaptation actions remain active and viable. Lead departments will be responsible for tracking indicators and monitoring any challenges, future improvements, and action success. Indicators will be developed and applied to each action, see Table 3 for an example.

A key element in adaptation planning is to share the success of the actions as they are implemented. Since each action has its own associated timeline it would be suggested to share progress as it happens. A series of possible metrics per goal and action are included in **Appendix F**.

Table 3

Goal	Action	Example of possible metrics
Prepare for hotter and drier summers	Action #2: Develop a public education and awareness campaign on ways to reduce heat stress, recognize heat exhaustion and further promote City services that are offered (e.g. cooling centers)	• Number and total capacity of cooling centers (CRCS) • Number of attendees at the centers per year (CRCS) • Number of social media posts related to combating heat stress (CSS)

6.2 Plan updates and review

An annual review of the adaptation actions will be used to monitor and communicate the progress of the adaptation plan into the future. The lead department will be responsible for providing updates and status of the actions. The Plan should be thoroughly reviewed in five years to ensure the actions have either been met, need revisions, or if further consideration is needed for implementation. This will also allow the City to re-evaluate future climate trends, vulnerabilities, risks, and relevant adaptation actions.

6.3 Future Recommendations

Continuing through Milestones 4 and 5 of the BARC framework for implementation, monitoring and review will represent the immediate next steps of this Plan. On-going review of progress on the actions should take place regularly based on the timelines of each action, annually, or as otherwise stated. Review of the whole Plan should be assessed in five years to continue adaptation implementation and progress.

There are a variety of next steps that could arise from this plan; however, the important message is the City needs to act now in response to a changing climate. Future opportunities and actions beyond the scope of this plan that could further aid St. Catharines' resiliency include:

- Development of a community adaptation plan
- Continued work through the PCP program milestones framework, with an aim to:
    - Develop a corporate mitigation plan
    - Develop a community mitigation plan
- Review of feasibility for setting renewable energy targets

Conclusion

Climate change is affecting St. Catharines today and will continue to do so into the future. This Corporate Climate Change Adaptation Plan ensures the City of St. Catharines will remain innovative, sustainable, and livable for generations to come.

The City acknowledges this is the first adaptation plan that has been completed and the course for action will continue past the timelines included in this Plan. Adaptation is not the only course of action and continued steps will be taken to reduce greenhouse gases. Proactive action will increase our adaptative capacity and address the highest vulnerabilities and risks to the City of St. Catharines.

As the City deals with uncertainty related to climate change, unforeseen issues may require the plan to be adjusted. More importantly, the City cannot make progress alone, and will require the support and buy-in from the public, external stakeholders, and higher levels of government.

The long-term success of climate change planning will require a shift in mindset, including the factoring in climate change into corporate decision making. The climate vision, goals and guiding principles of this Plan should be viewed as the foundational framework for St. Catharines' climate resilient future.

Appendices

Appendix A
Adaptation Milestone Framework and Timeline

Milestone 1: Initiate	Milestone: 2 Research		Milestone 3: Plan		Milestone 4: Implement		
2019	2020				2021		
Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
• Establish internal adaptation team • Research local climatic changes • Identify climate impacts	• Conduct Vulnerability Assessment • Community engagement no. 1: Household Vulnerability Survey	• Review vulnerability results • Conduct risk assessment	• Risk and vulnerability assessment prioritization • Identify adaptation options and actions • Develop draft Vision and Goals	• Community engagement no. 2: Vision and Goals Survey • Develop implementation schedule • Develop possible monitoring and evaluation metrics	• Finalize draft Plan • Community engagement no. 3: goals, actions and implementation online open house	• Finalized Plan and seek Council endorsement • Begin implementation based on action plan with team support • Use appropriate implementation tools	• Report on progress and successes regularly to maintain momentum

Appendices

Appendix B
St. Catharines Climate Change Projections

The projections included below were collected using the RCP 8.5 scenario, which is seen as the business as usual model or high emissions scenario.
Data collected in this table was from climatedata.ca and if noted with an asterisk (*) was collected from climateatlas.ca

Variable: Temperature

Sub-Variable	Basline Period (1976-2005)	2050 Projection	2100 Projection	Trend Description
Average Temperature	9 C	12 C	15 C	Increase of 3 C from baseline to 2050 and again to 2100 projection.
*Mean Spring	7 C	9 C	11 C	Trends show an increase in temperature across all seasons.
*Mean Summer	21 C	23 C	25 C	
*Mean Fall	11 C	14 C	15 C	
*Mean Winter	-2 C	0 C	2 C	
Min. Temp	5 C	8 C	11 C	Increase in minimum and maximum temperature by 6 C.
Max. Temp	14 C	17 C	20 C	
Hottest day	33C	37 C	41 C	General trend of having hotter days in the future. Projected to be 37 C in 2050, and up to 41 C by 2100.
Hot days (days over 30 C)	13 days	50 days (+37 days)	96 days (+83 days)	The number of hot days will increase from baseline of 13 days up to 50 days by 2050 and a total of 96 days by 2100.
Coldest day	-19 C	-12 C (+7 C)	-8 C (+11 C)	The coldest day will decrease in temperature from the baseline of -19 C to -12 C in 2050 and -8 C by 2100.
Cold days (below-15 C)	6 days	0 days	0 days	The number of cold days (below -15 C) is expected to decrease from baseline of 6 days to zero days by 2050 and into the future.
Days below - 25 C	0 days	0 days	0 days	N/A

Appendices

Variable: Precipitation

Sub-Variable	Basline Period (1976-2005)	2050 Projection	2100 Projection	Trend Description
Total precipitation (annual mm)	855 mm	1,018 mm (+163)	955 mm (+100)	Total precipitation increases by 163 mm from baseline to 2050 and 100 mm from baseline period to 2100 period.
Max one-day total	38 mm	39 mm	40 mm	1 mm increase from baseline max one-day total to 2050 and 2 mm increase from baseline to 2100.
Wet days >1 mm	125 days	126 days	128 days	Increase of 3 wet days over 1 mm of precipitation.
Wet days >10 mm	26 days	33 days	32 days	Number of wet days will be increasing another 7 days by 2050 and 6 days by 2100 from baseline year.
Wet days >20 mm	6 days	9 days	9 days	Increase of 3 wet days over 20 mm from baseline to 2050.
*Average winter	189 mm	208 mm (+19)		Precipitation levels will increase in all seasons except for the summer months, where it will remain relative to today's precipitation levels. Trends indicate that single storm events will become more intense and extreme.
*Average spring	211 mm	233 mm (+22)		
*Average summer	208 mm	210 mm (+2)		
*Average autumn	216 mm	223 mm (+7)		

Appendices

Variable: Other Variables

Sub-Variable	Basline Period (1976-2005)	2050 Projection	2100 Projection	Trend Description
Frost Days	120 days	79 days	43 days	Frost days will be reduced by 40 days or by a third in 2050 and reduced by two thirds by 2100.
Cooling degree days	414	707	1,246	Increase in warm season cooling degree days by three times the amount by 2100.
Growing degree days 10 C	1,439	2,051 days	2,796 days	Increases by 612 days for 2050.
Growing degree days 5°C	2,456 days	3,174 days	4,063 days	Increases by 718 days for 2050.
Cumulative Degree Days >0°C	3,742 days	4,585 days	5,640 days	Increases by 843 days for 2050.
Heating degree days	3,314	2,584 (-22%)	1,942 (-41%)	Decrease in cold season HDD by 41 per cent.
Ice Days (below 0 C)	42 days	20 days (-52%)	4 days (-90%)	Decrease in ice days from the baseline of 42 days by 52 per cent for 2050, and 90 per cent by 2100.
Tropical nights (over 18 C)	29 days	67 days (+57%)	107 days (+73%)	Increase of or average increase by 57 per cent and 73 per cent in the tropical nights above 18 C by the 2050s and 2100 years respectively.
Tropical Nights (over 20 C)	12 days	20 days (+90%)	62 days (+97%)	Increase of 71 per cent and 86 per cent in the tropical nights above 20 C by the 2050s and 2100 years respectively.
Tropical nights (over 22 C)	2 days	20 days (+90%)	62 days (+97%)	Increase of 90 per cent and 97 per cent in the tropical nights above 22 C by the 2050s and 2100 years respectively.
*Dry days:	209.0	208.2 (-0.8)	209.3 (+ 0.3)	Will stay consistent to baseline
*Freeze-thaw cycles	57.0	46.5 (-10.5)	34.7 (-22.2)	Freeze-thaw days will decrease by 11 days and 22 days from baseline until 2050 and 2100.
*Frost Days	114.8	87.3 (-27.5)	60.5 (-54.3)	Frost days will decrease by over 50 per cent.
*Date of last spring frost	April 16	April 7 (-8.5)	March 28 (-18.7)	Last spring frost will come two weeks earlier in the year.
*Date of first fall frost	Nov 3	Nov 15 (+11.4)	Nov 30 (+26.2)	First fall frost will take place almost four weeks later than baseline.

Temperature

Hottest Day
This is the highest maximum temperature value in this time period.

Mean temperature
Mean temperature is the average temperature on a given day and is usually obtained by averaging the daily maximum and minimum temperatures.

Minimum temperature
This is the average minimum temperature for a given time period and is derived by averaging all the daily minimum temperatures in that time period.

Maximum temperature
This is the average maximum temperature for a given time period and is derived by averaging all the daily maximum temperatures in that time period.

Days over 30 C
This is the number of days when daily maximum temperature is greater than 30 C and gives an indication of the number of very hot days.

Days below -15 C
The number of days with minimum temperatures less than -15 C gives an indication of the number of very cold days in each time period.

Days below -25 C
The number of days with minimum temperatures less than -25 C gives an indication of the number of extreme cold days in each time period.

Precipitation

Total Precipitation
This is the total precipitation (rain and snow) for a given time period.

Max one-day total
This is the largest precipitation total on a single day.

Wet Days >1 mm
Number of days with daily precipitation totals greater than 1 mm

Wet Days >10 mm
Number of days with daily precipitation totals greater than 10 mm.

Wet Days >20 mm
Number of days with daily precipitation totals greater than 20 mm.

Other Variables

Frost days
Number of days when daily minimum temperature is less than 0 C and indicates when conditions are below freezing, usually overnight.

Cooling degree days (CDD)
Indication of the amount of air conditioning that may be required to maintain comfortable conditions in a building during warmer months. A threshold temperature of 18 C is used and for any day when the mean temperature exceeds this value, cooling degree days are accrued. So, if the daily mean temperature on a given day is 24 C, then 6 CDDs are accrued for this day. CDD values are totaled over the year; the larger the CDD value the greater the requirement for air conditioning.

Growing degree days 10 C
The number of days in which the daily temperature exceeds the threshold temperature (temperatures that support plant growth). A threshold temperature of 10 C is generally used for crops such as corn and beans that require warmer temperatures to reach maturity.

Growing degree days 5 C
The number of days in which the daily temperature exceeds the threshold temperature (temperatures that support plant growth). A threshold temperature of 5 C is generally used for forage crops and canola.

Cumulative degree days above 0 C
Calculated by adding average daily temperature over a defined time period (for example a year or month) for those days when the mean temperature exceeds 0 C. This index can be used as an indicator for plant and insect growth. The warmer the weather, the more quickly these species develop, and the cooler the temperature, the slower they develop.

Heating degree days (HDD)
An indication of the amount of space heating that may be required to maintain comfortable conditions in a building during cooler months. A threshold temperature of 17 C is used and for any day when the mean temperature is below this value, heating degree days are accrued. So, if the daily mean temperature on a given day is 10 C, then 7 HDDs are accrued for this day. HDD values are totaled over the year; the larger the HDD value the greater the requirement for space heating.

Ice days (below O C)
The number of days when the daily maximum temperature does not exceed 0 C.

Tropical nights
The number of days when the minimum temperature (which usually refers to night-time temperature) value does not go below threshold. Threshold can be set at 18 C, 20 C, or 22 C

Dry days
The number of days when the daily maximum temperature does not exceed 0 C.

Freeze-thaw cycles
A freeze-thaw cycle occurs when the daily maximum temperature is higher than 0 C and the daily minimum temperature is less than or equal to -1 C. The minimum temperature of -1 C (rather than 0 °C) is used as the threshold for freezing to raise the likelihood that water actually froze at the surface.

Frost days
The number of days in a year without rain / snow.

Appendix C
Stakeholder Engagement Summary Report

Through the Niagara Adapts Partnership various engagement touchpoints occurred. The first was a formal launch of Niagara Adapts in the Fall of 2019 at the Celebration of Nations event featuring public speaking and presentation of a documentary film. Various forms of online communication tools (website, social media) were used as well as newspaper articles and videos. Both internal and external stakeholders were involved in surveys created and lead by Niagara Adapts. Below are further details on the two surveys performed by Niagara Adapts.

Engagement #1 - Household Vulnerability Survey

The study commenced in the fall of 2019 with a literature review conducted by Niagara Adapts. Additionally, an internal exercise was completed by the Climate Adaptation Team to sort 50 indicators specific to the Niagara Region and rank them according to the internal focus of the Corporation of The City of St. Catharines. Supplementary data was collected as required. The main component of the vulnerability report was to understand how climate change is affecting the community, how people are currently adapting, and to help inform decisions that support climate adaptation to decrease overall vulnerability.

The household survey was a community-wide effort, running from November until December 2019. Through social media outlets, the Garden City Current e-newsletter and promotion on the City's climate change webpage the survey was well received by the St. Catharines community with a total of 348 responses. Highest uptake was seen after the inclusion in the Current e-newsletter. There were 1,087 surveys completed for all participating municipalities.

Pop-up engagement events took place to promote the Climate Change Vulnerability Survey in partnership with Niagara Adapts. See Table 1 below for details on where outreach was conducted in person.

Table 1: Vulnerability Survey promotion

Date	Time	Location	Number of people reached
November 20, 2019	8 a.m. – 1:30 p.m.	Kiwanis Centre	20- 30 (primarily seniors)
November 21, 2019	8 a.m. – 2 p.m.	Market Square	25
November 22, 2019	11 p.m. – 1 p.m.	Dunlop Seniors Centre	40 – 60 (seniors)
November 25, 2019	Noon – 2 p.m.	Dunlop Seniors Centre	10 – 20 (seniors)
November 27, 2019	8 p.m. – 1 p.m.	Kiwanis Centre	5 – 10
December 5, 2019	8 a.m. – 1:30 p.m.	Market Square	10 - 15 residents 30 students attend booth from school tour
Total		6 events	140- 190

Figure #: Niagara Adapts Climate vulnerability fact sheet- St. Catharines (J Blythe 2020)

Brock University Environmental Sustainability Research Centre

Niagara Adapts

Climate Vulnerability Fact Sheet

Niagara Adapts Partnership Overview

The impacts of climate change are already being experienced in Niagara and will only intensify in the future. In response, seven municipalities in the region have partnered with Brock University to develop and implement climate adaptation plans. Understanding vulnerability to climate change is a critical component of effective climate adaptation planning.

We asked representatives from each participating municipality what 'adaptation to climate change' means to them. This word cloud summarized their responses.

Vulnerability Assessment

Vulnerability is defined as susceptibility to harm arising from climate change impacts. This factsheet highlights the results from a baseline climate vulnerability survey conducted in the fall 2019.

Surveys were conducted face-to-face and online.

Respondents

1087 people completed the survey

63% female

37% male

Municipal Partners

Grimsby, Pelham, Lincoln, Niagara Falls, Niagara-on-the-Lake, St. Catharines, Welland

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Exposure to climate change in St. Catharines

82% of respondents believe **climate change is impacting their community**

70% of respondents have experienced **community flooding**

58% of respondents have experienced **extreme heat**

26% of respondents have experienced **extreme cold**

20% of respondents have experienced **severe weather**

Only **19%** of respondents feel that St. Catharines is prepared to adapt to climate change

Opportunities for adaptation

88% of respondents believe humans have the capacity to address climate change

For **61%** of respondents, adapting to climate change is a top priority for their households

88% of respondents support municipal resources being used for climate change adaptation

Household Flood Preparedness

21% of respondents have experienced **household flooding**

Only **19%** of respondents have a **sump pump**

Only **33%** of respondents use **rain barrels**

Only **47%** of respondents have household **flood insurance**

Note: Percentages reported on this page reflect the 340 people who completed surveys from St. Catharines.

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Niagara Adapts Program Brief: 2020-06.

Engagement #2 - Adaptation Plan Draft Vision and Goals Survey

A second survey was conducted in late 2020 to gather feedback on the proposed vision and goals of the Plan from both internal and external stakeholders. The survey was made available online through Niagara Adapts Qualtrics survey platform and provided through online communications channels, including the City's. The survey was first opened to internal staff in November 2020, and was then made available to the public for a two-week period in December.

Participants were asked to identify their role in St. Catharines, providing insight into which stakeholders were providing feedback. An almost even percentage of staff to residents completed the survey, see Table 2. Final number of survey response completed was 83.

Table 2: Second engagement survey demographics

Number of responses		
Municipal Staff	41	49.40 %
Resident	37	44.58%
Other	5	6.02%

Draft Vision

The draft vision for the City of St. Catharines' climate adaptation plan was:
St. Catharines will adapt to and mitigate climate change through the integration of plans, policies and procedures to ensure the City of St. Catharines remains innovative, sustainable and livable.

Stakeholders were asked to rank their level of support for the draft vision and provide qualitative feedback on the draft vision. Their responses are found below, see Table 3.

Table 3: Stakeholders' levels of support for the City of St. Catharines' draft vision for their climate adaptation plan (n=76).

Table 3: Results of second engagement survey

Number of responses		
Strongly disapprove	1	1.32%
Disapprove	3	3.95 %
Neither support or disapprove	6	7.89 %
Support	27	35.53 %
Strongly Support	39	51.32 %

Key highlights from the engagement on the vision that were considered in the new vision statement:

- Include the word "action" in some way
- It is not radical enough
- No, I think it's strong
- Mitigate should come before adapt in the vision

Draft Goals

All goals showed the highest response rate and percentages for 'strongly supported to supported' throughout. Many comments received were in line with the actions being proposed within the Plan. No changes were made to the goals from the outcome of this survey.

Final thoughts and feedback gathered on the survey was:

- Looks good I fully support climate goals
- Simple language, seems straight forward…
- I like where this is going
- This project is very necessary. It will require strong public support to mitigate the undue influence developers and climate change deniers have on many of the political officials in charge of implanting the proposals. I could not proofread so please forgive any errors.
- This is the issue of our times. The only mistake we can make is not doing enough.
- I think there needs to be more emphasis on mitigation, as the majority of these goals are about adaptation. We need both.
- I think the goals capture the significant areas that need to be considered moving forward
- We all need to work together to make this work thanks
- I greatly appreciate that the City of St. Catharines is taking climate change seriously and is taking steps to identify mitigation efforts as well as long term effects that may require disaster planning.

Engagement #3: Climate Adaptation Plan virtual online open house:

A third engagement took place over a two-week period in the spring of 2021 via the City's online engagement platform at engageSTC.ca. A virtual open house provided a two-way forum for the community to ask questions and provide comments on the entire draft Corporate Climate Change Adaptation Plan. Questions were answered by staff publicly for participants to review. This engagement was promoted through press release, local media, The Garden City Current e-newsletter, the City website and social media channels. A total of 35 written comments and questions were received.

Key highlights and comments from the engagement about the Climate Adaptation Plan:

- Many supported the Plan and its implementation
- A high prevalence of comments related to trees, plants, community gardens to support public and ecosystem health. Topics included increased tree canopy for shade, ecosystem services such as shoreline protection, carbon sequestration benefits, species selection and park naturalization initiatives (forests, meadows, drought tolerance, native species, reduction of mowing practices on roadsides, parks and/or right of ways)
- Questions inquiring into the definition of green infrastructure
- Comments pertaining to inclusion of blue and green roofs on City buildings and opportunities for the public; parking lots with permeable surfaces; and reductions of parking lots to add green space opportunities
- Questions about how the City will overcome barriers, such as funding to support climate action
- City sewage and stormwater system capacity with climate impacts, such as flooding or increased precipitation events on new and old assets
- Stronger wording on specific actions, such as "encourage and promote or where feasible"
- COVID-19 and climate change impacts to vulnerable populations and social justice inequalities.
- Comments that were generally outside of the scope of the Plan involved actions or topics around climate mitigation (reduction of greenhouse gases) and public or private sector actions. The comments that were out of scope for this plan however, could help inform future considerations and recommendations for the City.

General Communication and Outreach Tools

Various mechanisms for communication were used to reach and engage a wide audience in the Plan's development. Key highlights include:

- **Project webpage:** A dedicated climate change page was created on the City's website (http://www.stcatharines.ca/climatechange) to promote both mitigation and adaptation progress and actions.
- **Social media promotion:** A new hashtag, #OurGreenSTC, was developed and utilized to promote City wide environmental initiatives, in addition to the Plan.
- **E-newsletter advertisements:** Promotion of surveys that were a part of the development of the Plan were included in the City's existing e-newsletter, The Garden City Current.
- **In-person events:** pop-up events and booth settings offered early-on engagement in the Plan's process through one-on-one interactions that also supported other City initiatives.
- **Online platforms:** The EngageSTC page was utilized for the final engagement process of the plan. This offered a two-way communication process between staff and the public through a questions and answers format.

Appendix D
Climate Impacts, Risk and Vulnerability Results

The impact statement workshop was held in December 2019 where members of the Climate Adaptation Team developed impact statements relevant to their departments and/or general municipal impacts. The team identified a total of 58 impact statements. Once all impact statements were developed, the team identified which City departments the impact statements would negatively affect, directly or indirectly, or if there were any positive tradeoffs or opportunities. Consideration was also included for external stakeholders where applicable. The statements were later used to inform risk and vulnerability assessments that refined and prioritized the adaptation options, and the final actions recommended in this plan.

Impact Statements and Assessments

	Climate Variable	Impact Statement	Municipal Departments										Vulnerability Outcome	Risk Outcome
			CRCS	CSS	EDTS	EFES	FMS	FS	LCS	MW	CAO	PBS		
1	Increased precipitation	Increased spring rainfall will lead to increased combined sewer overflow events (sewage discharge events) resulting in more contamination of local creeks and Lake Ontario.				X				X			High	Medium
2	more days above 30°C	Outdoor workers and firefightersexperience increased risk of heat stress and decreased productivity due to summer heat waves	X	X		X		X		X		X	Medium-High	Medium-High
3	Increased heavy rainfall/ rainstorm events	More frequent flooding events affecting more residents and infrastructure (ex. overland flooding of low-lying roads, basement flooding)				X	X		X	X	X	X	Medium-High	Medium-High
4	Increased heavy rainfall/ rainstorm events	Due to increased overland runoff there will be increased maintenance of storm drainage systems (ex. Sewers, ditches)				X	O			X	O		Medium-High	Medium-Low
5	Increased heavy rainfall/ rainstorm events	Increase in extreme events resulting in property damage and higher insurance risk		O		X	X		X	X	O	O	Medium-High	Medium
6	Increased heavy rainfall/ rainstorm events	Higher Lake levels leads to increased erosion resulting in damage to shorelines and requiring increased shoreline protection.	X		O	X	O		O	X	X	O	Medium-High	Medium
7	more days above 30°C	Reduced usage and increased closure of beaches from increase in algae and bacteria from warmer lake temperatures	X			X				X			Medium-High	Medium-Low
8	More days above 30°C	Vulnerable populations (such as elderly, youth, renters, recent immigrants) will be negatively impacted due to heat stress requiring more City services.	X								X	O	Medium	Medium-High
9	Increased precipitation	Increased runoff will increase stormwater pollution and impair water quality				X				X	O	O	Medium	Medium-High
10	Increase in thunderstorm, heavy wind and rainstorm events	Cause more flooding or fallen tree limbs on transportation routes (ex. Road closures) resulting in delays to emergency response (response time and capacity)			O	X			O	O	X		Medium	Medium
11	Increased temperature	Ecological impacts to plants from increased heat stress, leading to less growth and higher mortality	X		O							O	Medium	Medium
12	Increase in thunderstorm, heavy wind and rainstorm events	Environmental damage from extreme weather events (ice storms, severe wind, snowstorms) causes infrastructure damage	O				O		O	X		O	Medium	Medium
13	Increased precipitation	High lake levels reduce the ability to use beaches and city facilities (Lakeside beach and park)		O	O		O			X	X		Medium	Medium
14	Increased winter precipitation	As wet snow or freezing rain increases the application of road salt will also increase, concerns to water quality				X	O		O	X			Medium	Medium-Low
15	Increased heavy rainfall/ rainstorm events	Increased erosion (ravines, trails) producing more sediment runoff into waterways and fish habitat				X				X			Medium	Medium-Low
16	Increase in thunderstorm, heavy wind and rainstorm events	Increase in infrastructure damages and more blackouts to affect St. Catharines network access	X	X						X			Medium	Medium-Low

Department Impacts Legend: x = Direct impact | o = Indirect impact | + = opportunity

Impact Statements and Assessments

	Climate Variable	Impact Statement	Municipal Departments										Vulnerability Outcome	Risk Outcome
			CRCS	CSS	EDTS	EFES	FMS	FS	LCS	MW	CAO	PBS		
17	Increased heavy rainfall/ rainstorm events	Vulnerable areas (low lying roads, shoreline embankments) negatively impacted by flooding (road and bridge damage, closures, or trails unpassable)				X				X			Medium	Medium-Low
18	Increased temperature	More invasive species due to expanded ecological range (terrestrial and aquatic species)	X							X			Medium	Medium-Low
19	Increased precipitation	City parks will experience more drainage issues due to increase of rain and reduction of use on sports fields	X	O		X	O			X			Medium	Low
20	More days above 30°C	Outdoor workers maybe exposed to more biohazards such as Mosquitos, Ticks etc.		X		X				X	X	O	Medium-Low	Medium
21	More days above 30°C	More days and attendees in cooling centers will require more staff at the centers	X	X									Medium-Low	Medium
22	more days above 30°C	Community will need more areas and amenities to escape the heat (cooling centers such as splash pads, beaches, shade shelters, community buildings, water fountains) due to urban heat island effects.	X		O	X	X			O		O	Medium-Low	Medium
23	More days above 30°C	Higher demand on air conditioning for community centers or rinks, which would result in higher energy consumption or repair/ maintenance costs	X			X	X						Medium-Low	Medium
24	increased winter precipitation	increased concern to keep people safe during winter travel for community and staff (i.e. Alternate work arrangements)		X						X	X		Medium-Low	Medium-Low
25	Less frost days, with increase in winter precipitation	Shorter winter control however could lead to more active winter control days due to type of precipitation (snow, freezing rain)							O	X			Medium-Low	Medium-Low
26	Increase in ice storms	Early fall ice storms cause increased repair and maintenance costs due to weight on trees with leaves still attached. Increased clean up by forestry department		O				O	O	X	O		Medium-Low	Medium-Low
27	Tropical Nights (nighttime temperatures >19°C)	Increased demand for air conditioning for longer periods causes more power outage throughout the community and/or City activities	X	X		O	O				X		Medium-Low	Medium-Low
28	Increase in thunderstorm, heavy wind, and rainstorm events	Damage to boats, pier, docks and marina infrastructure from extreme events and high lake levels	O			O			O	O			Medium-Low	Medium-Low
29	increase in ice storms	Ice conditions limit access to services for vulnerable populations (i.e. senior centers)	O					O		X			Medium-Low	Medium-Low
30	Increased winter precipitation	Will increase resources required for winter control and snow removal operations					O			X	O		Medium-Low	Medium-Low
31	Increase in thunderstorm, heavy wind, and rainstorm events	Increased debris on the roads and pathways block catch basins or culverts								X			Medium-Low	Medium-Low
32	Increase in thunderstorm, heavy wind, and rainstorm events	Increase in extreme events leaves businesses impaired and business continuity planning is needed			O						X		Medium-Low	Medium-Low

Department Impacts Legend: x = Direct impact | o = Indirect impact | + = opportunity

Impact Statements and Assessments

	Climate Variable	Impact Statement	Municipal Departments										Vulnerability Outcome	Risk Outcome
			CRCS	CSS	EDTS	EFES	FMS	FS	LCS	MW	CAO	PBS		
33	More days above 30°C	Reduced [economic] benefit from community staying inside during extreme heat (i.e. outdoor downtown shopping verse indoor shopping, reduced numbers to summer festivals)			X								Medium-Low	Medium-Low
34	Increased temperature	increase in summer taste/ odour problems and complaints in potable water supply		O		X							Medium-Low	Low
35	More days above 30°C	City trees, green spaces and sports fields will require more frequent watering (currently use treated city water)	X	X			O			X			Medium-Low	Low
36	More days above 30°C	Increase in irrigation costs [due to hotter temperatures] for developers, later affecting tenants or city costs	O			O	X			X		X	Medium-Low	Low
37	More days above 30°C	Due to more stress on equipment could cause increased rate of replacement of infrastructure (roads, bridges, centers, equipment)	X			X	O			X	O		Medium-Low	Low
38	more days above 30°C	Due to rising temperatures, working conditions and hours of operation for City outdoor workers may need to be modified (union conditions mandated)	X	X	O					X			Medium-Low	Low
39	Irregular rainfall patterns/ drought periods	Less summer rainfall may require more drought tolerant species selections for gardens and parks	X							O		O	Medium-Low	Low
40	Irregular rainfall patterns/ drought periods	Changes in rainfall patterns may impact agricultural sustainability and require increased reliance on farm irrigation water demand				O							Medium-Low	Low
41	more days above 30°C	School's could have an increase in closures due to increased temperatures, could affect staff members as they may require more time off for childcare		X									Medium-Low	Low
42	more days above 30°C	Outdoor working hours for construction impacted due to noise by-law (currently cannot perform work before set time in the AM)				X			X	X		X	Medium-Low	Low
43	Increased temperature	increased odour from algae at beaches during warmer summers		O		X				X			Medium-Low	Low
44	Increased temperature	increased pests during warmer summers and winters		O		X				X			Medium-Low	Low
45	Number of growing degree days	Longer growing season resulting in increase in maintenance (cutting grass) and staff time, increased financial costs	X							X			Medium-Low	Low
46	more days above 30°C	Increased incidence reports from water and food borne illnesses									X		Medium-Low	Low
47	Increase in thunderstorm, heavy wind and rainstorm events	Heavy storms increase hazardous conditions (severe wind, flooding, lightning)	O					X		X	X		Low	Medium
48	Increased temperature and drought periods	increase in demand on water supply due to summer drought periods leading to system capacity issues and stress on water sources (which could require issuing of water use restrictions)				X				X		X	Low	Medium-Low

Department Impacts Legend: x = Direct impact | o = Indirect impact | + = opportunity

Impact Statements and Assessments

	Climate Variable	Impact Statement	Municipal Departments										Vulnerability Outcome	Risk Outcome
			CRCS	CSS	EDTS	EFES	FMS	FS	LCS	MW	CAO	PBS		
49	Less cold days	Increase in tourism industry from longer shoulder season (OPPORTUNITY)			+								Low	Low
50	less ice days	Winter recreational activities reduced in the area (skiing, skating, ice fishing)	X										Low	Low
51	Dry Periods	Increase of dry periods could result in [urban] forest fires, which could impair air quality and worsen respiratory health issues	O					X			X		Low	Low
52	Decrease in freeze- thaw cycles	Decrease in frozen services and main breaks, including Fire hydrants less susceptible to freezing (OPPORTUNITY)				+		+		+			Low	Very Low
53	less ice days	Increased opportunity for active transportation within the city and higher uptake for cycling facilities (OPPORTUNITY)	+			+							Low	Very Low
54	Increased temperature	more landfill leachate during winter months				X							Low	Very Low
55	Number of growing degree days	Possible increase in agriculture yields (if not impaired by spring precipitation and/or summer drought) leading to increase in economic gains (OPPORTUNITY)			O								Low	Very Low
56	Increased temperature	Impact on local animals and wildlife due to habitat requirements changing and shifting climate zones (native verse non-native species)	X			X						O	Low	Very Low
57	Decrease in coldest day (<-15C)	Less frost in the ground, therefore reduced minimum standard cover on underground infrastructure (OPPORTUNITY)				+				+			Low	Very Low
58	Increased heavy rainfall/ rainstorm events	Increased weight/ possible damage to flat roofed buildings due to rain or wet snow loading	O			X	X			X		X	Low	Very Low

Department Impacts Legend: x = Direct impact | o = Indirect impact | + = opportunity

Appendix E
Implementation schedule

The implementation of the Plan will commence following the approval and adoption by St. Catharines City Council.

The following implementation schedule outlines the actions and the key information to put the actions into motion. Details include the action; description; department leading the action; supporting departments; current practice(s); anticipated timing for initiation based on City priorities; expected duration; and the frequency involved. Below are the categories for how each action was defined.

Duration

Short Term	1 to 2 Years
Medium Term	2 to 3 Years
Long Term	3-plus years
Ongoing	Actions that are already underway and will continue to be implemented

Frequency

One-time	Completed once, with minimal review into the future
Re-occurring	Based on the actions implemented could include annual, bi-annual or as specified
Ongoing	Actions that require ongoing work throughout the year

Estimated Resources: Costs

$	Low cost, $0 to $25,000
$$	Medium cost, $25,000 to $75,000
$$$	High cost, over $75,000
N/A	Cost is accounted for within existing (operational / capital) budgets

Staff Effort

X	Low intensity effort
XX	Medium intensity effort
XXX	High intensity effort

Implementation

Goal 1: Prepare for hotter summers

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
1	Review and assess measures in place to protect municipal staff from heat stress and maintain productivity	"Become more proactive in planning for increased summer temperatures and more frequent heat waves. Enacting a regular review of current measures in place across the corporation will ensure staff stay safe during heat waves. This will develop a more standardized Heat Guideline to allow departments with outdoor staff to discuss current policies, extreme heat procedures and consider opportunities for improvements.. Further consideration and approval of a Heat Health Policy and education on the signs and preventative measures for heat stress will also be incorporated into this annual review. "	CSS	MW, FS, EFES, FMS, CRCS, PBS	Heat guidelines are dependant on individual department procedures and are considered on an event by event basis.	2022	"Short term Re-occurring (annual basis)"	"Cost: $ Staff Effort: XX"	
2	Develop a public education and awareness campaign on ways to reduce heat stress, recognize heat exhaustion and further promote city services that are offered (e.g. cooling centers)	Ensuring St. Catharines citizens are prepared for rising summer temperatures and know how to reduce heat stress helps lower heat related vulnerabilities. In 2020, the City created a "Beat the Heat" strategy to help inform residents on behavioural changes they can make to help reduce heat related illness. Increasing and promoting personal resiliency such as 72-hour emergency kits and emergency guides also aids in heat related concerns. Increasing education for this initiative will take place via online social media, platforms, website, in person events and workshops offered to the public and local businesses.	Office of the CAO	MW, CSS, FS, CRCS, EFES	Existing cooling and heat centres are available at various locations around the city. Current educational information is included on social media related to severe heat warning and heat alerts as well as community centres.	On-going	"Medium Term Re-occurring (annual basis)"	"Cost: $ Staff Effort: XX"	
3	Determine the areas most vulnerable to extreme heat to inform city planning, services and programming initiatives	Determine the areas most vulnerable to heat extremes through a mapping exercise. This will provide visual 'hot spots' in the city where targeted services would have the greatest impact. This would help guide relevant actions such as increased tree planting efforts for more shade, need for cooling centers, water fountains/re-filling stations, swimming or splash pad locations or increased green space. This application could later be applied to identifying areas that could be targeted for community energy retrofit programs.	CRCS and EFES	MW, FS, EFES, PBS	Many parks, pools and splash pads exist throughout the city offering services for the community. This approach will take a deeper dive to consider if programs are offered in the most strategic areas. This will be in line with the Recreational Master Plan, Parks Policy Plan and Urban Forestry Management Plan.	2022	"Short Term One time with future evaluation if required"	"Cost: $$ Staff Effort: XX"	Yes
4	Continue to implement the Urban Forestry Management Plan and achieve Urban Canopy Target	The City is working towards a goal of 30 per cent canopy cover by the year 2030. Current canopy coverage within the urban boundary has been estimated at 22.5 per cent as of 2019. The Urban Forestry Management Plan (UFMP) outlines the action items necessary to be able to achieve target canopy goals including a robust tree planting program, public education and materials on tree stewardship, tree giveaway program, etc.	CRCS	MW, PBS	"Current Urban Forestry Management Plan is in place with the Tree Management Report. Currently the City plants trees on an annual basis with implementation from various departments. This includes 1,000 trees provided to residents at the annual Free Tree Giveaway."	On-going	"Long Term Re-occurring (based on plan review timeline)"	"Cost: N/A Staff Effort: XXX"	Yes
5	Implement and support the City of St. Catharines Horticultural Management Plan	The Horticulture Management Plan (HMP) will maximize resources; maintain and improve horticulture assets across the City; and prioritize assets based on guiding principles and service levels. The HMP will provide direction for the improvement, maintenance, and evolution of horticulture assets and programs, including specifics for site naturalization; community gardens; use of native, drought resistant plant material; and more.	CRCS	MW	Supports initiatives within the Parks Policy Plan and the Urban Forestry Management Plan.	2021 (pending council approval)	"Short Term Re-occurring (based on plan review timeline)"	"Cost: $ Staff Effort: XX"	Yes

Implementation

Goal 2: Prepare and respond to extreme weather events

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
6	Improve communications to the public regarding health and safety updates and concerns during extreme weather events (e.g. road conditions in the winter and heat alerts)	Extreme weather events can happen quite suddenly and having a flexible and effective communication tool(s) to inform the public is required. Currently the city shares reputable sources of information such as Environment Canada watches, warnings and inclement weather alerts through social media channels. Continuing this communication allows the city to inform the community of concerns not only related to weather, but any services that have been interrupted from local utility companies (main breaks, power outages, road conditions). This also provides an opportunity to promote city services offered (e.g. warming and cooling centers).	CSS	MW, EFES, FS	"Through various city communication outlets (website, social media accounts etc.) the communications teams shares updates and current safety concerns from reputable sources in a timey manor. This is apart of the communication strategy that the city has in place along with Emergency Management Practices. "	On-going	"Long Term On-going"	"Cost: $ Staff Effort: X"	
7	Ensure mutual aid agreements are practiced and receive continuous review	Continuously practice and review current mutual aid agreement to ensure any extreme events or emergencies can be responded to emergency standards effectively. This will involve communications with various municipalities and upper tier government to ensure effective plans and procedures are in place.	Office of the CAO		Mutual aid agreements are already in place with local municipalities and upper tier government	2023- 2025	"Medium Term Re-occurring, annual review"	"Cost: X Staff Effort: X"	
8	Ensure communication plans are in place between departments (e.g. environmental, operations, roads, parks, facilities and fleet) to provide efficient clean up after an extreme weather event (snow operations, fallen trees on power lines etc.)	Ensure relevant departments and staff are communicating before, during and after extreme weather events to provide effective response, maintenance and clean up. This allows city operations to anticipate how to respond effectively to extreme events (heavy rainfall events, high lake levels, fallen trees, ice storms).	MW	CSS, FS, Office of the CAO	Response and clean up crews are assembled on a case by case basis and assembled as needed to a perform reactive techniques and clean up.	2022	"Medium Term Re-occurring, annual review"	"Cost: $$ Staff Effort: XXX"	
9	Enhance corporate business continuity to continue to deliver essential services, even though extreme weather events	Due to COVID-19 City operations had to scale up teleworking capabilities (e.g. working remotely/working from home). Continuing to work through unordinary circumstances allows the city to further consider and enhance teleworking practices and paperless opportunities. Increasing teleworking also increases the City's adaptative capacity when faced with extreme events. By reducing overall road safety risks from commuting city staff, this allows emergency services and response crews to work more efficiently.	CSS	All departments	Through current Alternative Work Arrangements some telecommuting practices are already in place. The COVID-19 work from home guidelines is the most recent teleworking practice at the City. Due to the number of different roles of staff, not all staff can perform telecommuting practices.	on-going	"Long Term One-going"	"Cost: $ Staff Effort: X"	Yes
10	Review and develop an inspection policy for high-risk infrastructure to identify any damage from events	Through the asset management plan and upgrade / replacement of work manager, this will allow a more streamlined approach to identifying high-risk infrastructure. Having this readily accessible inventory will help identify high-risk infrastructure from previous events to help inform the response to future events. This will also help with procedures on how to respond to the situation and any necessary back up supplies or surplus inventory.	MW	EFES, FS, Office of the CAO, CSS	Through past practice and anecdotal information supplied reactive procedures are in place.	2022	"Long Term Re-occurring, based on Asset Management Plan"	"Cost: $$ Staff Effort: XXX"	

Goal 3: Develop a flood prevention strategy

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
11	Help residents take actions to protect against flooding including; improved grants for protective plumbing, increased awareness, promotion and supports	Undertake a review of existing grants through the FLAP program with the goal of helping residents make their homes more resilient. This includes shifting to a more proactive program, protecting properties before flooding occurs, as well as streamlining and simplifying the process. Once program has been reviewed and updated, promote the changes and improvements through online formats.	EFES	PBS, CSS	Current FLAP program has been delivered since 1995, and the structure of the program and requirements has only undergone minor changes	2021 (pending council approval)	"Short Term One-time, until updates required"	"Cost: $ Staff Effort: X"	
12	Develop and promote homeowner awareness of storm water best management practices and flooding protection, with consideration to new programs where applicable	Increasing homeowner education about basement flooding and what they can do to protect their property. This will result in the goal of increasing the community's adaptative capacity. This will allow homeowners to be prepared for and know how to respond to basement flooding events. Tools in various formats, such as a best management guide will be developed for lot-level controls as well as online videos, checklists, and presentations. Continuation of current incentive programs for homeowners (e.g. rain barrels, tree giveaway) will be utilized with consideration to new programs where applicable.	EFES	CRCS, CSS, PBS	Resources are currently available on the City's website.	2021	"Medium Term Re-occurring, until updates are required"	"Cost: $ Staff Effort: XX"	
13	Update and review Flood Management Plans	Encourage the update and review of watershed plans and flood mapping from the Niagara Peninsula Conservation Authority. This will allow the city to make up to date, informed decision-making.	EFES	MW, PBS	Use of flood plain mapping is currently in place and is provided by site specific watercourses.	on-going	"Long Term One time, until updates required"	"Cost: $ Staff Effort: X"	
14	Update and implement the Pollution Prevention and Control plan to reflect current best practices to reduce water pollution from combined sewer overflows	This study will evaluate the wastewater system with a focus on the areas of the City still serviced by combined sewers. This will include looking at ways to reduce the volume and frequency of overflows and provide long-term strategies for the effective management of the wastewater system. Updated Intensity Duration Frequency (IDF) curves are included in the scope of this plan.	EFES	MW, FMS	The Pollution Control Plan (PCP) was completed in 1990 and most recently updated in 2008. The current update will summarize the recommendations implemented to date, revaluate CSO control alternatives and update the long-term strategy for the management of the City's CSO and wastewater collection system.	2021	"Long Term Re-occurring (every 5 years)"	"Cost: $$$ Staff Effort: XXX"	

Implementation

Goal 4: Prepare and respond to extreme weather events

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
15	Continue to undertake rehabilitation and restoration efforts in local watercourses to reduce erosion	With increased heavy rain events ensuring our local waterways remain stable and healthy, the City should promote and use restoration efforts. This will reduce erosion and runoff while enhancing local biodiversity, reducing long-term maintenance costs, and preventing damage to infrastructure.	EFES	MW, CRCS	Watercourse Flooding and Erosion Control Priority Studies are done on a regular basis and identify priority watercourse sites that need rehabilitation.	On-going	"Long Term On-going"	"Cost: $$$ Staff Effort: XX"	
16	Complete the Storm System Master Servicing study	The Storm Water Management Master Plan would assess the current state of the stormwater system and identify deficiencies. This plan would include reviewing major and minor flow routes. This will help inform proactive decision-making in terms of identifying projects to reduce surface flooding affects, high-risk infrastructure areas and identify opportunities for low impact development practices.	EFES	MW, PBS	Stormwater infrastructure has different standards based on when it was built and by whom. Over time standards have changed resulting in various types of systems. In addition, many retrofits have occurred over time to improve system performance and have aimed efforts to where there is aging infrastructure, which tends to decrease performance.	2021	"Long Term Re-occurring, every ten years"	"Cost: $$$ Staff Effort: XXX"	
17	Encourage and promote the use of Low Impact Development in corporate renewal projects and in new developments, to increase water quality to local waterways	Incorporate Low Impact Development (LID) into projects to help collect rainwater, improve water quality, and divert water away from storm sewers should be considered where possible. This will result in more green-based solutions for site controls. This should be implemented first by the City, though a 'lead by example' approach to make developers aware of low impact development practices. Examples can include low impact development/ green infrastructure, green roofs and rain collection systems. This will provide opportunities to reduce discharges via point source and nonpoint sources to local waterways and ultimately help make the system more resilient.	EFES and PBS	MW, PBS	"Currently through the development planning process, there is a requirement that post-development flows do not exceed pre-development flows and some projects may incorporate LIDs. Environmental Assessments may also have site specific considerations for LID. LIDs have been incorporated and implemented on municipal property based on an Ad-hoc basis."	2023	"Medium Term On-going"	"Cost: $$ Staff Effort: XX"	Yes

Implementation

Goal 5: Prepare for high Lake Ontario water levels

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
18	Continue to enhance and maintain municipal shoreline protection by following the recommendations of the St. Catharines Shoreline Review	Following the direction of the St. Catharines Shoreline Review implement critical shoreline infrastructure updates to prevent shoreline and beach erosion from lake effects and climate change impacts.	EFES		Priority projects are identified based on information from the City of St.Catharines Shoreline Review	On-going	"Long Term On-going"	"Cost: $$$ Staff Effort: X"	
19	Ensure amenities at beaches and waterfront parks are above revised high lake levels and/or design features to be resilient to higher lake levels	Previous high lake levels highlighted several infrastructure vulnerabilities that posed safety risks, closed parks to public use and damaged areas of cultural significance. The implications for high lake levels in the future will identify those vulnerabilities and put in place response measures for the future. Options will be identified to make infrastructure more resilient to higher lake levels.	EFES	MW, CRCS, PBS	"Setback restrictions are in place through the local conservation authority. For highwater level events, reactive measures such as the use of sandbags are used by MW staff. "	"2021 (pending NDMP funding)"	"Long Term On-going"	"Cost: $$$ Staff Effort: XXX"	

Goal 6: Re-think how the City addresses Climate Change

#	Action	Description	Lead Dept.	Supporting Dept.	Current Practice	Anticip. Start	Duration/ Frequency	Est. Resources	Mitigation Co-benefit
20	Establish a 'green' interdepartmental team	The interdepartmental team could implement various smaller tasks that would help the corporation reach a broader level of resilience actions including but not limited to; overseeing a climate change literacy program to departments, waste management tasks and promote climate change resilience to the City. The team could also oversee the proposed adaptation actions, with future monitoring and evaluation. This initiative would be considered a long term and active working group/ team to help drive corporate sustainability and climate resilience.	EFES	All departments	Currently there are various short-term staff working groups that are formed for a specific purpose such as the Climate Adaptation Team and the team that worked on the Waste Management Strategy.	2021	"Long Term On-going"	"Cost: $ Staff Effort: XX"	Yes
21	Develop a green reserve fund and seek available funding from different levels of government and non-government grants to advance climate change efforts	Developing a green reserve fund will strengthen the City's commitment to improving the environmental sustainability of the City. In addition, seeking new funding opportunities to help advance the city's adaptation and mitigation actions will be a priority as well. This will not only allow more actions to occur but will possibly allow projects to scale up in size, reach a higher-level goal with overall greater impact with smart economic responsibility in mind.	EFES and FMS	CAO	The Energy Conservation and Demand Management Plan has also recommended a green reserve fund, which was accepted by council. Anticipated timing of approval for a Green Reserve fund is expected for in the first half of 2021.	2021	"Short Term One time, to create the fund"	"Cost: $ Staff Effort: XX"	Yes
22	Incorporate climate change into the Corporate Asset Management Plan	Incorporating a detailed climate change assessment into key corporate assets, including stormwater and wastewater, will provide a process for identifying and prioritizing various infrastructure vulnerabilities. This not only will help to identify areas of improvement; this will reduce the overall risks known to the systems.	EFES	MW, FMS, CRCS	The City adopted and Asset Management Policy in April 2019. The Policy states: "The City will consider the impacts of climate change upon its assets, particularly how climate change may impact the operation of assets, levels of service, asset life cycle management, and the associated costs related to these areas. The City will balance the risks and vulnerabilities to climate change with the cost of reducing these vulnerabilities. The climate adaption strategies responding to these vulnerabilities will include disaster planning, emergency response plans, and financial contingency planning."	2021	"Short term Re-occurring, based on Asset Management Plan"	"Cost: $$$ Staff Effort: XXX"	Yes
23	Develop a strategy to include green infrastructure into the corporate asset management plan	Implement an integrated approach to asset management that includes both built infrastructure and natural assets will require the development of a strategy on how to incorporate them into corporate asset management planning. This will include assessing the information available and any gaps in inventory data, review of methods for placing a value (e.g. replacement cost vs cost of similar services) on green infrastructure and linking to the services they provided, establishing life cycle costs and risks.	EFES and FMS	MW, CRCS	Green infrastructure is reviewed through several plans. Work is often reactive and not linked clearly to levels of service. This is integrated in city operations through urban forestry, horticultural assets, water courses and shoreline protection.	2023	"Long Term Re-occurring, based on Asset Management Plan"	"Cost: $$$ Staff Effort: XXX"	Yes

Implementation	Goal 6: Re-think how the City addresses Climate Change								
24	Develop and implement a climate change lens tool	To continue to help the corporation meet its climate goals a climate change lens tool will be developed. This will better align municipal actions with the corporate climate goals. This will ensure that all departments consider climate change in the decision-making process. Maladaptive actions and corporate sustainability need to be considered in any significant new or renewal projects (e.g. energy and water conservation techniques).	EFES, LCS	All departments	"There is currently an environmental section that is included in council reports, that informs council decision making. The City's Strategic Plan identifies climate change and its considerations into corporate plans and practices. "	2023	"Short Term One-time, with updates as required"	"Cost: $ Staff Effort: XX"	Yes
25	Develop and implement a Green Procurement Policy	Municipalities have a large role in the purchasing power of goods and services. Developing and implementing a green procurement policy or plan will allow the same climate conscious decision making to take place through the procurement process specifically.	EFES and FMS		The City remains committed to the purchase of goods and services with due regard to the preservation of the natural environment and encourages the use of environmentally friendly products and services.	2022	"Medium Term One-time"	"Cost: $ Staff Effort: XX"	Yes
26	Regularly review climate projections and incorporate considerations into corporate plans, policies, and procedures	Maintain and update climate projections as new information becomes available. Ensuring the most up to date information is used will provide a clearer indication if the city greenhouse gas targets will be viable, programming or services are still relevant and if any new considerations arise for additional plans, policies, or procedures.	EFES	All departments	Stormwater plans have IDF curve considerations built into them, however not broad climate projections and not all staff use this information across the corporation.	2022	"Medium Term Re-occurring (annual or bi-annual review)"	"Cost: $ Staff Effort: X"	Yes
27	Promote the updated environmental considerations to developers included in the new Community Improvement Plan	The updated Community Improvement Plan includes new programs and a modified point system that holds a stronger emphasis on sustainable site design and public areas with streetscape contributions. Informing developers and promoting these new inclusions will help demonstrate the sustainable, green investment the City wants to promote to become a more sustainable community.	PBS	CSS	"The new Community Improvement Plan (CIP) was updated and approved in November of 2020. The previous Community Improvement Plan was in place from 2004 to 2019 where a focus was placed on brownfield development and building facades. The current Community Improvement Plan considers the St. Catharines Official Plan, Regional Plan and Provincial Policies. "	2021	"Short Term On-going"	"Cost: $ Staff Effort: X"	Yes
28	Use partnerships to address climate change considerations in food-security communications and programming such as the community gardens	St. Catharines has an established community garden network that has expanded over the years from community participation and interest. Incorporating climate change considerations and messaging can increase public knowledge through these networks. By expanding the education of food-security this can reach further networks to help increase public knowledge of the importance of local food systems and the support they offer to the local community and vulnerable populations.	CRCS	CSS	Current community gardens are in place around the city but more climate change promotion or education could be included into the programming. The Community Garden Policy provides the framework for these gardens.	2021	"Short Term On-going"	"Cost: $ Staff Effort: X"	

Appendix F
Monitoring and Evaluation Metrics

Included in the table below (Table 4) are possible monitoring and evaluation metrics per goal and action. These indicators will need to be revisited with the lead departments and revised as the actions are implemented and progress has occurred. This component of the Plan will help monitor and evaluate the overall success of the Plan's goals.

Table 4: Examples of possible indicators by goal and action

Goal 1	
Actions	**Examples of possible metrics**
1	• Number of days over 30 degrees Celsius or extreme heat days (EFES) • Number of incidences of staff heat stress reported in a year or lost time injuries (HR) • Number of training programs delivered (managers of various departments) • Progress of heat review with City departments (HR)
2	• Number and total capacity of cooling centers (CRCS) • Number of attendees at the centers per year (CRCS) • Number of social media posts related to combating heat stress (CAO)
3	• Number of services added from the outcome of the extreme heat vulnerability mapping action (CRCS) • Average distance to cooling centers from known hot spots / vulnerable population locations (CRCS)
4	• Percentage of urban forest canopy coverage (CRCS) • Number of community engagements (events, workshops etc.) (CRCS) • Number of trees supplied for Annual Tree Giveaway (CRCS)
5	• Progress of Horticultural Management Plan (CRCS)

Table 4: Examples of possible indicators by goal and action

Goal 2

Actions	Examples of possible metrics
6	• Progress of grant program re-evaluation (EFES) • Number of reported properties experiencing flooding (EFES) • Number of households participating in the FLAP program (EFES)
7	• Number of webpage views for home flood protection resources (CAO) • Number of events held in person to promote resources (booth events, workshops etc.) (EFES)
8	• Number of areas that require updated mapping (EFES) • Number of areas that have updated mapping (EFES)
9	• Progress of the Pollution Prevention and Control Plan (EFES) • Percentage of days in the summer when beaches have acceptable water quality and are safe for swimming (EFES) • Percentage of wet weather flows captured and treated at a wastewater treatment plant (EFES)

Table 4: Examples of possible indicators by goal and action

Goal 3

Actions	Examples of possible metrics
10	• Number of sites restored annually (EFES) • Length (m) of watercourse restored annually (EFES)
11	• Progress of the Stormwater Management Master Plan (EFES)
12	• Progress of a LID toolbox or best practices (EFES) • Progress of City LID Inventory (EFES) • Progress of educational plan / materials for LIDs (EFES)

Table 4: Examples of possible indicators by goal and action

Goal 4

Actions	Examples of possible metrics
13	• Length (km) of protected shoreline (EFES) • Length (km) of unprotected shoreline (EFES) • Length (m) of shoreline protection enhanced annually (EFES)
14	• Number of nearshore City property and facility closures (annually) (MW)

Table 4: Examples of possible indicators by goal and action

Goal 5	
Actions	**Examples of possible metrics**
15	• Number of social media posts related to extreme weather advisories (CAO)
16	• Number of meetings held to review the mutual aid agreements (CAO- Emergency Management)
17	• Number of extreme events that occurred (annually) (MW / CAO- Emergency Management) • Number of extreme events that required/ followed the coordinated response plans (MW)
18	• Number of City closures due to extreme weather events (HR / CAO- Emergency Management)
19	• Number of high-risk infrastructure classes or cases (MW) • Number of high-risk repairs or maintenance inspections to be completed (MW)

Table 4: Examples of possible indicators by goal and action

Goal 6	
Actions	**Examples of possible metrics**
20	• Progress of team development (EFES) • Number of meetings held annually (EFES) • Number of initiatives lead or completed by the team annually (EFES)
21	• Progress of the annual reserve report to council (March) (FMS) • Progress of the green reserve fund allocation (EFES)
22	• Number of assets that include a climate change assessment (EFES)
23	• Progress of a green infrastructure asset management strategy (EFES) • Triple bottom line (EFES)
24	• Progress of the climate change lens tool (EFES) • Number of presentations made on the climate lens tool (EFES) • Progress of climate change considerations into city and council decisions (EFES)
25	• Progress of the green procurement policy (FMS)
26	• Number of engagement points to internal staff (EFES) • Progress of climate change projection data updates (EFES)
27	• Annual report to council: number of proposals collected that included sustainable site design aspects (PBS)
28	• Number of community gardens (CRCS) • Number of new plots established (CRCS) • Number of residents involved / reached (CRCS)

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