

# CLIMATE-READY CITY

## CITY OF THUNDER BAY CLIMATE ADAPTATION STRATEGY

December 2015

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# EXECUTIVE SUMMARY

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Thousands of scientists around the world are warning that the Earth's climate system has been changing in an unprecedented way since the 1950's. The impacts of these large changes in weather patterns are already being felt globally and locally. Prolonged heat waves, torrential rainstorms, windstorms, and droughts are increasing throughout Ontario. In Thunder Bay, severe storms, extreme rain events, and the extreme cold temperatures experienced in recent years show that these types of impacts have the potential to affect all City Departments and can incur high costs to the community as a whole.

Over 170 people including members of City Council, City managers and staff, key professionals and stakeholders, and EarthCare community partners have been engaged in the development of the City of Thunder Bay Climate Adaptation Strategy.



In the face of climate change, the City of Thunder Bay recognizes the need for adaptation. While mitigation is necessary to reduce the rate and magnitude of climate change, adaptation is essential to reduce the damages from climate change impacts that cannot be avoided. Integrating climate adaptation across the Corporation provides an opportunity to coordinate decision-making and planning efforts in order to reduce vulnerabilities and build resilience in all departments, thereby minimizing the severity of the resulting impacts and taking advantage of opportunities.

The City of Thunder Bay has opted to utilize ICLEI Canada's (Local Governments for Sustainability) internationally-recognized municipal planning process, the Building Adaptive & Resilient Communities (BARC) Five Milestone Framework, and tailor it to the City's priorities to develop this Climate Adaptation Strategy. Using the ICLEI methodology, the City endeavoured to create a strategy led by the Corporation while incorporating multi-stakeholder involvement.

The development of this strategy centred on workshops and engagement activities that leveraged expertise and local knowledge of City Council, City managers and staff, service sector professionals, key community stakeholders and EarthCare community partners. In total, over 170 people have been engaged in the development of the City's Climate Adaptation Strategy to ensure that it aligns with existing organizational priorities and can be integrated within departmental functions.

The focus of the Climate Adaptation Strategy is to build on the City's existing strengths and align current resources to increase the resilience of the Corporation from a strategic perspective. The goal is to build resilience within the Corporation to reduce the risks inherent in climate change and

take advantage of opportunities while building upon existing adaptive actions to help the City prepare for, respond to, and recover from the potential impacts of climate change with an emphasis on increasing the resilience of infrastructure and the natural environment.

Hundreds of potential climate change impacts were considered for the City of Thunder Bay. Out of these, nine priority impacts were systematically identified and used to develop goals, objectives and key principles. Through analysis and prioritization, a total of 45 potential adaptation actions were identified.

While identifying the City's adaptive actions, several unifying themes emerged and offered a clear direction for the City to move forward with implementation. Thus, the following seven strategic directions were established:

- Integrate climate adaptation considerations into plans, policies, procedures, projects, and investment decisions;
- Assess potential threats to understand the risks of climate change impacts;
- Increase the resilience of municipal infrastructure and natural landscapes;
- Provide information, tools, and training on climate adaptation to facilitate and accelerate action;
- Plan for the financing and long term implementation of adaptive actions;
- Investigate opportunities to increase the resilience of the region through networks and strategic collaboration; and,
- Continue to plan for efficient response and recovery to extreme weather events.

The adaptation actions were analyzed from the lens of implementation to identify resources required to move forward. Short-term actions, i.e. those requiring less than two years to implement, were identified as 'quick wins' that can be used to build a sense of success and momentum. In comparison, longer-term actions will require ongoing and collaborative efforts

over a number of years to achieve success.

The Climate Adaptation Strategy reflects the significant commitment of the City of Thunder Bay to addressing climate change impacts. It is a long-term initiative that will require participation and engagement across all City Departments as well as collaboration amongst community stakeholders in order to successfully achieve the City's climate adaptation vision. An implementation framework was developed to provide a detailed roadmap with which to move forward in putting the adaptation opportunities identified into action.

The successful implementation of the strategy will require multi-year commitment of resources although the level of resources needed may change throughout implementation to reflect existing decision-making processes, evaluation, annual review, budget, and external factors. A number of key elements have emerged for consideration as the City moves forward into implementation and ongoing refinement of the Strategy including ongoing collaboration and partnerships, the need for staffing and resources, long-term governance, and emerging opportunities.

The Climate Adaptation Strategy is intended to be a living document and will continue to be revised and updated as climate change science and adaptation practices evolve. As the first Climate Adaptation Strategy for the City of Thunder Bay, many of the proposed actions focus on increasing understanding of coming challenges, identifying potential gaps, and integrating climate change into current processes to incorporate resiliency into existing everyday operations and long-term planning. The actions proposed herein are intended to be mainstreamed into regular municipal functions in a way that integrates climate adaptation as a core function within the Corporation.

# MESSAGE FROM THE MAYOR

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On behalf of City Council, I am pleased to present to you the City of Thunder Bay Climate Adaptation Strategy. In recent years, we have seen that the impacts of climate change can be costly to the community

as a whole as we experienced major storms with large hail and extreme winds in 2011, the extreme weather event that caused the City to declare a state of emergency in 2012, major snow storms in the springs of 2013 and 2014, and extreme

cold temperatures that added stress on our water utilities during the past two winters.

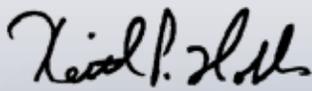
With extreme weather events becoming more and more common, the City of Thunder Bay is recognizing the need to plan for climate change impacts and is emerging as a regional leader in climate adaptation. This strategy is about becoming climate-ready to protect our city, our homes, our natural surroundings, and our well-being.

The goals, objectives, and actions presented in this strategy will guide the City of Thunder Bay as we prepare for, respond to, and recover from the impacts of climate change. These are both achievable and necessary if we are to become more resilient to the new challenges we face as a result of changing weather patterns.



A prosperous and more resilient city doesn't come from a plan, but through acting on it. That is why one of the goals of the City of Thunder Bay 2015-2018 Corporate Strategic Plan is to become a leader in climate change adaptation. Our Council and City Administration recognize the need to act on climate change impacts and this commitment is reflected in this strategy. With the support of the community, I believe that Thunder Bay can truly become a climate-ready city.

I hope that while you learn what the City is doing to adapt to climate change, you will also be inspired to take action. Together, we can continue to transform our city to make it its best.



Mayor Keith Hobbs  
City of Thunder Bay

*In 2014, the City of Thunder Bay answered a call-to-action from the Great Lakes and St. Lawrence Cities Initiative to demonstrate the City's commitment to climate adaptation action within the Great Lakes basin.*



# THUNDER BAY IS ALREADY SUPERIOR BY NATURE, AND THIS STRATEGY CAN MAKE OUR CITY EVEN BETTER.

We live in a beautiful City built on the Canadian Shield, removed from the risks of earthquakes, landslides, tsunamis, hurricanes, and sea level rise. We are surrounded by natural resources, agricultural land, forests, and we live on the shore of the largest fresh water lake in the world which provides us with abundant clean drinking water and an amazing quality of life. By proactively planning for climate change, we not only reduce our vulnerabilities, but also position ourselves to become a sustainable and resilient City with a prosperous future.

# ACKNOWLEDGEMENTS

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Strong leadership from City Council and the Executive Management Team has been driving the City of Thunder Bay's commendable work on climate adaptation. The Mayor and Council, City staff, key stakeholders, EarthCare Advisory Committee, and community partners have all made valuable contributions to the City of Thunder Bay Climate Adaptation Strategy. The on-the-ground experience and insights provided by those who live and work in Thunder Bay have contributed to the development of robust and relevant goals, objectives, and actions to address local climate change impacts. The City of Thunder Bay would like to thank all those who contributed to the development of the Climate Adaptation Strategy and acknowledge the following individuals for their dedication to climate adaptation:

## PROJECT TEAM

Darrell Matson, General Manager of Infrastructure & Operations (Retired), City of Thunder Bay

Kerri Marshall, General Manager of Infrastructure & Operations, City of Thunder Bay

Michelle Warywoda, Acting Director of Environment, City of Thunder Bay

Sarah Kerton, Sustainability Coordinator, EarthCare, City of Thunder Bay

Brad Doff, Sustainability Coordinator, EarthCare, City of Thunder Bay

Curniss McGoldrick, Climate Adaptation and Communication Coordinator, EarthCare, City of Thunder Bay

## STEERING COMMITTEE

Ken Allan, Director of Health Protection, Thunder Bay District Health Unit

Gerry Broere, Director of Asset Management, City of Thunder Bay

Thora Cartlidge, Senior Planner, City of Thunder Bay

Tammy Cook, Watershed Manager, Lakehead Region Conservation Authority

Kayla Dixon, Director of Engineering, City of Thunder Bay

Wayne Fletcher, Citizen

Moira Gallagher, Budget & Planning Accountant and Financial Analyst, City of Thunder Bay

Don Stokes, EMS Deputy Chief, City of Thunder Bay

Shelley Vescio, City Forester, City of Thunder Bay

*The development of the City of Thunder Bay's Climate Adaptation Strategy was in part funded by the Ontario Ministry of Environment and Climate Change; however, the views expressed in this report are the views of the City of Thunder Bay and do not necessarily reflect those of the Province.*

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## ACRONYMS

**BARC** Building Adaptive & Resilient Communities

**ICLEI** Local Governments for Sustainability

**MCA** Multi-Criteria Analysis

**MECG** Municipal Emergency Control Group

# 1.

# INTRODUCTION

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The impacts of climate change have the potential to affect all City Departments and their ability to deliver services. In the face of climate change, it is evident that the City must take action to increase its adaptive capacity and resilience. While mitigation is necessary to reduce the rate and magnitude of climate change, adaptation is essential to reduce the potential for damages that cannot be avoided and take advantage of opportunities.

**“This is not just about coping  
with climate change, but  
prospering through it.”**

— Canada’s National Round Table on  
the Environment and Economy, 2012



# 1.1. OVERVIEW

Recognizing the need to integrate climate adaptation across the Corporation of the City of Thunder Bay provides an opportunity to coordinate decision-making and planning efforts, in order to reduce vulnerabilities and build resilience in all departments.

*The vision of the Climate Adaptation Strategy is to build community resilience to reduce the risks inherent in climate change and take advantage of opportunities while building upon existing adaptive actions.*

## THUNDER BAY'S COMMITMENT TO CLIMATE CHANGE ADAPTATION

The City of Thunder Bay recognizes the need for climate adaptation in addition to ongoing mitigation and sustainability efforts. The City has been implementing mitigation measures since 2007 through the [EarthCare Sustainability Plan](#) and has made the commitment to transition to a carbon-neutral future beginning with a reduction of greenhouse gas emissions by 20% below 2009 levels by 2020<sup>1</sup>. However, the scientific community has warned that the world will experience further changes in climate regardless of future greenhouse gas emission scenarios.<sup>2</sup>

While mitigating emissions remains necessary to avoid catastrophic change, adaptation to the risks posed by climate change is key to minimizing their immediate impacts.<sup>3</sup>

The need to proactively plan for climate adaptation has become a priority for the City of Thunder Bay and is supported by the Mayor, Councillors, City staff, citizens, community stakeholders, regional groups, the Government of Ontario, and the Government of Canada. The work currently being done in Thunder Bay on climate adaptation has been recognized as an example of progressive municipal governance. It is an opportunity for the City to place itself amongst leaders and capitalize on opportunities related to climate change, while proactively planning to reduce risks, save resources, and continue to offer a high quality of life for residents of Thunder Bay.

## WHY DEVELOP A CLIMATE ADAPTATION STRATEGY

The impacts of climate change have been recognized as an important issue in Canada, Ontario, the Great Lakes Region, and for the City of Thunder Bay. Ontario's Great Lakes Strategy (2012) lists climate change as one of the main challenges facing the cities in the Great Lakes basin<sup>4</sup> and the Government of Ontario is taking measures to adapt to the unavoidable impacts of changing weather patterns.

The Ontario Ministry of Environment and Climate Change released a climate adaptation strategy and action plan in 2011 and a discussion paper in 2015 to address climate impacts and climate change in the province. Both documents acknowledge that adapting to climate change goes beyond the mandate of any one ministry, and recognize the need for adaptation in the communities where the consequences are felt.<sup>5</sup>

The Lake Superior Climate Change Impacts and Adaptation Report (2014), completed under the Lakewide Action Management Plan, also states that it is important for stakeholders and partners in the Lake Superior region to work together to adopt and implement climate management strategies based on current knowledge, and to gather information to inform future climate change adaptation actions.<sup>6</sup>

It is widely recognized that the impacts of climate change affect the services and infrastructure of local governments. Thankfully, municipalities possess many of the tools necessary to increase resilience such as emergency response groups, standards, codes, and official plans. The 2014 Ontario Provincial Policy Statement makes reference to climate change in a number of policies and mandates local planning authorities to support climate change adaptation through land use and development decisions.<sup>7</sup>

Ultimately, the purpose of developing a Climate Adaptation Strategy for the Corporation is to: 1) identify the potential impacts related to climate

A survey conducted in 2013 found that 70% of citizens felt they had already experienced the impacts of climate change in Thunder Bay.<sup>8</sup>



change in Thunder Bay and the risks they pose to our various service sectors and to our community; and, 2) propose possible actions to reduce risk and vulnerability associated with climate change impacts through adaptive measures.

The strategy will complement existing municipal processes as well as ongoing climate adaptation initiatives of the Province of Ontario and will serve as a resource for other municipalities in Northern Ontario, particularly along Lake Superior's North Shore. Having a Climate Adaptation Strategy will also place the City in a strong position to access potential sources of funding as the federal and provincial governments integrate climate change adaptation and resilience considerations in infrastructure and asset planning decisions.<sup>9,10</sup>

## 1.2. OUR APPROACH

Municipalities of all sizes across Canada are employing planning processes to adapt to the realities of climate change. As the field of climate adaptation planning evolves, the range of approaches that communities may choose to employ also expands. Adaptation plans must be relevant to local circumstances, resources, and capacity.

### ABOUT THIS STRATEGY

This Climate Adaptation Strategy was developed for the Corporation of the City of Thunder Bay. The information presented in the strategy brings together outcomes from over two and a half years of work. It is intended to be a living document and will continue to be revised and updated as climate change science and adaptation practice evolves. As the first Climate Adaptation Strategy for the City of Thunder Bay, many of the proposed actions focus on increasing understanding of challenges, identifying

potential gaps, and integrating climate change into current planning, design, and emergency management practices to build on existing strengths and incorporate resiliency into everyday operations as well as infrastructure investments. The strategy and the actions proposed herein are intended to be mainstreamed and integrated into regular municipal functions.

*Adaptation is defined as the initiatives or measures to reduce the vulnerability of human and natural systems to the actual or anticipated effects of climate change*

— IPCC, 2007

## ICLEI'S FIVE MILESTONE FRAMEWORK

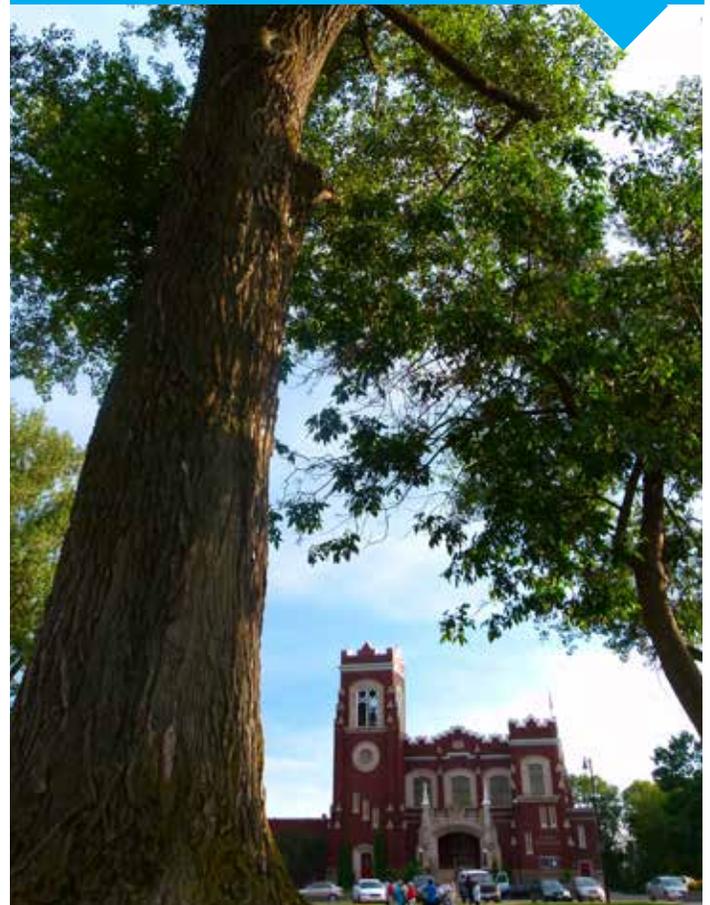
The City of Thunder Bay has opted to utilize ICLEI Canada's (Local Governments for Sustainability) Building Adaptive & Resilient Communities (BARC) Five Milestone Framework, and tailor it to the City's priorities. Using the ICLEI methodology, the City of Thunder Bay has embarked on an internationally-recognized municipal planning process to create a strategy that is led by the Corporation while incorporating multi-stakeholder involvement. The BARC Five Milestone methodology provides a structured approach to adaptation planning which moves local governments through a series of progressive steps where each milestone builds on the findings of the

one before as illustrated in [Table 1](#). By following ICLEI's approach, local governments develop an understanding of the regional and infrastructure challenges they face. The five-milestone process is outlined in ICLEI's *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation*.

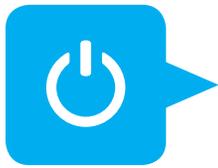
The City of Thunder Bay joined the BARC Program in October 2012, and EarthCare has been leading the development of the Climate Adaptation Strategy with the support of City Council since September 2013.

### ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI is an international non-profit that has established itself as a leading organization and expert in climate change planning.



**Table 1: Five Milestone Framework.**



MILESTONE #1:  
**INITIATE**



- Build corporate and community support
- Identify stakeholders
- Identify potential impacts and existing adaptation



MILESTONE #2:  
**RESEARCH**



- Review climate change science for the region
- Conduct vulnerability and risk assessment
- Identify priority impacts



MILESTONE #3:  
**PLAN**



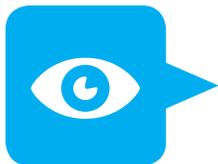
- Establish goals and objectives
- Identify and prioritize actions
- Develop monitoring and evaluation strategy
- Identify indicators
- Draft implementation framework



MILESTONE #4:  
**IMPLEMENT**



- Adopt Climate Adaptation Strategy
- Develop detailed implementation plan
- Implement actions



MILESTONE #5:  
**MONITOR/  
REVIEW**



- Track implementation progress
- Evaluate effectiveness with indicators
- Report on progress and accomplishments
- Review annual work plan and prioritization of actions
- Assess new information
- Review Climate Adaptation Strategy



## A COLLABORATIVE APPROACH

Enhancing awareness and building capacity have been cornerstones to the City's approach to climate adaptation planning, bringing together key community stakeholders, municipal decision-makers, and cross-jurisdictional partners to shape the City's Climate Adaptation Strategy.

The climate change impacts, goals, objectives and actions presented in this strategy have been centred on workshops and engagement activities that leveraged expertise and local knowledge of City Council, City managers and staff, service sector professionals, key community stakeholders, and EarthCare community partners to ensure that the overall strategy aligns with existing organizational priorities and can be integrated within departmental functions. These collaborative efforts have been instrumental to strengthen existing partnerships, to draw on community expertise, and to identify where additional engagement may be required to implement the adaptation actions identified.

In total, over 170 people have been engaged in the development of the City's Climate Adaptation Strategy. A strong collaborative approach was followed to ensure:

- Local knowledge integration;
- Involvement of decision-makers and City staff, and stakeholder engagement throughout the process;
- Reflection of practical needs and fiscal realities of the City; and,
- Integration of actions into existing plans and policies.

## MILESTONE ONE: INITIATE

Milestone One was completed in March 2014 by identifying stakeholders, building internal capacity, and communicating with stakeholders. A total of 12 Climate Adaptation Workshops were held from December 2013 to May 2014 as the first step in the development of the City's Climate Adaptation Strategy. Workshop participants were asked how changes in climate or weather patterns would impact Thunder Bay's various sectors including:

- Environment & Sustainability;
- Lifestyle & Culture;
- Local Economy & Growth;
- Public Administration & Governance;
- Community Health & Safety; and,
- Utility Services & Municipal Infrastructure.

A total of 46 potential impacts were identified through this process. Internal and external stakeholders as well as existing adaptive municipal actions were also identified. The outcomes of Milestone One are detailed in the [Climate Adaptation Workshop Series: Report on Climate Impacts in Thunder Bay](#) and the [Milestone One Output Report: BARC Program Report Prepared for the City of Thunder Bay](#).

## MILESTONE TWO: RESEARCH

Milestone Two focused on developing an understanding of the potential climate impacts for Thunder Bay. It involved assessing climatic changes, identifying impacts, conducting vulnerability and risk assessments, and engaging stakeholders.

Climate projections for the region were compiled and summarized in the [Thunder Bay Climate Change Research Project Final Report](#) to highlight climate change impacts to which Thunder Bay is particularly susceptible. These include increases in temperature and temperature variability, changes in precipitation, and increased frequency and severity of extreme weather events.

A vulnerability and risk assessment was used to identify which climate change impacts pose the greatest risk to the Corporation of the City of Thunder Bay. Results from the assessments were used to prioritize the list of 46 potential climate change impacts previously identified in Milestone One. Impacts with medium to high risk scores were carried forward to the planning-phase of Milestone Three. Outcomes of the vulnerability and risk assessments are summarized in [Appendix D](#) and detailed in the [Thunder Bay Climate Adaptation Strategy: Risk & Vulnerability Assessments Results report](#).

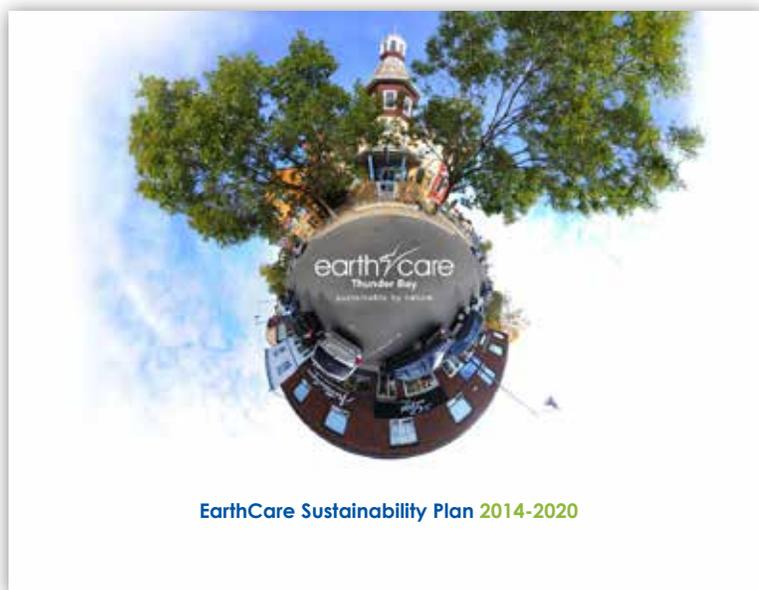
## MILESTONE THREE: PLAN

Milestone Three built on the extensive consultation, communication and research carried out in Milestones One and Two to: establish goals and objectives, identify and prioritize potential climate adaptation actions specific to the City of Thunder Bay, establish a monitoring and evaluation strategy with a list of 20 indicators, and draft an implementation framework. Milestone Three was completed with consulting services and support from Arbora Management Services and Sustainability Solutions Group.

The outcomes of Milestone Three are detailed in the [Milestone Three Climate Adaptation Action Plan](#). These were also presented to the public during a reception event held on June 23, 2015. The event was successful and showed there is strong community support for climate change adaptation in Thunder Bay.

## MILESTONES FOUR AND FIVE: IMPLEMENT AND MONITOR/REVIEW

Following the approval of the Climate Adaptation Strategy, City staff will move to Milestones Four and Five, the Implement and Monitor/Review Phases. These include identifying implementation tools and initiating actions while engaging and communicating with residents and stakeholders, tracking the progress and effectiveness of actions, and updating the strategy as necessary.



Climate change adaptation has been identified as an important direction for the City in the EarthCare Sustainability Plan 2014-2020 and as a strategic goal in the 2015-2018 Corporate Strategic Plan.

## 2.

# CLIMATE CHANGE IN CONTEXT

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Scientists around the world agree that the Earth's climate is changing and the impacts of climate change are already being felt in cities across Canada including Thunder Bay. Local experiences of climate change impacts show that these can incur high costs to the community as a whole. Early adaptation action to reduce climate risk and increase resilience is necessary.



**"Communities across  
Canada are already  
dealing with the impact  
of climate change."**

— Federation of Canadian  
Municipalities, 2015

## 2.1. THE SCIENCE

Scientific evidence shows that the climate is changing. The Intergovernmental Panel on Climate Change is an authoritative body composed of hundreds of scientists that assess scientific information available on climate change. Their Fifth Assessment was the most comprehensive yet and concludes that “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amount of snow and ice have diminished, and sea levels have risen” .<sup>11</sup>

The overwhelming majority of scientists agree this is due to rising concentrations of heat-trapping greenhouse gases in the atmosphere caused by human activities<sup>12</sup>, stating that “human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history”.<sup>13</sup> They have concluded that some level of climate change is inevitable even if action is taken to reduce greenhouse gas emissions. Annual climate data shows noticeable temperature highs and lows, but over longer periods of time there has been a discernible warming trend across the globe. The global average temperature over the first decade of the 21st century was significantly warmer than any preceding decade on record over the past 160 years.<sup>14</sup> With the exception of 1998, the 10 warmest years on record have happened since the year 2000.

Since warmer air holds more moisture than cooler air, this additional moisture provides “fuel” for extreme events. The amount of water vapour in the atmosphere has already increased by roughly 5% since the 1950s<sup>15</sup> and scientists predict that the main way in which climate change is likely to affect societies is through extreme weather events.<sup>16</sup>

## REGIONAL CLIMATE CONTEXT

*Just as weather and climate varies around the world, the effects of climate change will also vary dramatically from location to location.*

The impacts of climate change in the Great Lakes basin, on Lake Superior, and in Ontario are already being felt. Lake Superior has been recognized as one of the most rapidly warming lakes in the world as summer lake surface temperatures have risen 2.5°C between 1979 and 2006.<sup>17</sup> It is predicted that a number of climatic changes will impact Lake Superior, including longer water renewal times, increased water temperatures, longer ice-free seasons, variations in lake-water chemistry, lake water level changes, limited ranges of coastal wetlands, changes in forest habitat, shorelines that are more susceptible to erosion and damage, release of toxic sediments, decreased lake productivity, and decrease in amounts of cold-water fish.<sup>18</sup>

Extreme weather events including prolonged heat waves, torrential rainstorms, windstorms, and drought have increased throughout Ontario in recent years.<sup>19</sup> The frequency of very hot days (above 32°C) is expected to increase by 2.4-fold in Ontario by the late 21st century.<sup>20</sup> These extreme heat days, combined with drier summers and generally warmer weather, will add to the frequency of large fire years and by the end of the century, the average area burned in the boreal shield is expected to increase by 64 - 92%.<sup>21</sup>

# CLIMATE CHANGE PROJECTIONS FOR THUNDER BAY

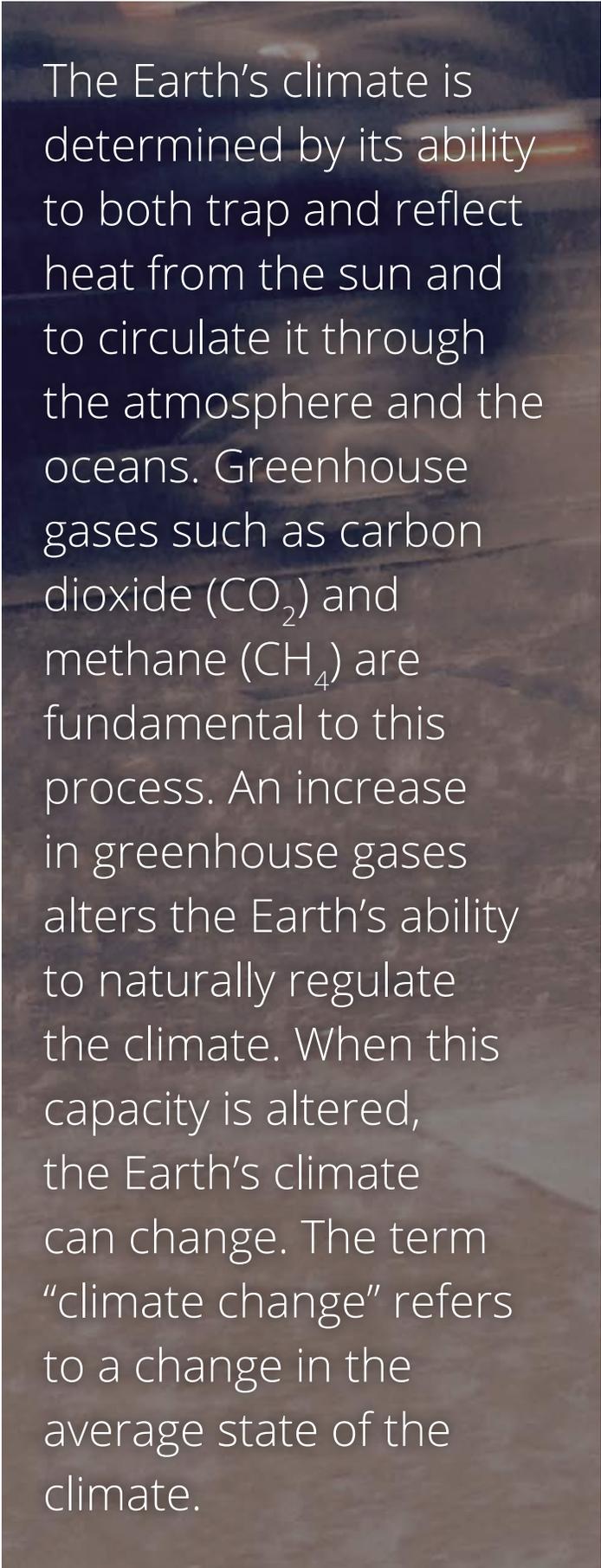
Thunder Bay has been impacted by climate change in recent years, including the hail and wind storms of 2011, the heavy rains of 2012, extreme cold temperatures in 2013-2015, and severe storms and heat waves in 2015. Climate change is projected to continue to impact Thunder Bay as shown in [Table 2](#).

Climate projections for the Thunder Bay region include an increase in extreme weather, temperature fluctuations, frequent high intensity rainfall events, and drought conditions in the summer. Between 1948 and 2008, the average annual temperature in Northwestern Ontario has already increased by 1.4°C and scientists project that by 2050 the annual average temperature could increase by 2.7°C and 4.6°C by 2080.<sup>22</sup>

Precipitation patterns will also change in the coming decades, principally through greater uncertainty. It is believed that annual precipitation will increase but this will likely be predominantly during the winter and spring months in the form of snow and freezing rain.<sup>23</sup> Although Thunder Bay might experience 6.5% more precipitation by 2050 and 11% more by 2080, summer months will likely see a decrease in precipitation of 1.4% by 2050 and of 0.9% by 2080.<sup>24</sup>

## 2.2. THE IMPACTS

Climate change impacts have the potential to affect all City departments and service delivery. This is why municipal governments have a unique interest and opportunity in planning to adapt to climate change. Understanding the impacts and local vulnerability to climate change will determine how to address projected changes and reduce the risks they pose to our environment, lifestyle, economy, governance, and



The Earth's climate is determined by its ability to both trap and reflect heat from the sun and to circulate it through the atmosphere and the oceans. Greenhouse gases such as carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>) are fundamental to this process. An increase in greenhouse gases alters the Earth's ability to naturally regulate the climate. When this capacity is altered, the Earth's climate can change. The term "climate change" refers to a change in the average state of the climate.

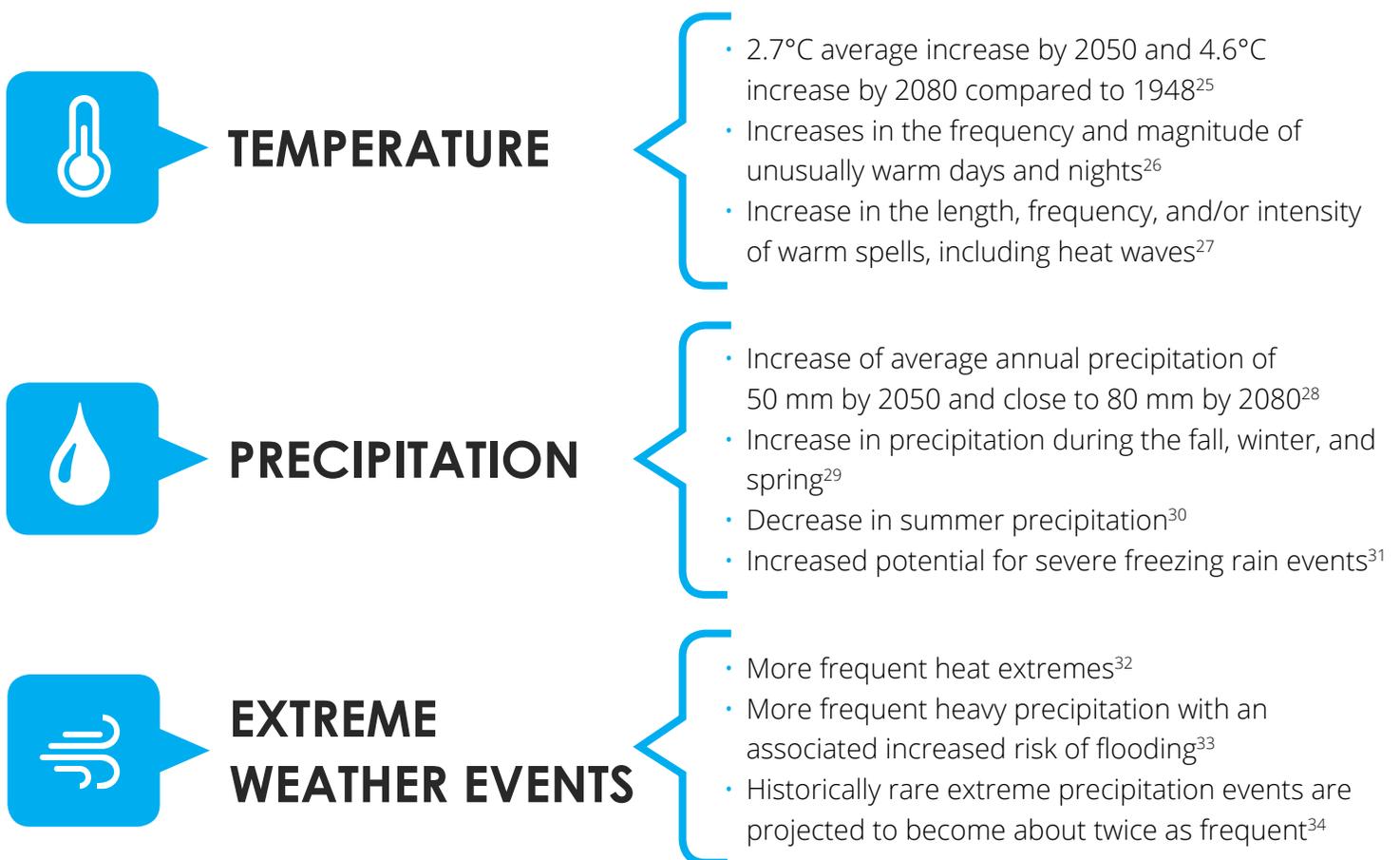
overall quality of life. These impacts are shown in [Table 3](#) as they relate to the four pillars of the City's 2015-2018 Corporate Strategic Plan.

## PRIORITY IMPACTS

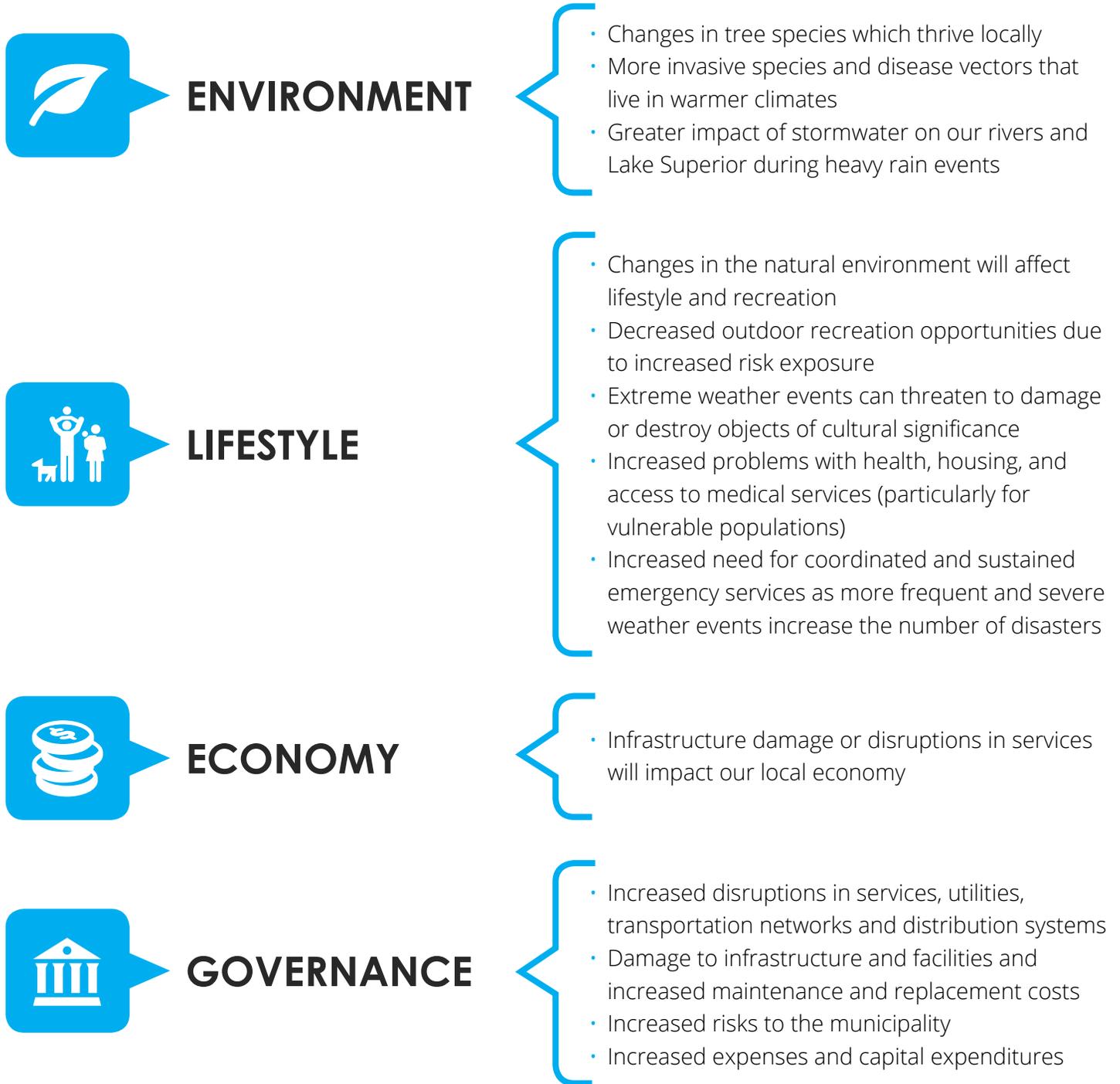
Hundreds of potential climate change impacts were considered for the City of Thunder Bay and ranked according to their potential for risk to the Corporation. A total of nine priority impacts were identified through a three-step consultation process including a general importance assessment, a vulnerability assessment, and a risk assessment. The outcomes of this process is summarized in [Appendix D](#) and detailed in the [Thunder Bay Climate Adaptation Strategy: Risk & Vulnerability Assessments Results](#).

Of the nine priority impacts, eight have to do with projected increase in intensity and frequency of extreme weather events and one is related to projected increases in temperature. These are presented on page 21 where each impact has an assigned code for reference purposes. "EX" represents impacts related to extreme weather events and "TEMP" represents impacts related to increasing temperatures.

**Table 2: Summary of projected changes in climate for Thunder Bay.**



**Table 3: Examples of how the priority impacts have the potential to affect the four pillars of the City's 2015-2018 Corporate Strategic Plan.**



# PRIORITY IMPACTS FOR THE CITY OF THUNDER BAY:

**EX-1** Potential increased expenses and capital expenditures as more frequent and severe extreme weather events damage infrastructure and buildings.

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**EX-2** Potential increased service disruptions in utilities (communication, energy, water, and wastewater), transportation networks, and distribution systems with more frequent and severe weather events.

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**EX-3** Potential increased maintenance and replacement costs as infrastructure and facilities durability and lifespan decreases with more frequent and severe weather events.

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**EX-4** Potential increased liability risks and insurance costs to the municipality due to more frequent and severe weather events.

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**EX-5** Potential increased infrastructure and building damage as more frequent and severe weather events increase overland flooding from storm water ponding in low-lying areas.

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**EX-6** Potential increased water treatment and management as more frequent and severe weather events increase contamination from storm water runoff and wastewater overflow during heavy rain as a result of increased frequency and severity of extreme weather events.

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**EX-7** Potential increased housing, medical and social support service demands (particularly for vulnerable populations) as more extreme weather events increase problems with indoor mould, loss of housing, and accessibility to medical services.

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**EX-8** Potential increased demand for emergency services as more frequent and severe weather events increase the number of disasters.

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**TEMP-1** Potential increased presence and management of invasive species in parks, urban landscapes and forests due to warmer summer temperatures, warmer water temperatures, and a longer growing season.

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## 2.3. THE BUSINESS CASE

The risks associated with climate change to economies are real and imminent. Early action to address climate risk and to overcome barriers to implementing adaptation measures should be a priority for decision-makers.<sup>35</sup>

Through proactive action, the City can achieve its climate adaptation goals and simultaneously realize a host of community benefits, including economic development, community health and wellness, and the continued development of a sustainable and liveable City over the decades to come. In fact, research shows that climate adaptation is most cost-effective when solutions work to serve multiple benefactors.<sup>36</sup>

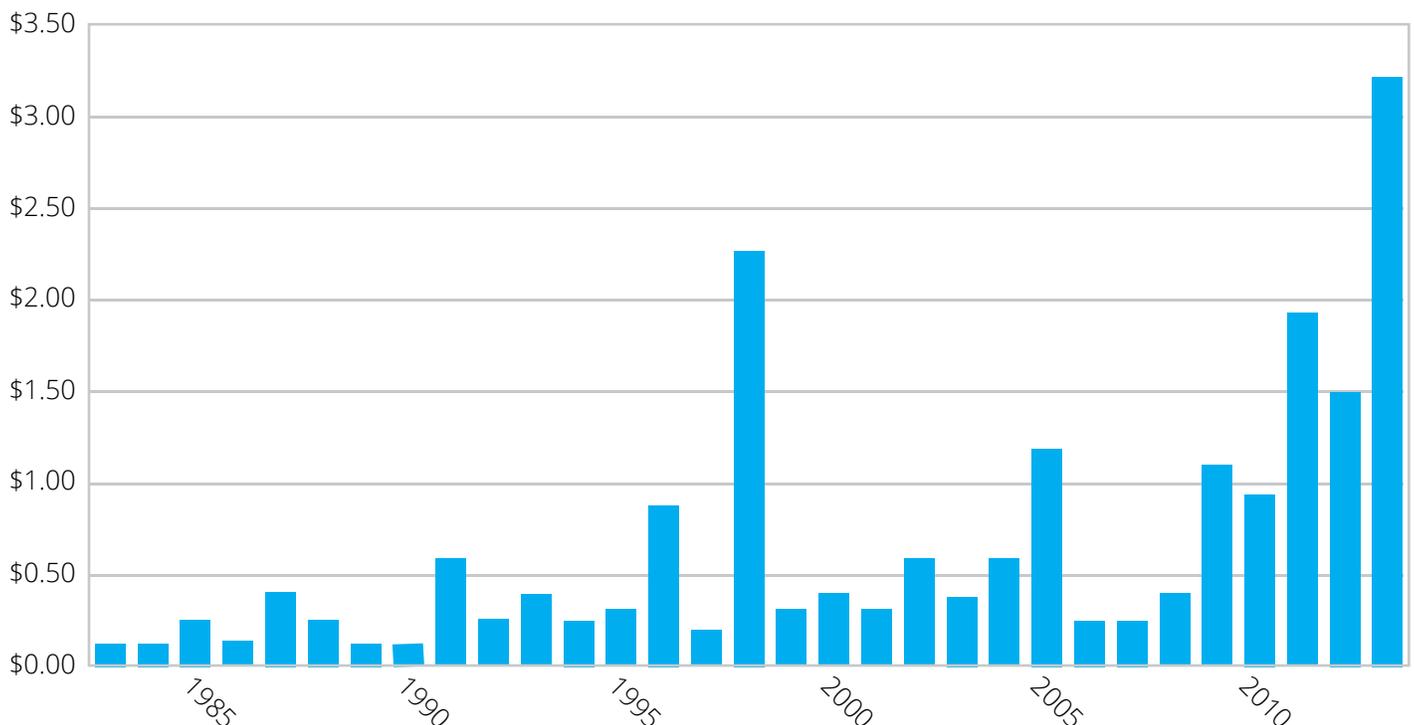
Cities are increasingly recognized as critical to progress in adaptation given their roles in scaling up adaptation of communities, households, and civil society, and in managing risk information

and financing.<sup>37</sup> Since local governments invest in capital projects and programs that are expected to serve the City over many decades, decisions can be made today to reduce risk, take advantage of opportunities, and avoid high costs associated with:

- Property destruction and/or damage;
- Infrastructure destruction and/or damage;
- Loss of production;
- Supply chain interruption;
- Unemployment from destroyed or bankrupt businesses;
- Loss of biodiversity and green infrastructure;
- Loss of housing price value; and,
- Lost tax revenue.<sup>38</sup>

The increase in severity and frequency of extreme weather events is perhaps the most costly of climate change impacts. *Figure 1* shows a clear rising trend of insurable catastrophic losses in Canada from 1983-2013. While annual insurance losses in Canada due to extreme weather events have previously been “stable” around \$400 million a year from 1938-2008, these costs have surpassed \$1 billion in insurable

**Figure 1: Catastrophic Losses in Canada 1983-2013 in Billions.**



damages from 2008-2013 excluding damages from residential overland flooding.<sup>39</sup> In the absence of adaptation, estimates indicate that climate change may cost the people of Canada approximately \$5 billion in insurable losses per year by 2020, and between \$21 and \$43 billion by 2050.<sup>40</sup>

Taking proactive adaptation measures can avoid these high costs and bring long term cost-savings to all levels of government. Several studies have found that local governments can save money by incorporating adaptation actions in regular infrastructure upgrading cycles since the benefits outweigh the costs.<sup>41, 42</sup> Some estimates claim that every dollar invested in adaptation now will yield anywhere from \$9-\$38 worth of avoided damages in the future.<sup>43</sup> A recent study from the University of Waterloo found that in some cases, building new infrastructure that is adapted to climate change for its lifecycle will only add 0-5% to construction costs.<sup>44</sup>

In a cost benefit analysis completed by the National Round Table on the Environment and the Economy, implementing proactive adaptation actions versus dealing with the consequences when they occur was found to be a cost effective way of dealing with many climate change impacts.<sup>45</sup> The Economics of Climate Adaptation Working Group also came to the conclusion that “well-targeted early investment to improve climate resilience is cheaper and more effective for communities than complex disaster relief efforts after the event”.<sup>46</sup>

Adaptation also presents potential economic opportunities aside from long-term cost savings and returns on investments. In many cases, adaptation measures are also effective steps to strengthen economic development and attract investment.<sup>47</sup> Economic opportunities may be most evident in the tourism and agriculture sectors, which both stand to potentially benefit from longer summers.<sup>4</sup>

The hail and wind storms of 2011, the heavy rains of 2012, and extreme cold temperatures experienced in 2013 and 2014 are all examples of how climate change has impacted Thunder Bay in recent years.



# POTENTIAL OPPORTUNITIES FOR THE CITY OF THUNDER BAY:

Increase in long term cost-saving due to proactive planning to reduce damage to infrastructure from increased frequency and severity of extreme weather events.

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Decrease in energy use to heat buildings due to longer shoulder seasons.

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Increase in year-round active transportation and walking due to warmer winter temperatures.

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Increase in local agriculture and food production due to a longer growing season.

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Increase in potential for biomass energy generation due to increased plant productivity from a longer growing season.

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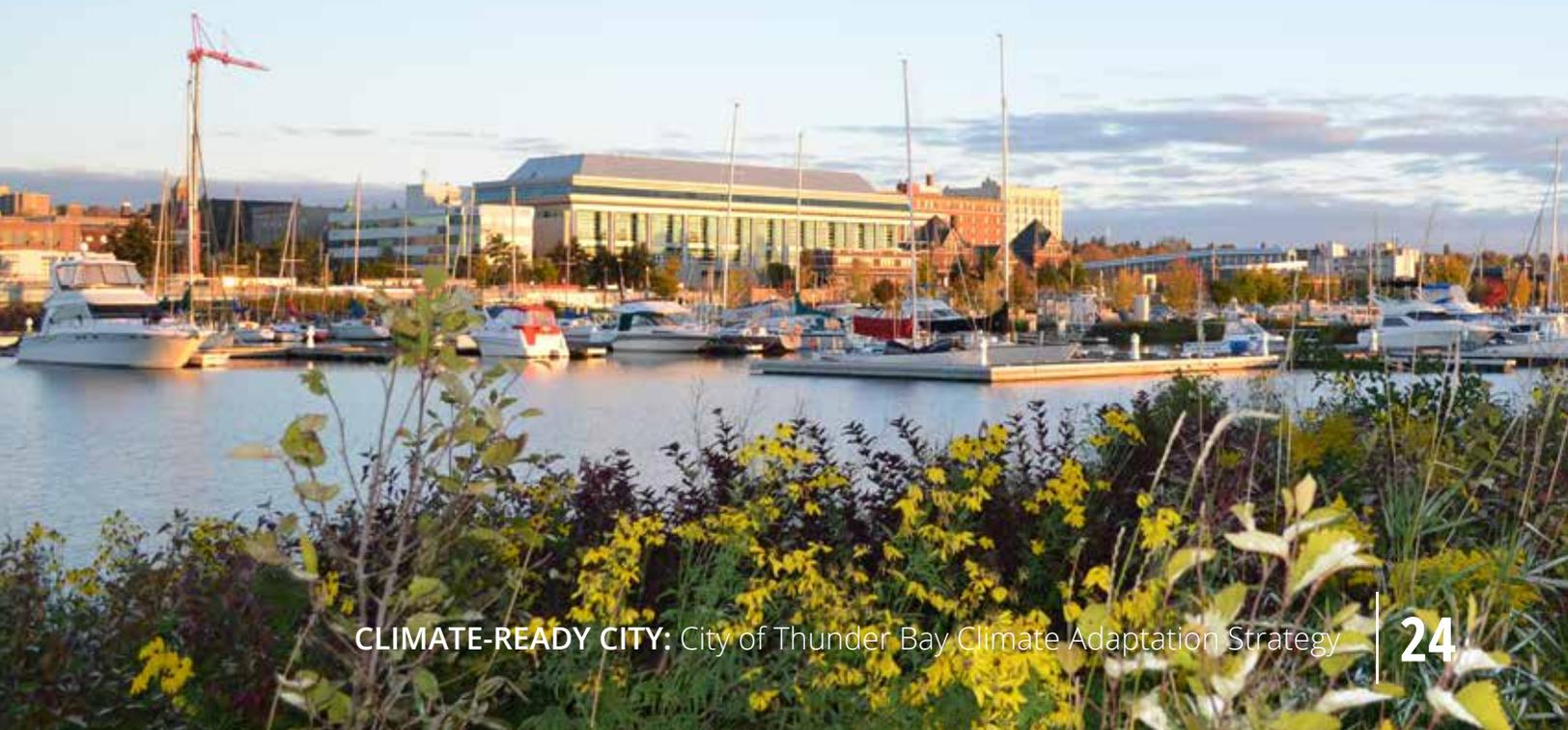
Increase in plant species used in green infrastructure, urban forestry, landscaping, and agriculture due to warmer summer temperatures and a longer growing season.

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Increase in the urban forest canopy due to a longer tree planting season from warmer summer temperatures and a longer growing season.

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Increase in summer tourism economy due to increased outdoor activities from warmer summer temperatures, a longer summer season, and lower summer precipitation.



# WHY THIS MATTERS

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## IMPACTS ON OUR ENVIRONMENT

Water bodies, trees, natural landscapes, and healthy ecosystems in Thunder Bay play important roles. As green infrastructure, vegetation provides adaptive services by absorbing carbon, keeping the city cooler in the summer, and contributing to stormwater management thereby lowering flood risk. Similarly, wetlands and riparian zones attenuate peak flow associated with flooding and serve as natural filters to remove pollutants from the water.

However, warmer temperatures and extreme weather events pose risks to our natural landscapes. In addition to new environmental stresses associated with increasing average temperatures and changes in precipitation patterns, climate change is predicted to exacerbate undesirable agents of rapid change, such as invasive pests, and increase pollutant loading into our waterways during heavy rain events. Extreme wind, freeze-thaw, and freezing rain events also have the potential to significantly damage/destroy our urban forest and impact local food production.

## IMPACTS ON OUR ECONOMY

Climate change can be thought of as a pervasive economic shock that will potentially affect all sectors of the economy.<sup>49</sup> The impacts of extreme weather event (such as flooding or ice storms) on roads and other infrastructure could disrupt distribution and communication networks, local businesses that depend on these networks,<sup>50</sup> and have the potential to compromise Thunder Bay's economy. Disruptions to essential service suppliers, such as grocery and drug stores, would also impact the health and safety of residents.

The economy of winter recreation activities that depends on consistent deep snow or ice (such as ice fishing, snowmobiling, and skiing) are most vulnerable while summer tourism will likely experience a boom if temperature increases are moderate. The loss of green infrastructure in neighbourhoods may also affect real estate value and decrease energy efficiency of residential buildings.

Aside from tourism, prospects in climate-adaptation based job growth (such as green technologies, alternative energy, infrastructure needs, building energy efficiency, new products and services, etc.) may prove beneficial.<sup>51</sup> By planning for climate change impacts, local agricultural food production may also benefit from a longer growing season and with it, a local food system that will build economic resiliency.

# Climate adaptation is needed for the City of Thunder Bay to have a healthy, vibrant, connected, and strong future.

## IMPACTS ON OUR LIFESTYLE

Human health concerns and quality of life are extremely important aspects of climate change adaptation planning.<sup>52</sup> Climate change poses significant risks to human health and well-being, particularly to those with special needs and on limited incomes. The impacts from extreme weather events, air quality, and water-, food-, vector- and rodent-borne diseases all have the potential to affect the lifestyle of Thunder Bay residents.<sup>53</sup>

More summer heat spells expected in the region will likely lead to an increase in related health problems especially for vulnerable people. Higher humidity, an increase in ground-level ozone, and drifting smoke from forest fires may also result in poor air quality days and increased respiratory problems leading to an increased demand for medical services.<sup>54</sup> The loss or decreased vitality of the urban forest that provides shade, absorbs pollutants, and provides feelings of well-being also has the potential to exacerbate health-related conditions.

The impacts of climate change are expected to affect outdoor activities and therefore the lifestyle of many Thunder Bay residents. Extreme weather events will increase risk exposure and warming temperatures will increase temperature dependent vector-borne diseases such as Lyme disease. Warmer temperatures and changes in precipitation patterns may also affect seasonal recreation as well as the distribution and availability of fish, wildlife, and local food.

## IMPACTS ON OUR GOVERNANCE

Erratic and intense weather conditions will affect municipal infrastructure. Increased precipitation in the form of intense downpours will challenge culvert capacity and other floodwater control systems. Roads may be impassable due to wash-outs, high water, downed trees, and deep snow. Infrastructure is also at risk from increased degradation and damage due to intense storm events and occurrence of more pronounced freeze/thaw situations.<sup>55</sup> In general, climate change is expected to shorten asset-replacement cycles.<sup>56</sup>

While Thunder Bay is used to and well prepared for snowy winters, climate change may produce more ice and sleet than usual, which will bring new challenges to infrastructure maintenance.<sup>57</sup> Liability concerns will increase as extreme weather events cause damage to both grey and green infrastructure. Many aspects of energy supply, transmission, and demand will also be impacted by various dimensions of climate change, including higher temperatures, changing frequency and intensity of extreme events, and changes in water availability.<sup>58</sup>

There are many opportunities to implement adaptive actions which will translate into long-term cost-savings for the whole community.

# 3.

# BECOMING A CLIMATE-READY CITY

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The City of Thunder Bay recognizes the need for climate change adaptation to build long-term resilience, reduce risks, and take advantage of future opportunities. The vision, goals, objectives, and actions of this strategy have been developed to achieve this and foster a prosperous future for the City.



**“Urban governments are at the heart of successful urban adaptation because so much of this depends on local assessments and integrating adaptation into local investments, policies and regulatory frameworks.”**

— Cambridge Institute for Sustainability Leadership, 2014

## 3.1. CURRENT STATUS

Many of the City's past and current actions are contributing to its ability to adapt to climate change, but existing plans, policies and procedures are not necessarily labelled as "adaptation actions". The focus of the Climate Adaptation Strategy is to align current resources to increase the resilience of the Corporation from a strategic perspective. The actions presented in this strategy provide direction for the City to strengthen policies, develop new programs or practices where gaps exist, work collaboratively with key partners and other levels of governments, and undertake the steps necessary to integrate climate adaptation as a core function within the Corporation.

There is significant overlap between climate change adaptation and existing corporate priorities and many of the adaptation actions presented in this strategy contribute to goals identified in other plans, strategies, and policies. Examples include stormwater management, urban forest management, urban design guidelines, official planning, community emergency preparedness, and sustainability goals in general. The integration of the Climate Adaptation Strategy with existing plans will serve to pull everything together, bridge cross-departmental gaps, and increase the City's resilience to climate change impacts while building on existing strengths.

## 3.2. THE VISION

The vision of the City's Climate Adaptation Strategy is to build resilience within the Corporation to reduce the risks inherent in climate change while taking advantage of opportunities and building upon existing adaptive actions.

The intent of this strategy is to provide strategic direction to the City of Thunder Bay in order to achieve this vision and become a climate-ready city. The goals, objectives, and key principles that were developed to do this are listed in [Table 4](#) while the

actions identified have been grouped into seven strategic directions and are presented in [section four](#) of the strategy. Details on the work completed to develop these goals, objectives, key principles, and actions are provided in the [Milestone Three Climate Adaptation Action Plan](#).

## GOALS

The goals of the Climate Adaptation Strategy are the foundation around which the objectives and potential adaptation actions for the were identified. These were developed based on the City's nine priority impacts, stakeholder engagement, and additional background analysis. They provide the framework to move forward in achieving the climate adaptation vision.

## OBJECTIVES & KEY PRINCIPLES

As per the ICLEI BARC Five Milestone Framework, while the climate adaptation goals were developed as statements of intention to guide the City's efforts at a high level, the objectives address specific issues within the context of a goal and are designed to address the SMART criteria (strategic, measurable, achievable, realistic, and time-bound). The objectives describe the City's approach in addressing the priority impacts and represent a detailed articulation of the ways in which the vision will be achieved.

It became evident that some of the opportunities for climate adaption planning were common to all goals and would be essential to the success of the overall strategy. These items were designated as key principles and separated from the other objectives in recognition of their overarching relevance to all goals.

## ACTIONS

The 45 climate adaptation actions identified in this strategy represent options the municipality can employ to act on the potential impacts of climate change. These are presented as potential short, medium, and long-term climate adaptation actions

which would contribute to the realization of the overall climate adaptation vision, goals, objectives and key principles.

## STRATEGIC DIRECTIONS

While identifying the City's adaptive actions, several unifying themes emerged. These are presented

as seven strategic directions and provide a clear direction for the City to move forward with the implementation of its actions. The City's seven strategic directions and their associated actions are the core of this strategy and presented in [section four](#).

# WHERE TO FOCUS ADAPTATION EFFORTS:



## EMERGENCY MANAGEMENT

In Thunder Bay, the Community Emergency Management Group coordinates the City's response to emergencies in order to preserve life, health, property and the environment. Emergency managers will continue to play a critical role in our community's preparation, response and recovery to extreme weather events.



## STORMWATER MANAGEMENT

The way stormwater is managed will be crucial as extreme weather events increase in frequency and intensity. The City's Stormwater Management Master Plan will consider climate change impacts and focus on resilient Low Impact Development (LID) and Green Infrastructure to reduce and treat stormwater while also delivering many other benefits to the community.



## URBAN FORESTRY

Healthy trees and forests provide communities with a host of climate change mitigation, adaptation, and sustainability benefits. Active planning, management, and care of our urban forest through the City's Urban Forest Management Plan and urban forest programs are necessary to increase the resiliency of the City.



## INFRASTRUCTURE ASSET MANAGEMENT

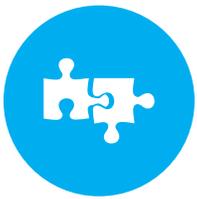
The impacts of climate change pose immediate and long-term threats to the City's infrastructure. Integrating climate adaptation into municipal asset management can inform decision-making and strategic long-term investments to reduce the risks associated with climate change impacts and capitalize on opportunities.



## COMMUNITY PLANNING

Land use planning and development policies through the City's Official Plan can increase resilience and decrease vulnerability. Through the Zoning By-law and with Urban Design Guidelines, community planning can promote compact form and a mix of employment and housing to shorten commute journeys, encourage energy-efficient design to lessen impacts on the environment, and consider the benefits of healthy ecosystems and local food production.

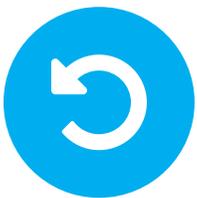
**Table 4: Goals, Objectives & Key Principles informing the Strategic Directions and Actions presented in [section four](#) of the strategy.**



## **GOAL 1. INTEGRATE CLIMATE CHANGE ADAPTATION INTO OPERATIONAL PROCEDURES AS WELL AS LAND-USE, FINANCIAL AND STRATEGIC PLANNING.**

**Objective 1.1** Systematically incorporate adaptation considerations into City of Thunder Bay strategies, policies, procedures, plans (including land-use planning), and asset management, as well as into annual and long-term financial planning.

**Objective 1.2** Create partnerships to regularly assess climate change risks and vulnerabilities to the community and the Corporation and use this knowledge to inform decision-making.



## **GOAL 2. RESPOND AND RECOVER EFFECTIVELY FROM SUSTAINED AND/OR MULTIPLE EXTREME EVENTS IN THE REGION.**

**Objective 2.1** Work in partnership with federal, provincial and aboriginal governments to improve the ability of the City of Thunder Bay to prepare for, respond to, and recover from extreme weather events.

**Objective 2.2** Determine proactive measures to support the financial and infrastructure recovery of the City of Thunder Bay following extreme weather events.

**Objective 2.3** Identify opportunities to support existing, and pursue new, business, governmental and community networks that bring resiliency to the region.



## **GOAL 3. SUPPORT THE COMMUNITY IN PREPARING FOR, RESPONDING TO AND RECOVERING FROM EXTREME WEATHER EVENTS.**

**Objective 3.1** Increase safety and reduce health risks for populations impacted by severe weather events, particularly those who have an increased need for housing, medical and social support services.

**Objective 3.2** Evaluate the capacity of City-run and community-based social and emergency services to respond to and recover from extreme weather events.

**Objective 3.3** Educate citizens on impacts of extreme weather events and the importance of preparedness for and recovery from these events.



## GOAL 4. CONSIDER CLIMATE CHANGE IMPACTS IN THE DESIGN, CONSTRUCTION AND MAINTENANCE OF PHYSICAL INFRASTRUCTURE WHILE CONSIDERING AFFORDABILITY AND CO-BENEFITS.

**Objective 4.1** Incorporate new technology and best practices in the design, construction and maintenance of new municipal infrastructure and facilities to minimize service disruption and increase resiliency.

**Objective 4.2** Identify retrofit opportunities for municipal infrastructure to minimize service disruptions related to extreme weather events.

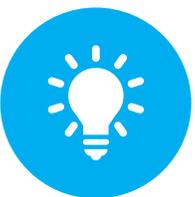
**Objective 4.3** Investigate areas of priority to incorporate best practices and green infrastructure into community and land-use planning and design.



## GOAL 5. FOSTER RESILIENCY OF THE CITY'S NATURAL LANDSCAPE TO ONGOING CHANGES IN CLIMATE.

**Objective 5.1** Increase the long-term resiliency of the urban forest, parks, open spaces and natural heritage features including water bodies to minimize the impacts of climate change.

**Objective 5.2** Preserve and enhance natural landscape features that increase the City's resiliency.



## KEY PRINCIPLES COMMON TO ALL GOALS

**Key Principle I.** Provide ongoing funding and support of adaptation projects that are in line with City's short-term and long-term financial planning framework.

**Key Principle II.** Seek investment and lobby for resources (federal, provincial, private) to support the City's adaptation efforts.

**Key Principle III.** Develop and provide internal education and staff training regarding the City's adaptation efforts.

**Key Principle IV.** Communicate adaptation efforts to a variety of public/community audiences and encourage residents to adopt climate resilient adaptation efforts.

# 4.

# STRATEGIC DIRECTIONS

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- **Integrate**
- **Assess Potential Threats**
- **Increase Resilience**
- **Inform & Equip**
- **Finance**
- **Network & Collaborate**
- **Respond & Recover**

45 potential adaptation actions are presented under seven strategic directions to guide the implementation of the strategy. These actions were developed specifically for the Corporation of the City of Thunder Bay to formalize and build upon the City's existing adaptive capacity, increase resilience, and reduce risk.

Details relevant to the implementation of each action, including primary leads, potential partnership sectors, associated plans and strategies, estimated costs, estimated duration, and timelines can be found in the Implementation Framework in *Appendix A*. Each action has a number which corresponds to goals and objectives it seeks to realize and as well as its priority ranking. For example, action 1.1a relates to goal one, objective one and has a higher priority than action 1.1b.

The prioritization of the actions may change to reflect the City of Thunder Bay's existing decision-making processes, evaluation, annual review, and external factors. Key actions and quick wins have been identified based on the priority rating of each action, their role as precedent actions, estimated duration, and estimated costs.



**“All levels of government and all sections of society have a responsibility to become informed and to take appropriate action within their mandates to prepare for and adapt to the impacts of climate change.”**

— ICLEI Canada, 2012

# 4.1

# INTEGRATE

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## Integrate climate adaptation into plans, policies, procedures, projects, and investment decisions.

Policy and regulatory choices can be powerful enablers of adaptation to help implement technical, behavioural, and financial measures at an optimal scale<sup>59</sup>. Integrating concepts of climate resilience into the City's existing processes allows for adaptation to be implemented at the municipal scale through planning, design, and the allocation of human, capital, and material resources. Climate resilience should be considered within every department to make Thunder Bay resilient to the impacts of climate change.

## KEY ACTIONS

- 1.1 a:** Evaluate existing projects that address climate change impacts or considerations to identify opportunities for accelerated implementation.
- 1.1 b:** Create and implement a process to review and assess all new standards, policies, plans, and projects so that climate change adaptation is considered within them.

## QUICK WIN ACTIONS

- 1.1 c:** Review current Standard Operating Procedures (SOPs), Policies, Plans, and Strategies for alignment with adaptation and update where necessary with the goal of strengthening using an adaptation lens.
- 2.1 b:** Identify and integrate extreme weather events and impacts into all corporate emergency response testing and plans.
- 3.1 a:** Review land-use planning and policies from a climate change adaptation lens to ensure that the impacts of extreme weather events are addressed.
- 4.1 b:** Assess and prioritize actions in the Stormwater Management Master Plan using a climate change lens on an annual basis.

## OTHER ACTIONS

- 5.1 b:** Assess and prioritize actions from the Urban Forest Management Plan using a climate change lens on an annual basis.

# 4.2

# ASSESS POTENTIAL THREATS

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## Understand the risks specific to climate change impacts.

The potential risks of climate change impacts must be understood to make informed decisions to increase the resilience of the City. Gaining a better understanding of the potential threats of climate change impacts will allow the City to target adaptation actions where these are most necessary and make better use of resources. In some cases, specialized information is needed to make informed decisions to increase the resilience of the City and develop appropriate adaptation policies.

## KEY ACTIONS

**3.2 b:** Conduct a ‘threat mapping’ exercise to identify critical areas that would be impacted by extreme weather events and pose risks to infrastructure and populations.

**4.2 a:** Conduct a detailed evaluation of potential impacts from extreme weather events on municipal (or City-owned) infrastructure.

**4.2 c:** Identify non-municipal infrastructure/facilities that provide critical support for City and determine their vulnerability to extreme weather events.

## OTHER ACTIONS

**4.2 b:** Conduct a ‘threat mapping’ exercise to identify critical City infrastructure and facilities that would be impacted by extreme weather events, and prioritize and implement projects to protect them.

**4.2 d:** Evaluate municipal long-term drinking water storage capacity with a climate change adaptation lens.

**5.2 a:** Identify natural heritage features and conduct threat mapping to identify priority areas that are at greatest risk to climate change and work with partners to conserve and reclaim them.

# 4.3

# INCREASE RESILIENCE

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## Increase resilience of infrastructure and natural landscapes.

Protecting infrastructure systems (grey and green) and the natural environment is essential to achieve the City of Thunder Bay's adaptation vision. The actions presented here aim to increase the resilience of municipal infrastructure and our natural landscapes to maintain and enhance the services they provide.

Urban infrastructure will play a significant role in the resilience of Thunder Bay in the future since infrastructure renewal, upgrades, and new development are all key actions for cities adapting to climate change.<sup>60</sup> The effectiveness, lifespan, and long-term financial implications of municipal infrastructure must be evaluated through a climate resiliency lens to prevent damage and improve the resilience of the City.

Protecting and restoring natural systems is also a crucial aspect of climate change adaptation. The City's natural landscapes not only provide resiliency services but also mitigate the impacts of climate change and increase sustainability. Healthy ecosystems absorb carbon, retain soil (prevent erosion), clean the air, buffer against floods, absorb moisture, create shade for cooling, help species cope with changes, provide a source of local food, and improve quality of life.<sup>61</sup>

## KEY ACTIONS

- 4.1 a:** Identify suitable best management practices for design, construction, and maintenance that can be adopted and implemented into City standards and projects.
- 4.3 a:** Identify new and existing best management practices for green infrastructure, land-use planning, and design which address climate change impacts to the community, and review annually.

## QUICK WIN ACTIONS

- 5.1 a:** Identify priority resilient species for planting.
- 5.1 c:** Identify incentive programs that could be adopted to support the conservation and planting of the City's urban forest.
- 5.2 b:** Support the preservation of natural features in new developments through policy.
- 5.2 c:** Develop policies and bylaws to protect existing and prioritized natural areas.
- 5.1 d:** Support the establishment of a local tree nursery which grows regionally-specific tree species.

## OTHER ACTIONS

- 4.2 e:** Provide support to non-municipal infrastructure/facilities to increase resiliency and recovery.
- 4.3 c:** Identify and implement incentives to promote the adoption of green infrastructure on private, commercial, and institutional properties.

# 4.4 INFORM & EQUIP

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## **Provide information, tools and training on climate adaptation to facilitate and accelerate action.**

Climate adaptation should occur across the whole community including at the governmental, institutional, commercial, and household levels. The tailoring of climate information is a crucial step in making sure that the information is not only understood but also used in an adaptation framework. These actions aim to develop knowledge and tools to empower City staff and community members to reduce the risks of climate change impacts and maximize opportunities.

Providing tools and training to City staff will play an important role in the successful implementation of adaptation actions across all departments and divisions. With improved information and tools, City staff will be better positioned to identify, prioritize, and implement climate adaptation actions. Educating residents and engaging community stakeholders is also a crucial step in increasing the City's resilience. Everyone must be aware of the potential risks associated with climate change impacts and extreme weather in order to build resilience within the community as a whole since resilience is not just a function of government alone.

## KEY ACTIONS

**III.ii:** Train City staff within various departments to establish cross-departmental adaptation specialists.

## QUICK WIN ACTIONS

**3.3 a:** Investigate collating various organizations' educational materials into a central resource database/portal to be shared amongst community organizations.

## OTHER ACTIONS

**III.i:** Provide resources and training to staff to support the City's adaptation efforts.

**IV.i:** Develop external communication, promotion, and education materials focused on a variety of target audiences in the community.

**IV.ii:** Develop communication and education materials to support citizens' response and recovery from extreme weather events and to increase resiliency.

**IV.iii:** Improve current efforts to communicate the City's emergency response plans to the public and raise awareness of the Municipal Emergency Control Group.

**IV.iv:** Develop education and communication materials promoting the use and benefits of green infrastructure.

**1.2 b:** Develop and share a climate change adaptation tool kit with resources to support administration and community agencies.

**4.3 b:** Prepare a tool kit or resource kit for City administration with information on available best practices and latest innovations in green infrastructure relating to community and land-use planning and design.

# 4.5 FINANCE

## Plan for the financing and long term implementation of adaptive actions.

Climate change presents real financial risks and opportunities for the City of Thunder Bay. Setting aside resources dedicated to climate adaptation will be necessary to successfully implement this strategy and benefit from the long-term cost savings associated with proactive adaptation measures as described in *Section 2.3*. However, uncertainty surrounding the economics of resiliency, including cost-benefit or return on investments, can be a barrier to financing climate adaptation.

An understanding based upon the costs of action versus inaction is needed to ensure the actions are given due importance within the context of climate adaptation and are not carried out in isolation. This economic knowledge is needed to guide adaptation investment choices, policy decisions, and spur action on adaptation.<sup>62</sup>

While there are numerous policies and instruments available to local governments to increase investment in climate change adaptation, it is also clear that municipal financing will not be sufficient to fund the implementation of all actions identified at the local level.<sup>63</sup> Additional funds will be required from other levels of government and the private sector to support the City's efforts.

## KEY ACTIONS

**I.i:** Identify financial implications and incorporate climate adaptation priorities into existing short and long term financial projections for the City of Thunder Bay.

**II.i:** Work with partners to lobby provincial and federal governments to provide financial support for recovery efforts.

**II.ii:** Work with partners to lobby provincial and federal governments to support increasing funding to improve infrastructure resiliency.

## QUICK WIN ACTIONS

**I.ii:** Investigate a funding model to support recovery from extreme weather events and other climate change impacts.

# 4.6

# NETWORK & COLLABORATE

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## Investigate opportunities to increase the resiliency of the region through networks and strategic collaboration.

The City has a strong foundation upon which to build climate resilience but the impacts of climate change go beyond the responsibilities and capacity of the City of Thunder Bay as a Corporation. In order to truly increase resilience of the community, all citizens, businesses, organizations, and levels of government must work together. There must be opportunities for horizontal learning and the sharing of resources.

Collaboration across jurisdictions, disciplines and sectors is at the core of what creates effective solutions to address adaptation priorities.<sup>64</sup> Partnerships are powerful mechanisms to enhance resilience since they bring together stakeholders from various sectors, build on their strengths, and create capacity that would not otherwise exist. Like other municipalities, the City of Thunder Bay has much to gain from collaborative work and can play a central role in bringing stakeholders together to address challenges of adaptation planning and implementation.

## QUICK WIN ACTIONS

**2.1 a:** Keep current knowledge of local and regional capacity, and identify opportunities to improve response and recovery through partnerships (i.e. municipal, Aboriginal, private, NGO).

## OTHER ACTIONS

**1.2 a:** Create and/or leverage existing regional groups to share best practices and information.

**2.3 a:** Develop and implement a Community Recovery Strategy or Framework that includes regional and Aboriginal communities.

# 4.7

# RESPOND & RECOVER

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## Plan for efficient response and recovery to extreme weather events and disasters.

Minimizing damage to homes, livelihoods, and people is a paramount function of resilience just as the need for rapid rebound when extreme events cannot be avoided. Continued operation and delivery of critical infrastructure and services, even when an event exceeds the normal coping capacity of organizations and governments, is important for the resilience of the community as a whole. The City of Thunder Bay has excellent emergency response procedures in place which can be strengthened through a climate adaptation lens.

## QUICK WIN ACTIONS

**2.1 c:** Evaluate corporate emergency response plans and look for opportunities to integrate plans or areas where plans can support each other.

**2.2 a:** Identify the services, organizations and private sector services that are available to support recovery from an extreme weather event.

**2.2 b:** Improve internal communication strategy and identify staff resources to support citizens during an extreme weather event as well as during recovery from an extreme weather event.

**3.1 b:** Evaluate the feasibility for the development of a neighbourhood-level response program.

**3.1 c:** Investigate opportunities to integrate other organizations' communication/emergency plans and information for high-need/hard-to-reach populations to support the City's first response and recovery efforts.

**3.2 a:** Evaluate community preparedness for response to extreme weather events and promote the importance of emergency response plans for community organizations and businesses.

**3.3 b:** Update and formalize first response communications plan/strategy to ensure it responds to the needs of the City and clarifies roles of external agencies in communicating to the public.

# 5.

# MOVING FORWARD

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As a municipality with jurisdiction over local land use and infrastructure planning, the City of Thunder Bay is well positioned to adapt to the challenges of climate change. With strong leadership, collaboration, and dedicated resources, Thunder Bay can become a climate-ready City. This strategy provides the roadmap to make this happen and to lead the rest of the community in this endeavour.

A photograph of a conference or meeting. In the background, a woman is speaking at a podium. The foreground shows the backs of several audience members' heads. A large blue semi-transparent rectangle is overlaid on the center of the image, containing white text. The text is a quote about the role of local governments in Canada regarding climate change impacts.

**“Local governments  
in Canada have a  
significant role to play in  
minimizing the impacts of  
climate change on their  
population, economy,  
and fiscal budgets.”**

— Simon Fraser University Adaptation  
to Climate Change Team, 2015

## 5.1. IMPLEMENTATION

*The potential adaptive actions and implementation framework were developed based on extensive consultation.*

The Climate Adaptation Strategy is a long-term initiative that will require participation and engagement across all City Departments as well as collaboration amongst community stakeholders in order to successfully achieve the City's climate adaptation vision. An implementation framework was developed to provide a detailed roadmap with which the City of Thunder Bay can move forward in putting the adaptation opportunities identified into action.

This framework is intended to be a living document that will be further refined as the City moves forward into the implementation phase of Milestone Four. Details and prioritization of the actions may change to reflect the City of Thunder Bay's existing procedures, decision-making processes, evaluation, annual review, and external factors. Best practices, internal structures, and collaboration will inform successful implementation of the actions that are presented in the strategy.

### IMPLEMENTATION FRAMEWORK

The implementation framework developed is reflective of extensive consultation and feedback received from City managers and staff, service sector professionals, key community stakeholder,

and EarthCare community partners. As a whole, the implementation framework documents financial, human, and other resources required to carry out the climate adaptation actions.

The adaptation actions presented in the framework were analyzed through an implementation lens to identify resources required to move forward. Short-term actions, i.e. those requiring less than two years to implement, can be seen as 'quick wins' that can be achieved to build a sense of success and momentum. In comparison, longer-term actions will require ongoing and collaborative efforts over a number of years to achieve success. The implementation framework also identifies key actions that should be completed sooner rather than later. The complete implementation framework is presented in [Appendix A](#).

### ACTION REGISTERS & IMPLEMENTATION PLAN

To assist in achieving the adaptation actions and documenting the collaborative processes that may be required to do so, an action register approach will complement the implementation framework. The action register is a template developed to document the implementation of each action item. The content of the action registers will inform the development of an implementation plan in Milestone Four to complement the Climate Adaptation Strategy.

The action registers allow for fine-tuning of the details and elements required for the successful implementation of the actions. The details of the action registers will include information such as the person(s) responsible to facilitate the completion of the action, departmental approval, budget, community partners, detailed implementation dates, specific actions, and supporting documentation. A sample action register is provided in [Appendix B](#).

It is the intention that action registers will be filled out for each action by the primary leads

identified in the implementation framework. Once developed and approved, the action registers will form and feed back into a constantly evolving implementation plan and also serve as institutional memory for the City to track progress towards meeting its adaptation goals and vision.

## 5.2. MONITORING, EVALUATION & FUTURE UPDATES

The process of monitoring and evaluation informs an ongoing cycle of learning that provides insight into the nature of climate change adaptation. Based on experiences and responses observed, corrections or new opportunities can be integrated into future climate adaptation strategies. A five-year monitoring and evaluation cycle has been recommended to guide future monitoring and evaluation activities as well as regularly update the Climate Adaptation Strategy.

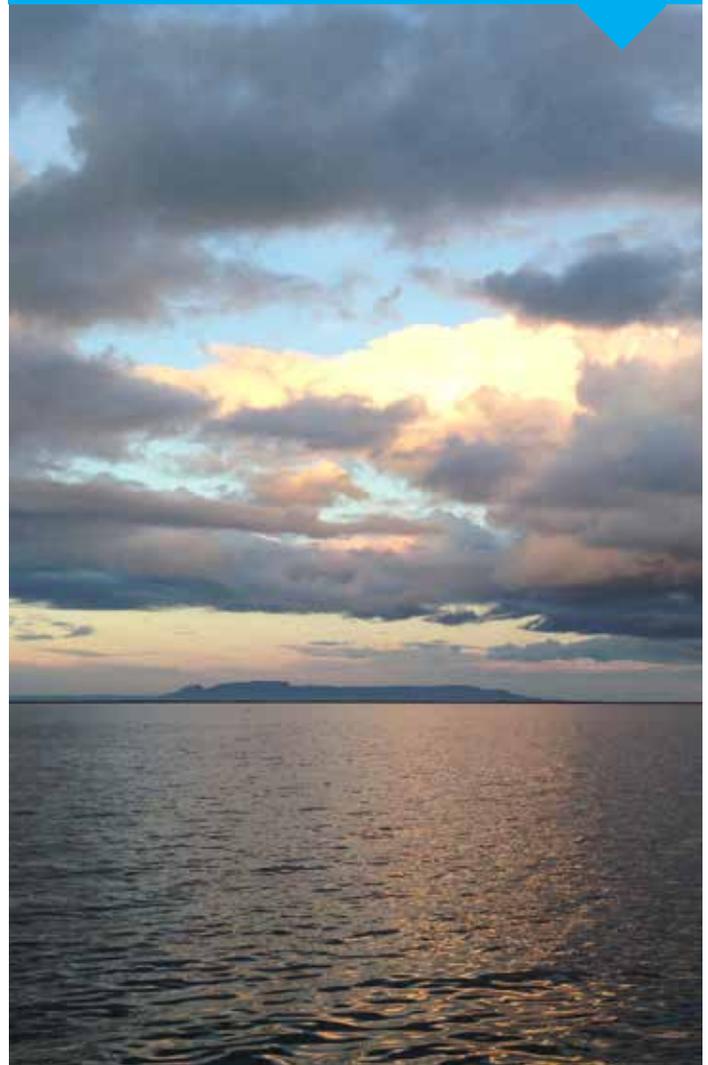
*Figure 2* illustrates the type of data proposed for this purpose and the frequency with which it would be collected. The magnitude of effort required to complete the activities is represented by circle size, where larger circles will require a greater effort. All activities culminate in a five-year review of the Climate Adaptation Strategy, its goals, objectives, and actions. Additional details regarding the proposed monitoring and evaluation activities are presented in a *Monitoring & Evaluation Strategy* developed to complement the Climate Adaptation Strategy.

### INDICATORS

A total of 20 indicators have been recommended as measures of the success of the Climate Adaptation Strategy and to track how the Corporation and the community are achieving the City of Thunder Bay's climate adaptation vision and goals. Though

the majority of these indicators are existing ones that the City is already tracking, new indicators were also identified. For the purpose of the Climate Adaptation Strategy, a baseline year of 2016 was established for overall consistency and comparison of data. Progress over time will be tracked against this baseline. All indicators, data sources, and responsibility for reporting are listed in *Appendix C*.

In a recent survey completed by Thunder Bay residents, 98% indicated that climate adaptation should be a priority for the City of Thunder Bay.



## ANNUAL REPORT, WORKPLAN REVIEW & PRIORITIZATION

Each year the City will report progress to City Council and the community through the EarthCare Annual Report. The focus of the Annual Report will be based on the trends seen amongst the identified indicators and reflections on the factors which influence the trends. The City will also review work-to-date and prioritize actions on a yearly basis. Prioritization of actions is expected to change from year to year based on the City of Thunder Bay's existing decision-making processes, evaluation, annual review, budget, and external factors.

## RISK & VULNERABILITY SURVEY

It is recommended that every two years, a simple risk and vulnerability survey should be considered to gauge preparedness and awareness of climate change adaptation both within the City of Thunder Bay and the community.

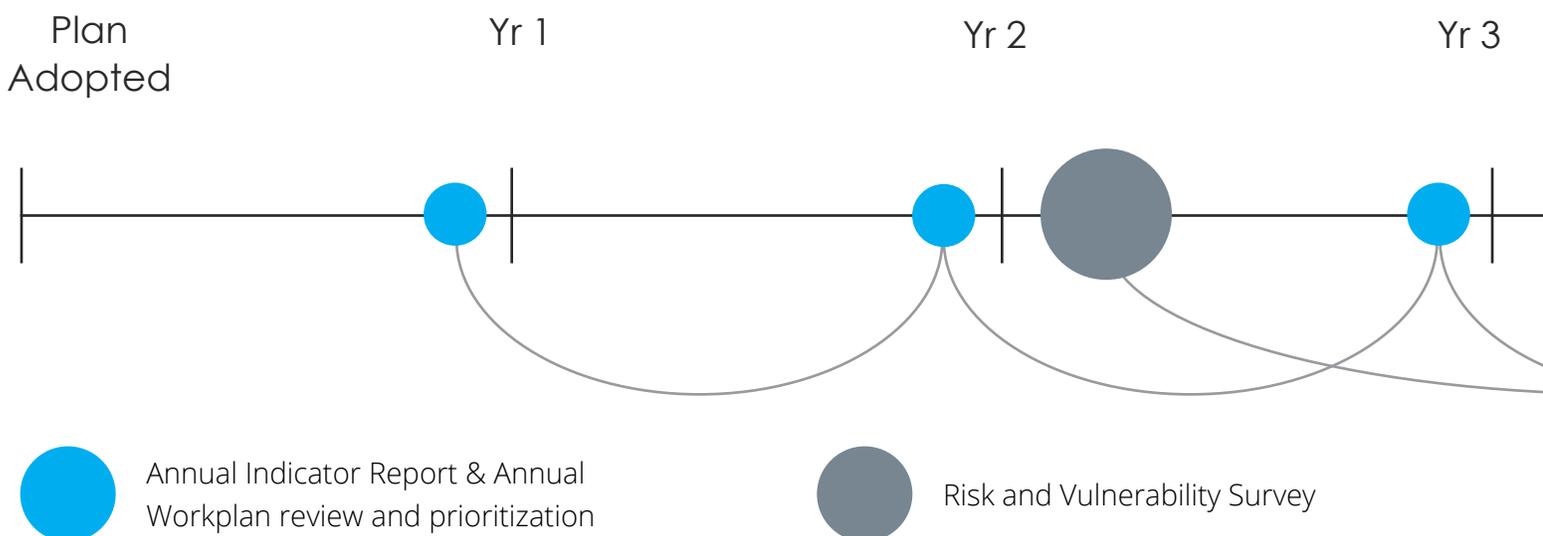
## FORMAL SCIENCE REVIEW

Science and best practices should be reviewed on an ongoing basis and incorporated into the annual work plan and priorities as required. It is recommended that every five years, working with a university or research organization, a formal science review be considered to collate the above and to review new findings and information on global, regional, and local climate change and/or new adaptation techniques.

## REVIEW OF GOALS, OBJECTIVES AND ACTIONS

It is recommended that every five years the Climate Adaptation Strategy itself be reviewed. This five-year review would be an explicit opportunity to consider the appropriateness of the goals, objectives, actions and strategic directions.

Figure 2: Proposed monitoring and evaluation activities.





## STAFFING & RESOURCES

Given the wide ranging list of actions and cross-departmental responsibilities, along with the ever-changing information and science associated with climate change, the Climate Adaptation Strategy will need to be administered and managed on a long-term basis to ensure its success.

A strategy of this scale and scope will require dedicated individuals who will be able to act as lead administrators, providing the necessary resources, support, and expertise to assist City Departments in implementing their actions. Collating and reporting on performance indicators, preparing reports, communicating to City Council and the community, assisting with annual prioritization of actions, and continuing to build stakeholder involvement are some of the administrative tasks that are likely to be associated with this strategy in implementation. To this effect, financial resources will be required for ongoing implementation and management. Allocating both human and financial resources to the Climate Adaptation Strategy will be essential in achieving the City's adaptation vision.

## GOVERNANCE

City Departments, Primary Leads, and staff will require ongoing support and feedback throughout implementation and management of the Climate Adaptation Strategy. The EarthCare network and a dedicated Climate Adaptation Steering Committee are existing structures that can be employed to house and oversee the implementation of the Strategy and achieve of the City's climate adaptation vision.

## OPPORTUNITIES

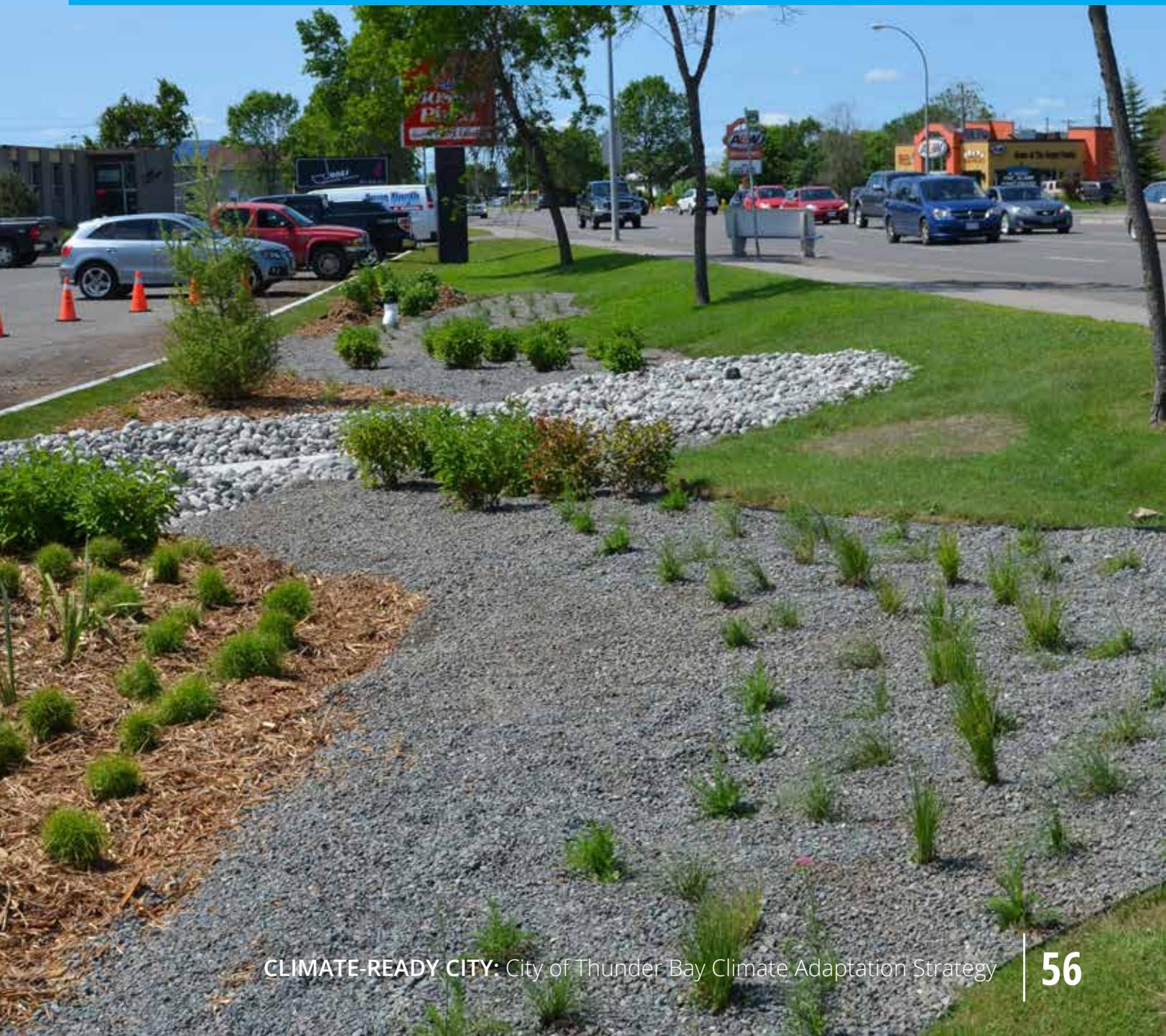
Adaptation planning can increase benefits and reduce risks associated with climate change impacts. Through proactive action, the City can achieve its climate adaptation goals and simultaneously realize a host of community benefits including economic development, community health and wellness, and the continued development of a sustainable and liveable city over decades to come. Climate adaptation is an opportunity to drive sustainable development by combining synergies between different levels of governments, private partners, and local residents.<sup>65</sup>

Key findings from the Intergovernmental Panel on Climate Change Fifth Assessment Report predict that climate change impacts will have significant effects on migration flow and patterns of investment. If the City of Thunder Bay can show that it is climate-ready, it can capitalize on the opportunity to attract businesses, people, and investments.

The City will also become well-positioned to access potential sources of funding from the federal and provincial governments in the future. Assessment of climate risk together with quantification of the costs and benefits of climate-resilient development measures will highlight new investment opportunities and so should help unlock innovation, public-private partnerships, and investment.<sup>66</sup>

## CLIMATE ADAPTATION IN ACTION

Thunder Bay's Memorial Avenue Low Impact Development biofiltration facility is an example of how the municipality is using green and grey infrastructure to manage stormwater and mitigate flooding to address climate change impacts. External funds for this project were made available through the Great Lakes & St. Lawrence Cities Initiative to increase municipal adaptation and resilience through stormwater and watershed management.



# 6.

# CONCLUSION

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**The City of Thunder Bay is emerging as a leader of climate change adaptation in the region and has the opportunity to build on the great work accomplished to date to become a climate-ready City.**

Climate change is an unpredictable phenomenon with implications that cross political and physical boundaries and traditional disciplines. The challenge, therefore, requires a combination of collaboration and adaptive learning that is unprecedented.

The City will need to continue to build collaborative relationships to achieve its goals and begin to implement priority actions as it moves into Milestones Four and Five. In doing so, staffing, resources, and governance will need to be considered and allocated so that Thunder Bay is successful in meeting its vision.

The City of Thunder Bay has shown leadership in recognizing the impacts of climate change and making a commitment to continue to adapt to them. By planning to reduce vulnerabilities, increase resilience, build on existing strengths, and minimize the severity of the emerging impacts of climate change on the Corporation, the City of Thunder Bay can become climate-ready. Implementing this Climate Adaptation Strategy serves to do just that.



**“The work currently being done in Thunder Bay on adaptation and community sustainability is impressive and can serve as an example of progressive municipal governance.”**

— Dan Sandink, Institute of Catastrophic Loss Reduction

# 7.

# APPENDICES

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## APPENDIX A:

# IMPLEMENTATION FRAMEWORK

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This implementation framework has been developed as a result of extensive feedback from City staff and sector professionals. It provides a roadmap to move forward to Milestone Four and the development of an implementation plan through the use of action registers. The implementation framework is intended to assign timelines and identify the resources needed to complete the actions. Best practices, internal structures and collaboration will best inform successful implementation of all the actions.

The actions are listed in order of priority based on the results of a Multi-Criteria Analysis workshop, detailed in the [Milestone Three Climate Adaptation Action Plan](#) which gathered feedback from City staff and sector professionals. The prioritization of the actions is expected to change to reflect the City of Thunder Bay's existing decision-making processes, evaluation, annual review and external factors. The prioritization of the actions is expected to change to reflect the City of Thunder Bay's existing decision-making processes, evaluation, annual review and external factors. Those actions with an asterisk (\*) have been prioritized based on their role as a precedent action, and actions with a dagger (†)

indicate that climate adaptation expertise is needed to move forward with implementation. It is important to note that the estimated costs assigned to actions requiring expertise (†) assume that the expertise will be available internally. If this is not the case, then the costs of implementation of those actions will be higher to reflect the need to bring in external expertise.

Key principles are separated from the other actions in recognition of their overarching relevance to all goals. Estimated Initial/Operating Costs are those that are expected to be incurred by the City of Thunder Bay (CTB). Detailed action registers will be created with the Primary Leads identified for each action in order to complement the implementation framework and provide a greater level of detail needed for implementation.

The proposed Partnerships and Sectors identified here are potential areas to consider in developing collaborative relationships to move forward with achieving actions. It is the intention that a further examination of opportunities for partnerships will be considered in the implementation phase.

# LEGEND

QUICK WIN	KEY ACTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
Actions with low costs and short implementation durations.	Actions that should be completed prior to other actions.	Lead department that will facilitate the completion of the action in collaboration with other departments and partners.	Proposed sectors for collaboration during implementation.	List of existing City plans, policies and procedures that are tied to the proposed action.	Proposed start date to being implementing the action.	Proposed duration to complete implementing the action.	Estimated cost needed to complete the action. \$ <\$4,999 \$\$ \$5,000-9,999 \$\$\$ \$10,000-29,999 \$\$\$\$ \$30,000-99,999 \$\$\$\$\$ >\$100,000

\* Indicate actions that have been prioritized based on their role as precedent actions.

† Indicate actions requiring climate adaptation expertise.

Note: Supporting departments and their roles will be identified and defined in detailed Action Registers. All timelines and costs are subject to annual review and subject to approval. Suggestions regarding potential sectors for collaboration have been proposed and are to be confirmed through the development of Action Registers during implementation.

# GOAL #1: INTEGRATE CLIMATE CHANGE ADAPTATION INTO OPERATIONAL PROCEDURES AS WELL AS LAND-USE, FINANCIAL, AND STRATEGIC PLANNING.

OBJECTIVE 1.1 SYSTEMATICALLY INCORPORATE ADAPTATION CONSIDERATIONS INTO CITY OF THUNDER BAY STRATEGIES, POLICIES, PROCEDURES, PLANS (INCLUDING LAND-USE PLANNING), AND ASSET MANAGEMENT, AS WELL AS INTO ANNUAL AND LONG-TERM FINANCIAL PLANNING.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•	•	Integrate	1.1 a	Evaluate existing projects that address climate change impacts or considerations to identify opportunities for accelerated implementation.	Infrastructure & Operations – Engineering	All City Departments	Asset Management	2018	< 2 years	\$\$
•	•	Integrate	1.1 b	Create and implement a process to review and assess all new standards, policies, plans, and projects so that climate change adaptation is considered within them.	Infrastructure & Operations – Engineering	All City Departments	Subdivision Plans Universal Site Plan Control Design Standards Engineering Development	2019	< 2 years / Ongoing	\$\$ / \$
•		Integrate	1.1 c †	Review current Standard Operating Procedures (SOPs), Policies, Plans, and Strategies for alignment with adaptation and update where necessary with the goal of strengthening using an adaptation lens.	Infrastructure & Operations – EarthCare	All City Departments	Standard Operating Procedure Service Levels Stormwater Master Plan Active Transportation Plan Facility Design Guidelines Strategic Approach to Corporate Energy Management Thunder Bay and Area Food Strategy Source Water Protection Plan Urban Forest Management Plan Subdivision Plans Universal Site Plan Control	2018	< 2 years / Ongoing	\$\$ / \$

OBJECTIVE 1.2 CREATE PARTNERSHIPS TO REGULARLY ASSESS CLIMATE CHANGE RISKS AND VULNERABILITIES TO THE COMMUNITY AND THE CORPORATION AND USE THIS KNOWLEDGE TO INFORM DECISION-MAKING.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Network & Collaborate	1.2 a †	Create and/or leverage existing regional groups to share best practices and information.	Infrastructure & Operations – EarthCare	Community/ Environmental Organizations Conservation Authorities Educational Institutions Industry Organizations Facility Design Guidelines	Facilities Urban Design Guidelines Master Site Plan and Urban Design Guidelines Engineering and Development Standards Thunder Bay and Area Food Strategy	2016	< 2 years / Ongoing	\$\$\$ / \$\$\$
		Inform & Equip	1.2 b †	Develop and share a climate change adaptation tool kit with resources to support administration and community agencies.	Infrastructure & Operations - EarthCare	Aboriginal Groups/ Agencies Community/ Environmental Organizations Community Social Service Agencies/ Organizations Conservation Authorities MECG Members & First Response Local Public Utility Providers Media Public Health & Health Care Providers	Emergency Plan	2017	< 2 years / Ongoing	\$\$\$ / \$

## GOAL #2: RESPOND AND RECOVER EFFECTIVELY FROM SUSTAINED AND/OR MULTIPLE EXTREME EVENTS IN THE REGION.

OBJECTIVE 2.1 WORK IN PARTNERSHIP WITH FEDERAL, PROVINCIAL, AND ABORIGINAL GOVERNMENTS TO IMPROVE THE ABILITY OF THE CITY OF THUNDER BAY TO PREPARE FOR, RESPOND TO AND, RECOVER FROM EXTREME WEATHER EVENTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Network & Collaborate	2.1 a *	Keep current knowledge of local and regional capacity, and identify opportunities to improve response and recovery through partnerships (i.e. municipal, Aboriginal, private, NGO).	Development & Emergency Services – Fire Rescue	Aboriginal Groups/ Agencies Business Improvement Associations Community Environmental Organizations Community Social Service Agencies/ Organizations Economic Development Agencies MECG Members & First Response Government Agencies Local Public Utility Providers Local Unions Municipal Associations Regional Public Health & Health Care Providers	Emergency Plan	Current - 2016	Ongoing	\$
•		Integrate	2.1 b	Identify and integrate extreme weather events and impacts into all corporate emergency response testing and plans.	Development & Emergency Services – Fire Rescue	All City Departments MECG Members & First Response	Emergency Plan	2016	< 2 years / ongoing	\$ / \$
•		Respond & Recover	2.1 c	Evaluate corporate emergency response plans and look for opportunities to integrate plans, or areas where plans could support each other.	Community Services - Asset Management	All City Departments MECG Members & First Response	Emergency Plan	2016	< 2 years / Ongoing	\$\$ / \$\$

OBJECTIVE 2.2 DETERMINE PROACTIVE MEASURES TO SUPPORT THE FINANCIAL AND INFRASTRUCTURE RECOVERY OF THE CITY OF THUNDER BAY FOLLOWING EXTREME WEATHER EVENTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Respond & Recover	2.2 a	Identify the services, organizations, and private sector services that are available to support recovery from an extreme weather event.	Development & Emergency Services – Fire Rescue	Community/ Environmental Organizations Community Social Service Agencies/ Organizations Economic Development Agencies MECG Members & First Response Local Public Utility Providers Regional Public Health & Health Care Providers Restoration Companies	Emergency Plan Thunder Bay and Area Food Strategy	Current - 2016	< 2 years / ongoing	\$\$ / \$
•		Respond & Recover	2.2 b	Improve internal communication strategy and identify staff resources to support citizens during an extreme weather event as well as during recovery from an extreme weather event.	City Manager's Office – Corporate Strategic Services	All City Departments Community/ Environmental Organizations Community Social Service Agencies/ Organizations MECG Members & First Response Local Public Utility Providers Regional Public Health & Health Care Providers	Emergency Plan	2016	< 2 years / ongoing	\$\$ / \$

OBJECTIVE 2.3 IDENTIFY OPPORTUNITIES TO SUPPORT EXISTING, AND PURSUE NEW, BUSINESS, GOVERNMENTAL, AND COMMUNITY NETWORKS THAT BRING RESILIENCY TO THE REGION.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Network & Collaborate	2.3 a	Develop and implement a Community Recovery Strategy or Framework that includes regional and Aboriginal communities.	City Manager's Office	All City Departments Aboriginal Groups/ Agencies Business Improvement Associations Community/ Environmental Organizations Community Social Service Agencies/ Organizations EarthCare Thunder Bay Economic Development Agencies MECG Members & First Response Government Agencies. Intergovernmental Committee Local Public Utility Providers Local Unions Municipal Associations Regional Public Health & Health Care Providers	Emergency Plan Thunder Bay and Area Food Strategy	2016	3-5 years / ongoing	\$\$\$ / \$\$

# GOAL #3: SUPPORT THE COMMUNITY IN PREPARING FOR, RESPONDING TO, AND RECOVERING FROM EXTREME WEATHER EVENTS.

OBJECTIVE 3.1 INCREASE SAFETY AND REDUCE HEALTH RISKS FOR POPULATIONS IMPACTED BY SEVERE WEATHER EVENTS, PARTICULARLY THOSE WHO HAVE AN INCREASED NEED FOR HOUSING, MEDICAL AND SOCIAL SUPPORT SERVICES.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Integrate	3.1 a	Review land-use planning and policies from a climate change adaptation lens to address the impacts of extreme weather events.	Development & Emergency Services - Planning	All City Departments Community Social Service Agencies/ Organizations Conservation Authorities Government Agencies Educational Institutions Regional Public Health & Health Care Providers	Official Plan Thunder Bay and Area Food Strategy	Current - 2016	< 2 years / ongoing	\$\$/ \$
•		Respond & Recover	3.1 b	Evaluate the feasibility for the development of a neighbourhood-level response program.	Development & Emergency Services - Fire Rescue	All City Departments Corporate Strategic Services City Council MECG & First Response Community Social Service Agencies/Organizations	Emergency Plan	2016	< 2 years / ongoing	\$ / \$
•		Respond & Recover	3.1 c	Investigate opportunities to integrate other organizations' communication/emergency plans and information for high-need/hard-to-reach populations to support the City's first response and recovery efforts.	Development & Emergency Services – Fire Rescue	Community Social Service Agencies/ Organizations Conservation Authorities MECG Members & First Response Regional Public Health & Health Care Providers	Emergency Plan	Current - 2016	< 2 years / ongoing	\$ / \$

OBJECTIVE 3.2 EVALUATE THE CAPACITY OF CITY-RUN AND COMMUNITY-BASED SOCIAL AND EMERGENCY SERVICES TO RESPOND TO AND RECOVER FROM EXTREME WEATHER EVENTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Respond & Recover	3.2 a *	Evaluate community preparedness for response to extreme weather events and promote the importance of emergency response plans for community organizations and businesses.	Development & Emergency Services – Fire Rescue	Community Social Service Agencies/ Organizations Conservation Authorities MECG Members & First Response Local Public Utility Providers	Emergency Plan Other Community Emergency Response Plans (i.e. Community Agencies' Plans)	Current - 2016	< 2 years / Ongoing	\$\$ / \$
•	•	Assess Potential Threats	3.2 b	Conduct a 'threat mapping' exercise to identify critical areas that would be impacted by extreme weather events and pose risks to infrastructure and populations.	Development & Emergency Services – Planning	Conservation Authorities Educational Institutions MECG Members & First Response Government Agencies	Stormwater Master Plan Emergency Plan	2017	3 -5 years / Ongoing	\$\$ / \$

OBJECTIVE 3.3 EDUCATE CITIZENS ON IMPACT OF SEVERE WEATHER EVENTS AND THE IMPORTANCE OF PREPAREDNESS FOR, AND RECOVERY FROM, THESE EVENTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Inform & Equip	3.3 a †	Investigate collating various organizations' educational materials into a central resource database/portal to be shared amongst community organizations.	Infrastructure & Operations – EarthCare	All City Departments Aboriginal Groups/ Agencies Community/ Environmental Organizations Conservation Authorities EOC Members & First Response Local Public Utility Providers Municipal Associations	Emergency Plan Thunder Bay and Area Food Strategy	2018	< 2 years	\$\$
•		Respond & Recover	3.3 b †	Update and formalize first response communications plan/strategy to ensure it responds to the needs of the City and clarifies roles of external agencies in communicating to the public.	City Manager's Office – Corporate Strategic Services	Community/ Environmental Organizations Community Social Service Agencies/ Organizations MECG Members & First Response Local Public Utility Providers Regional Public Health & Health Care Providers	Emergency Plan Thunder Bay and Area Food Strategy	2016	3-5 years / Ongoing	\$\$ / \$

## GOAL #4: CONSIDER CLIMATE CHANGE IMPACTS IN THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF PHYSICAL INFRASTRUCTURE WHILE CONSIDERING AFFORDABILITY AND CO-BENEFITS.

OBJECTIVE 4.1 INCORPORATE NEW TECHNOLOGY AND BEST PRACTICES IN THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF NEW MUNICIPAL INFRASTRUCTURE AND FACILITIES TO MINIMIZE SERVICE DISRUPTIONS AND INCREASE RESILIENCY.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•	•	Increase Resilience	4.1a †	Identify suitable best management practices for design, construction, and maintenance that can be adopted and implemented into City standards and projects.	Infrastructure & Operations – Engineering	All City Departments Builders/Developers Conservation Authorities Educational Institutions Government Agencies Industry Partners	Standard Operating Procedures Stormwater Master Plan Asset Management Urban Design Guidelines Engineering and Development Standards Master Site Plan Urban Design Guidelines Facilities Design Guidelines	2017	< 2 years / Ongoing	\$\$/\$
•		Integrate	4.1b †	Assess and prioritize actions in the Stormwater Management Master Plan using a climate change lens on an annual basis.	Infrastructure & Operations – Engineering	Conservation Authorities Educational Institutions	Stormwater Master Plan	2019	< 2 years / Ongoing	\$\$/\$

OBJECTIVE 4.2 IDENTIFY RETROFIT OPPORTUNITIES FOR MUNICIPAL INFRASTRUCTURE TO MINIMIZE SERVICE DISRUPTIONS RELATED TO EXTREME WEATHER EVENTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
	•	Assess Potential Threats	4.2 a * †	Conduct a detailed evaluation of potential impacts from extreme weather events on municipal (or City-owned) infrastructure.	Infrastructure & Operations – EarthCare	All City Departments Community and Environmental Organizations Conservation Authorities Educational Institutions Government Agencies Industry Associations	Stormwater Master Plan Asset Management Drinking Water Quality Management System Emergency Plan	2020	3-5 years	\$\$\$\$
		Assess Potential Threats	4.2 b †	Conduct a ‘threat mapping’ exercise to identify critical City infrastructure and facilities that would be impacted by extreme weather events, and prioritize and implement projects to protect them.	Infrastructure & Operations – EarthCare	All City Departments Conservation Authorities Educational Institutions Industry Associations Government Agencies	City of Thunder Bay Conservation Authorities Educational Institutions Industry Associations Government Agencies Asset Management Drinking Water Quality Management System Emergency Plan	2025	3-5 years	\$\$\$\$
•	•	Assess Potential Threats	4.2 c †	Update and maintain list of non-municipal infrastructure/ facilities that provide critical support for City and determine their vulnerability to extreme weather events.	Development & Emergency Services – Fire Rescue	All City Departments Business Improvement Associations Community Social Service Agencies/ Organizations Economic Development Agencies MECG Members & First Response Local Public Utility Providers Owners of Infrastructure / Facilities Regional Public Health & Health Care Providers Food Strategy Committee	Emergency Plan Thunder Bay and Area Food Strategy	Current - 2016	> 2 years / Ongoing	\$\$ / \$

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Assess Potential Threats	4.2 d †	Evaluate municipal long-term drinking water storage capacity with a climate change adaptation lens.	Infrastructure & Operations – Environment	All City Departments Conservation Authorities Government Agencies	Drinking Water Quality Management System Lakehead Source Water Protection Plan	2020	3-5 years	\$\$\$\$
		Increase Resilience	4.2 e †	Investigate ways to support to non-municipal infrastructure/ facilities to increase resiliency and recovery.	Infrastructure & Operations – EarthCare	All City Departments Community/ Environmental Organizations Community Social Service Agencies/ Organizations Economic Development Agencies MECG Members & First Response Government Agencies Local Public Utility Providers Regional Public Health & Health Care Providers	Thunder Bay and Area Food Strategy	2020	3-5 years	\$\$\$

OBJECTIVE 4.3 INVESTIGATE AREAS OF PRIORITY TO INCORPORATE BEST PRACTICES AND GREEN INFRASTRUCTURE INTO COMMUNITY AND LAND-USE PLANNING AND DESIGN.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•	•	Increase Resilience	4.3 a * †	Identify new and existing best management practices for green infrastructure, land-use planning, and design, which address climate change impacts to the community, and review annually.	Infrastructure & Operations – Engineering	Educational Institutions Industry Associations Government Agencies Community/ Environmental Organizations	Stormwater Master Plan Official Plan Universal Site Plan Engineering Development Standards Urban Forest Management Plan	2018	< 2 years / Ongoing	\$\$ / \$
		Inform & Equip	4.3 b * †	Prepare a tool kit or resource kit for City administration with information on available best practices and latest innovations in green infrastructure relating to community and land-use planning and design.	Infrastructure & Operations – EarthCare	Community/ Environmental Organizations Conservation Authorities Educational Institutions Government Agencies	Stormwater Master Plan Official Plan Urban Forest Management Plan	2019	< 2 years / Ongoing	\$\$\$\$ / \$
		Increase Resilience	4.3 c †	Identify and implement incentives to promote the adoption of green infrastructure on private, commercial, and institutional properties.	Infrastructure & Operations – EarthCare	Builders/Developers Business Improvement Associations Community/ Environmental Organizations Conservation Authorities Economic Development Agencies Educational Institutions Government Agencies	Stormwater Master Plan EcoSuperior Environmental Programs Urban Design Guidelines Image Route Guidelines Sustainability Plan	2020	3-5 years / Ongoing	\$\$\$ / \$\$\$\$\$

## GOAL #5: FOSTER RESILIENCY OF THE CITY'S NATURAL LANDSCAPE TO ONGOING CHANGES IN CLIMATE.

OBJECTIVE 5.1 INCREASE THE LONG-TERM RESILIENCY OF THE URBAN FOREST, PARKS, OPEN SPACES, AND NATURAL HERITAGE FEATURES INCLUDING WATER BODIES TO MINIMIZE THE IMPACTS OF CLIMATE CHANGE.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•		Increase Resilience	5.1 a	Identify priority resilient species for planting.	Infrastructure & Operations – Parks	Educational Institutions Forest Industry/ Forest Companies Government Agencies Local Public Utility Providers Community/ Environmental Organizations Tree / Forestry Associations Tree Nurseries	Urban Forest Management Plan Planting Standards Parks Division Standards	2016	< 2 years / Ongoing	\$ / \$
		Integrate	5.1 b †	Assess and prioritize actions from the Urban Forest Management Plan using a climate change lens on an annual basis.	Infrastructure & Operations – Parks	Educational Institutions Community/ Environmental Organizations	Urban Forest Management Plan Sustainability Plan	2016	< 2 years / Ongoing	\$\$\$\$ / \$\$
•		Increase Resilience	5.1 c	Identify incentive programs that could be adopted to support the conservation and planting of the City's urban forest.	Infrastructure & Operations – Parks	Community/ Environmental Organizations Conservation Authorities	Urban Forest Management Plan	2016	< 2 years	\$
•		Increase Resilience	5.1 d †	Communicate the need to establish a local tree nursery which grows regionally-specific tree species.	Infrastructure & Operations – Parks	Conservation Authorities Economic Development Agencies Forestry Industry Government Agencies Tree Nurseries	Urban Forest Management Plan	2017	< 2 years / Ongoing	\$ / \$

OBJECTIVE 5.2 PRESERVE AND ENHANCE NATURAL LANDSCAPE FEATURES THAT INCREASE THE CITY'S RESILIENCY.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Assess Potential Threats	5.2 a * †	Identify natural heritage features and conduct threat mapping to identify priority areas that are at greatest risk to climate change and work with partners to conserve and reclaim them.	Development & Emergency Services – Planning	Community/ Environmental Organizations Conservation Authorities Government Agencies	Official Plan Zoning By-laws Provincial significant wetlands	2020	3-5 years	\$\$\$\$
•		Increase Resilience	5.2 b	Continue to support the preservation of natural features in new developments through policy.	Development & Emergency Services – Planning	Builders/ Developers Community/ Environmental Organizations Educational Institutions	Master Site Plan Urban Design Guidelines Official Plan Zoning By-laws Provincial Policy Statement	Current - 2016	< 2 years / Ongoing	\$ / \$
•		Increase Resilience	5.2 c	Develop and maintain policies and bylaws to protect known vulnerable natural areas.	Development & Emergency Services – Planning	Builders / Developers Community/ Environmental Organizations Educational Institutions	Official Plan Zoning By-laws	Current - 2016	< 2 years / Ongoing	\$\$ / \$

# KEY PRINCIPLES

## I. PROVIDE ONGOING FUNDING AND SUPPORT OF ADAPTATION PROJECTS THAT ARE IN LINE WITH CITY'S SHORT TERM AND LONG TERM FINANCIAL PLANNING FRAMEWORK.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•	•	Finance	I.i * †	Identify financial implications and incorporate climate adaptation priorities into existing short and long term financial projections for the City of Thunder Bay.	Corporate Services and Long Term Care - Financial Services	All City Departments Educational Institutions	Financial Projections Asset Management	2016	3-5 years / Ongoing	\$ / \$
•		Finance	I.ii *	Investigate a funding model to support recovery from extreme weather events and other climate change impacts.	Corporate Services and Long Term Care - Financial Services	All City Departments	Emergency Plan	2018	< 2 years / ongoing	\$ / \$

## II. SEEK INVESTMENT AND LOBBY FOR RESOURCES (FEDERAL, PROVINCIAL, PRIVATE) TO SUPPORT CITY'S ADAPTATION EFFORTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
•	•	Finance	II.i *	Work with partners to lobby provincial and federal governments to provide financial support for recovery efforts.	City Manager's Office - Intergovernmental Affairs Committee	Aboriginal Communities Community Social Service Agencies/ Organizations Elected Officials Local Businesses Regional Public Health & Health Care Providers	Emergency Plan	Current - 2016	Ongoing	\$\$ / \$\$
•	•	Finance	II.ii * †	Work with partners to lobby provincial and federal governments to support increasing funding to improve infrastructure resiliency.	City Manager's Office - Intergovernmental Affairs Committee	EarthCare Thunder Bay Conservation Authorities Elected Officials Government Agencies Community/ Environmental Organizations	Asset Management Stormwater Master Plan	Current - 2016	Ongoing	\$\$ / \$\$

III. DEVELOP AND PROVIDE INTERNAL EDUCATION AND STAFF TRAINING REGARDING CITY'S ADAPTATION EFFORTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Inform & Equip	III.i * †	Provide resources and training to staff to support the City's adaptation efforts.	Infrastructure & Operations – EarthCare	All City Departments Conservation Authorities Educational Institutions Elected Officials	Asset Management Stormwater Master Plan	2016	< 2 years / Ongoing	\$\$\$ / \$
•	•	Inform & Equip	III.ii * †	Train City staff within various departments to establish cross-departmental adaptation specialists.	Corporate Services & Long Term Care - Human Resources	All City Departments Municipal Associations Training Coordinators in Divisions	None identified	2017	3-5 years / ongoing	\$\$ / \$

IV. COMMUNICATE ADAPTATION EFFORTS TO A VARIETY OF PUBLIC/COMMUNITY AUDIENCES AND ENCOURAGE RESIDENTS TO ADOPT CLIMATE RESILIENT ADAPTATION EFFORTS.

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Inform & Equip	IV.i * †	Develop external communication, promotional and educational materials focused on a variety of target audiences in the community.	Infrastructure & Operations – EarthCare	Corporate Communications & Strategic Initiatives Conservation Authorities Community/ Environmental Organizations Community Social Service Agencies/ Organizations MECG Members & First Response Government Agencies Local Public Utility Providers Regional Public Health & Health Care Providers	City of Thunder Bay Communication Plan Sustainability Plan Thunder Bay and Area Food Strategy	2016	< 2 years / Ongoing	\$\$\$ / \$

QUICK WIN	KEY ACTION	STRATEGIC DIRECTION	ACTION #	DESCRIPTION	PRIMARY LEAD	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES	ANTICIPATED START DATE	ANTICIPATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)
		Inform & Equip	IV.ii * †	Develop communication and education materials to support citizens' response and recovery from extreme weather events and to increase resiliency.	Infrastructure & Operations – EarthCare	Corporate Communications & Strategic Initiatives Community/ Environmental Organizations Community Social Service Agencies/ Organizations	Emergency Plan Sustainability Plan Thunder Bay and Area Food Strategy	2016	3-5 years / Ongoing	\$\$\$ / \$
		Inform & Equip	IV.iii * †	Improve current efforts to communicate the City's emergency response plans to the public and raise awareness of the Municipal Emergency Control Group.	City Manager's Office – Corporate Strategic Services	EarthCare Thunder Bay Community/ Environmental Organizations Conservation Authorities Local Public Utility Providers Media	Emergency Plan	2016	< 2 years / Ongoing	\$\$\$ / \$\$\$
		Inform & Equip	IV. iv * †	Develop education and communication materials promoting the use and benefits of green infrastructure.	Infrastructure & Operations – EarthCare	Builders / Developers Community/ Environmental Organizations Conservation Authorities Educational Institutions	Urban Design Guidelines Stormwater Master Plan Site Control Plan Asset Management Facility Design Guidelines Sustainability Plan Thunder Bay and Area Food Strategy	2017	< 2 years / Ongoing	\$\$\$ / \$



# APPENDIX B:

# ACTION REGISTER

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Action Registers are intended to complement the Climate Adaptation Strategy's implementation framework to assist the implementation of the actions and to document the collaborative processes that may be required to do so. The Action Registers provide a template to document the implementation of each action item and allow for fine-tuning of the details and elements required for the successful implementation of the actions.

The details of the Action Registers will include information such as the person(s) responsible to facilitate the completion of the action, departmental approval, budget, community partners, detailed implementation dates, specific actions, and supporting documentation. It is the intention that Action Registers will be filled out for each action by the Primary Leads identified in the implementation framework. Primary Leads may choose to assign the Register to an individual who will act as the 'champion' to facilitate the implementation of the action.

Once developed and approved, the Action Registers will feed back into the constantly evolving implementation framework and also serve as institutional memory for the City to track progress towards meeting its adaptation goals and vision. As a whole, the Action Registers are intended to assist with decision-making during annual work plans and prioritization processes.

# DETAILED ACTION REGISTRY | THUNDER BAY CLIMATE ADAPTATION STRATEGY

Action Registry #:	####-##	Status	Approval Date:	yyyy/mm/dd	Action Registry Approved	Name, Department
		<input type="checkbox"/> Completed				
Revision #:	####-##	<input type="checkbox"/> Ongoing	Revision Date:	yyyy/mm/dd	Revision Approved by:	Name, Department
		<input type="checkbox"/> Pending				
		<input type="checkbox"/> Other				
Lead Staff:	Name, Department			Support Staff:	Name, Department	

**ACTION:** # Description **STRATEGIC DIRECTION:** Description

PRIMARY LEAD	ESTIMATED DURATION	ESTIMATED INITIAL / OPERATING COST (CTB)	POTENTIAL PARTNERSHIPS & SECTORS	ASSOCIATED PLANS / STRATEGIES
Lead department	Short 0-2 yrs Med: 3-5 yrs Long: 6-10+ yrs Ongoing	\$: <\$4,999 \$\$: \$5,000-9,999 \$\$\$: \$10,000-29,999 \$\$\$\$: \$30,000-99,999 \$\$\$\$\$: >\$100,000	List of potential partnerships & sectors	List existing City plans, policies and procedures that tie to the action

## BACKGROUND ON THIS ACTION

**GOAL:** # Description

**OBJECTIVE:** # Description

**OVERVIEW:** Pre-populated with Milestone Three information as part of Implementation process.

## DESCRIPTION OF PROPOSED ACTION PLAN:

Provide short written narrative of how the action is going to be accomplished.

## REVISED COST ESTIMATES

Initial cost to implement: \$X Approved? Y  N

Funding source: Source

Ongoing / operating costs: \$X Approved? Y  N

Funding source: Source

## PROPOSED DETAILED TASKS:

1. Provide detailed task description
2. Provide detailed task description
3. Provide detailed task description
4. Provide detailed task description
5. Provide detailed task description

## PROPOSED COMPLETION DATE

yyyy/mm/dd

yyyy/mm/dd

yyyy/mm/dd

yyyy/mm/dd

yyyy/mm/dd

## PERFORMANCE MEASURES:

How will success be measured and how will you know that you've achieved success? If possible, use indicators from the Climate Adaptation Strategy.

## ADDITIONAL COMMENTS:

Insert any additional comments, supporting documentation or clarifications. If "other" was selected under status, provide explanation.



# APPENDIX C:

# INDICATORS

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A total of 20 indicators were developed in consultation with the City's Climate Adaptation Strategy Project Team. Indicators were developed to align with the goals, objectives, and actions of the final Climate Adaptation Strategy, using the following criteria:

- **Process-based approach:** A process-based approach seeks to illustrate trends rather than specific outcomes. By using process indicators it is possible to consider whether the direction of travel is correct given the current information.
- **Ability to tell a story:** A good indicator represents a number of different inputs and outcomes so that it provides a quick snapshot of a complex situation.
- **Availability of data:** The City of Thunder Bay already prepares a wide range of indicators on different issues. Where possible, these indicators were included to minimize the additional work involved in the annual report.

These indicators are based on the five goals and their underlying objectives and priority actions. The intention is that they will measure the success of the Climate Adaptation Strategy itself and demonstrate how the City is preparing for, responding to, and recovering from the priority climate change impacts identified in Milestone Two. In addition, several overarching indicators were also identified which track the impacts of climate change on the City of Thunder Bay.

Note that while indicators provide an indication of trends, analysis is required to understand the drivers of the trends. The indicators will be reviewed on an annual basis and coordination is implied as being necessary to carry out this work.

## Recommended overarching indicators.

OVERARCHING INDICATORS			
Indicator	Trend	Baseline Year	Data Sources
# of Environment Canada warnings per annum	Level of impact of extreme weather on the community	2016	Environment Canada
# of instances and # of days on flood watch and flood warning	Threat that flooding poses to the community	2016	LRCA
# of weeks in declared low water condition	Drought warning	2016	LRCA
% of impervious area within City limits	Risks associated with peak flows and urban flooding	2016	New

## Recommended indicators for Goal 1.

GOAL #1: INTEGRATE CLIMATE CHANGE ADAPTATION INTO OPERATIONAL PROCEDURES AS WELL AS LAND-USE, FINANCIAL AND STRATEGIC PLANNING			
Indicator	Trend	Baseline Year	Data Sources
% of annual expenditures that are directly attributed to adaptation	Degree to which resources are being allocated to climate change adaptation; reflects the level of priority which the City is placing on adaptation	2016	New
% of Corporate Reports that include climate adaptation in support of the Climate Adaptation Strategy	Degree to which the City is embedding adaptation in its activities	2016	New

## Recommended indicators for Goal 2.

GOAL #2: RESPOND AND RECOVER EFFECTIVELY FROM SUSTAINED AND/OR MULTIPLE EXTREME EVENTS IN THE REGION.			
Indicator	Trend	Baseline Year	Data Sources
# of times and # of days MECC response is triggered in response to weather-related events	Changing climate and its impact on the community	2016	MECC Database
# of times and # of days fire response is triggered in response to weather-related events	Level of service required to address weather-related issues	2016	Fire Database
# of hours of power failures per customer are triggered in response to weather-related events	Impact of climate change on critical infrastructure	2016	Hydro Database

## Recommended indicators for Goal 3.

GOAL #3: SUPPORT THE COMMUNITY IN PREPARING FOR, RESPONDING TO, AND RECOVERING FROM EXTREME WEATHER EVENTS.			
Indicator	Trend	Baseline Year	Data Sources
# of people engaged in activities through EarthCare related to climate change adaptation	Effort and success of the City's outreach activities	2016	New
# of hits on climate change adaptation section of the City's website	Level of interest amongst citizens	2016	New

## Recommended indicators for Goal 4.

GOAL #4: CONSIDER CLIMATE CHANGE IMPACTS IN THE DESIGN, CONSTRUCTION, AND MAINTENANCE OF PHYSICAL INFRASTRUCTURE WHILE CONSIDERING AFFORDABILITY AND CO-BENEFITS.			
Indicator	Trend	Baseline Year	Data Sources
# of weather-related by-pass events at the Water Pollution and Control Plant	Ability of the City's infrastructure to address the changing climate	2016	ENV
# of days Bare Point Water Treatment Plant operated >90% and >100% capacity	Capacity of the system to respond to extreme temperatures	2016	ENV
% of design Average Annual Flow Capacity Utilized	Sufficiency of the waste water treatment plant capacity	2016	ENV
# of frozen water services	Capacity of the system to respond to extreme weather	2016	ENV
Hectares of catchment areas of Low Impact Development sites	How much stormwater is treated through LIDs before being released into the waterways	2016	New
# of days the Neebing-McIntyre Floodway diverted flow	Capacity of the floodway to respond to extreme precipitation / snow melt events	2016	LRCA

## Recommended indicators for Goal 5.

GOAL #5: FOSTER RESILIENCY OF THE CITY'S NATURAL LANDSCAPE TO ONGOING CHANGES IN CLIMATE.			
Indicator	Trend	Baseline Year	Data Sources
% of municipality with tree canopy coverage	Resilience of the City to climate change and the ability of the City to increase the forest cover	2016	Parks
% of municipality dedicated to parkland	Ability of the City to maintain natural ecosystems which in turn provide a wide range of co-benefits in responding to a changing climate	2016	Parks



## APPENDIX D:

# BARC METHODOLOGY OUTCOMES

ICLEI's BARC methodology involved identifying potential impacts of climate change and conducting a vulnerability and risk assessment to determine the areas in which the City should focus effort. The table below lists 46 potential impacts of climate change that were identified in Milestone One and

presents the results of the vulnerability and risk assessment which were used to identify Thunder Bay's nine priority climate change impacts ([Section 2.2](#)). An additional 'importance survey' was added to the ICLEI BARC process and those results are also presented.

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Potential Impacts Related to Extreme Weather Events			
Increased service disruptions in utilities (communication, energy, water, wastewater), transportation networks and distribution systems with more frequent and severe weather events. (EX-2)	Medium-High	69.7	17.4
Increased water treatment and management as more frequent and severe weather events increase contamination from stormwater runoff and wastewater overflow during heavy rain a result of increased frequency and severity of extreme weather events. (EX-6)	Medium-High	67.2	16.8
Increased demand for emergency services as more frequent and severe weather events increase the number of disasters. (EX-8)	Medium-High	66.2	16.5

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
4	3.2	3.4	3	2.7
4	4.5	4	1.5	2.4
4	3	3	3	2.4

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Increased housing, medical and social support service demands (particularly for vulnerable populations) as more extreme weather events increase problems with indoor mould, loss of housing, and accessibility to medical services. (EX-7)	Medium	65.2	16.3
Increased infrastructure and building damage as more frequent and severe weather events increase overland flooding from stormwater ponding in low-lying areas. (EX-5)	Medium	65.1	16.3
Increased expenses and capital expenditures as more frequent and severe extreme weather events (such as flooding) damage infrastructure and buildings. (EX-1)	Medium	63.5	15.9
Increased legal liability risks and insurance costs to the municipality due to more frequent and severe weather events. (EX-4)	Medium	63.2	15.8
Increased maintenance and replacement costs as infrastructure and facilities durability and lifespan decreases with more frequent and severe weather events. (EX-3)	Medium	62.8	15.7
Increased damage to archives, irreplaceable objects and culturally significant objects with more extreme weather events.	Medium-Low	37.7	12.6
Decreased emergency service response times due to damaged infrastructure from more frequent and severe extreme weather events.	—	—	—
Increased damage to foundations and in-ground infrastructure due to deep frost, frost-heaving and freeze-thaw cycles from greater temperature variability.	—	—	—

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
4	3.7	3.7	2.7	2.5
4	3.8	3.6	2	2.5
4	3	3	3	2.9
4	4	4	2	2.6
4	3.3	3.3	2.3	2.6
3	3.5	4	2.5	1.9
—	2.7	3.3	3.7	2.3
—	2.7	2.7	3	2.4

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Increased replacement costs for urban trees, landscape vegetation and crops due to extreme temperature fluctuations from greater temperature variability.	—	—	—
Increased springtime flooding and decrease in springtime groundwater recharge due to greater frost depth from extreme cold as a result of greater temperature variability.	—	—	—
Decreased outdoor work because of increased health and safety concerns due to more frequent and severe weather events.	—	—	—
Increased building energy use during heat waves and cold snaps due to greater temperature variability.	—	—	—
Decrease in outdoor recreation, tourism, active transportation and accessibility (particularly for vulnerable populations) due to increased risk exposure from frequent and severe extreme weather events.	—	—	—
Increase in demands for waste disposal due to waste generated during disasters as a result of increased frequency and severity of extreme weather events.	—	—	—
Decrease in the health and productivity of urban trees and crops due to increased erosion and soil nutrient loss from heavy rains as a result of increased frequency and severity of extreme weather events.	—	—	—
Increase in costs to protect and replace urban trees, landscape vegetation and crops due to their damage and death as a result of extreme temperature fluctuations from greater temperature variability.	—	—	—

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
—	2.5	2.5	3.5	1.7
—	2.5	3	2.5	2
—	2.1	2.6	3.9	2.6
—	2	1	2	2.3
—	—	—	—	2
—	—	—	—	1.9
—	—	—	—	1.9
—	—	—	—	1.9

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Increase in building and infrastructure damage due to soil erosion from heavy rains and wave actions as a result of increased frequency and severity of extreme weather events.	—	—	—
Potential Impacts Related to Increase in Temperature			
Increased presence and management of invasive species in parks, urban landscapes and forests due warmer summer temperatures, warmer water temperatures, and a longer growing season. (TEMP-1)	Medium	57.4	14.4
Increased demand for medical and social support services due to higher rates of respiratory problems, illness, deaths and other diseases (particularly for vulnerable residents) due to human heat exposure, increased ground-level ozone, increased forest fires, increased allergies and increased spread of vector-borne disease (associated with warmer temperatures and heat waves).	Medium-Low	48.8	16.3
Decreased carrying capacity of shipping vessels due to lower Lake Superior water levels that result from lower summer precipitation and warmer summer temperatures.	—	—	—
Increased energy use and power disruptions due to increased cooling needs in warmer summer temperatures and more frequent heat waves.	—	—	—
Decreased lake tourism and beach recreation due to increased bacterial growth and toxic algae blooms that result from warmer temperatures and low lake levels.	—	—	—

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
—	—	—	—	1.8
4	4	3	2.5	2.3
3	3.3	3.3	2.3	2.3
—	1.8	2.3	4.5	2.5
—	1	1	5	2.3
—	1	1	5	2.1

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Increase in health and safety risk in public buildings without cooling due to warmer summer temperatures and heat waves.	—	—	—
Decrease winter tourism economy due to a decrease in snow accumulation from warmer winter temperatures.	—	—	—
Decrease in local food production due to increased nuisance animals, pests, insects and disease from warmer temperatures and due to damage to crops from increased frequency and severity of extreme weather events.	—	—	—
Increase in the demand for crime prevention and social support services due to an increase in criminal activity and substance abuse as a result of warmer summer night time temperatures and heat waves.	—	—	—
Increase in the demand for cooling centers and aquatic facilities due to warmer summer temperatures and heat waves.	—	—	—
Decrease in commercial and recreational fishing due to a decline of native fish populations who's habitat will decrease due to warmer water temperatures.	—	—	—
Increase in urban tree maintenance and removal due to decreased health and survival of native tree species who's habitat will decrease as a results of warmer summer temperatures and a longer growing season.	—	—	—
Increase in maintenance of urban trees and landscaped green spaces due to increased plant growth from a longer growing season.	—	—	—

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
—	—	—	—	2.1
—	—	—	—	2
—	—	—	—	2
—	—	—	—	1.9
—	—	—	—	1.9
—	—	—	—	1.9
—	—	—	—	1.8
—	—	—	—	1.6

POTENTIAL IMPACT	RISK SPECTRUM	RISK SCORE/125	CONSEQUENCE SCORE/25
Increase in waste odour problems due to increased decomposition from warmer summer temperatures.	—	—	—
Potential Impacts Related to Changes in Precipitation Patterns			
Decreased well water supplies in rural areas due to decreased groundwater recharge from lower summer precipitation (increase in rural water demand).	Medium-Low	47.2	15.7
Increased traffic accidents and decreased motorized and pedestrian options as the frequency of freezing rain and ice storms increase.	Medium-Low	41.7	13.9
Increased water demand and watering maintenance of urban trees and landscaped areas due to lower summer precipitation.	Medium-Low	40.4	13.5
Increased damage to grey and green infrastructure and crop damage as the frequency of freezing rain and ice storms increase.	Low	30.6	15.3
Increased demand of medical services and other resources to support displaced populations due to more frequent forest fires as summer precipitation decreases.	Low	30.3	15.2
Decreased summertime availability of hydroelectric power due to low water levels that result from decreased summer precipitation.	—	—	—
Increased salt and gravel use in road management as the frequency of freezing rain and ice storms increase.	—	—	—

LIKELIHOOD SCORE/5	VULNERABILITY SCORE/5	SENSITIVITY SCORE/5	ADAPTIVE CAPACITY SCORE/5	IMPORTANCE SCORE/3
—	—	—	—	1.4
3	3	3.3	3	2.2
3	3	3.5	3.2	2.4
3	3	3	2.3	2.2
2	3	2.8	2.6	2.1
2	3	3	2.7	2.5
—	2.7	2.3	3	2.3
—	2	1.5	4	2.3

## RISK LEGEND

SCORE	RISK	DEFINITION
111 - 125 96 - 110	Extreme Very High	Demands urgent attention at the most senior level and cannot be simple accepted as a part of routine operations without executive sanction.
81 - 95 66 - 80	High Medium - High	Severe risks that can still be accepted as part of routine operations without executive sanction but they will be the responsibility of the most senior operational management and reported upon at the executive level.
51 - 65 36 - 50	Medium Medium - Low	These can be part of routine operations but they will be explicitly assigned to relevant managers for actions, maintained under review and reported upon at senior management levels.
21 - 35	Low	These are maintained under review but it is expected that existing controls will be sufficient and no further action will be required to treat them unless they become more severe.

## CONSEQUENCE LEGEND

SCORE	CONSEQUENCE	SECTOR	DEFINITION
21-25	Catastrophic	Public Health and Safety	Large numbers of serious injuries or loss of lives.
		Local Economy and Growth	Regional decline leading to widespread business failure, loss of employment and hardship.
		Community and Lifestyle	The region would be seen as very unattractive, moribund and unable to support its community.
		Environment & Sustainability	Major widespread loss of environmental amenities/systems and irreparable environmental damage.
		Public Administration	Public administration would fail and cease to be effective.

SCORE	CONSEQUENCE	SECTOR	DEFINITION
16-20	Major	Public Health and Safety	Isolated instances of serious injuries or loss of life.
		Local Economy and Growth	Regional stagnation such that businesses are unable to thrive and employment does not keep pace with population growth.
		Community and Lifestyle	Severe and widespread decline in services and quality of life within the community.
		Environment & Sustainability	Severely compromised environmental amenities/systems and a danger of continuing environmental damage.
		Public Administration	Public administration would struggle to remain effective and would be seen to be in danger of failing completely.
11-15	Moderate	Public Health and Safety	General increase in number of injuries.
		Local Economy and Growth	General reduction in overall economic performance relative to current forecasts.
		Community and Lifestyle	General decline in services.
		Environment & Sustainability	Isolated but significant instances of environmental damage that might be reversed with intensive efforts.
		Public Administration	Public administration would be under severe pressure on several fronts.
6-10	Minor	Public Health and Safety	Minor injuries will be incurred.
		Local Economy and Growth	Individually significant but isolated areas of reduction in economic performance relative to current forecasts.
		Community and Lifestyle	Isolated but noticeable examples of decline in services.

SCORE	CONSEQUENCE	SECTOR	DEFINITION
6-10	Minor	Environment & Sustainability	Minor instances of environmental damage that could be reversed.
		Public Administration	Isolated instances of public administration being under severe pressure.
0-5	Negligible	Public Health and Safety	Appearance of a threat but no actual harm.
		Local Economy and Growth	Inconveniences that cause minor shortfalls relative to current forecasts but no real consequence on the local economy and growth.
		Community and Lifestyle	There would be minor areas in which the region unable to maintain its current services with no real consequence on the community.
		Environment & Sustainability	Barriers to ongoing efforts to enhance and restore environmental amenities but no additional environmental damage occurs.
		Public Administration	There would be minor instances of public administration being under more than usual stress but it could be managed with no consequence.

## LIKELIHOOD LEGEND

SCORE	CONSEQUENCE	TYPE OF EVENT	DEFINITION
5	Almost Certain	Recurrent Impact	Could occur several times per year
		Single Event	More likely than not - probability greater than 50%
4	Likely	Recurrent Impact	May arise about once per year
		Single Event	As likely as not - 50/50 chance
3	Possible	Recurrent Impact	May arise once in 10 years
		Single Event	Less likely than not but still appreciable - probability less than 50% but still quite high

SCORE	CONSEQUENCE	TYPE OF EVENT	DEFINITION
2	Unlikely	Recurrent Impact	May arise once in 10 years to 25 years
		Single Event	Unlikely but not negligible - probability greater than zero
1	Rare	Recurrent Impact	Unlikely during the next 25 years
		Single Event	Negligible - probability very small, close to zero

## VULNERABILITY LEGEND

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

## SENSITIVITY LEGEND

SCORE	DEFINITION
5	If the impact occurs, the City of Thunder Bay's functionality and/or health will become unmanageable.
4	If the impact occurs, the City of Thunder Bay's functionality and/or health will get worse.
3	If the impact occurs, the City of Thunder Bay's functionality and/or health will likely get worse.
2	If the impact occurs, the City of Thunder Bay's functionality and/or health will likely stay the same.
1	If the impact occurs, the City of Thunder Bay's functionality and/or health will stay the same.

# ADAPTIVE CAPACITY LEGEND

SCORE	DEFINITION
5	The City of Thunder Bay will require substantial costs (\$\$\$\$) and staff intervention to adjust to the anticipated climatic change.
4	The City of Thunder Bay will require significant costs (\$\$\$\$) and staff intervention to adjust to the anticipated climatic change.
3	The City of Thunder Bay will require some costs (\$\$\$) and staff intervention to adjust to the anticipated climatic change.
2	The City of Thunder Bay will require some slight costs (\$\$) and staff intervention to adjust to the anticipated climatic change.
1	The City of Thunder Bay will require little to no costs (\$) and staff intervention to adjust to the anticipated climatic change.

# APPENDIX E:

# SUPPORTING DOCUMENTS

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The following is a list of plans and reports that complement the Climate Adaptation Strategy:

- EarthCare Sustainability Plan 2014-2020. Available online at <http://www.thunderbay.ca/Assets/Living/Environment/images/2014-2020+EarthCare+Sustainability+Plan.pdf>
- Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation, ICLEI Canada (2012). Available online at [http://www.icleicanada.org/images/icleicanada/pdfs/GuideWorkbookInfoAnnexes\\_WebsiteCombo.pdf](http://www.icleicanada.org/images/icleicanada/pdfs/GuideWorkbookInfoAnnexes_WebsiteCombo.pdf).
- Climate Adaptation Workshop Series: Report on Climate Impacts in Thunder Bay (2014). Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*
- Milestone One Output Report: BARC Program Report Prepared for the City of Thunder Bay (2014). Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*
- Thunder Bay Climate Change Research Project Final Report. Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*
- Thunder Bay Climate Adaptation Strategy: Risk & Vulnerability Assessments Results, EarthCare Thunder Bay (2014). Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*
- Milestone Three Climate Adaptation Action Plan (2015). Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*
- Monitoring and Evaluation Strategy (2015). Available from EarthCare Thunder Bay. *E: earthcare@thunderbay.ca T: 807.625.2411 F: 807.625.3588*

# APPENDIX F:

# GLOSSARY

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## **ADAPTATION (I.E., IN REFERENCE TO ADAPTATION ACTIONS OR ADAPTIVE ACTIONS)**

Includes any initiatives or actions in response to actual or projected climate change impacts and which reduce the effects of climate change on built, natural and social systems.<sup>67</sup>

## **ADAPTIVE CAPACITY**

The ability of built, natural and social systems to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.<sup>68</sup>

## **ANTHROPOGENIC EMISSIONS**

Greenhouse gas emissions resulting from human activity.

## **CITY'S NATURAL LANDSCAPE**

Natural and human made landscape features found within City limits which serve or have the potential to serve an ecological function including but not limited to parks, open spaces, environmental protection areas, natural heritage features, natural corridors, water bodies, woodlots, urban trees and green infrastructure.

## **CLIMATE CHANGE**

Refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typical decades or longer). Climate change may be due to natural internal processes or external forces, or persistent anthropogenic changes in the composition of the atmosphere or in land use.<sup>69</sup>

## **EXTREME WEATHER EVENT**

Extreme weather includes unusual, severe or unseasonal weather; weather at the extremes of the historical distribution that has been seen in the past.

## **INFRASTRUCTURE**

The fundamental facilities and systems serving the City of Thunder Bay and its citizens including both green and grey infrastructure, such as transportation systems, utilities, public facilities and urban trees.

## **GREAT LAKES REGION**

Canadian-American region that includes eight U.S. states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) and the Canadian Province of Ontario encompassing the Great Lakes watershed, which include the Great Lakes (Superior, Michigan, Huron, Erie and Ontario).

## **GREENHOUSE GAS**

A gas in the atmosphere that absorbs and emits radiation within the thermal infrared range, causing the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

## **GREEN INFRASTRUCTURE**

Natural and human-made infrastructure that solve urban and climatic challenges, while providing other co-benefits, by building with nature. Green infrastructure can include components such as natural heritage features and systems, parklands, storm-water management systems, street trees, urban forests, natural channels, natural permeable surfaces, and green roofs.

**GREY INFRASTRUCTURE**

Human-made traditional infrastructure such as sewers, and pipes.

**MITIGATION**

The promotion of policy, regulatory and project-based measures that contribute to 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.<sup>70</sup>

**NATURAL HERITAGE FEATURE**

Features and areas, including significant wetlands, fish habitat, significant woodlands, habitat of endangered species and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscapes of an area.

**OPEN SPACE**

Any open piece of land that is undeveloped (has no buildings or other built structures).

**PRIMARY LEAD**

Refers to the Lead Department, as outlined in the draft Implementation Framework, which will facilitate the completion of the action in collaboration with other departments and partners.

**RESILIENCE**

The capacity of a system, community or society exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.<sup>71</sup>

**SERVICE SECTOR PROFESSIONALS**

Large group of City staff and external stakeholders that have been providing input to inform the content of the Climate Adaptation Strategy from the perspective of the City's main service sectors. Sector professionals include City Leadership, Directors, Managers, members of the Emergency Operating and Control Groups and other key stakeholders.

**THE CITY**

Refers to the City of Thunder Bay.

**THE STRATEGY**

Refers to the City of Thunder Bay's Climate Adaptation Strategy.

**URBAN FOREST**

Refers to the City's total complement of owned Trees on Municipal Property.

# APPENDIX G:

# END NOTES

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EarthCare Thunder Bay  
Infrastructure & Operations  
Department

Victoriaville Civic Centre  
111 Syndicate Ave. S.  
PO Box 800  
Thunder Bay, ON  
P7C 5K4

T: 807.625.2411  
F: 807.625.3588  
E: [earthcare@thunderbay.ca](mailto:earthcare@thunderbay.ca)

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[thunderbay.ca/climate-ready](http://thunderbay.ca/climate-ready)

