A CLIMATE OF RESILIENCE

St. Albert Climate Adaptation Plan

May 2022

City of St. Albert
Cultivate Life

Municipal Climate Change Action Centre

All One Sky Foundation

LAND ACKNOWLEDGEMENT

We respectfully acknowledge that we are on Treaty 6 territory, traditional lands of First Nations and Métis peoples. As treaty People, Indigenous and non-Indigenous, we share the responsibility for stewardship of this beautiful land.

General Acknowledgements

We would like to thank the members of the City of St. Albert's Environmental Advisory Committee and City of St. Albert municipal staff for their support in the creation of this Climate Adaptation Plan. Their participation was vital to the assessment of priority climate impacts facing St. Albert, as well as the generation of actions to manage these impacts.

This Climate Adaptation Plan was led by Calvin Kwan, Project Assistant, University of Alberta. The Plan was also prepared with support from the following organizations:

- Municipal Climate Change Action Centre: Project Management and Partial Project Funding
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- All One Sky Foundation: Project Delivery and Technical Expertise

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Version Control:

Version	Date	Notes
2	May 31, 2022	Final CAP Report

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EXECUTIVE SUMMARY

Climate change is occurring, and it is causing changes to the planet and, therefore, to all of us. Every year, summers get hotter, winters get shorter, and extreme weather happens more frequently. These effects are being felt now, and will be experienced in the future, by the residents of St. Albert.

This Climate Adaptation Plan (CAP) is written to guide the City of St. Albert towards building climate resilience; helping residents prepare their homes, businesses, and livelihoods for the expected impacts of climate change. The CAP revolves around a central vision to inspire its development and implementation.

> *"St. Albert is a safe, healthy, and prosperous community that supports its environment, infrastructure, and water resources in adapting to and minimizing the adverse impacts of climate change".*

With this vision in mind, analysis was conducted to identify climate impacts that will affect St. Albert in the coming years. Through this process, six priority risks and two priority opportunities were identified:

Climate Risks	Climate Opportunities
Heat Wave **Freezing Rain** **Wildfire Smoke** **Wildland Fire** **Invasive Species** **Seasonal Drought**	**Changes in Energy Demand for Heating, Ventilation, and Air Cooling (HVAC)** **Increased Agricultural Productivity**

In order to manage these priority impacts effectively, actions to address these risks and opportunities were grouped into four primary pillars of climate resilience:

01 Built Environment

Guiding Principle: *St. Albert is a city with energy efficient and climate resilient infrastructure*

Objectives

1. Construct weather resilient infrastructure
2. Strengthen indoor facilities with the provision of excellent air quality, energy efficient designs, and protection against the elements
3. Ensure land development regulations account for climate impacts

02 Natural Environment

Guiding Principle: *St. Albert conserves the natural environment which can provide protection from extreme weather events*

Objectives

1. Increase the size and diversity of St. Albert's urban forest
2. Plant native vegetation that is resilient to heat-related climate impacts
3. Monitor and minimize invasive weed species across the city
4. Take advantage of longer growing seasons to increase urban agriculture

03 Public Health & Safety

Guiding Principle: *St. Albert continues to be a healthy and safe city to live in despite the impacts of climate change*

Objectives

1. Ensure outdoor spaces are used safely and appropriately
2. Prepare safe indoor spaces that can be used for shelter when outdoor weather conditions are hazardous
3. Provide reliable climate impact communications for all residents, businesses, and City staff
4. Increase public safety education and awareness to empower residents to build climate resilience
5. Provide adequate equipment and materials to strengthen St. Albert's ability to respond effectively against climate impacts

04 Water Management

Guiding Principle: *St. Albert continues to provide all residents with safe and reliable drinking water*

Objectives

1. Implement effective strategies to conserve water, especially for heat-related climate impacts
2. Enhance the city's water supply to ensure adequate reservoir capacity

Each pillar contains a number of actions the City can take to adapt to climate change. There are 51 total recommended actions. Specific actions and priority levels are detailed in Section 4 of the CAP.

By taking action on the recommendations outlined in this plan, we will be helping to create benefits for our community residents, both now and into the future.

SECTION 1: INTRODUCTION

Climate Change

The Earth's climate is changing. Based on information from the Intergovernmental Panel on Climate Change (IPCC) (2022), our planet is currently on track to warm by 3.2°C by 2100 since the pre-industrial period of the 1850s. This level of warming – which is larger than the planet has experienced in tens of thousands of years – has the ability to alter temperature, precipitation, and weather patterns in both far away countries and here at home, and will have many impacts to our daily lives.

We can take action to make positive changes for our people, economy, and environment. There are two complementary ways to do this. The first way is climate mitigation, where actions are taken to reduce greenhouse gas (GHG) emissions into our environment. This is done by reducing the quantity of carbon-intensive fuels such as coal, oil, natural gas, and gasoline that we burn for energy. The second way – climate adaptation – helps us manage the impacts of climate change that are affecting our livelihoods, now and in the future. Figure 1 below illustrates the difference between climate mitigation and climate adaptation.

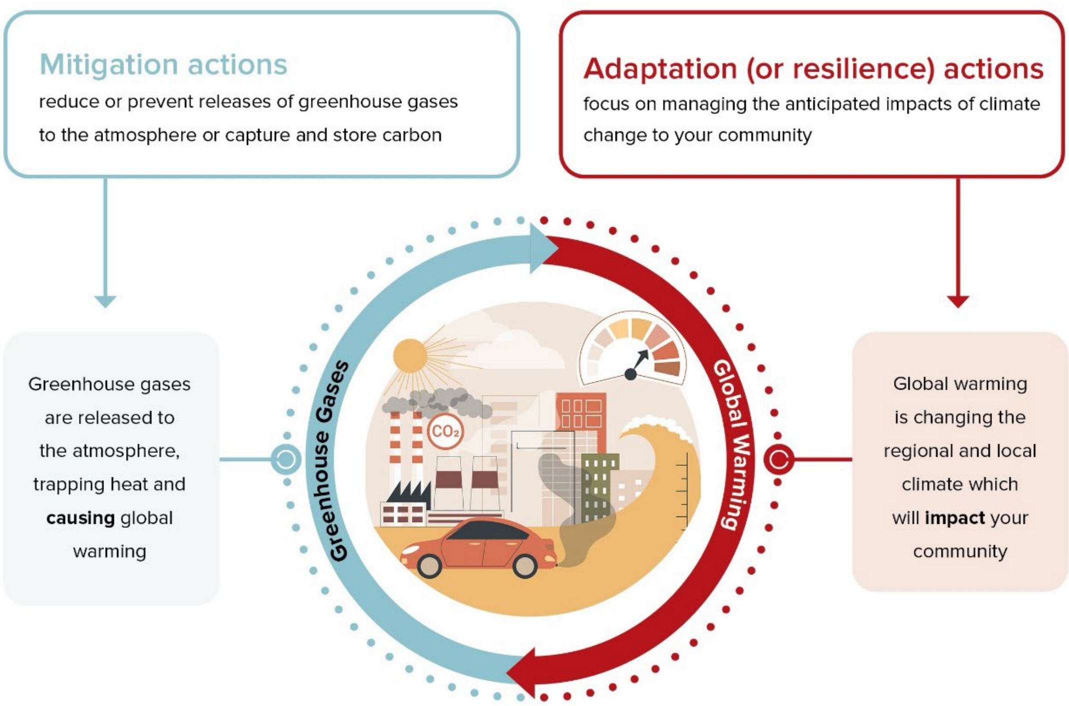

Figure 1: Climate Mitigation vs. Adaptation

Source: All One Sky Foundation, 2021

Both climate adaptation and mitigation actions and plans are important to create a sustainable future. This report focuses on climate adaptation: helping our community respond in a timely manner to the expected effects of changes in our local climate.

Climate Adaptation in St. Albert

Known as the Botanical Arts City, St. Albert is consistently ranked as one of Canada's best places to live (City of St. Albert, 2021). With a population of over 65,000 residents and an average of 1,000 new residents every year, St. Albert is rapidly growing and transforming to prepare for a future population of 100,000.

However, the impacts of climate change are starting to be experienced across the city in the past few years. These impacts – from heatwaves and droughts to flooding and freezing rain – are expected to increase in intensity and frequency over the coming decades.

In April 2021, the City of St. Albert officially approved their new Municipal Development Plan (MDP), *Flourish: Growing to 100K.* As part of the MDP's Risk Management and Resiliency strategy, the City developed Policy 10.8.1 to "conduct a Climate Change Vulnerability Assessment to understand the risks of climate change, and develop a Climate Change Mitigation and Adaptation Strategy to minimize such risks".

In alignment with the policy above, the City created this Climate Adaptation Plan (CAP). The CAP serves to address priority climate risks and opportunities that impact St. Albert's local communities, resources, services, and infrastructure.

Support to create this Plan was provided through the Climate Adaptation Challenge. This program was developed to help municipalities across Alberta build resilience against the expected local effects of climate change, and was delivered in partnership between All One Sky Foundation (AOS) and the Municipal Climate Change Action Centre (MCCAC).

About AOS

All One Sky Foundation is a not-for-profit, charitable organization established to help vulnerable populations at the crossroads of energy and climate change. They do this through education, research and community-led programs, and focusing their efforts on adaptation to climate change and energy poverty. Their vision is a society in which all people can afford the energy they require to live in warm, comfortable homes, in communities that are resilient and adaptive to a changing climate.

About MCCAC

The Municipal Climate Change Action Centre (Action Centre) was established in 2009 as a partnership initiative between the Alberta Municipalities, Rural Municipalities of Alberta, and the Government of Alberta. The Action Centre provides municipalities, schools, and non-profit community related organizations with support, technical assistance, and funding programs to implement energy efficiency and renewable energy projects that reduce greenhouse gas emissions and energy costs, while increasing community resilience.

Developing the Plan

Creation of this CAP followed the 4-step process described in the Climate Resilience Express Action Guide (All One Sky Foundation, 2021). The process is shown in Figure 2 below:

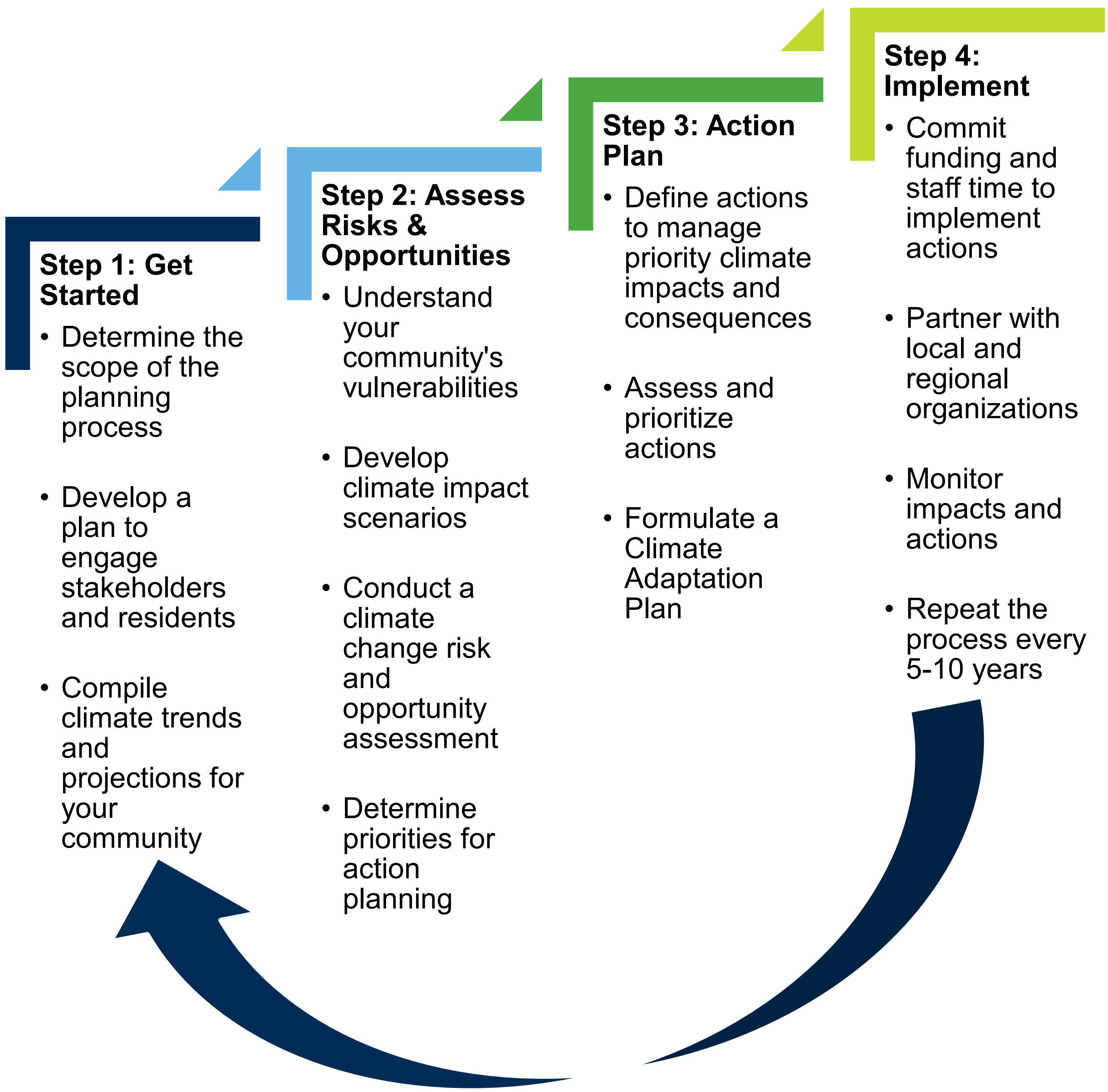

Figure 2: Climate Adaptation Planning Process

Source: All One Sky Foundation, 2021

Scope

The scope of the CAP is defined at a community-wide level. This includes the following:

- All municipal assets, services and operations (e.g., parks, transportation networks, civic buildings and infrastructure, etc.); and
- All homes, private buildings and infrastructure, the local economy, ecosystem functions and services, the health and well-being of residents, etc., across the entire community of St. Albert.

While potentially an important topic for future consideration, this Plan did not investigate the effects of future changes to critical infrastructure and services outside St. Albert's municipal boundaries, or potential changes to St. Albert resulting from overall changes to our social, economic, or political system.

Vision & Guiding Documents

A climate adaptation vision sets the stage for shaping the future of a community. The following vision serves as the underlying foundation of this CAP. This vision was created in consultation with St. Albert staff who are engaged on this topic.

> *"St. Albert is a safe, healthy, and prosperous community that supports its environment, infrastructure, and water resources in adapting to and minimizing the adverse impacts of climate change".*

The three key documents below describe St. Albert's previous work towards achieving this vision. Appendix A details other plans, policies, and bylaws that also contribute towards this vision.

- Flourish: Growing to 100K (MDP): *Flourish* is St. Albert's Municipal Development Plan (MDP). It contains a growth strategy and planned urban structure that shapes the physical growth of the city. The Plan's goals, policies, and strategic directions complement the growth strategy, taking a holistic approach that integrates the City's environmental, economic, social, and cultural aspirations. Residents, property owners, businesses, community groups and other stakeholders can look to *Flourish* for changes they can expect in the years to come.

- Environmental Master Plan (EMP): The *EMP* is a long-term community plan that identifies, prioritizes and sets specific goals and targets for key environmental issues for the City and the community. It is the basis for the City's future environmental plans and initiatives.

- Environmental Sustainability Policy: The *Environmental Sustainability Policy* sets the overall direction for the City and provides a framework to advance the organization's and community's environmental goals. In August 2019, St. Albert City Council approved a minor update to the *Environmental Sustainability Policy* to include climate change resilience and mitigation, leadership in waste reduction and recycling, and regional collaboration.

SECTION 2: CLIMATE SCIENCE & PROJECTIONS

The climate projections described in this report are from the Climate Atlas of Canada (Prairie Climate Centre, 2021). The Climate Atlas of Canada is an interactive tool for citizens, researchers, businesses, and community and political leaders to learn about climate change in Canada. The Atlas provided valuable information used for climate risk and vulnerability assessment and adaptation planning, such as:

- Future climate projections for a range of mean temperature and precipitation variables as well as extremes
- Projections for the 2030’s (2021-2050) and the 2060’s (2051-2080), relative to the historic climate
- Projections for two climate change scenarios – a low emissions scenario (RCP 4.5) and a high emissions scenario (RCP 8.5)
- Downloadable data which can be used to approximate the likelihood of climate impact events occurring in the future

While climate change has been affecting the world since the industrial era began in the late 1800s, the rate of change has been most visible within the last several decades. For that reason, the ‘baseline’ data period for climate modelling used in this report is the period from 1976-2005.

St. Albert needs to be mindful of how its policies and investment decisions will affect the city, both now and in the coming decades. As a result, this plan references the results of climate change modelling for 30-60 years from now (2051-2080), or approximately the 2060s. The climate projections from these models are based on a scenario of the future known as RCP 8.5, where GHGs continue to rise at existing rates over the coming decades.

Details on the climate projections used in this report and a comprehensive table of all climate variables and projections can be found in Appendix B.

Temperature and Precipitation Patterns

The climograph in Figure 3 illustrates predicted future annual average temperature and precipitation patterns in St. Albert. Both patterns are projected to increase between the baseline and the 2060s time periods, although precipitation patterns show a relatively smaller increase than temperature patterns.

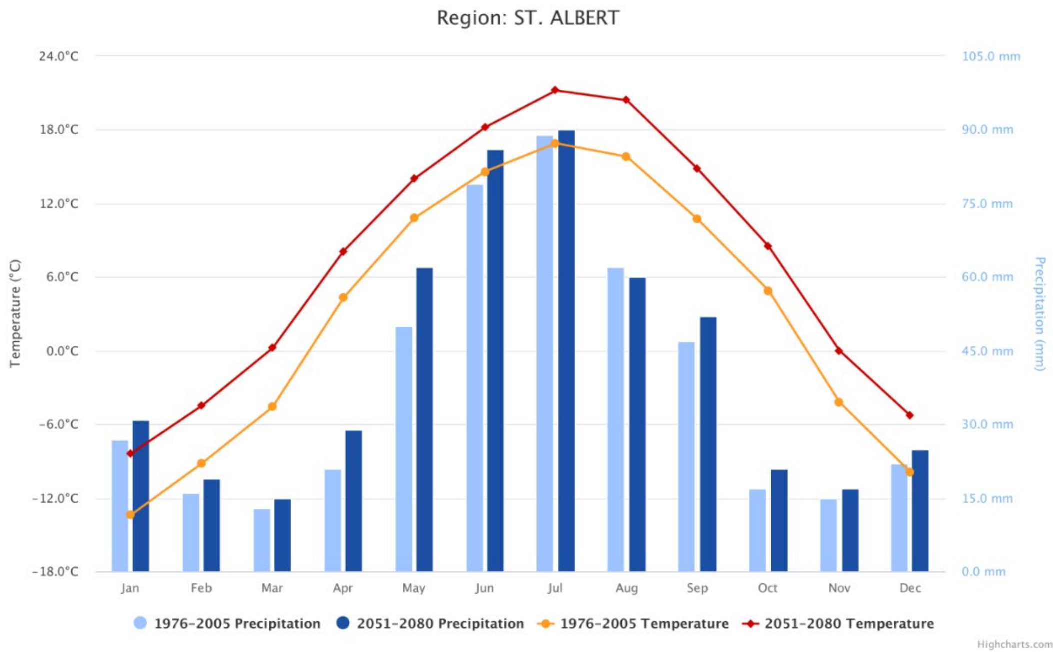

Figure 3: Predicted Changes to Average Annual Temperature and Precipitation Patterns in St. Albert between baseline and future time periods

Source: Prairie Climate Centre, 2021

More specifically, mean annual temperatures in St. Albert are expected to rise from 3.1°C per year in the baseline model to 7.3°C per year in the 2060s. Mean annual precipitation patterns also follow a similar trend, increasing slightly from 457 mm to 509 mm by the 2060s.

Specific Climate Projections

Longer and Hotter Summers

According to the Climate Atlas (Prairie Climate Centre, 2021), a summer day occurs when temperatures reach a minimum of 25°C. The number of summer days in St. Albert is predicted to increase from 28.1 days a year in the baseline period to 73.4 days per year in the 2060s.

In addition, the average number of >30°C days in St. Albert is expected to increase from 3.1 days per year to 24.3 days per year by the 2060s. Hotter weather may also cause an increase in the occurrence of rare climate events in St. Albert. By the 2060s, the number of extremely hot days where temperatures reach 32°C and 34°C is projected to increase, respectively, from 0.7 to 13 days per year, and from 0.1 to 6.3 days per year.

Furthermore, St. Albert may experience 2.1 tropical nights – a climate event that has not previously been experienced in the city – per year in the 2060s. Tropical nights occur when the minimum temperature in a day does not drop below 20°C (Prairie Climate Centre, 2021).

Shorter and Milder Winters

The winter season in St. Albert is expected to shorten as temperatures continue to warm. The number of very cold days where temperatures drop to -30°C or below is expected to decrease from 8 days per year to 1 day per year by the 2060s. Similarly, the number of mild winter days where temperatures reach -5°C could almost be cut in half by the 2060s.

Importantly, the number of freeze-thaw cycles (i.e., the number of days when the air temperature fluctuates between freezing and non-freezing temperatures) is expected to decrease from 86.2 days per year to 66.4 days per year.

More Extreme Weather

As the climate becomes more unpredictable, the intensity and frequency of extreme weather events is projected to increase into the 2060s. A notable example is the number of heat waves that occur, where temperatures of 30°C or hotter are experienced in the city for three consecutive days or more. The number of heat waves in St. Albert is expected to rise from 0.4 per year to 3.2 per year by the 2060s.

Moreover, heat waves create favorable conditions for strong thunderstorms, which can produce high winds, lightning strikes, hail, tornadoes, and extreme rainfall. The number of heavy precipitation days where at least 20 mm of rain or frozen precipitation falls in a single day is estimated to increase from 2.3 to 3 days (a 30% increase) by the 2060s.

SECTION 3: CLIMATE CHANGE VULNERABILITY AND RISK ASSESSMENT

The projected changes to St. Albert's local climate described above could affect the city in many ways, both negative and positive. For example:

- A projected increase in precipitation levels could intensify urban flooding as stormwater catch basins become overwhelmed. It could also cause flooding of the Sturgeon River.
- Hotter summer temperatures could cause a variety of health problems, such as heat exhaustion and heat stroke. This is especially concerning for vulnerable populations, including the elderly, infants, homeless, and those who live in dwellings without air conditioning.
- A longer summer season creates opportunities for extended summer recreation, urban agriculture, and construction activities.
- A milder winter season could open more opportunities for people to venture outside. On the other hand, it could also shorten the outdoor winter recreation season as temperatures become unable to sustain adequate snow and ice for these activities.
- A fewer number of freeze-thaw cycles may reduce damage to road infrastructure (e.g., potholes) and outdoor structures, especially during the spring and mid-winter seasons.
- Hotter weather could trigger a number of heat-related extreme weather events inside city boundaries, such as heat waves, droughts, wildfires, wildfire smoke, and stronger thunderstorms.

Defining Climate Impacts

A total of 23 unique climate impact scenarios were developed through a combination of utilizing the findings from the climate projections above, reviewing St. Albert's existing plans, policies, and bylaws, and engaging in conversations with local staff. Impacts that negatively affect St. Albert are called climate risks, whereas those that offer benefits are called climate opportunities. A complete list of all the climate impact scenarios can be found in Appendix D.

Climate Impact Assessment

A Vulnerability and Risk Assessment (VRA) workshop was delivered in January for City staff to review climate impact scenarios and vote on the consequences of each impact to the community. During the workshop, participants were given the opportunity to assess climate impacts and offer their feedback on each scenario.

Prior to the workshop, research was conducted to identify the likelihood of given climate scenarios. These likelihoods were estimated using available climate science data analysis, local staff knowledge, and external academic research. The scale that was used to determine the likelihood scores for each scenario is available in Appendix C. These scores were then reviewed and used by workshop participants.

Impact Evaluation

For each climate impact scenario, votes on the severity to the community of a given climate impact were combined into an average 'Consequence Score'. This score was multiplied by the 'Likelihood Score' to derive an overall Risk or Opportunity Score. The scores for all impacts were then verified with City staff to determine if any impacts were underestimated or overestimated in comparison to one another.

Impact Score Results

The final results of this procedure are shown in Table 1 and Table 2, ranked from highest to lowest risk (Table 1) and opportunity (Table 2). Climate impacts that had an overall score of 15 or higher were shortlisted as priority impacts for action planning and are bolded in the tables below. The assessment scales that were used to calculate the likelihood, consequence, and overall impact scores can be referenced in Appendix C.

Table 1: Climate Risk Assessment Results

Climate Risks	Threshold	Consequence Score	Likelihood Score	Risk Score
Heat Wave	2 heat waves occur in any given year	3.9	5	**19.3**
Freezing Rain	A freezing rain event that meets the criteria for an Environment Canada & Climate Change Canada warning occurs in any given year	3.5	5	**17.7**
Wildfire Smoke	The maximum Air Quality Health Index (AQHI) reaches level 10 (high risk) in any given year	3.4	5	**17.3**
Wildland Fire	One wildland fire penetrates the municipal boundary in a year	3.1	5	**15.6**
Invasive Species*	Total length of the frost-free season is 168 days in a year	3.7	4	**14.8**
Seasonal Drought*	A class D3 (1:20 year) drought occurs in any given year	3.6	4	**14.5**
Reduced Winter Recreation	The number of mild winter days where temperatures are -5°C or colder is 88 days in any given year	2.4	5	12.2
Water Demand Increase	Annual mean maximum summer temperature is 26.3°C (corresponding to a 23% increase in water use)	2.9	4	11.6
Urban Flooding	3 heavy precipitation days occurs in any given year	2.8	4	11.1
High Winds	Wind speeds of 90km/h are experienced in any given year	2.8	4	11.0
Increased Electricity Demand for Space Cooling	The Cooling Degree Days (CDD) index in any given year is 289.4	2.8	4	11.0
Sturgeon River Flooding	Sturgeon River levels rise to 2.2m in any given year	3.6	3	10.8

Climate Risks	Threshold	Consequence Score	Likelihood Score	Risk Score
Water Supply Shortage	The North Saskatchewan River flow rate is 25 m³ per second in any given year	3.6	3	10.8
Lightning	One year with 60 hours of lightning activity	2.5	4	10.0
Freeze-Thaw Cycles	66 freeze-thaw cycles occur in any given year	2.1	4	8.5
Hailstorm	A hailstorm with loonie-sized hailstones occurs in any given year	2.6	3	7.9
Heavy Snowfall	A heavy snowfall event with 50cm of snow occurs in any given year	2.4	3	7.1
Cold Stress in Winter	One cold stress event (-30°C or colder) occurs in a year	1.7	4	6.8
Tornado	An EF3 tornado occurs inside city limits	4.1	1	4.1

***denotes risks that scored below 15.0 but were also prioritized based on consultation with City staff**

Table 2: Climate Opportunity Assessment Results

Climate Opportunities	Threshold	Consequence Score	Likelihood Score	Opportunity Score
Changes in Energy Demand for Heating, Ventilation, and Air Conditioning (HVAC)	The Heating Degree Days (HDDs) index in any given year is 4178	3.0	5	**15.0**
Increased Agricultural Productivity*	Total length of the frost-free season is 168 days in a year	3.6	4	**14.5**
Increased Summer Recreation Season	Total length of the frost-free season is 168 days in a year	3.3	4	13.3
Longer Construction Season	Total length of the frost-free season is 168 days in a year	3.3	4	13.3

***denotes opportunities that scored below 15.0 but were also prioritized based on consultation with City staff**

SECTION 4: ST. ALBERT'S ADAPTATION PLAN

This section is the heart of St. Albert's Climate Adaptation Plan. A series of action planning sessions were conducted with various City departments and the Environmental Advisory Committee (EAC). During these sessions, participants brainstormed ideas that the City could take to manage each of the eight priority climate impacts. Their ideas were transformed into 51 distinct actions, which are classified into the following six action types:

- **Bylaw:** Updating the City's bylaws to include the action. This often refers to the Land Use Bylaw unless stated otherwise.
- **Plan:** Incorporating the action into a long-range planning document that is created by the municipality.
- **Policy:** Writing a new policy or amending an existing policy for the action.
- **Program:** Launching an official program or initiative for the public that is centered around the action.
- **Project:** Creating a specialized project that is conducted internally by the City for the action.
- **Operations:** Modifying the municipality's daily operations to include the action.

These actions subsequently led to the development of the four primary pillars of climate resilience for St. Albert.

Each pillar is divided into a number of objectives that fulfill its guiding principle. Recommended actions are grouped under each objective and ordered from highest to lowest priority. In order to determine if an action would be recommended for implementation, a qualitative cost-benefit analysis was completed using eight different criteria. These criteria were also used to prioritize the recommended actions, where a higher priority was assigned to actions that provided the most benefits for the least cost. The evaluation framework that was used for these criteria can be found in Appendix E.

All recommended actions that qualified as priority actions are included in this Plan. It is recommended that all priority actions be initiated between 2022-2027.

The 4 Pillars of Climate Resilience

01 BUILT ENVIRONMENT

The built environment where St. Albert residents live, work, and play is an important opportunity for climate adaptation. Buildings offer protection against extreme weather and provide shelter for vulnerable populations. Swimming pools and clean air shelters lessens the impact of certain climate events. This allows people to continue outdoor activities even when extreme weather is occurring.

The City is also encouraging residents to enhance their own built environment through the Clean Energy Investment Program (CEIP), Home Energy Efficiency Grant, and Home Energy Assessment Toolkit (HEAT). Within this pillar, the recommended actions are intended to further optimize the functionality, efficiency, and operational capacity of St. Albert's buildings and infrastructure.

Guiding Principle	St. Albert is a city with energy efficient and climate resilient infrastructure
Objectives	1. Ensure land development regulations account for climate impacts 2. Strengthen indoor facilities with excellent air quality, energy efficient designs, and protection against the elements 3. Construct weather resilient infrastructure

RECOMMENDED ACTIONS

Facilities	Action Type	Priority Level
Retrofit one or more civic facilities with design features that improve air quality indoors, such as HEPA filters and higher quality air intake screens	Project	Medium
Infrastructure & Transportation	**Action Type**	**Priority Level**
Maintain and enhance the City's existing Road Network Information Systems (RWIS) to identify and prioritize problem areas for snow and ice control	Operations	Medium

Incorporate outdoor cooling infrastructure, including shade shelters, water/splash parks, and umbrellas into new developments. Ensure existing spray park and outdoor pools have adequate shelter from sun and inclement weather	Project	Medium
Assess road maintenance budgets to ensure road damage due to climate impacts are repaired efficiently	Operations	Medium
Pilot new initiatives and technologies that prevent freezing rain from forming on roads and sidewalks	Project	Low
Land Development	**Action Type**	**Priority Level**
Create a policy that requires all new developments in St. Albert to incorporate Low Impact Development (LID) practices into their designs. This will reduce the impact of heat-related impacts and improve accessibility to water	Policy	High
Ensure development regulations in the Land Use Bylaw includes appropriate setbacks to prevent fires from reaching forested areas and emergency corridors	Bylaw	High

02 NATURAL ENVIRONMENT

The trees and vegetation that define St. Albert as the Botanical Arts City are an important resource for climate resilience. Having an extensive tree canopy shields the community from heat-related climate impacts and creates clean air to breathe. Encouraging diversity within the natural environment limits invasive weed species and increases food availability from local sources.

St. Albert has already made progress in this area with its *Urban Forest Management Plan, Integrated Pest Management Plan*, and *Natural Areas Conservation and Management Plan* to protect and maintain a healthy natural environment. However, there remains opportunities for improvement. The actions within this pillar will help to further improve the climate resiliency benefits of St. Albert's natural environment.

Guiding Principle	St. Albert conserves the natural environment which can provide protection to the community from extreme weather events
Objectives	1. Increase the size and diversity of St. Albert's urban forest 2. Plant native vegetation that is resilient to heat-related climate impacts 3. Monitor and minimize invasive weed species across the city 4. Take advantage of longer growing seasons to increase urban agriculture

RECOMMENDED ACTIONS

Invasive Species	Action Type	Priority Level
Expand the number of weed-pull events per year to increase invasive weed species education for residents	Program	High
Ensure funding continues to be provided towards monitoring and managing invasive weed species with mechanical controls, and minimizing chemical controls as part of the City's Integrated Pest Management Plan	Plan	High

Provide invasive weed species information in new resident packages	Program	High
Develop a natural predator species program (e.g., using goats in a controlled grazing environment) to minimize invasive weeds organically	Program	Medium
Plant native vegetation and use rocks where watering can be reduced to limit areas where invasive species can live	Operations	Medium

Resilient Vegetation	Action Type	Priority Level
Add development regulations in the Land Use Bylaw that restrict the removal of moisture retaining vegetation (i.e., wetlands, riparian areas, soils, and moisture retaining deadfall). This is in alignment with the Natural Areas Conservation and Management Plan	Bylaw	High
Ensure vegetation is resilient to hot and dry weather through xeriscaping and planting drought resilient native species at City facilities	Operations	Low

Urban Agriculture	Action Type	Priority Level
Establish partnerships with local greenhouses and businesses when developing city-wide urban agriculture programming	Program	High
Update the Land Use Bylaw to change the use of non-developed City lands (i.e., the Urban Reserve district) for urban agriculture from discretionary to permitted	Bylaw	Medium

Urban Forest	Action Type	Priority Level
Increase support for the following actions in the MDP. This will promote the preservation, protection, and enhancement of St. Albert’s tree canopy. • Incorporate existing tree stands into parks, other public open spaces, and private amenity spaces, where feasible and appropriate. • Encourage the protection and maintenance of existing private mature trees. • Promote tree planting on private property to support tree canopy succession and regeneration. • Protect City trees through requirements such as tree preservation plans, hoarding, and securities. • Support maximum opportunity for boulevard tree planting through engineering standards and design guidelines.	Plan	Medium

03 PUBLIC HEALTH & SAFETY

A city cannot function without its people. Because of this, every action that is taken to improve the health and safety of residents contributes towards a more resilient St. Albert. In the context of climate adaptation, this involves delivering proper communications and education at the right time to address all types of climate impacts. It is also important to maintain safe spaces for residents in both indoor and outdoor environments.

There are only a handful of resources that relate to priority climate impacts to public health and safety, including the *Emergency Management Plan* and *Emergency Preparedness Guide* for residents. The actions within this pillar complement these resources to maximize health and safety across the community.

Guiding Principle	St. Albert continues to be a healthy and safe city to live, work and play in despite of the impacts of climate change
Objectives	1. Ensure outdoor spaces are used safely and appropriately 2. Prepare safe indoor spaces that can be used for shelter when outdoor weather conditions are hazardous 3. Provide reliable climate impact communications for all residents, businesses, and City staff 4. Increase public safety education and awareness to empower residents to build climate resilience 5. Provide adequate equipment and materials to strengthen St. Albert's ability to respond effectively against climate impacts

RECOMMENDED ACTIONS

Communications	Action Type	Priority Level
Improve air quality messaging across electronic platforms and signage (i.e., ensuring messaging is consistent and delivered in a timely manner)	Operations	High
Upgrade the City's Spruce it Up smartphone application to include a reporting section specifically for damage caused by hazardous weather events	Project	High

Expand energy efficiency messaging (e.g., proper insulation, energy efficient windows, etc.) for homeowners to reduce negative effects caused by heat-related climate impacts	Operations	High
Strengthen existing electronic communications and outreach for freezing rain events through social media and the City website	Operations	Medium
Equipment & Materials	**Action Type**	**Priority Level**
Provide or sell traction/foot aids in City facilities to improve safety	Program	High
Provide masks and clean air kits at public facilities (civic buildings, first aid stations, libraries, recreation centres, etc.) to protect against wildfire smoke	Program	Medium
Install community sandboxes across residential areas and community facilities to increase protection against the impact of a freezing rain event	Operations	Medium
Indoor Spaces	**Action Type**	**Priority Level**
Mandate a stay/work at home policy for City staff during extreme weather events	Policy	High
Create an emergency response program for vulnerable populations to stay overnight at designated clean air facilities when outdoor air quality is hazardous	Program	Medium
Identify and designate cooling shelters and clean air facilities (e.g., indoor recreation centres, civic buildings, etc.) that can be used during hot weather and wildfire smoke events	Operations	Medium
Outdoor Spaces	**Action Type**	**Priority Level**
Expand the City's Snow Angel program to include measures for freezing rain and ice	Program	Medium

Develop a City policy to adjust and reduce outdoor working hours when conditions are hazardous due to extreme heat and wildfire smoke (e.g., implementing siestas, transitioning outdoor work to be completed during night shifts, etc.)	Policy	Medium
Develop a wildfire smoke emergency plan that includes guidelines for closing outdoor facilities during hazardous smoke levels	Plan	Medium
Expand summer outdoor recreation programs into the spring and fall seasons	Program	Medium
Identify, train, and deploy a specialized unit from public operations to manage freezing rain on parking lots, roads, and sidewalks	Operations	Low

Safety Education	**Action Type**	**Priority Level**
Launch a wildfire smoke awareness program that educates citizens on health impacts, AQHI, and smoke protection	Program	High
Encourage residents to use winter tires through public safety education (e.g., digital brochures, safety webinars, etc.)	Program	High
Develop a fire smart education and awareness program to prevent, protect, and respond to wildland fires	Program	Medium

04 WATER MANAGEMENT

Water is a fundamental need for all life on Earth. When heat waves and droughts occur, water can quickly become scarce as demand increases. Consequently, it is critical to ensure all St. Albert residents continue to have safe and adequate access to water as climate change intensifies.

The City already has a number of plans in place to manage water resources, such as the *Water Conservation Bylaw* and *Stormwater Management Master Plan*. The recommendations within this pillar of climate resilience build upon the strategies in those plans.

Guiding Principle	St. Albert continues to provide all residents with safe and reliable drinking water
Objectives	1. Implement effective strategies to conserve water, especially for heat-related climate impacts 2. Enhance the city's water supply to ensure adequate reservoir capacity

RECOMMENDED ACTIONS

Water Conservation	Action Type	Priority Level
Update the Water Conservation Bylaw to incorporate water demand management guidelines for heat-related climate impacts	Bylaw	High
Add water regulations that encourage sustainable outdoor watering into water statutory documents. These regulations promote "purple pipes" that recycle water for irrigation and industrial uses	Plan	Medium
Facilitate public gardening workshops that focus on water conservation strategies (e.g., vertical gardening)	Program	Medium

Water Supply	Action Type	Priority Level
Review the Storm Water Management Master Plan to assess which system upgrade recommendations have been completed since 2004. Prioritize recommendations within the plan to further enhance St. Albert's water capacity and storage.	Plan	Medium

SECTION 5: THE PATH AHEAD

> ***"Knowledge is only potential power. It becomes power only when, and if it is organized into definite plans of action and directed to a definite end". - Napoleon Hill***

The actions suggested in this report provide a path forward for St. Albert to increase its climate change resiliency. Many of these actions can be incorporated through the City's existing plans, policies, and programs. Some actions may require new projects to be developed and take more time to complete. This Plan should be updated every five years as it is a living document.

The path ahead for St. Albert can be one that is paved with resilience. The adaptation actions within this Plan are a start to this journey, as they provide direction for the City to manage the most significant climate impacts that are predicted to affect St. Albert. By working together to invest in solutions that help the city adapt, we can truly build a climate of resilience for the place we call home.

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APPENDICES

Appendix A: Other Relevant Plans, Policies and Bylaws

Emergency Management Plan: The City's *Emergency Management Plan* provides a framework for how the City conducts its comprehensive emergency management program. The plan also provides guidance on how the entire community can work together to create a more resilient city in response to the impacts of a major emergency or disaster.

Emergency Preparedness Guide: The City of St. Albert has developed an *Emergency Preparedness Guide* to help families prepare for emergencies and disasters. The guide includes sections on understanding the risks, how to make a plan, how to prepare a kit, knowing what to do in an emergency, and knowing what to do after an emergency.

Home Energy Assessment Toolkit (HEAT): *The Home Energy Assessment Toolkit (HEAT)* supplies residents of the City of St. Albert with tools, tips and strategies to determine how energy is used in the home. It's a Do-It-Yourself home energy audit!

Integrated Pest Management Plan (IPM): The City of St. Albert has developed its *IPM Plan*, which is used to prevent and manage all pest problems within St. Albert. It promotes healthy vegetation and guides pest control activities on all public land and within civic structures and facilities.

Natural Areas Conservation and Management Plan: The Natural Area Assessment provides the foundation for the *Natural Area Conservation and Management Plan*, which outlines best management practices on how to manage existing protected natural areas and how to conserve new natural areas as the City develops.

Stormwater Management Plan: This document provides the proposed master plan for the stormwater drainage system within the existing City boundaries.

Urban Forest Management Plan (UMFP): St. Albert's *Urban Forest Management Plan (UFMP)* will sustainably manage and enhance our diverse urban forest. The plan provides strategic direction for the entire urban forest, including all trees within city limits – whether planted, naturally occurring, or accidentally seeded. Trees in parks, natural areas, the river valley, ravines, roadways, and roof-top gardens, as well as on commercial, residential, and private lands, are all part of the urban forest and within the scope of this plan.

Water Conservation Bylaw: St. Albert City Council approved the *Water Conservation Bylaw* in 2015. The bylaw focuses on low-flow fixtures for new developments and major renovations, as well as restrictions for outdoor daytime sprinkler use. The goal of the bylaw is to help promote the efficient use of water in the community and to reduce water waste, which will lower maintenance and upgrading costs to water and wastewater infrastructure.

Appendix B: Detailed Climate Projections Information

Climate Variable Definitions

Hot Weather Variables

Average Length of Heat Waves: The average length of a heat wave. A heat wave occurs when at least three days in a row reach or exceed 30°C.

Cooling Degree Days: Cooling Degree Days (CDD) are equal to the number of degrees Celsius a given day's mean temperature is above 18°C. For example, if the daily mean temperature is 21°C, the CDD value for that day is equal to 3°C. If the daily mean temperature is below 18°C, the CDD value for that day is set to zero.

Extremely Hot Days (+32°C): A day when the temperature rises to at least 32°C.

Extremely Hot Days (+34°C): A day when the temperature rises to at least 34°C.

Hot (+30°C) Season: The number of days when +30°C temperatures can be expected.

Longest Spell of +30°C Days: The maximum number of days in a row with temperatures 30°C or higher.

Number of Heat Waves: The average number of heat waves per year. A heat wave occurs when at least three days in a row reach or exceed 30°C.

Summer Days: A Summer Day is a day when the temperature rises to at least 25°C.

Tropical Nights: A Tropical Night occurs when the lowest temperature of the day does not go below 20°C.

Very Hot Days: A Very Hot Day is a day when the temperature rises to at least 30°C.

Warmest Maximum Temperature: The highest temperature of the year.

Cold Weather Variables

Coldest Minimum Temperature: The very coldest temperature of the year.

Freeze-Thaw Cycles: This is a simple count of days when the air temperature fluctuates between freezing and non-freezing temperatures. Under these conditions, it is likely that some water at the surface was both liquid and ice at some point during the 24-hour period.

Freezing Degree Days: Freezing degree days (FDD) begin to accumulate when the daily mean temperature drops below freezing: if a day's mean temperature is -21°C, for example, it increases the annual FDD value by 21. Days when the mean temperature is 0°C or warmer do not contribute to the annual sum.

Frost Days: A frost day is one on which the coldest temperature of the day is lower than 0°C. Under these conditions frost might form at ground level or on cold surfaces.

Heating Degree Days: Heating Degree Days (HDD) are equal to the number of degrees Celsius a given day's mean temperature is below 18°C. For example, if the daily mean temperature is 12°C, the HDD value for that day is equal to 6°C. If the daily mean temperature is above 18°C, the HDD value for that day is set to zero.

Icing Days: An Icing Day is a day on which the air temperature does not go above freezing (0°C).

Mild Winter Days (-5°C): A Mild Winter Day is a day when the temperature drops to at least -5°C.

Very Cold Days (-30°C): A Very Cold Day is a day when the temperature drops to at least -30°C.

Winter Days (-5 °C): A Winter Day is a day when the temperature drops to at least -15°C.

__**Temperature Variables**__

Maximum Temperature: The highest temperature of the day.

Mean Temperature: The average temperature of the day.

Minimum Temperature: The lowest temperature of the day.

__**Precipitation Variables**__

Dry Days: The number of days in a year without rain/snow.

Heavy Precipitation Days: A Heavy Precipitation Day (HPD) is a day on which at least a total of 10mm (or 20mm) of rain or frozen precipitation falls. Frozen precipitation is measured according to its liquid equivalent: 10cm of snow is usually about 10mm of precipitation.

Max 1-Day Precipitation: The amount of precipitation that falls on the wettest day of the year.

Max 3-Day Precipitation: The wettest three-day period.

Max 5-Day Precipitation: The wettest five-day period.

Mean Annual Precipitation: The average amount of precipitation that falls in a year.

Mean Growing Precipitation: The average amount of precipitation that falls during the growing season.

Precipitation: The total amount of rain, drizzle, snow, sleet, etc. Frozen precipitation is measured according to its liquid equivalent: 10cm of snow is usually about 10mm of precipitation.

Wet Days: The number of days in a year with rain/snow.

Agriculture Variables

Corn Heat Units: Corn Heat Units (CHU) is a temperature-based index often used by farmers and agricultural researchers to estimate whether the climate is warm enough (but not too hot) to grow corn. A minimum of 2200 CHUs are required to mature most varieties of corn.

Date of First Fall Frost: The date of the first fall frost, which marks the approximate end of the growing season for frost-sensitive crops and plants.

Date of Last Spring Frost: The date of the last spring frost, which marks the approximate beginning of the growing season for frost-sensitive crops and plants.

Frost-Free Season: The Frost-Free Season is the approximate length of the growing season, during which there are no freezing temperatures to kill or damage plants.

Growing Degree Days: Growing Degree Days (GDD) provide an index of the amount of heat available for the growth and maturation of plants and insects. Different base temperatures (5, 10 and 15°C) are used to capture results for organisms that demand different amounts of heat.

Climate Projections and Charts

Table 3 below displays data from the Climate Atlas of Canada (Prairie Climate Centre, 2021) for five climate variable categories: Hot Weather, Cold Weather, Temperature, Precipitation, and Agriculture. Comparisons are made between the baseline (1976-2005) and 2060s (2051-2080) mean values.

Table 3: Summary of Projected Climate Changes for St. Albert

Climate Variable	Baseline Mean	2060s Projections			
		Low (10th percentile)	Mean	High (90th percentile)	Mean % Change
Hot Weather					
Number of Very Hot Days (+30°C days)	**3.1**	6.1	**24.3**	46.9	684%
Tropical Nights	**0**	0	**2.1**	7.1	210%[1]
Average warmest max temperature (°C)	**30.9**	31.9	**35.7**	39.8	16%
Summer Days	**28.1**	46.8	**73.4**	99.5	161%
Cooling Degree Days (CDD)	**53.0**	133.5	**289.4**	468.8	446%
Number of Heat Waves	**0.4**	0.6	**3.2**	6.1	700%
Average Length of Heat Waves (days)	**1.1**	1.6	**5.2**	9.1	373%
Longest Spell of +30°C Days	**1.1**	1.6	**7.5**	16.2	582%
Number of expected +30°C days ("Hot Season")	**16.4**	29.3	**77.8**	123.6	374%
Extremely Hot Days (+32°C to +33°C)	**0.7**	1.2	**13.0**	30.5	1757%
Extremely Hot Days (+34°C or hotter)	**0.1**	0.0	**6.3**	18.6	6200%
Cold Weather					
Number of very cold days (-30°C days	**7.8**	0.0	**1.1**	4.3	-86%

[1] The percentage change assumes that a change from 0 to 1 tropical night represents a 100% increase.

Climate Variable	Baseline Mean	2060s Projections			
		Low (10th percentile)	Mean	High (90th percentile)	Mean % Change
Freeze Thaw Cycles (days)	**86.2**	49.2	**66.4**	84.4	-23%
Frost Days	**190.1**	120.4	**144.9**	170.1	-24%
Icing Days	**90.4**	41.2	**64.9**	89.4	-28%
Coldest Minimum Temperature (°C)	**-35.2**	-33.5	**-27.4**	-21.0	-22%
Heating Degree Days (HDD)	**5482**	3520	**4178**	4833	-24%
Freezing Degree Days (FDD)	**1374**	434.5	**792.7**	120.7	-42%
Mild Winter Days (-5°C or colder)	**129.3**	60.9	**87.7**	113.9	-32%
Winter Days (-15°C or colder)	**57.0**	9.7	**29.0**	51.2	-49%
Temperature					
Annual Mean Temperatures (°C)	**3.1**	5.3	**7.3**	9.4	135%
Spring Mean Temperature (°C)	**3.5**	4.3	**7.5**	10.9	114%
Summer Mean Temperature (°C)	**15.7**	17.8	**20.0**	22.2	27%
Fall Mean Temperature (°C)	**3.8**	5.6	**7.8**	10.8	105%
Winter Mean Temperature (°C)	**-10.9**	-10.4	**-6.1**	-2.1	-44%
Annual Max. Temperature (°C)	**8.7**	10.6	**12.7**	15.0	46%
Spring Max. Temperature (°C)	**9.4**	9.7	**13.2**	17.1	40%
Summer Max. Temperature (°C)	**21.9**	23.7	**26.3**	29.1	20%
Fall Max. Temperature (°C)	**9.2**	10.5	**13.1**	15.9	42%

Climate Variable	Baseline Mean	2060s Projections			
		Low (10th percentile)	Mean	High (90th percentile)	Mean % Change
Winter Max. Temperature (°C)	**-6.1**	-6.2	**-2.0**	2.0	-67%
Annual Min. Temperature (°C)	**-2.5**	-0.1	**1.9**	3.8	-176%
Spring Min. Temperature (°C)	**-2.3**	-1.2	**1.7**	4.7	-174%
Summer Min. Temperature (°C)	**9.6**	11.7	**13.6**	15.4	42%
Fall Min. Temperature (°C)	**-1.6**	0.4	**2.4**	4.4	-250%
Winter Min. Temperature (°C)	**-15.7**	-14.8	**-10.2**	-6.0	-35%
Precipitation					
Mean Annual Precipitation (mm)	**457**	366	**509**	666	11%
Mean Spring Precipitation (mm)	**84**	54	**107**	167	27%
Mean Summer Precipitation (mm)	**229**	133	**237**	365	3%
Mean Fall Precipitation (mm)	**79**	46	**90**	151	14%
Mean Winter Precipitation (mm)	**65**	44	**75**	111	15%
Mean Growing Precipitation (mm)	**365**	262	**401**	557	10%
Heavy Precipitation Days (10 mm)	**9.5**	5.8	**11.3**	17.4	19%
Heavy Precipitation Days (20 mm)	**2.3**	0.6	**3.0**	6.0	30%

Climate Variable	Baseline Mean	2060s Projections			
		Low (10th percentile)	Mean	High (90th percentile)	Mean % Change
Wet Days	**134.7**	116.2	**135.6**	155.4	1%
Dry Days	**230.0**	209.2	**229.1**	248.3	0%
Max 1-Day Precipitation (mm)	**33**	20	**37**	59	12%
Max 3-Day Precipitation (mm)	**47**	29	**52**	83	11%
Max 5-Day Precipitation (mm)	**58**	36	**65**	103	12%
Agriculture					
Frost-Free Season (days)	**128.8**	140.1	**168.2**	200.6	31%
Date of First Fall Frost	**Sept. 21**	Sept. 22	**Oct. 10**	Oct. 31	N/A
Date of Last Spring Frost	**May 12**	Mar. 29	**Apr. 21**	May 11	N/A
Corn Heat Units (CHU)	**2151**	2722	**3272**	3830	52%
Growing Degree Days Index (Base 4°C)	**1663**	2081	**2480**	2876	49%
Growing Degree Days Index (Base 5°C)	**1476**	1874	**2258**	2638	53%
Growing Degree Days Index (Base 10°C)	**692.9**	991.4	**1296**	1598	87%
Growing Degree Days Index (Base 15°C)	**189.7**	362.5	**583.4**	814.6	208%

Figure 4 below compares the baseline and predicted future trend for the annual number of summer days in St. Albert. The trend shows a steady pattern during the baseline period and changes to a sharper increase after 2005.

Past and Predicted Annual Number of Summer Days in St. Albert

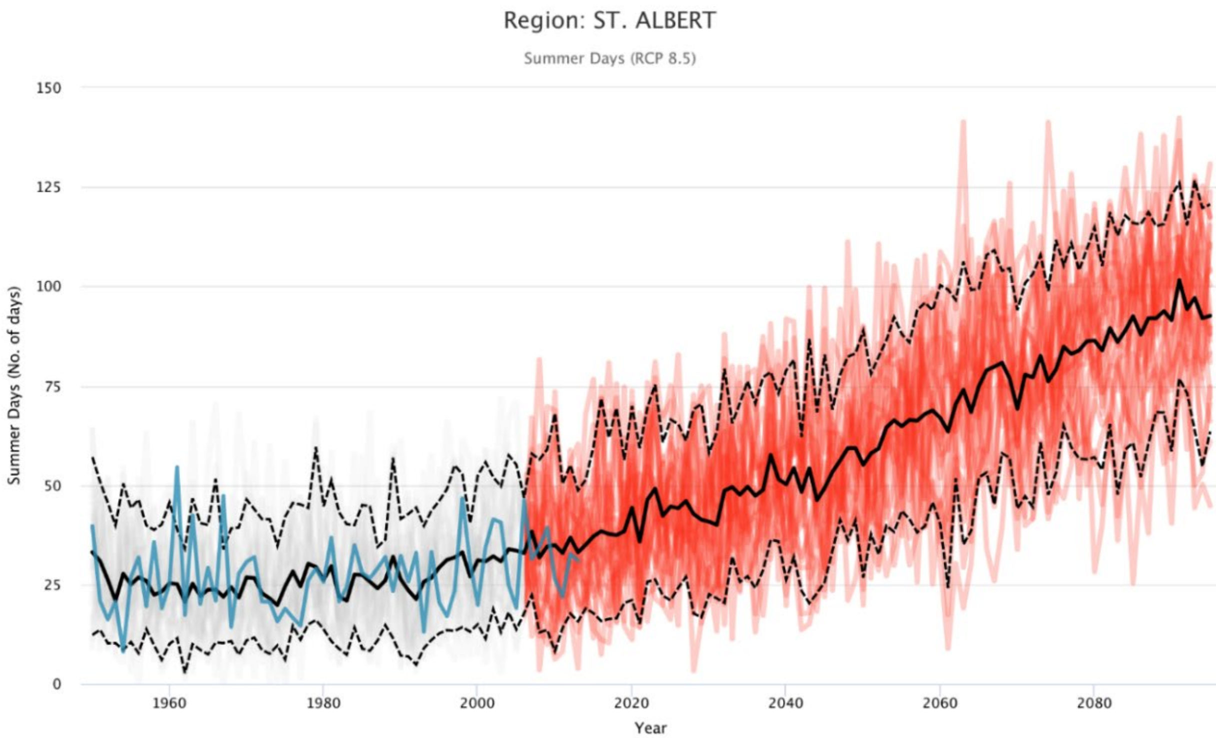

Figure 4 . Past and Predicted Annual Number of Summer Days in St. Albert

Source: Prairie Climate Centre, 2021

Figure 5 below compares the baseline and predicted future trend for the annual number of very cold days in St. Albert. The trend shows a steady pattern during the baseline period and follows with a decline in both the average and the variability of predicted results after 2005.

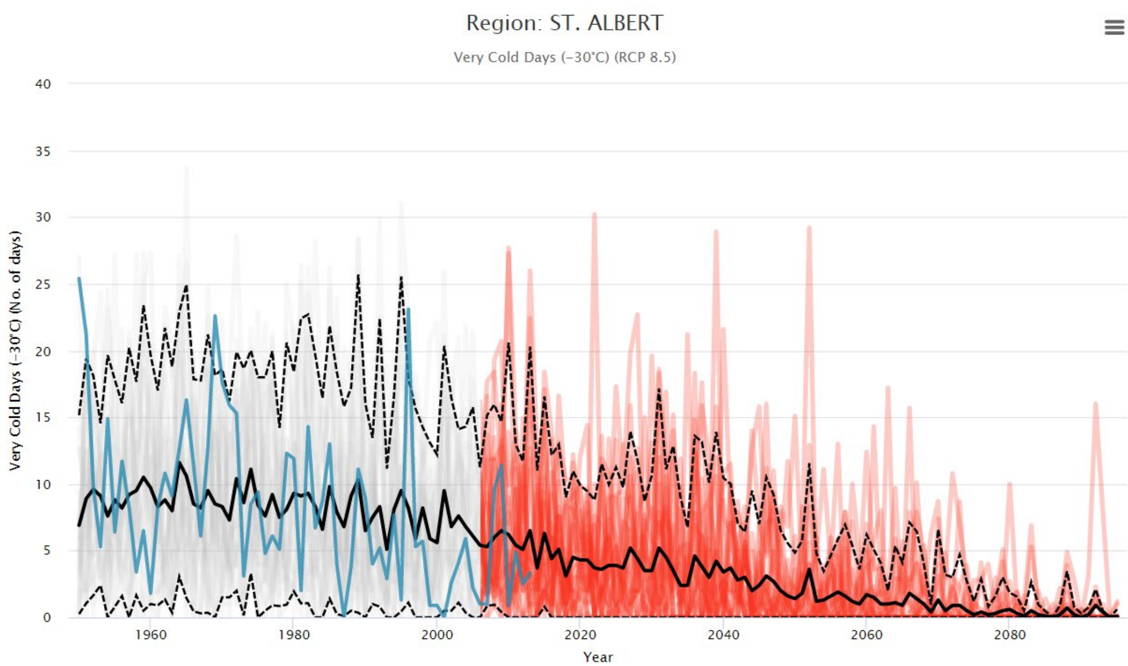

Figure 5 Past and Predicted Annual Number of Very Cold Days (-30°C) in St. Albert

Source: Prairie Climate Centre, 2021

Figure 6 below compares the baseline and predicted future trend for the annual number of heat waves in St. Albert. The trend shows a relatively steady pattern until 2040 and follows with a gradual increase in the variability of predicted results.

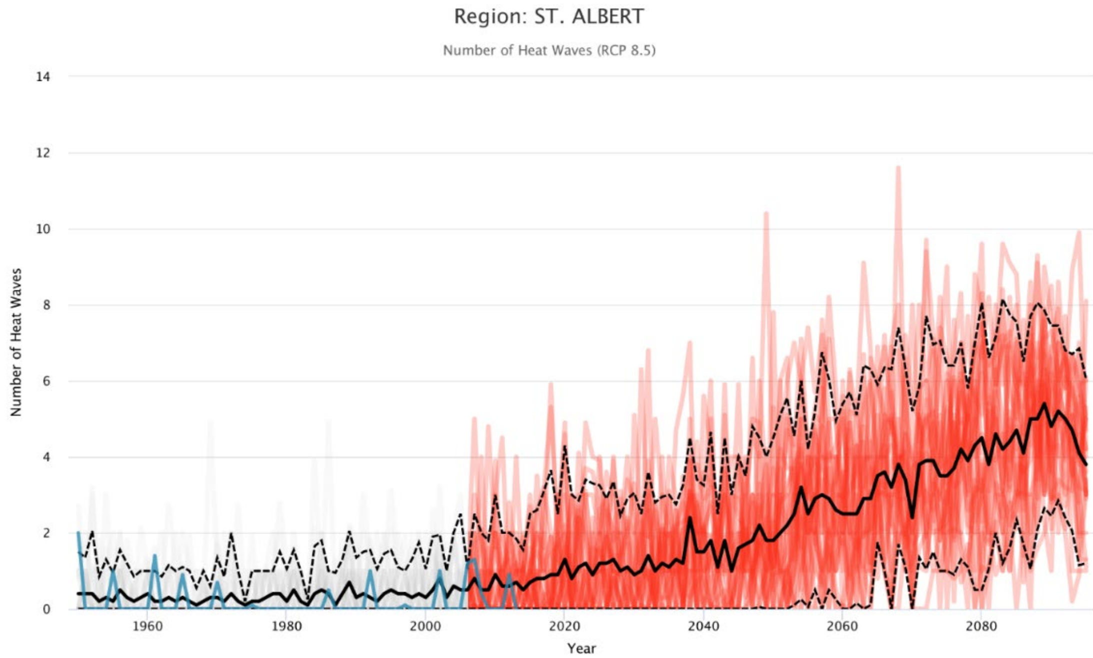

Figure 6 Past and Predicted Annual Number of Heat Waves in St. Albert

Source: Prairie Climate Centre, 2021

Description of Climate Atlas Data

Where did this data come from?

This data originates from the Prairie Climate Centre (2021). Global Climate Models (GCMs) are used to depict how the climate is likely to change in the future. Since no one climate model can be considered 'correct', it is important to use many GCMs to capture a range of possible conditions. The GCM Climate Atlas data were obtained from the Pacific Climate Impacts Consortium (PCIC). PCIC collected temperature and precipitation data produced by 24 different models and used advanced statistical techniques to create high-resolution (daily, 10km) versions of the data for all of Canada (for more information visit pacificclimate.org). Data used in this workshop was from the 'St Albert' grid.

What are the RCP 8.5 and RCP 4.5 future climate scenarios?

One of the most important inputs into GCM simulations of the future climate is the expected concentration of greenhouse gases (GHGs; especially carbon dioxide) in the atmosphere as a result of human activity. In the scientific literature these future GHG concentrations are used to calculate Representative Concentration Pathways (RCPs). The High Carbon scenario (RCP8.5) assumes that humans continue to emit very large amounts of carbon dioxide from the burning of fossil fuels; the Low Carbon scenario (RCP4.5) assumes that drastic reductions of emissions in the coming decades will stabilize the concentration of GHGs in the atmosphere by the end of this century. The Climate Atlas did not use RCP2.6, an even lower emissions scenario.

How are the minimum, mean, and maximum calculated?

The Climate Atlas used an ensemble of 24 different GCMs to analyze the future climate. The mean values are the average values of this ensemble over the 1976-2005, 2021-2050 and 2051-2080 periods. The range of values in each time period is indicated by the High (90th percentile) and Low (10th percentile) values in the tables. This means about 10% of the predicted values are above the "High" value, and 10% are lower than the "Low" value.

Appendix C: Climate Impact Assessment Scales

Likelihood Scale

Score	Description	Climate Event
1	**Rare**	Event is expected to happen less than once every 100 years (Annual probability < 1% in the 2060s)
2	**Unlikely**	Event is expected to happen about once every 51-100 years (1 - 2% annual probability in the 2060s)
3	**Possible**	Event is expected to happen about once every 11-50 years (2 - 10% annual probability in the 2060s)
4	**Likely**	Event is expected to happen about once every 3-10 years (10 - 50% annual probability in the 2060s)
5	**Almost Certain**	Event is expected to happen once every two years or more frequently (Annual probability > 50% in the 2060s)

Consequence Scale for Climate Risks

Criteria	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)
Public Health & Safety	No directly related loss of life No directly related injuries, illnesses, diseases or need to access healthcare services Minimal short-term reaction of fear or anxiety, or disruption to daily life	⟷	No directly related deaths A few people injured or experiencing illness, some requiring hospital treatment Widespread moderate, temporary feelings of fear and anxiety	⟷	Any directly related deaths Many more people injured, many seriously, or experiencing illness, many requiring hospital treatment Widespread and severe disturbance resulting in chronic psychological effects, like PTSD
Social Functioning	Minimal disruption to daily life Minimal or no change in community cohesion and trust in others No self-evacuations Minimal or no impact on cultural resources, recovering full functionality within days	⟷	Week-long disruption to daily life Moderate erosion of community cohesion and trust in others Small areas of the city (1 block) seeing temporary self-evacuations Moderate damage to cultural resources, with full recovery taking months	⟷	Months long disruption to daily life (e.g., inability to access schools, recreation) Severe, widespread erosion of community cohesion and trust in others Large areas of some neighbourhoods requiring temporary evacuations, with some permanent displacement High damage to cultural resources, full recovery may not be possible or could take years
Economic Vitality	Little or no potential direct and indirect economic losses Minimal or no disruption to economic sectors, jobs and livelihoods	⟷	Notable potential direct and indirect economic losses Week-long disruption to an important economic sector and associated jobs & livelihoods	⟷	Significant potential direct and indirect economic losses Long-term disruption or loss of an important economic sector and associated job & livelihood losses

Criteria	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)
	Minimal or no impact to infrastructure services Negligible impact on existing disparities, inequalities, or deprivation		Week-long disruption to infrastructure services Moderate, temporary exacerbation of existing disparities, inequalities, or deprivation		Months long disruption to infrastructure services Significant, prolonged exacerbation of existing disparities, inequalities, or deprivation
Natural Environment	Minimal or no environmental disruption or damage Affected resources recovering full functionality within days	⟷	Isolated but reversible damage to wildlife, habitat or and ecosystems, or short-term disruption to environmental amenities Full restoration of function possible, but could months	⟷	Widespread and irreversible damage to wildlife, habitat and ecosystems, or long-term damage, disruption to environmental amenities Full restoration of function is not possible, or could take decades
City Services	Little or no expected additional costs to City Minimal or no impact on operations and delivery of services Public reaction is minimal- little or no erosion of trust in City (council & staff)	⟷	Added costs are near or equivalent to available contingency / extreme weather reserves Operations and services temporarily interrupted for weeks before backlog is cleared Public reaction is moderate - negative view of City (council & staff) is held by several community groups or a neighbourhood	⟷	Added costs far exceed contingency and extreme weather reserves Operations and services severely interrupted – additional resources required to clear backlog, taking months Public reaction is significant - negative view of City (council & staff) is widespread, spanning the majority of population

Consequence Scale for Climate Opportunities

Very Low [1]	Low [2]	Medium [3]	High [4]	Very High [5]
• Minimal or no increase in jobs and economic activity, benefiting a few businesses • Minimal improvement to the lifestyle, and/o physical and emotional well-being of some residents • Existing disparities, inequalities and deprivation across the community is unchanged • Minimal or no improvement in the City's annual operating surplus (revenues less expenses)	⟷	• Moderate direct and indirect economic gains, and/or modest increases in employment opportunities in a sector of the local economy • Modest improvements to the lifestyle, and/or physical and emotional well-being of specific population groups (e.g., outdoor recreationalists) in St. Albert • Moderate reduction in existing disparities, inequalities and deprivation for some marginalized groups • Modest improvement in the City's annual operating surplus (revenues less expenses)	⟷	• Significant direct and indirect economic gains, and/or large increases in employment opportunities in key sectors of the local economy, or the creation of a new sector • Noteworthy improvements to the lifestyle, and/or physical and emotional well-being of the majority of residents in St. Albert • Large reductions in existing disparities, inequalities and deprivation for majority of marginalized groups • Significant improvement in the City's annual operating surplus (revenues less expenses)

Appendix D: Climate Impact Scenarios

Priority Risks

HEAT WAVE	
Projected Climate Change	Hotter summer temperatures and more extreme heat
Impact Event Description	Three or more consecutive days of +30°C temperatures or hotter
Key Consequences	• Injuries and fatalities related to heat exhaustion and heat stroke; public health and safety risks • Impacts exacerbated for vulnerable populations, including the young, elderly, disabled and long-term sick, as well people experiencing homelessness or living in poor-quality homes. • Damage to building infrastructure and related components (e.g., mechanical, electrical, etc.) • Increased need for regular maintenance • Increased risk of forest fires and smoke • Higher cooling demands on buildings • Economic impacts • Ecological and environmental damage
Proxy Indicator / Threshold	2 heat waves occur in any given year
Historic Value (1976-2005)	0.4 heat waves per year
Future Value (2060s)	3.2 heat waves per year (700% increase from base period)
Annual Probability	• Historic: 4% • Future: 67%
Likelihood Score	• Historic: 3 • Future: 5
Consequence Score	• 3.9
FINAL RISK SCORE: 19.3	

FREEZING RAIN	
Projected Climate Change	Increased average temperatures and precipitation in fall, winter, and spring
Impact Event Description	Precipitation event in which rain freezes on impact to form a coating of clear ice on the ground and on exposed objects
Key Consequences	• Public risk of injuries from slips, trips and falls • Transportation disruption and mobility impacts, particularly for people with accessibility issues. Vulnerable groups disproportionately affected • Increased road and sidewalk maintenance costs
Proxy Indicator / Threshold	A freezing rain event that meets the criteria for an Environment Canada & Climate Change Canada warning occurs in any given year
Historic Value (1976-2005)	0.4 events per year
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 40% • Future: 100%
Likelihood Score	• Historic: 4 • Future: 5
Consequence Score	• 3.5
FINAL RISK SCORE: 17.7	

WILDFIRE SMOKE	
Projected Climate Change	Reduced summer precipitation, increased summer temperatures
Impact Event Description	Smoke from wildfires enters into municipal boundaries
Key Consequences	• Negative health outcomes related to smoke inhalation and poor air quality • Poor air quality at civic facilities, including concerns over the ability of current HVAC systems to manage smoke • Cancellation of local and outdoor events
Proxy Indicator / Threshold	The maximum Air Quality Health Index (AQHI) reaches level 10 (high risk) in any given year
Historic Value	• 2016-2021 records show 3 years where AQHI values were 10 or higher • Average = 1 event every 1.5 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 60% • Future: 80%
Likelihood Score	• Historic: 5 • Future: 5
Consequence Score	• 3.5
FINAL RISK SCORE: 17.3	

WILDLAND FIRE	
Projected Climate Change	Reduced summer precipitation, increased summer temperatures
Impact Event Description	A wildfire, small or large, that occurs in an area where development is essentially nonexistent, except for roads, railroads, power lines and other linear infrastructure
Key Consequences	• Human safety issues and loss of life • Increased air and heat pollution • Damage to the natural environment
Proxy Indicator / Threshold	A wildland fire penetrates the municipal boundary in any given year
Historic Value	• 14 wildland fire incidents recorded between 2013-2021 • Average = 1 incident every half a year
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 100% • Future: 100%
Likelihood Score	• Historic: 5 • Future: 5
Consequence Score	• 3.1
FINAL RISK SCORE: 15.6	

INVASIVE SPECIES	
Projected Climate Change	Warmer seasonal temperatures
Impact Event Description	An outbreak of invasive weed species, including species of concern such as Flowering Rush, Garlic Mustard, and Himalayan Balsam
Key Consequences	• Increased weed management costs and vegetation management costs • Reduced plant/vegetation biodiversity
Proxy Indicator / Threshold	Total length of the frost-free season is 168 days in a year
Historic Value (1976-2005)	• 129 Days
Future Value (2060s)	168 Days (30% increase from base period)
Annual Probability	• Historic: 11% • Future: 46%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 3.7
FINAL RISK SCORE: 14.8	

SEASONAL DROUGHT	
Projected Climate Change	Reduced summer precipitation, increased summer temperatures
Impact Event Description	A period of anomalously low moisture during the frost-free season
Key Consequences	• Stress on natural systems (e.g., soil, water, etc.) • Impacts to and loss of local trees and forests
Proxy Indicator / Threshold	A class D3 (1:20 year) drought occurs in any given year
Historic Value	• 4 D3 droughts were reported in St. Albert between 2002-2021 • Average = 1 drought every 5 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 21% • Future: >21%
Likelihood Score	• Historic: 4 • Future: 4
Consequence Score	• 3.6
FINAL RISK SCORE: 14.5	

Priority Opportunities

CHANGES IN ENERGY DEMAND FOR HEATING, VENTILATION, & AIR CONDITIONING (HVAC)	
Projected Climate Change	Higher average winter temperatures
Impact Event Description	A shift from winter to summer demand for HVAC is predicted to occur as higher average winter temperatures reduce the energy requirements needed to maintain indoor spaces at temperatures of 18°C or warmer
Key Consequences	• Space heating cost savings for businesses, residents, and the city
Proxy Indicator / Threshold	The Heating Degree Days (HDDs) index in any given year is equal to 4178
Historic Value (1976-2005)	5482 HDDs
Future Value (2060s)	4178 HDDs (24% reduction from base period)
Annual Probability	• Historic: 0% • Future: 54%
Likelihood Score	• Historic: 1 • Future: 5
Consequence Score	• 3.0
FINAL OPPORTUNITY SCORE: 15.0	

INCREASED AGRICULTURAL PRODUCTIVITY	
Projected Climate Change	Warmer spring, summer and fall temperatures
Impact Event Description	A warmer growing season for plants and crops, providing favorable conditions for agriculture
Key Consequences	• Increased economic benefits for local agriculture • Increased food production and food supply
Proxy Indicator / Threshold	Total length of the frost-free season is 168 days in a year
Historic Value (1976-2005)	129 Days
Future Value (2060s)	168 days (30% increase from base period)
Annual Probability	• Historic: 11% • Future: 46%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 3.6
FINAL OPPORTUNITY SCORE: 14.5	

Non-priority Risks

REDUCED WINTER RECREATION	
Projected Climate Change	Warmer winter temperatures
Impact Event Description	A shorter, more variable season for winter recreation activities that are dependent on cold, snow and ice
Key Consequences	• Increased difficulty in maintaining outdoor ice rinks, leading to higher maintenance costs and/or poorer quality skating conditions • Reduced snow accumulation leads to poorer quality cross country skiing conditions • Increased maintenance of indoor facilities as people shift indoors for winter recreation
Proxy Indicator / Threshold	The number of mild winter days where temperatures are -5°C or colder is 88 days in any given year
Historic Value (1976-2005)	129 Days
Future Value (2060s)	88 Days (32% reduction from base period)
Annual Probability	• Historic: <1% • Future: 53%
Likelihood Score	• Historic: 1 • Future: 5
Consequence Score	• 2.4
FINAL RISK SCORE: 12.2	

WATER DEMAND INCREASE	
Projected Climate Change	Hotter summer temperatures, more extreme heat and drier summer conditions
Impact Event Description	Increased demand for the consumption of potable water and Sturgeon River water for irrigation
Key Consequences	• Increased operating costs to municipality • Increased utility costs for businesses and residents • Water quality concerns
Proxy Indicator / Threshold	Annual mean maximum summer temperature is 26.3°C (corresponding to a 23% increase in water use)
Historic Value (1976-2005)	21.9°C
Future Value (2060s)	26.3°C (20% increase from base period)
Annual Probability	• Historic: 3% • Future: 46%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 2.9
FINAL RISK SCORE: 11.6	

URBAN FLOODING	
Projected Climate Change	Increased precipitation in spring, summer, and fall seasons
Impact Event Description	Heavy precipitation of 20mm or more rain in a day causes flooding inside city boundaries
Key Consequences	• Flooding damage to property and infrastructure, including basement flooding and road damage • Increased insurance costs • Increased runoff and erosion
Proxy Indicator / Threshold	3 heavy precipitation days occurs in any given year
Historic Value (1976-2005)	2.3 Days
Future Value (2060s)	3.0 Days (30% increase from base period)
Annual Probability	• Historic: 29% • Future: 40%
Likelihood Score	• Historic: 4 • Future: 4
Consequence Score	• 2.8
FINAL RISK SCORE: 11.1	

HIGH WINDS	
Projected Climate Change	Increased storm intensity
Impact Event Description	A windstorm with gusts of 90km/h
Key Consequences	• Damage to property and infrastructure, including trees, signs, roofs, siding, automobiles, etc.
Proxy Indicator / Threshold	Wind speeds of 90km/h are experienced in any given year
Historic Value (1976-2005)	• 9 high wind events were reported between 1976-2005 • Average = 1 high wind event every 3 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 30% • Future: <30%
Likelihood Score	• Historic: 4 • Future: 4
Consequence Score	• 2.8
FINAL RISK SCORE: 11.0	

INCREASED ELECTRICITY DEMAND FOR SPACE COOLING	
Projected Climate Change	Increased summer temperatures and extreme heat
Impact Event Description	The need for space cooling, most likely using fans and air conditioners that use electricity, increases as indoor temperatures become warmer than 18 °C
Key Consequences	• Increased space cooling and building operating costs to municipality • Costs to retrofit and upgrade buildings and facilities • Utilities affected/overloaded as demand increases
Proxy Indicator / Threshold	Cooling Degree Days (CDD) in any given year are 289.4
Historic Value (1976-2005)	53.0 CDDs
Future Value (2060s)	289.4 CDDs (445% increase from base period)
Annual Probability	• Historic: 4% • Future: 42%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 2.8
FINAL RISK SCORE: 11.0	

STURGEON RIVER FLOODING	
Projected Climate Change	Increased precipitation in spring, summer, and fall seasons
Impact Event Description	Higher water levels in the Sturgeon River causes local flooding
Key Consequences	• Damage to downtown core • Damage to nearby property, infrastructure, and utilities that are located in low-lying areas or floodplains • Damage to riparian areas and recreational trails
Proxy Indicator / Threshold	Sturgeon River levels rise to 2.2m in any given year
Historic Value	• 4 flooding events of concern recorded between 1968-2022 • Average = 1 flooding event every 14 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 7% • Future: 7%
Likelihood Score	• Historic: 3 • Future: 3
Consequence Score	• 3.6
FINAL RISK SCORE: 10.8	

WATER SUPPLY SHORTAGE	
Projected Climate Change	Reduced snowpack, reduced precipitation, hotter summer temperatures
Impact Event Description	Extreme low flow conditions in the North Saskatchewan River, endangering local water supply (at EPCOR water facility located in Edmonton)
Key Consequences	• At risk water supply, with potential water restrictions • Impacts to aquatic ecosystems
Proxy Indicator / Threshold	The North Saskatchewan River flow rate is 25 m^3 per second in any given year
Historic Value	In the past 100 years there were two times when flow volumes fell below the 25 m^3/s threshold
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 2% • Future: 5%
Likelihood Score	• Historic: 2 • Future: 3
Consequence Score	• 3.6
FINAL RISK SCORE: 10.8	

LIGHTNING	
Projected Climate Change	Increased storm intensity, increased summer temperatures
Impact Event Description	Occurrence of lightning strikes within the city with the potential to contact and cause harmful effects to people, infrastructure and the environment
Key Consequences	• Damage to property and infrastructure, including trees, signs, roofs, siding, automobiles, etc. • Injuries or fatalities from lightning strikes • Trigger wildland/grassland fires
Proxy Indicator / Threshold	One year with 60 hours of lightning activity
Historic Value	2016 was a record lightning year with 95 hours of lightning activity
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 17% • Future: 22%
Likelihood Score	• Historic: 4 • Future: 4
Consequence Score	• 2.5
FINAL RISK SCORE: 10.0	

FREEZE-THAW CYCLES	
Projected Climate Change	Warmer average temperatures in fall and spring
Impact Event Description	Temperatures fluctuate above and below freezing
Key Consequences	• Infrastructure damage and associated maintenance costs • Hazardous walking and driving conditions
Proxy Indicator / Threshold	66 freeze-thaw cycles occur in any given year
Historic Value (1976-2005)	86 Cycles
Future Value (2060s)	66 Cycles (23% reduction from base period)
Annual Probability	• Historic: 91% • Future: 47%
Likelihood Score	• Historic: 5 • Future: 4
Consequence Score	• 2.1
FINAL RISK SCORE: 8.5	

HAILSTORM	
Projected Climate Change	Increased storm intensity
Impact Event Description	A storm producing hail stones of 27 mm (“loonie-sized”) in diameter
Key Consequences	• Damage to property and infrastructure, including trees, signs, roofs, siding, automobiles, etc. • Increased insurance costs for repair and replacement of damaged property
Proxy Indicator / Threshold	A hailstorm with loonie-sized hailstones occurs in any given year
Historic Value	• 2 hail events with loonie-sized hail or greater were reported between 1982-2020 • Average = 1 hailstorm every 19 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 5% • Future: 5%
Likelihood Score	• Historic: 3 • Future: 3
Consequence Score	• 2.6
FINAL RISK SCORE: 7.9	

HEAVY SNOWFALL	
Projected Climate Change	Increased precipitation in winter
Impact Event Description	A snowfall event where 50cm of snow accumulates within 24 hours
Key Consequences	• Structural damage to buildings (roof collapse) • Transportation disruption
Proxy Indicator / Threshold	One heavy snowfall event occurs in any given year
Historic Value	• 7 years with heavy snowfall events recorded between 1960-2015 • Average = 1 heavy snowfall event every 8 years
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 13% • Future: 5%
Likelihood Score	• Historic: 4 • Future: 3
Consequence Score	• 2.4
FINAL RISK SCORE: 7.1	

COLD STRESS IN WINTER	
Projected Climate Change	Warmer winter temperatures, fewer very cold days
Impact Event Description	Very cold days with temperatures reaching -30°C or colder
Key Consequences	• Injuries and fatalities related to cold exposure • Impacts for vulnerable populations, including the young, elderly, disabled and long-term sick, as well people experiencing homelessness or living in poor-quality homes. • Reduced recreation opportunities
Proxy Indicator / Threshold	One very cold day occurs in a year
Historic Value (1976-2005)	8 Days
Future Value (2060s)	1 Day (88% reduction from base period)
Annual Probability	• Historic: 84% • Future: 48%
Likelihood Score	• Historic: 5 • Future: 4
Consequence Score	• 1.7
FINAL RISK SCORE: 6.8	

TORNADO	
Projected Climate Change	Increased summer storm intensity
Impact Event Description	An EF (Enhanced Fujita) 3+ tornado with wind speeds between 218 to 266 km per hour and potential for “severe damage”
Key Consequences	• Damage to property and infrastructure, including trees, signs, roofs, siding, automobiles, etc. • Severe injuries and fatalities
Proxy Indicator / Threshold	An EF3 tornado occurs inside city limits
Historic Value	Significant tornado events in Alberta include an EF4 tornado in 1987 (Edmonton), and EF3 in 2000 (Pine Lake)
Future Value (2060s)	Not modelled
Annual Probability	• Historic: 0.3% • Future: 0.3%
Likelihood Score	• Historic: 1 • Future: 1
Consequence Score	• 4.1
FINAL RISK SCORE: 4.1	

Non-priority Opportunities

INCREASED SUMMER RECREATION SEASON	
Projected Climate Change	Warmer weather in spring and fall
Impact Event Description	A longer recreation season for summer outdoor recreation activities
Key Consequences	• Increased accessibility and use of active transportation methods such as bicycles • Increased summer festivals and events
Proxy Indicator / Threshold	Total length of the frost-free season is 168 days in a year
Historic Value (1976-2005)	129 Days
Future Value (2060s)	168 days (30% increase from base period)
Annual Probability	• Historic: 11% • Future: 46%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 3.3
FINAL OPPORTUNITY SCORE: 13.3	

LONGER CONSTRUCTION SEASON	
Projected Climate Change	Warmer spring and fall temperatures
Impact Event Description	A longer season for construction projects and related activities
Key Consequences	• Increased efficiency of summer construction projects such as road repairs and underground utility work (more projects complete, more opportunities) • Economic benefits • Potential for higher quality products and workmanship
Proxy Indicator / Threshold	Total length of the frost-free season is 168 days in a year
Historic Value (1976-2005)	129 Days
Future Value (2060s)	168 days (30% increase from base period)
Annual Probability	• Historic: 11% • Future: 46%
Likelihood Score	• Historic: 3 • Future: 4
Consequence Score	• 3.3
FINAL OPPORTUNITY SCORE: 13.3	

Appendix E: Actions Ranking Evaluation

Criteria Evaluation Framework

The framework below shows the eight criteria and their respective descriptions that were used to evaluate recommended actions. Each action was given a score based on the description it was most suited for (e.g., an action with initial costs less than $10,000 would be given a score of 1).

Once the action was scored on all eight criteria, the average of all benefit scores was divided by the average of all cost scores to calculate its total cost-benefit score (i.e., total cost-benefit score = average benefit score/average cost score)

Cost/ Benefit	Criteria	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)
Cost	Initial Costs	Initial investment cost of action <$10,000	$10,000-$50,000	Initial investment cost of action is between $50,000-$100,000	$100,000 - $500,000	Initial investment cost of action >$500,000
Cost	Operating Costs	Total annual operating costs <$10,000	$10,000-$50,000	Total annual operating costs between $50,000-$100,000	$100,000-$200,000	Total annual operating costs >$200,000
Cost	Negative Side-effects	Little to no unintentional negative impacts and consequences for St. Albert		Unintentional negative impacts with moderate consequences for St. Albert		Unintentional negative impacts with significant consequences for St. Albert
Cost	Feasibility	Little to no technological knowledge, staff training, or public acceptance barriers prevent the action from being implemented successfully		Moderate technological knowledge, staff training, or public acceptance barriers prevent the action from being implemented successfully		Significant technological knowledge, staff training, or public acceptance barriers prevent the action from being implemented successfully

Benefit	Impact	Minor reduction in priority climate risk or minimal potential to realize projected climate opportunities	Moderate reduction in priority climate risk or moderate potential to realize projected climate opportunities	Significant reduction in priority climate risk or significant potential to realize projected climate opportunities
Benefit	Co-benefits	Little to no cross-over and positive contribution to other City economic, social or environmental objectives, including greenhouse gas reduction	Modest cross-over and positive contribution to other City economic, social or environmental objectives, including greenhouse gas reduction	Significant cross-over and positive contribution to other City economic, social or environmental objectives, including greenhouse gas reduction
Benefit	Equity	Action benefits a narrow segment of the population or business community AND does not help disadvantaged and underserved segments of the population. [That is, the action only helps a small group of middle- to upper-income households]	Action benefits a wide segment of the population or business community OR helps disadvantaged and underserved segments of the population. [That is, the action either offers widespread benefits OR alleviates inequalities in the community]	Action benefits a wide segment of the population or business community AND helps disadvantaged and underserved segments of the population. [That is, everyone is made better-off, including underserved groups]
Benefit	Flexibility	Action and implementation strategy has little to no ability to be adjusted (brought forward or delayed, or scaled up or down)	Action and implementation strategy can be partially adjusted, but at moderate additional costs	Action and implementation strategy can be fully adjusted at minimal additional costs

Actions Prioritization Methodology

Actions that qualified for prioritized implementation were assigned a label of 'high', 'medium' or 'low'. Each prioritized action was compared to the standard deviation and average of all the total cost-benefit scores that were ranked one or above, to determine its appropriate label. The following chart details this calculation.

Priority Level	Description
High	The cost-benefit score of the action is higher than the average cost-benefit score plus half of the standard deviation
Medium	The cost-benefit score is in between the high and low ranges
Low	The cost-benefit score of the action is at least one, but lower than the average cost-benefit score minus half of the standard deviation

Appendix F: Events Attendance List

- St. Albert Environmental Advisory Committee (EAC)
- City of St. Albert Staff Departments
  - Public Operations
  - Engineering
  - Community Services
  - Economic Development
  - Emergency Services
  - Planning & Development
  - Recreation & Parks
  - HR Safety & Environment


ALBERTA
WHEAT POOL
FARMER OWNED
CO-OPERATIVE
ST. ALBERT
ALBERTA
WHEAT POOL
ST. ALBERT