THE RESILIENCE INSTITUTE

Climate Risk Assessment Report

February 13, 2024

Town of Hinton

Gateway to the Rockies
HINTON

Prepared by the Resilience Institute in partnership with Associated Engineering and the Prairie Adaptation Research Collaborative

Gratitude

We are grateful for the opportunity to partner with the Town of Hinton on this important step towards climate resilience. This project was funded by the Government of Alberta through the Municipal Climate Change Action Centre's Climate Resilience Capacity Building Program. The Municipal Climate Change Action Centre is a partnership of Alberta Municipalities, Rural Municipalities of Alberta, and the Government of Alberta.

Our journey in identifying and assessing Hinton's climate risks was made possible thanks to the open engagement and generous guidance of numerous community members. This report reflects your stories, concerns, and ideas for addressing local climate threats.

With gratitude,
Henry Penn, PhD, Research Fellow
Laura Lynes, LLM, President/CEO

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Introduction

On behalf of the Resilience Institute and our partners on this project, the Prairie Adaptation Research Collaborative and Associated Engineering, we are happy to provide the Town of Hinton with a Climate Risk Assessment Report. At the community's request, we can provide a suite of tools, including PowerPoint slides and a Summary Document, to communicate with various audiences in the future.

This report is based on the best available knowledge from our partnership. It is important to note that ***climate change is an evolving circumstance*** that could impact risks to your community.

We recommend revisiting the scoring and impact statements in this report (and appendices) annually or biennially to ensure that the rationale is still relevant to current circumstances. We would be happy to provide additional guidance on how to do this.

What is Climate Resilience and Why is it Critical?

Adaptation

Deliberate actions by communities in response to current or expected climate change impacts, which moderate potential harm or take advantage of beneficial opportunities. Actions can include monitoring, research, and other information gathering, education, capacity building, infrastructure changes, creating new policies and regulations, developing economic and other incentives, and ensuring governance considers climate change.

Resilience

The ability of a community to prepare for, resist, respond to, and recover from the impacts of climate change in a timely and efficient manner, with minimum damage and disruption to the environment, and the community's social well-being and economic vitality. Resilience and adaptive capacity are strongly linked. Thus, different groups within the community will be relatively more or less resilient to climate phenomena, depending on their adaptive capacity.

Mitigation

An action that will reduce or prevent GHG emissions, such as using renewable energies like wind and solar, making buildings, vehicles and equipment more energy efficient, and walking or cycling from time to time instead of using a car. It can also include planting trees to absorb and store atmospheric carbon dioxide.

Climate and weather refer to separate things. **Weather describes atmospheric conditions** (such as temperature, humidity, precipitation, wind, cloudiness) in a place or region in the **short-term** – usually, hour-to-hour, day-to-day, and even weeks to months.

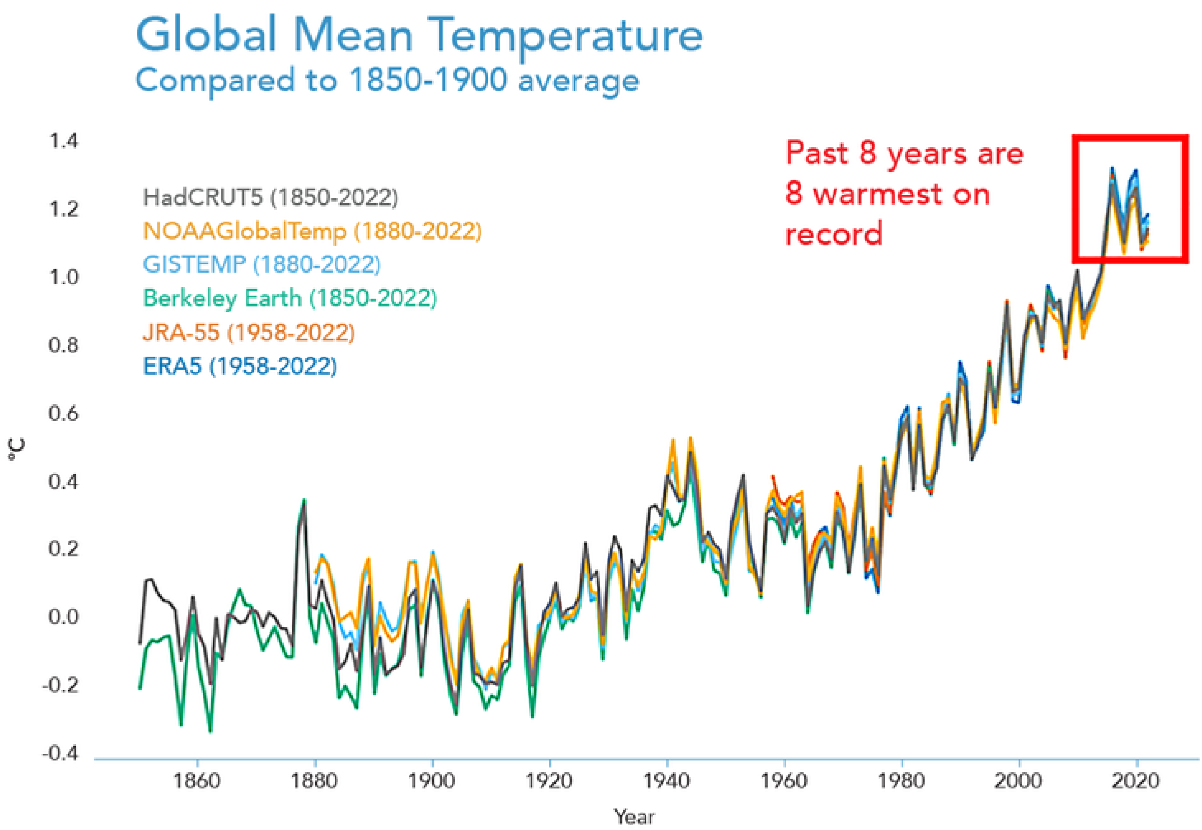
Climate refers to the average of weather conditions over 30 years or more. When describing southern Alberta as typically windy, you describe an aspect of its climate. Weather can change dramatically in a place or region from day-to-day (e.g., hot and dry one day, followed by cold, wet conditions the next day). Climate, in contrast, changes more slowly since it represents the average weather over the long term.

Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020.

Widespread and rapid changes in the atmosphere, ocean, cryosphere, and biosphere have occurred. Human-caused climate change is already affecting many global weather and climate extremes in every region.

This has led to widespread adverse impacts and related losses and damages to nature and people. Every increment of global warming will intensify multiple and concurrent hazards.

For any future warming level, many climate-related risks are higher and projected long-term impacts are up to multiple times higher than currently observed. Climatic and non-climatic risks will increasingly interact, creating compound and cascading risks that are more complex and difficult to manage.



The global mean temperature 2022 was 1.15°C above the 1850-1900 average. 2015 to 2022 were the eighth warmest in the instrumental record back to 1850. 2022 was the 5th or 6th warmest year.

The magnitude and rate of change in the climate over the remainder of this century are uncertain and will largely **depend on global efforts to reduce GHG emissions and** protect and enhance **carbon sinks.** This uncertainty is captured using different emission scenarios, known as **Representative Concentration Pathways** (or "RCPs"). Each RCP is based on varying levels of "radiative forcing" by the end of the century.

Radiative forcing is a measure of how much energy inflows from the sun and outflows back into space are out of balance because of different factors, including atmospheric concentrations of GHGs in the atmosphere. **RCP 8.5** (indicating an end-of-century increase in radiative forcing of 8.5 watts per meter squared relative to pre-industrial times) is a high baseline emission scenario associated with higher levels of global warming.

The Scope of this Assessment

The risk assessment examines the impacts of climate change on built, natural, and social/cultural systems. These are called systems because they interact and are interrelated, so they are considered collectively.

The scope of the risk assessment is defined along four boundary conditions:

Climate-Related Hazards

The assessment is primarily confined to climate-related hazards that directly impact the Town's boundaries and are within the Town's control and influence. Within these boundaries, a Nationwide approach is adopted that considers impacts on the Town and private property, the local economy, the health and lifestyle of residents, social equity, and natural capital, as well as impacts within Hinton's boundaries that may impact regional economic systems.

Chronic and Acute Stresses

Regarding climate-related hazards, both slow-onset (chronic) stresses and sudden-onset (acute) discrete events are within scope. The latter are short-duration events that typically last minutes, hours, days, or weeks. These will generally occur irrespective of climate change – though their frequency, intensity, or distribution may alter because of climate change. Examples include windstorms, heavy snowfall events, freezing rain, wildfires, and temperature extremes. Slow-onset stresses, in contrast, are caused entirely by climate change, with impacts unfolding gradually, building up over more extended time frames – decades or more. Examples of the slow-onset effects include warming trends in air and surface water temperatures and ecosystem shifts.

RCP8.5 Scenario

Projections of future climate change are available for a range of GHG emissions, concentrations, and radiative forcing scenarios referred to as *representative concentrations pathways* (RCPs). When assessing climate-related risks, it is prudent to consider the greatest plausible change scenario relative to the present, which in practice means working with projected changes for the region under the RCP 8.5 scenario, i.e., the most conservative scenarios. The primary justification for using RCP 8.5 is that it means no risks are missed during the risk assessment. Uncertainties about whether the future unfolds along RCP 8.5 or along a different, lower-emission RCP are managed during the adaptation planning and implementation phase.

Time Horizon

The assessment considers impacts arising from projected climate and associated environmental changes out to a future 30-year time period centred around the 2050s. In some instances, data provided by PARC is used to discuss climate change hazards projected to the 2090s.

Key Findings

"Wildfires and flooding are Hinton's greatest risks. Both would exceed existing operational capacity to meet emergency needs."

Town of Hinton Leadership

The most significant shifts in likelihood are for extreme heat (days above +30°C), wildfires, wildfire smoke, and freezing rain.

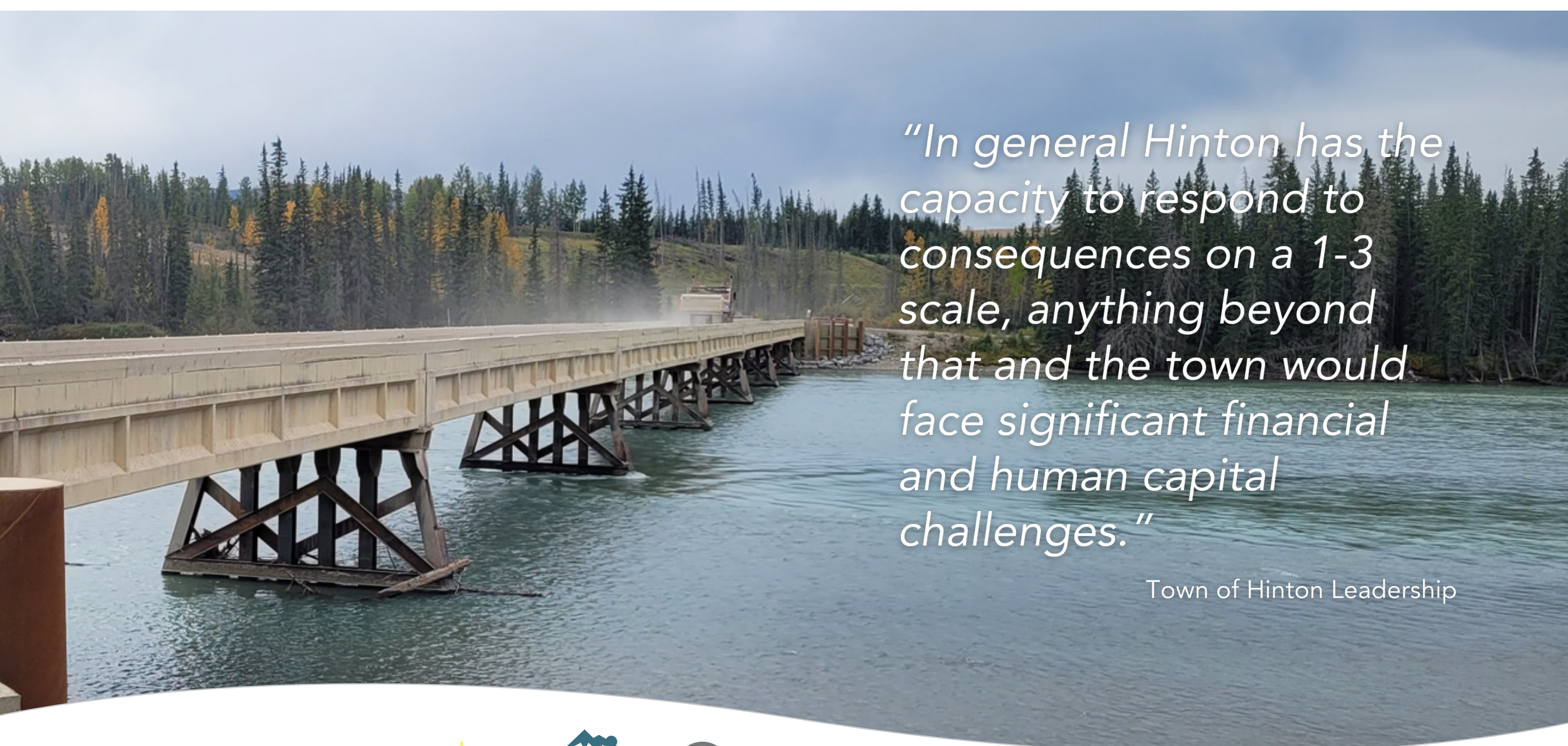
An extreme wildfire event would exceed Hinton's existing capacity to respond to the emergency. The Town has not identified a firebreak around it, which puts the community at risk.

The likelihood of freezing rain events is increased in part by increasing annual precipitation and dramatically increasing winter temperatures.

By the 2090s, this average winter temperature is expected to increase to minus 2°C or an almost 80% increase in winter daily mean temperatures (based on PARC data).

The total number of hot days per year is expected to increase from single digits in the 1950s to over 20 by the end of the century.

The Town can expect an approximate 20% increase in annual precipitation in all forms by the end of the century.



"In general Hinton has the capacity to respond to consequences on a 1-3 scale, anything beyond that and the town would face significant financial and human capital challenges."

Town of Hinton Leadership

Next Steps

We recommend that Hinton develop a **Climate Adaptation Action Plan** that includes early actions (achievable within approximately two years) and longer-term goals and addresses multiple risks, including the highest risks, as identified in this assessment. Ideally, local government staff, community organizations, knowledge holders, and citizens should work collaboratively to co-create a plan. Support the development of adaptation strategies that generate co-benefits and can be incorporated into existing processes and funding sources. Implementation planning to operationalize the action should include the following:

- Targets and indicators to drive action and accountability are to be communicated publicly.
- Roles and responsibilities to carry out each action, including partnerships with community groups.
- Identify existing initiatives and resources best suited to drive and align each action.
- Develop activities that lead to inclusive, community-relevant, multi-valued climate action planning and the identification of early actions that could be implemented with minimal to no delay, for example, in collaboration with the Hinton Friendship Centre Society and the Hinton Youth Advisory Council.

Natural System

- Investigate ways to conserve water for reducing demands on the natural environment. This could include control infrastructure, such as water meters, and a public campaign on the importance of water conservation. Collaborating with water users and interest groups (residents, commercial sector, environmental groups) to create a dialogue on water conservation and sharing is also recommended.
- Investigate water sources that the Town could use to diversify its supply and reliance on the sole water license (e.g., wells, water reuse, additional licenses). Education options, such as informational flyers and community members, can strengthen public awareness.
- Install signage to bring awareness to increased potential of wildlife-human interactions on roadways in smoky conditions. This signage could be temporary and only displayed when smoky conditions exist and should be included as an action in the emergency response plan.

Built System

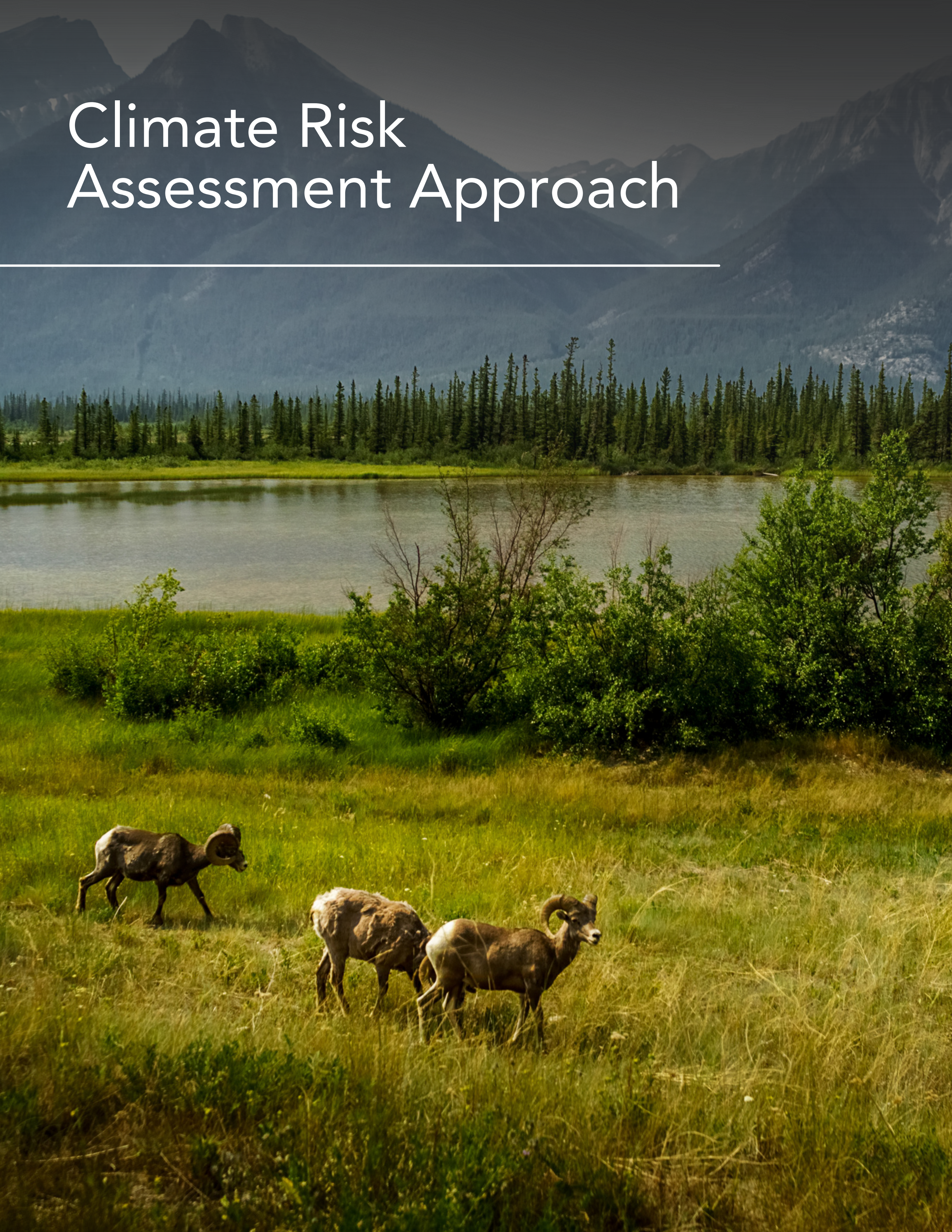
- Initiate and maintain an ongoing dialogue between the Town, utility companies and other surrounding and connected communities on the risks to power infrastructure. For example, the Town could create local partnerships with utility providers to discuss concerns and challenges and collaborate on coordinated efforts (e.g., resource pooling) to address vulnerabilities.
- Review the existing asset management studies and incorporate consideration of climate impacts relating to short- and long-range funding needs, asset risk, and level of service considerations into future revisions and asset management plans. Incorporate findings from this climate risk assessment into asset management practices moving forward (e.g., building ventilation may require more maintenance due to increased smoke events).

- Complete air sealing upgrades on priority buildings, such as those that serve as points of refuge (e.g., cooling spaces) for the public.
- To ensure stormwater systems have the capacity they were designed for, regular sedimentation cleaning of maintenance holes must be conducted.
- Share information with homeowners on good-practice maintenance of their properties (e.g., walls, landscaping) in sloped areas. Provide information on the danger of erosion and pooling water.
- Review evacuation plans and identify ways to reduce the number of vehicles on the road or coordinate in a manner that reduces congestion on the limited transportation infrastructure.
- Investigate opportunities to install on-site renewables, battery storage, or backup generators that would improve the self-sufficiency of critical infrastructure during a power outage.
- Develop an overarching preparedness approach for water and sewer supply, including mutual aid agreements, MOUs with Town partners and organizations, and a local task force. Look for options to include surrounding communities.

Social System

- Share information with the public on how to avoid heat and smoke-related illnesses and respond to distress.
- Promote existing resources on emergency preparedness and evacuation plans. Consider updating those materials based on findings from this climate risk assessment (e.g., climate risk and strategies to improve resilience).
- Upgrade air exchange systems for Town buildings, particularly those accessible to the public. Include partnerships with senior housing, hospitals, and health clinics. Share information on how people can access cooling and clean air spaces, with special consideration for vulnerable populations (e.g., the elderly, people with medical conditions, and the unhoused).
- Review evacuation plans, including transportation routes, emergency accommodations and supplies, and considerations for vulnerable populations. Meet with surrounding communities to share information and confirm mutual aid agreements. Look to integrate schools into evacuation plans as an emergency accommodation option.
- Continue to develop a relationship with the Hinton Friendship Centre Society and collaborate to improve resilience by sharing space and resources and supporting information sharing in the community.
- Develop standard operating procedures (SOPs) for outdoor workers exposed to extreme heat or wildfire smoke. Modify working schedules, equipment, and processes to reduce the risk to workers who need to be outdoors to complete their jobs.
- Continue to increase outdoor cooling amenities (e.g., water misters, water stations, shade structures) to make it more comfortable to spend time outside, even despite the extreme heat.
- Review communication protocols used during evacuations and make updates as required to ensure clear information flow between Town departments, residents, and other relevant entities.

Climate Risk Assessment Approach



Determining Climate Risk: Methodology

Risk is evaluated as the product of the likelihood of the hazard, events, or condition that could occur and the level of the consequence of the impact. In terms of climate risk, our approach is to develop an understanding of how the variability of climate patterns impacts the built, natural, and societal/cultural systems. We then describe each as a system to recognize each impact's interconnected and tangled nature relative to one or multiple others.

The purpose of a risk assessment is to identify as many potential risks as possible, not just the highest risks so that subsequent adaptation actions are focused along a spectrum of short, medium and long-term actions that address both those highest risks and those of greatest concern to your community.

Our project partners at **Associated Engineering's Strategic Advisory Services** have used a blended approach to the risk assessment process used for this project based on the ISO 31000's risk management principles. The principles follow a systematic cycle of actions to create and protect the value of the community. Their approach to the climate risk assessment methodology also aligns with 'good practice' methodology including:

Public Infrastructure Engineering Vulnerability Committee (PIEVC) High-Level Screening Guide (HLSG) developed by Engineers Canada and assumed by the Institute for Catastrophic Loss Reduction (ICLR), the Climate Risk Institute (CRI) and Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ).

International Standards Organization (ISO) guideline 14092: ***Adaptation to Climate Change – Requirements and guidance on adaptation planning for local governments and communities***, and with the Intergovernmental Panel on Climate Change's (IPCC) latest conceptualization of climate risk assessment methods.

The risk assessment begins by assigning **likelihood** and **consequence scores** for each hazard. The scores are then multiplied to get a risk score for each potential impact. The steps are summarized below:

1. **Identify climate hazards applicable to the study area.**
2. **Analyze the likelihood of each hazard or how frequently a hazard may occur.**
   - Identify a climate parameter from available climate data representative of the frequency and/or severity of each hazard (e.g., number of days above 30 °C, 24-hour, 100-year rainfall (mm/hr)). Multiple parameters could describe a hazard, but only one is selected to represent the relative change in the hazard over time due to climate change.
   - Collect climate data for a high emissions scenario by looking at historical and future (the 2050s) timeframes and calculating the projected increase or reduction of the likelihood of each hazard. Climate models do not capture all climate hazards, such as forest fires or hail. Therefore alternative data sources (research, national monitoring indices) are used, along with experience and good practice.
   - Agree on a baseline likelihood score (1 to 5) according to historical data and community conversations around the experiences with the hazard.
   - Assign a future likelihood score (1 to 5) according to the calculated change in parameter likelihood.
3. **Analyze the consequences of each hazard** (how severe the impacts will be on the community)
   - Identify the various impacts of each hazard to the built, natural, social, and economic systems within the scope of the assessment.
   - Co-develop with community input consequence scores (1 to 5) for each impact, considering severity such as cost of impacts, duration of interruption, significant health impacts, or resources to respond.
4. **Calculate the baseline and future risk score for each hazard and impact** by multiplying the corresponding likelihood score and consequence scores are summarized below:

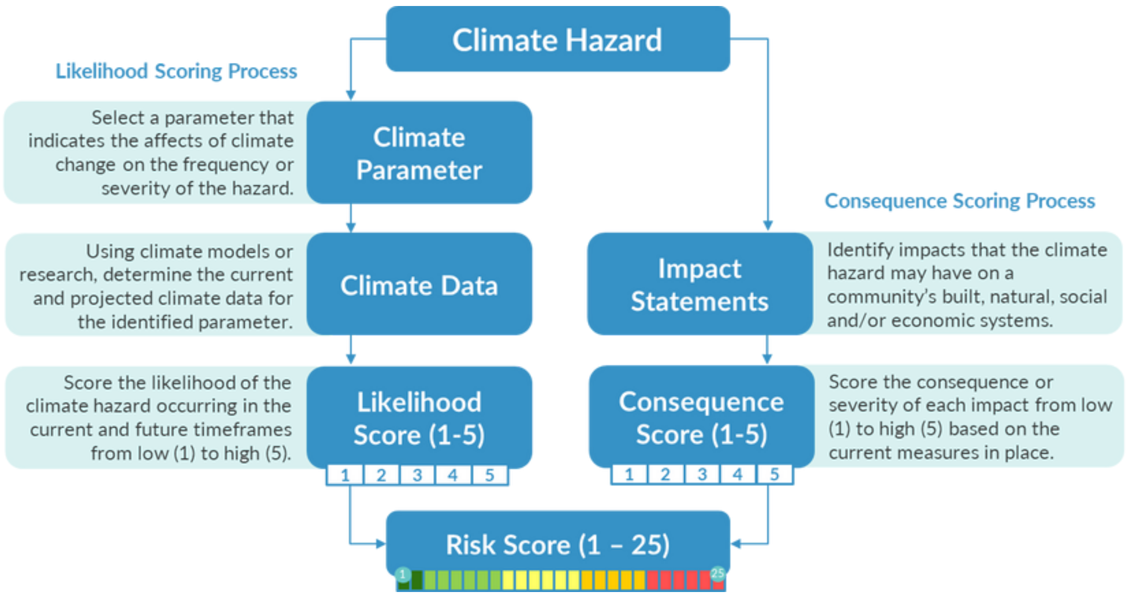


Figure: Climate Risk Assessment Process Flow Chart

Source: Associated Engineering's Strategic Advisory Services; see appendix D for more details.

Determining Climate Hazards

Selected climate hazards were chosen according to their relevance to the community and project scope at the time of the assessment. Climate hazards are **weather-related hydrometeorological events that can cause harm** and may also be referred to as **extreme weather events.**

In terms of climate-related hazards, both **slow-onset (chronic) stresses** and **sudden-onset (acute) discrete events** are discussed in this assessment. The latter are short-duration events that typically last minutes, hours, days, or weeks. These will generally occur irrespective of climate change – though their frequency, intensity, or distribution may alter because of climate change. Examples include windstorms, heavy snowfall events, freezing rain events, wildfires, and temperature extremes. **Slow-onset stresses, in contrast,** are caused entirely by climate change, with impacts unfolding gradually, building up over longer time frames – decades or more. Examples of slow-onset impacts include **warming trends** in air and surface, water temperatures, drought and **ecosystem shifts.**

The assessment considers impacts arising from projected climate and associated environmental changes over a 30-year time period centred around the 2050s. Projections of future climate change are available for a range of greenhouse gas emissions, concentrations, and radiative forcing scenarios – *Representative Concentrations Pathways* (RCPs).

When assessing climate-related risks it is prudent to consider the greatest plausible change scenario relative to the present, which in practice means working with projected changes for the region under the **RCP 8.5** scenario, i.e., the most conservative of global "limited climate policy" scenarios. The primary justification for using **RCP 8.5** is that it means no risks are missed during the risk assessment. Uncertainties relating to whether the future unfolds along RCP 8.5 or along a different, lower-emission RCP are managed during the adaptation planning and implementation phase.

Some climate hazards are not adequately captured in global climate models (GCMs) due to **spatial scale** of the hazard (e.g. hail events) or due to the **complexity** of the hazard (e.g. forest fire being influenced by multiple factors such as moisture deficit, temperature, winds, etc.). Where appropriate, additional resources from research or federal datasets are used to inform the relative change in the likelihood or frequency of the hazard over time.

Determining Climate Hazards

Climate Hazard	Parameter	Data Source
Drought	Standardized precipitation evapotranspiration index (SPEI 3)[1]	PARC[2]
Lightning	Annual average number of days with lightning[3]	ECCC[4]; Paquin, et al (2024)[5]
Overland Flooding	15 min 25-year rainfall (mm/hr)	Climate Data[6]
River/Creek Flooding	24 hour 100-year rainfall (mm/hr)	Climate Data[6]
Lake Flooding	3 day rain (mm)	Canadian Climate Atlas[7]
Wildfires	Annual average area burned (ha) within region	Wang et al. (2022)[8]
Wildfire Smoke	Annual average area burned (ha) within region	Wang et al. (2022)[8]
Hail	Annual severe summer hail days	Brimelow et al. (2017)[9]
Freezing Rain	Change in annual ice accretion (2020-2050)	ECCC[10]
High Winds	Change in annual hourly wind pressure (1/50) (2020-2050)	ECCC[10]
Heavy Snow	Annual winter precipitation (mm)	PARC[2]
Extreme Heat	Annual days above +30°C	PARC[2]
Extreme Cold	Annual days below -15 °C	PARC[2]
Freeze-Thaw Cycles	Annual # of freeze-thaw events	Canadian Climate Atlas[7]
Eco-region Shift	Ecoregion shift[11]	AdaptWest[12]
Glacial Recession	Freezing degree days	Canadian Climate Atlas[7]; Science Daily[13]

[1] Values range from -5 to 5, with higher numbers indicating higher levels of moisture; a reduction in value indicates an increase in drought conditions.

[2] Prairie Adaptation Research Collaborative (PARC) supplied data.

[3] While no projected values are available, research points towards a slight increase in lightning frequency.

[4] Environment and Climate Change Canada (ECCC) (2019), Lightning Activity in Canadian Cities. https://www.canada.ca/en/environment-climate-change/services/lightning/statistics/activity-canadian-cities.html

[5] Dominique Paquin, Ramón de Elía & Anne Frigon (2014) Change in North American Atmospheric Conditions Associated with Deep Convection and Severe Weather using CRCM4 Climate Projections, Atmosphere-Ocean, 52:3, 175-190, DOI: 10.1080/07055900.2013.877868

[6] Climate Data for a Resilient Canada: climatedata.ca Short-duration Rainfall IDF Data, Version 3.30 (2022-10-31).

[7] Climate Atlas of Canada: climateatlas.ca

[8] Wang, Xianli, Tom Swystun, and Mike D. Flannigan (2022). Future wildfire extent and frequency determined by the longest fire-conducive weather spell. Science of the total environment 830 (2022): 154752.

[9] Brimelow et al. (2017). The changing hail threat over North America in response to anthropogenic climate change. Nature Climate Change, DOI: 10.1038/nclimate3321

[10] Environment and Climate Change Canada (ECCC), Climate-Resilient Buildings and Core Public Infrastructure - An Assessment of the Impact of Climate Change on Climatic Design Data In Canada - Annex 1.2. https://publications.gc.ca/collections/collection_2021/eccc/En4-415-2020-eng.pdf

[11] Eco-region maps project a shift in ecoregion in the area.

[12] AdaptWest – A Climate Adaptation Conservation Planning Database for North America: adaptwest.databasin.org

[13] Science Daily (2005). Most of Arctic's Near-surface Permafrost to Thaw by 2100. Science News. https://www.sciencedaily.com/releases/2005/12/051220085054.htm

Change in Climate Hazard Likelihood

Figure 1

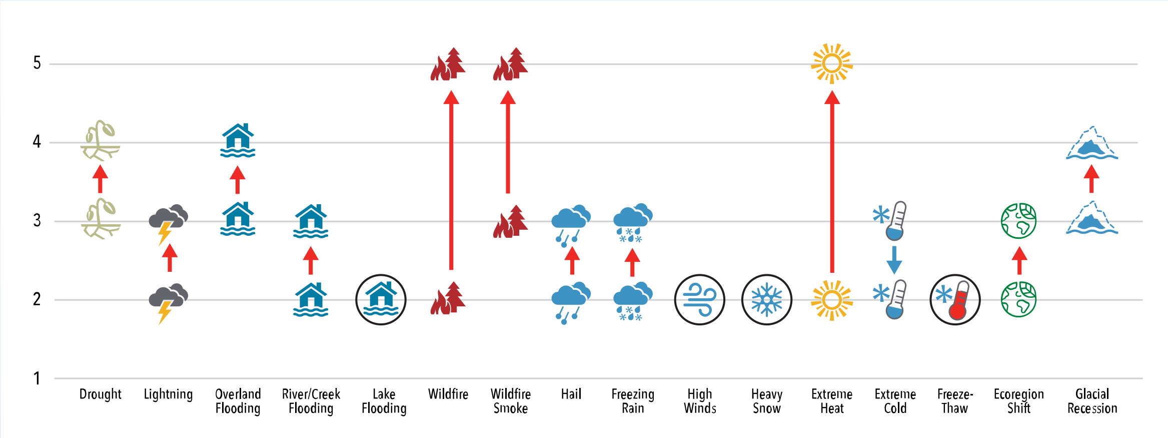


Figure 1: Change in Climate Hazard Likelihood (historic baseline to 2050). Many hazards will see an increase in how likely they are to occur between historical data and 2050 projections. The largest shifts in likelihood are for extreme heat (days above +30°C), wildfires, wildfire smoke, and freezing rain. Of the hazards explored in this assessment, the annual number of extreme cold days and freeze-thaw cycles are projected to see a decrease in likelihood between historical data and 2050. Risk is driven by both the consequences of different climate hazards and their likelihoods. Changes in likelihoods drive a large portion of risk, as rare events become more common.

Understanding Climate Hazard Risk

Climate Impact Consequence

Not all impacts have the same severity of consequence, and therefore, each impact is assessed individually through the risk assessment process. Different criteria are used to assess impacts to built, natural, social, and economic systems as shown in the consequence rubric, with a high or more severe consequence scored a **5** and a lower severity score of **1** (see Appendix D). Recognizing that some impacts affect multiple systems, consequences were scored by looking at multiple criteria where necessary. The final consequence score indicates the highest score across all criteria for the considered impact.

Consequence scores were co-assigned with community input, considering the level of consequence that is expected to be seen from the climate hazard given the current understanding of the hazard.

Assessing Impact Likelihood

Likelihood scores were assigned for the **historical and future (2050s) time horizons** according to climate parameter trends, with increasing/decreasing values reflecting increasing/decreasing occurrence or severity over the time horizon. Climate projections are considered a high-emission scenario, with the earth reaching **2 degrees of global warming in the mid to late 2050s.** Translation into likelihood scores normalizes the various climate change trend measures into a common numerical ranking. These scores allow for both **qualitative** (collective judgement) and **quantitative** (data-informed) translations into likelihood score values. In alignment with the **PIEVC Protocol** for climate risk methodology, a baseline approach was used to assign the historic likelihood scores based on feedback in workshops to date with the following assumptions:

A historic likelihood score of 2 **...indicates that, while the climate hazard may be occurring, it does not cause recurring issues or significant concern for the community at this time;**

A historic likelihood score of 3 **...indicates that the climate hazard is already a problem for the community, and impacts have been experienced several times in the recent past.**

A single climate parameter was selected for each hazard to represent the change in likelihood. Some hazards, such as high winds, heavy snow, and forest fires, are complex, with several contributing factors not captured within available climate modelling and projections. In these cases, a climate parameter was selected that was considered to represent the hazard in the context of the impacts.

Where representative climate parameters or projected data were unavailable, scores were assigned based on available research, studies and good practice.

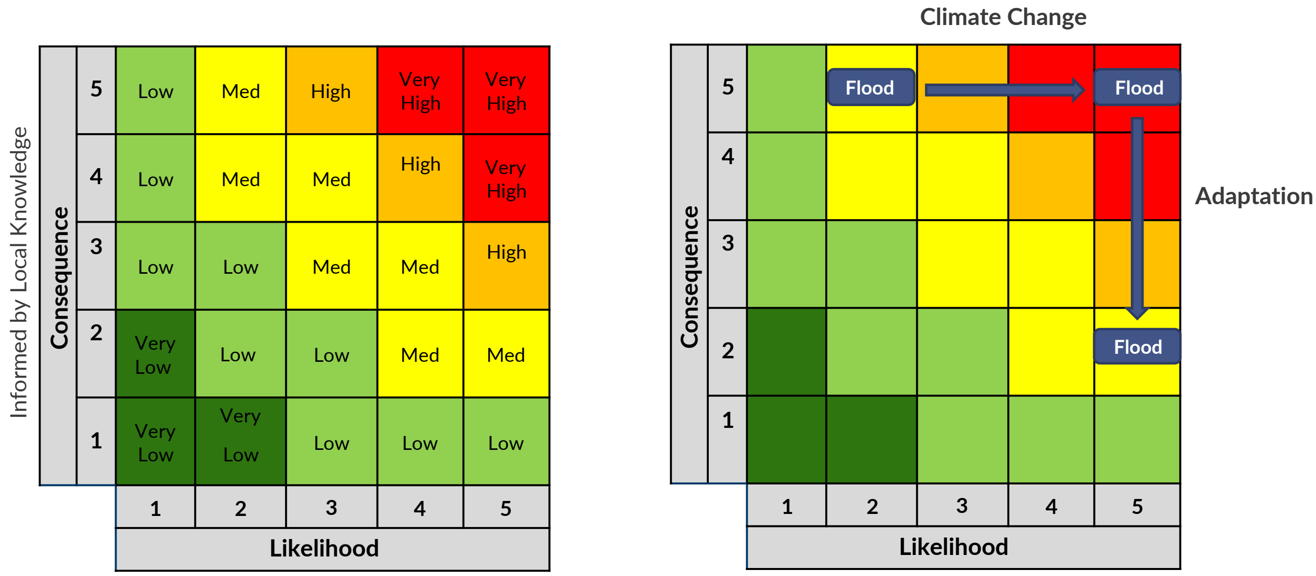


Figure: Climate Risk Assessment Heat Map

Source: Associated Engineering's Strategic Advisory Services; see appendix D for more details.

Community Engagement Process

Initial engagement with community leaders to agree scope.

Desktop review of existing community plans and assessments, and any local data sources.

Engagement with community leaders to confirm scope, discuss desktop review, and agree on climate hazards.

Climate data modelled and project data calculated.

Draft risk likelihood scores calculated and shared with community leaders.

Draft risk consequence rubric created and initial impact statements drafted, and shared with community leaders.

In-person visits to the community for discussions with diverse members of the community. **Meetings held.**

Additional **virtual discussions with individual community members** held for those unable to attend in person meetings (optional).

Likelihood scores, consequence rubric, and impact statements agreed to based on community feedback.

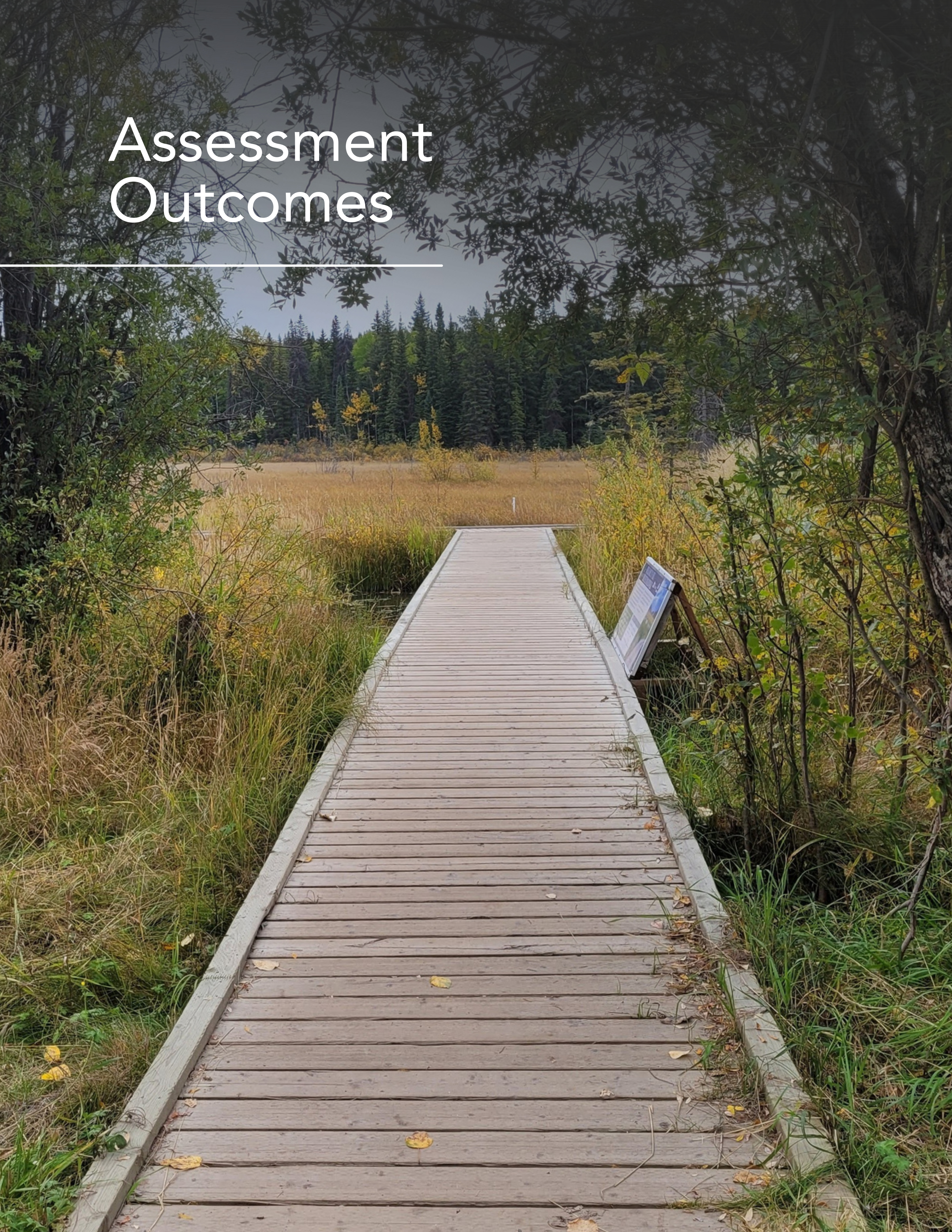
Draft scoring of impact statement consequences sent to community for review.

Review of feedback on draft impact statement consequence scores by project team.

Draft final report shared with community leaders.

Final report submitted.

Assessment Outcomes



Key Findings and Recommendations

"The frequency and intensity of hot extremes will continue to increase and those of cold extremes will continue to decrease, at global and continental scales and in nearly all inhabited regions with increasing global warming levels."

IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK: Cambridge University Press (global comment)

The climate risk assessment considers the impacts on different 'systems' that make up a community. Importantly, though, community resilience benefits from considering climate hazards as a system, too, and one where singular climate hazards are interconnected. For the Town of Hinton, many hazards will see an increase in how likely they are to occur between historical data and 2050 projections.

The largest shifts in likelihood are for wildfires, wildfire smoke, and freezing rain. As will be discussed, there are also significant implications for overland flooding and glacial recession. However, many of these climate hazards' risks and potential impacts are driven by an overarching increase in extreme heat likelihood. Within this assessment, we can consider extreme heat as a key driver, or the trunk of the climate hazard tree, with all other climate hazards associated as branches.

Extreme Heat

Daily mean temperatures in every season are expected to increase over this century. Figure 2 shows that while daily mean temperatures will increase throughout the year, the greatest increase will be in winter. Using data provided by PARC, in the 1950s, daily mean temperatures for winter months were, on average, around minus 9°C. Similarly, by the 2090s, this average is expected to increase to minus 2°C; an almost 80% increase in winter daily mean temperatures.

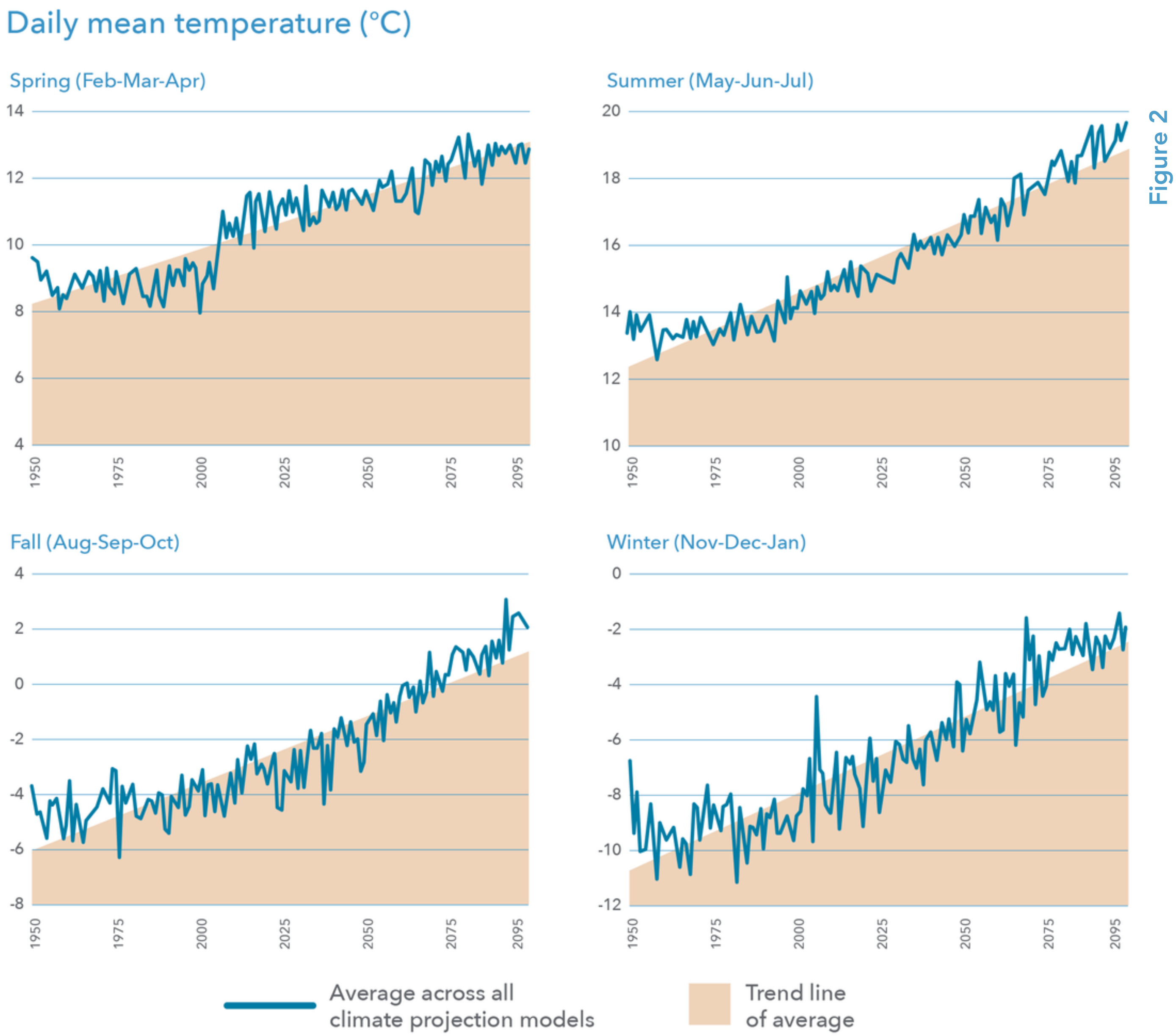


Figure 2: Seasonal daily mean temperatures (°C) each year for historical (1950s) to future projections (2099) using PARC data.

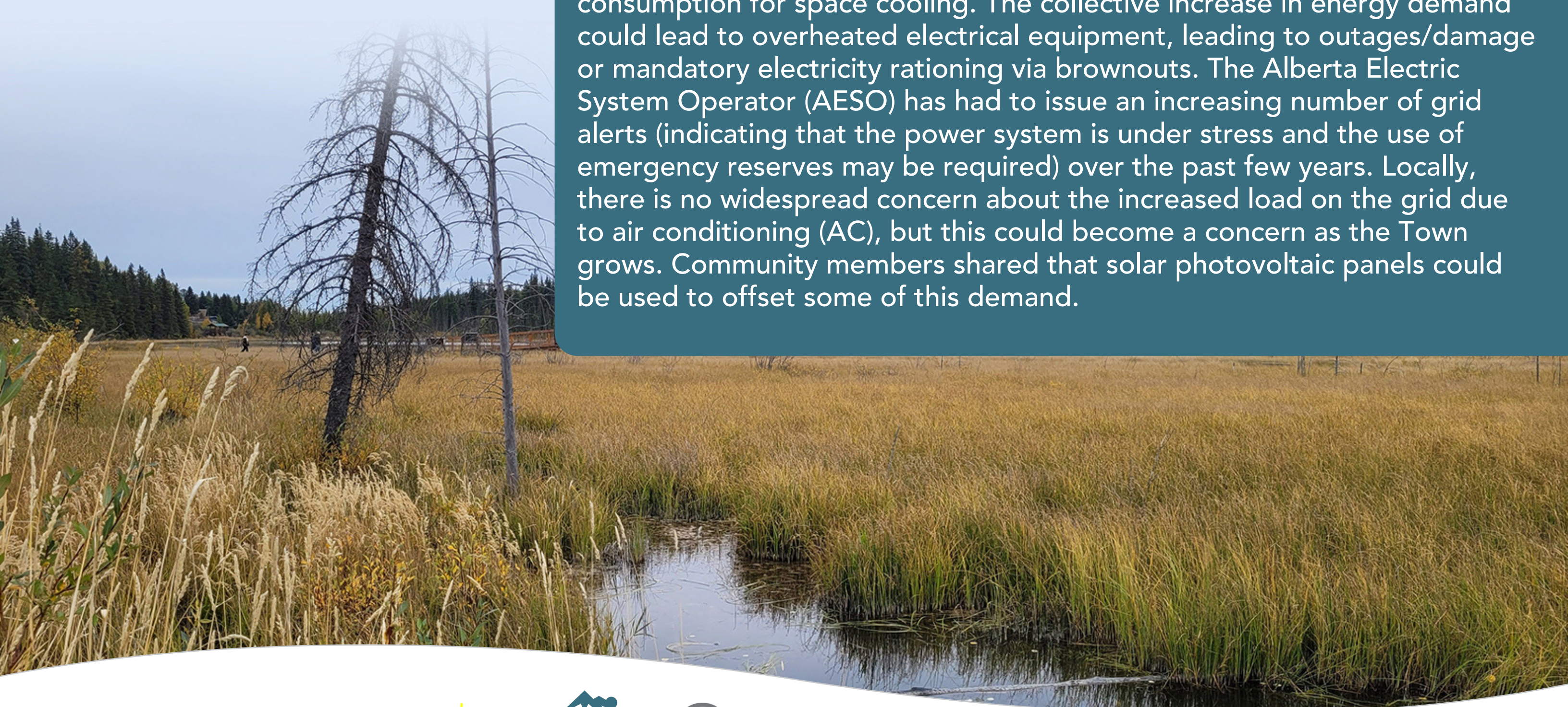
While daily mean temperatures are significant, the extremes have the potential to cause more significant concerns. During the project's engagement with the Town of Hinton, community members shared the following concerns:

- The impact of extreme heat and the longer summer conditions on outdoor operators. Public Works leaders also identified that there may not be enough seasonal workers if the summer season is extended, and extreme heat reduces working hours. This could lead to a decreased level of community services, especially because many seasonal workers are school-aged and will be returning to school.
- Increase risk of human-wildlife interactions at the Town's area. Water features, pools, stormwater ponds, garbage bins, picnic sites, and fruit bearing vegetation within the town are a few examples of areas wildlife may frequent. Public safety (including fatalities in extreme situations) may be compromised with increased human-wildlife interactions.
- Additional strain on physical infrastructure and equipment, such as pumps and HVAC systems, due to extreme heat. This may result in additional maintenance costs or early equipment replacement.

The daily mean temperature provides information on long-term climate variability and change. The daily mean temperature (°C) is representative of the temperature at a height of 2m above the surface. This index provides values for the monthly mean of daily mean air temperature. The seasonal and annual statistics for this index are averages of these monthly values.

Alongside a projected general warming trend, the number of hot days and consecutively hot days are expected to increase (see Figure 3 and Figure 4). Extreme or hot days are described as days with a daily mean temperature of 30°C or more. Note that this is the average temperature of the whole day, not just the hottest time of the day.

An increase in extreme heat days will lead to increased electricity consumption for space cooling. The collective increase in energy demand could lead to overheated electrical equipment, leading to outages/damage or mandatory electricity rationing via brownouts. The Alberta Electric System Operator (AESO) has had to issue an increasing number of grid alerts (indicating that the power system is under stress and the use of emergency reserves may be required) over the past few years. Locally, there is no widespread concern about the increased load on the grid due to air conditioning (AC), but this could become a concern as the Town grows. Community members shared that solar photovoltaic panels could be used to offset some of this demand.



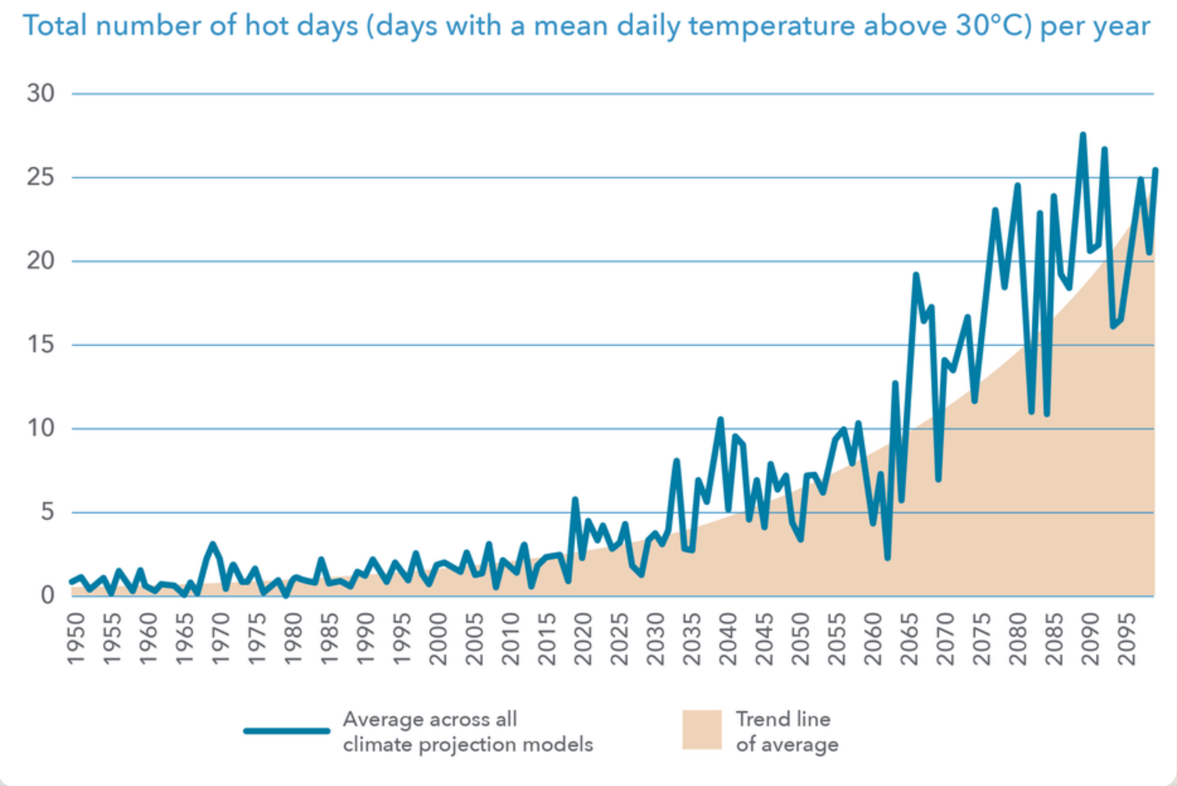


Figure 3: The total number of hot days (days with a daily mean temperature of 30°C or more) per year. In the 1950s each year would, on average, have one hot day. By the end of the century this number is expected on average to reach twenty-one hot days.

Extreme heat could increase the presence of algal blooms in local water bodies. The community shared that there has been an increase in algae in Maxwell Lake, and this could have severe impacts throughout the ecosystem. More broadly, the presence of blooms in water bodies throughout the Town could impact wildlife health, water quality (increasing costs), and the quality of recreation in affected areas.

Extreme heat effects on wildlife can result in heat stroke, inability to forage and/or reduced weight gain, or even death. Wildlife behaviour may change as they try to adapt to extreme heat. This could be seen through changes in habitat range, adjustments in active hours (e.g., hunting/grazing during cooler periods), or more frequent human-animal interactions as they seek out alternative food and water sources.

Extreme heat can result in heat-related illnesses (e.g., heat stroke) and even death in some cases. Elders, children, people who are pregnant, and people with medical conditions are all vulnerable populations at greatest risk of heat-related discomfort and medical issues. The health impacts can also lead to lost time and absenteeism.

Total number of consecutive hot days (days with a mean daily temperature above 30°C) per year

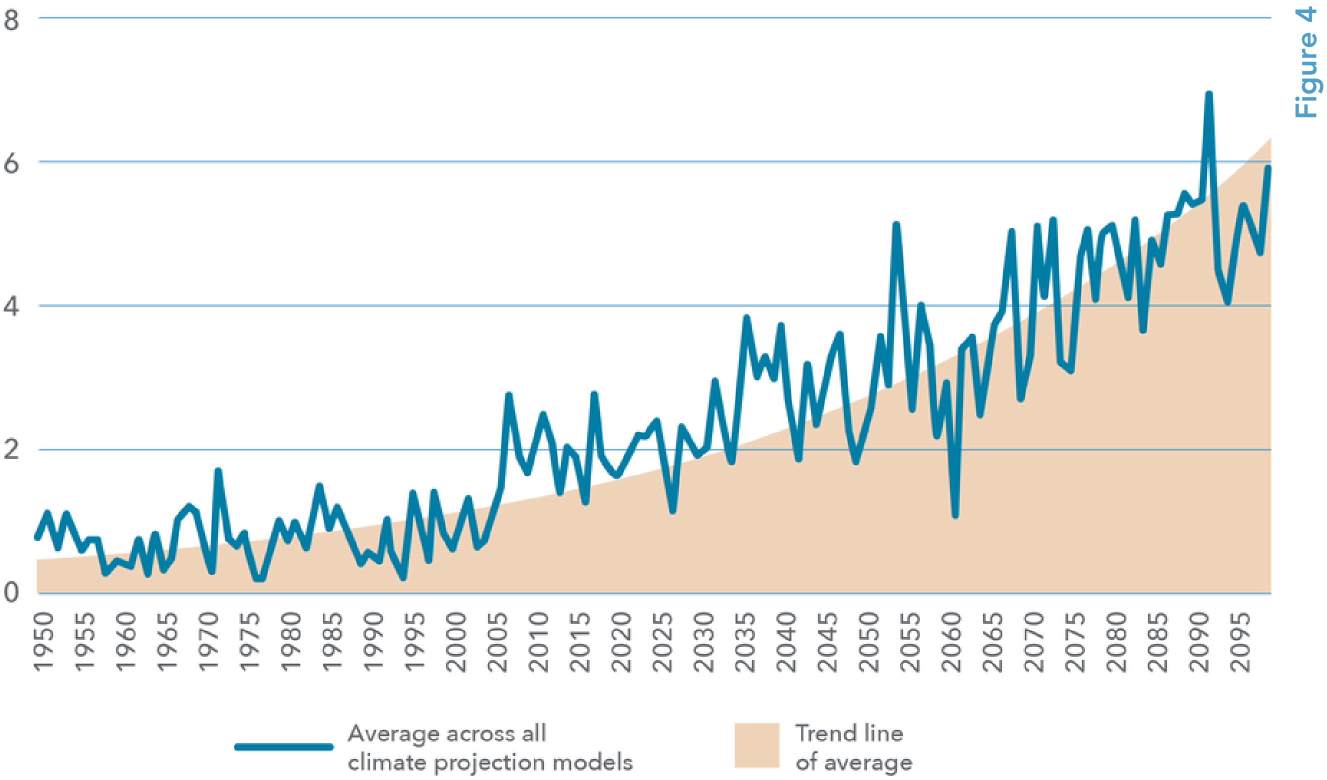


Figure 4: The total number of consecutive hot days (days with a daily mean temperature of 30°C or more) per year. In the 1950s, each year would, on average, have zero consecutive hot days. Based on PARC data, by the end of the century, this number is expected on average to reach five consecutive hot days, i.e. periods of five hot days back-to-back.

Water Supply and Security

A Note On Glacial Recession

Extreme heat alongside general warming trends will impact the entire Athabasca River Basin, including the Columbia Icefields. Some areas of the icefields have already seen significant recession largely due to climate change.

The glaciers of the Columbia Icefield serve as an important raw water source for both the Town and downstream communities. Glaciers contribute to groundwater volume as well as surface water baseflow. Community members shared concerns that the impacted Columbia Icefields could, in turn, affect the Athabasca River, which is the Town's main source of water. The Town noted that it has not had issues with seasonal changes in water availability up to this point since glacial baseflow has sustained fall and winter low flow conditions appropriate for water supply. Baseflow will be impacted by melting glaciers and long-term impacts should be assessed.

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Water Supply and Security

Local Water

Glacial recession (as a hazard included in this risk assessment) has contributed to a broader conversation about water supply and security. The Town relies on a 3rd party (West Fraser Mills Ltd.) to supply potable water to the Town from its pulp and paper mill ("the Mill"). The Town does not hold its own water license, which has resulted in a perceived risk that water rights could be retracted if there is a shortage. Since 2015, the Town and West Fraser have been working on the Water Treatment Plant Transfer Project, which would transition the responsibility of water treatment to the Town (through the development of a new waterworks system), to which the Mill would supply untreated water. The Mill is in the process of being sold to another company (Mondi Group), which has contributed to the Town's interest in improving its water self-sufficiency. In the event water cannot be pumped to the Town, there is a water reservoir with a 3-day backup supply. Wells may be an alternative water source if glacial water becomes less reliable. Still, it is unclear if it is a viable solution (municipal staff noted that Edson is on wells but is not happy with that source).

The Town of Hinton leadership team also discussed that the community has high water usage, potentially due to a lack of water meters. The lack of metering means people may need to understand their individual consumption, which contributes to high use and a lack of incentive to fix leaks. A Water Meter Strategy is on the Council's agenda, but the high cost (approximately $4M in 2023 dollars) may result in delays. There is also discussion about pushing this cost onto developers or offering lower rates to consumers who voluntarily install meters. The initiative is also considered part of a larger stormwater system upgrade.

Freezing Rain

Extreme temperatures, but more than the previously described warming trends, will increase annual precipitation. Warmer air increases evapotranspiration and will hold a greater amount of moisture. This is particularly significant in winter, and instances of freezing rain are expected to increase in the future. Figure 5 projects the total annual rainfall for the Town of Hinton. Using data provided by PARC, there is broad agreement between all climate models used by this assessment, and by the end of the century the Town can expect an approximate 20% increase in annual precipitation of all forms.

Total annual precipitation (mm), of all forms including snow and rain, per year.

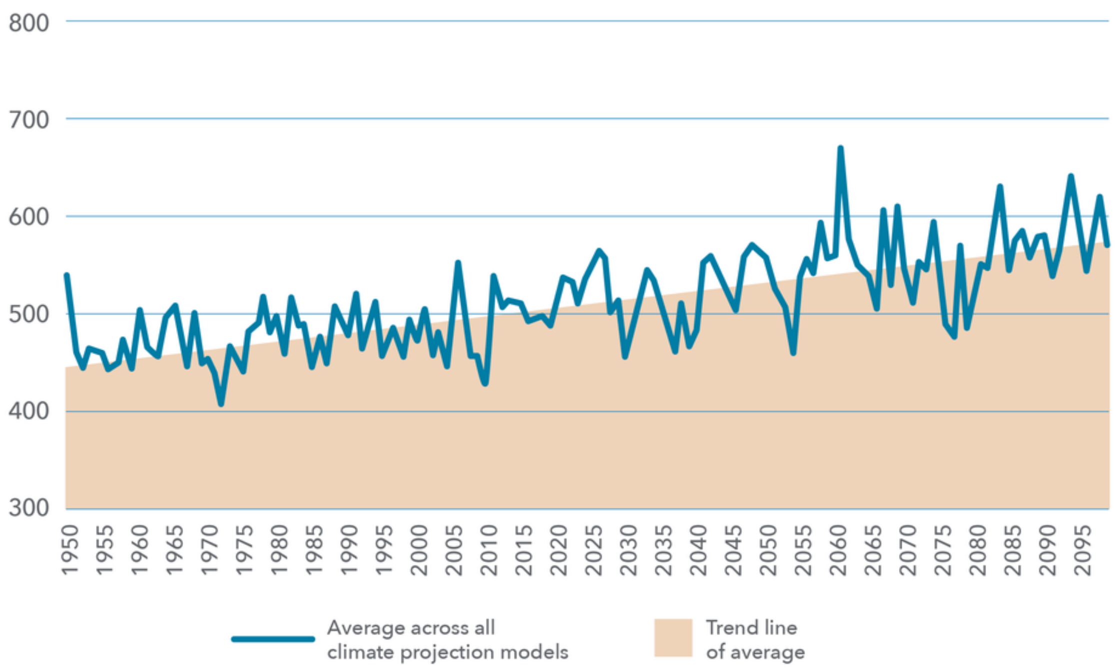

Figure 5: Total annual precipitation (mm), of all forms including snow and rain, per year.

The likelihood of freezing rain events is increased in part by increasing annual precipitation, but also dramatically increasingly winter temperatures (Figure 7). Steadily increasing winter temperatures will increase the likelihood of winter precipitation falling as rain rather than snow in the future.

Freezing rain can have a variety of impacts, particularly in locations which are not accustomed to experiencing such a phenomenon:

- Road traffic accidents can increase, and there can be transportation delays for vital services and goods, as well as disruption to active transportation.
- Ice laden branches can cause tress to fall damaging private property, as well as impacting or damaging town buildings and facilities. Equally, fallen tress can cause power outages, as can ice accretion on key power infrastructure. Gas and power lines may also experience interruptions.
- Fallen debris blocking catch basins, culverts leading to localized flooding (also see a note on overland flooding later in the assessment).
- Community members can experience an increased likelihood of injuries from falls on icy surfaces.

Wildfires

Conversations with the Town leadership identified that wildfires and overland flooding (as previously detailed) are perceived to be the greatest hazards to the Town. Community members, including the Hinton Youth Advisory Council, have a strong local awareness of wildfire risks. For example, during community conversations, it was noted that while pine beetle populations are declining, the volume of deadfall has resulted in increased forest fuel and increased fire potential. Town leadership explained that various fire and vegetation management practices are employed to address wildfire risk.

There appears to be a gap in communication and emergency planning between the Town and private entities supplying power utilities. During engagement, it was explained that the municipality does not spend a lot of time thinking about the resilience of the power grid because that is a service provided by private entities. During previous outages, the Town has had to externally source generators/backup power because they do not own their own equipment. There have not been emergency planning or response meetings between the local government and utilities, which may mean there are missed opportunities for resource sharing and communication flow.

Wildfires are driven largely by the climate hazards so far described in this assessment:

- Prolonged warming and extreme heat increase the drying of forest floors and increase evapotranspiration, which further increases the drying effects.
- Precipitation patterns are projected to increase in volume annually but also change in how they are absorbed. Figure 7 shows the average number of very wet days expected each year. A very wet day is a day in which the precipitation rate is greater than 10mm per hour. The town can expect future precipitation events to be more sporadic and erratic, meaning that rainfall will be shorter in duration and with increased intensity. Such rainfall overwhelms soils and does not necessarily increase the overall moisture content that can provide resilience to wildfires. This information is provided in addition to the risk assessment provided by Associated.
- Community members shared that wind speeds have generally been perceived to be increasing. While these local observations are valid and reflect community members' lived experiences, the climate projection data suggests that there will be little to no difference between historical (1950s) and future average wind speeds. That said, existing average wind speeds are significant enough to support wildfire movement.
- Overall, these climatic conditions will increase the level of drought that the Town of Hinton experiences (see Figure 6). Drought is measured using the Standardized Precipitation Evapotranspiration (SPEI) Index, which calculates a drought condition based on the water balance between precipitation and evapotranspiration. This assessment is based on a 12-month SPEI index and recognizes that seasonal droughts, particularly in the summer, could be more significant and further support wildfires.

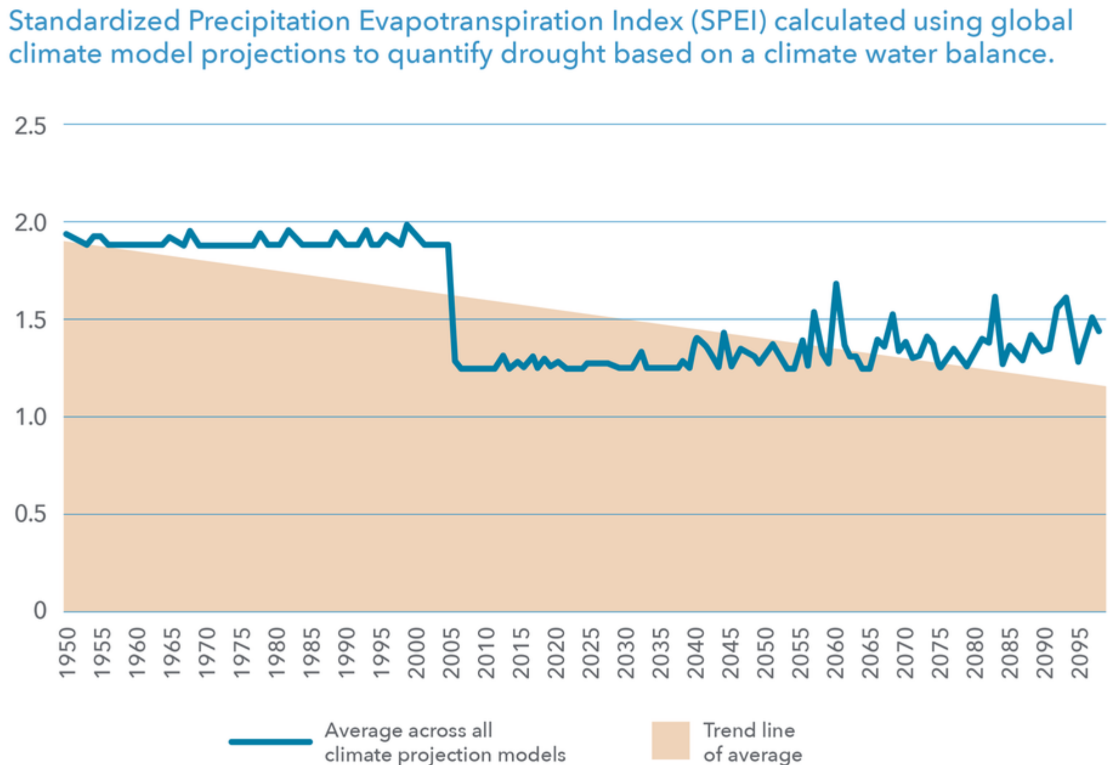

Figure 6: Graph showing 25 sq km, 12-month Standardized Precipitation Evapotranspiration Index (SPEI) values for the Town of Hinton. Data provided by PARC

Impacts from wildfires were shared by all community members, leadership and the Hinton Youth Advisory Council:

- Highway 16 is the major transportation corridor for Hinton. If a wildfire is in proximity to the Town, safe access and egress to/from the area could be compromised. Wildfire-related damage or highway closures would result in significant traffic delays and congestion. Town leadership noted that there are plans to have a bypass (Highway 16X) around the Town, which would alleviate some of the strain on the existing transportation network. If a mandatory evacuation were required (or residents felt compelled to leave prior to a public directive), there is the risk of increased motor vehicle accidents or automobile/pedestrian interactions due to the increased traffic. This would be exacerbated if people are scared, and judgement becomes impaired in their haste to leave the area. The rail line that runs through the Town was identified as another option for passenger transport.

- A wildfire in the community itself could damage infrastructure, requiring significant repairs or full replacement depending on the extent of the damages. Community member homes could be impacted, damaged, or destroyed. Critical (water treatment, medical, etc.) and less critical buildings and facilities (libraries, schools) are also at risk from wildfires. The potential of wildfire destroying part of the town was shared particularly by community members.

- Electrical infrastructure (e.g., above-ground powerlines, transformers) could also be damaged by wildfire. Subsequent power outages would affect the lives of everyone in the community, but vulnerable populations (e.g., people in the healthcare centre) would experience the most severe impacts if they do not have a backup generator available.

- Lost of habitat due to wildfire could induce local ecosystems change. While ecosystems will adapt, the length of time to recover and the types of species that will stay in the area will depend on the extent of damage.

- Water quality will decline with soil erosion, ash, and contamination from firefighting agents. Chemicals from fire retardants can increase chemical levels in soil and water, such as phosphate, nitrate, and nitrite.

- Wildfires in the region could result in residents being displaced from their homes, either temporarily or permanently. The length of time and number of residents displaced will depend on the extent of the fire. A large-scale evacuation would require a corresponding amount of emergency housing and transportation logistics, with additional support made available for vulnerable populations. Town leadership shared expectations that the Town may need to house evacuees from neighbouring communities as fires become more frequent.

- Town leadership, and particularly the Hinton Friendship Center, shared that there is a concern for the safety of residents who are unprepared or uninformed about the risk of fires (and emergency response at large). The recent active shooter drill revealed that there are challenges in providing fast and clear information during an emergency, particularly with Indigenous peoples, and that evacuation locations (i.e., the Royal Legion) were not adequately set up for large groups of people.

- Mental and emotional health could also be impacted. The stress of fire damaging or destroying property, evacuation, and fear decrease mental and emotional well-being. Lack of personal preparedness, confusion, and displacement could exacerbate these mental health impacts.

- While a consideration of the economic/tourism section was outside the scope of this report (as per discussion with Town staff), Associated identified that wildfire poses a very high risk to livestock and other businesses. Business owners may see a shortened tourism season with road closures, and resources are directed toward recovery. Businesses associated with livestock see impacts such as supply chain issues, damage to property, or declining health in animals. These impacts are likely to put increased socio-economic stress on residents.

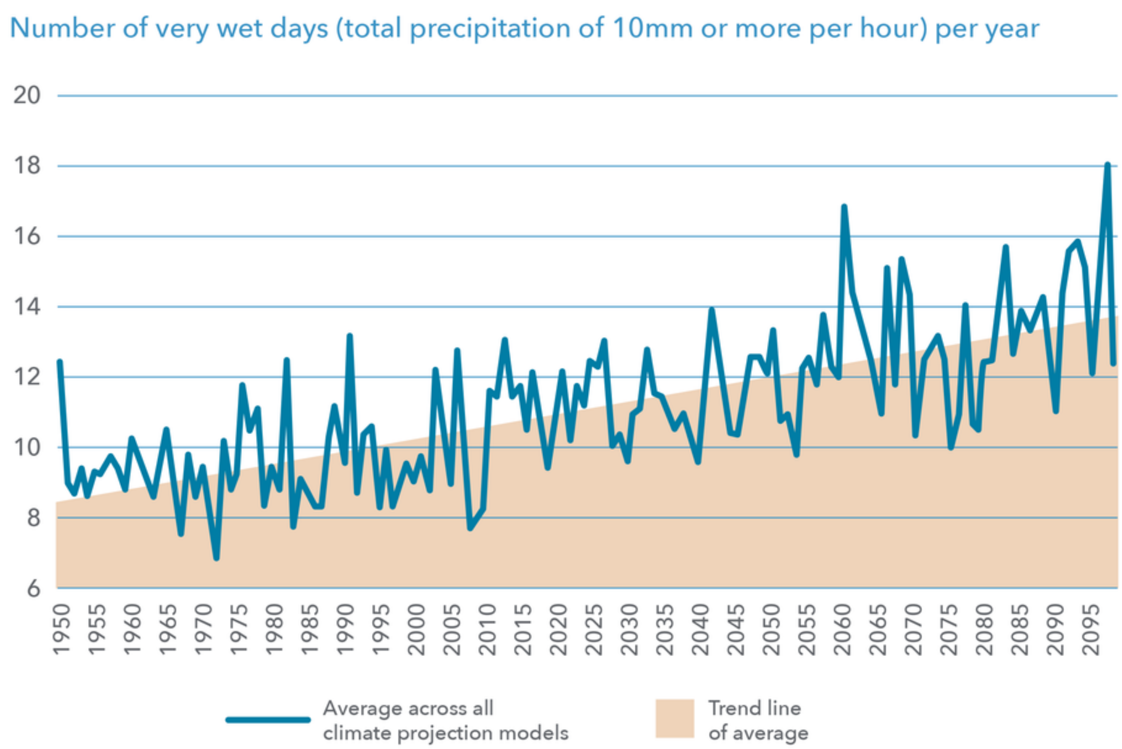

Figure 7: Annual number of very wet days each year. A very wet day is characterized as a 24-hour period receiving 10mm or more of rainfall per hour. (Data provided by PARC)

An additional potential impact of a wildfire, which was shared by Town Leadership, was an overland flood or significant flooding event following a wildfire event. Such events have been seen in British Columbia following large scale wildfire events.

Physical damage to water and wastewater infrastructure and treatment facilities could compromise access to potable water and sanitary systems. These utility services are critical to the Town's various services, residents, and businesses.

Erosion from overland flooding has also damaged trail systems (entire systems have been destroyed before) and river access.

The Town's stormwater drainage system was identified as undersized and easily inundated, meaning these systems cannot be relied upon to manage future extreme rainfall events. It was specifically noted that there are limited to no backflow preventers at outfalls, which can result in backups. Slope erosion and the potential for structural damage to these systems may exacerbate the risk of backup.

Flood waters can wash away roads or saturate road foundations, resulting in subgrade deterioration and damage. Damaged or destroyed roads can impact access/egress impacting emergency services. The Town's representatives noted that there has not been a history of roads and services being disrupted due to flooding, but it was recognized that it is a possibility in the future. Damaged or flooded roads can pose a barrier to reaching vulnerable populations (such as people with certain medical conditions and the elderly).

A Note on Overland Flooding

"The Town of Hinton has very little flood mitigation capacity and is ill-prepared to flood."

Town of Hinton Leadership Team

Overland flooding was shared as a significant hazard and top priority for the Town. This type of flooding is often caused by periods of intense or prolonged precipitation (Figure 5), where the water cannot be collected by stormwater infrastructure or absorbed by soil fast enough. Town leadership said that the town has seen unprecedented flooding in recent years, with two flash floods in less than 24 hours in one case. Broadly, this assessment considers three potential causes of overland flooding has seen unprecedented flooding in recent years, with two flash floods in less than 24 hours in one case. Broadly, this assessment considers three potential causes of overland flooding..

Overland flooding could result in erosion, reduced ground stability, and slumping. While these processes contribute to creating habitats that support biodiversity, the frequency and intensity of flooding could cause more harm than good for ecosystems. The shape and stability of the land will be changed, which could impact the areas that animals choose to inhabit. Landslides due to overland flooding could wipe out sources of vegetation relied upon by terrestrial species. Mass movement of debris and sediment could also impact aquatic habitats, including the quality and quantity of water. These changes to the physical environment can have cascading effects on ecosystems and may result in declining populations or emigration if animals cannot survive in the new conditions.

Locally, residents have observed increased flood-related erosion after wildfire events. This occurs because wildfires can destroy plants and trees that provide ground stability and char soil so that it cannot absorb rainfall. It was also noted that the Town has very few flood mitigation measures making it particularly vulnerable. The recent 1 in 50-year rainfall event caused some home basement flooding in the College Road area, leaving homeowners with significant repair costs. Stormwater and sanitary system surcharges are also more likely to occur due to overland flooding. During recent high precipitation events, maintenance holes overflowed with water and gravel providing evidence of significant sedimentation associated with these intense rainfall events.

Ground instability and erosion, brought on by intense precipitation and overland flooding, were also identified as significant concerns by the community. The Town is built on a slope, which may create the risk of buildings being damaged by falling debris or, in extreme cases, being physically displaced during a landslide. This potential impact was raised during engagement when participants expressed concern about development (homes and private retaining walls) that has occurred in steep areas. It was noted that many private retaining walls are not adequately maintained by private homeowners due to limited knowledge of drainage. Flooding could impact the integrity of these walls.

Wildfires Smoke

Town leadership identified that options are somewhat limited in reducing the risk of wildfire smoke (smoke is a cross-border issue, meaning external fires could impact the Town). Minimal work has been done to address this risk beyond considering Standard Operating Procedures (SOPs). It was emphasized that any policies or SOPs must ensure that emergency response and maintenance crews are still available regardless of smoky conditions.

> *"The Town of Hinton is in a mountain corridor, so smoke either comes from the South West via Jasper or from the North. Either way, Hinton is very smoky."*
>
> Town of Hinton Leadership Team

More frequent wildfire smoke events will increase wear on building HVAC systems. This may lead to more frequent equipment replacement and maintenance costs. Town staff expressed concern about smoke infiltrating buildings, so the air tightness of buildings and the type of ventilation filters are very important. While airtightness upgrades (e.g., caulking, weatherstripping) and installation of high-efficiency HEPA filters can be straightforward and relatively cost-effective, the cost of these items and required resources for installation may not have been accounted for in capital and operating plans. These types of upgrades could be coordinated with other building works to maximize efficiency.

Wildfire smoke in the area could increase the risk of wildlife and human interactions, potentially leading to injuries or fatalities in certain situations. Vehicle collisions due to poor visibility are one way this may occur. Wildlife will experience health impacts from wildfire smoke, expanding their habitat range as they flee the fire and seek out more comfortable living conditions. There is the risk that animals, such as bears, moose, and cougars, will enter more populated areas as they expand their territory. The chance of human-wildlife encounters will increase as people and animals spend more time in the same spaces. Community members share that this risk is a serious concern for the safety of humans and wildlife.

Increased and/or prolonged exposure to wildfire smoke could impact the respiratory well-being of people, particularly the elderly or those with pre-existing respiratory conditions such as asthma. During smoke events in 2023, the Friendship Centre supported the evacuation of Elders from the Town and surrounding areas.

Outdoor activities are an important part of life in the Town and contribute to the local economy. Poor air quality has the potential to impact social and economic activity. Livestock will see similar health impacts including disorientation, eye irritation, difficulty breathing, and malaise. This is relevant to the social system because there are residents who rely on horses for their guiding and outfitting ventures.

Wind

Community members and Town leadership identified several concerns about the winds that they experience and described an expectation that winds will continue to increase in the future. This project understands that wind speeds can dramatically change the air quality and even the type of particles and pollutants blown into the community. While not considered by the risk assessment provided by Associated, the discussion here utilizes data provided by PARC.

Based on the analysis of maximum daily wind speed, the historical (1950 to present) mean wind speed has been 7.70 m/s. The future (present to 2099) mean wind speed is projected to be 7.72 m/s. This represents a difference of 0.02 m/s or a marginal increase of 0.26%.

This project does not propose climate projection data as a substitute for local and community-based knowledge, but it is rather one resource that can provide some insight into current and future climate. It is also important to recognize that the modelled data only considered daily maximum averages, which will (to a certain extent) remove extreme winds events that the Town will experience.

Appendix A: Glossary of Climate Change Terms

Addressing Climate Change

There are two complementary courses of action to address climate change. Good climate change planning includes **both mitigation and adaptation strategies.**

Mitigation

One course of action targets the causes of climate change and seeks to **reduce the amount of greenhouse gases** (GHGs) that are released to the atmosphere as the result of human activities; for example, by reducing energy consumption in our homes or vehicles, or reducing the GHG-intensity of the energy we use. This is called climate mitigation.

Adaptation

A second course of action targets the impacts of climate change and seeks to **enhance our resilience** to changing climate conditions, enabling us to **better cope with and manage risks**, as well as take advantage of opportunities that arise. This is commonly referred to as climate adaptation.

Key Terms and Concepts

Adaptation (actions)

Deliberate actions by communities in response to current or expected climate phenomena, which moderate potential harm or take advantage of beneficial opportunities. Actions can include monitoring, research, and other information gathering, education and capacity building, changes to infrastructure, creating new policies and regulations, developing economic and other incentives, and ensuring governance takes into account climate change. Adjusting to actual or expected climate impacts to reduce negative effects on people, society, infrastructure, and the environment.

Adaptive capacity

The capability of a community to moderate potential harm, to take advantage of opportunities, or to cope with the consequences of current and expected climate phenomena. The adaptive capacity of individuals, households and communities is determined by their access to, and control over, human (e.g., awareness of climate risks), social (e.g., healthcare), physical (e.g., irrigation infrastructure), natural (e.g., reliable raw water supply) and financial (e.g., savings) resources.

Adaptation planning

The collection of participatory activities and steps undertaken to moderate potential harm or to take advantage of beneficial opportunities from climate phenomena.

Climate

Climate and weather refer to separate things. Weather describes atmospheric conditions (such as temperature, humidity, precipitation, wind, cloudiness) in a place or region in the short-term – usually, hour-to-hour, day-to-day, and even weeks to months. For example, Medicine Hat may have a particularly hot day, wet week, or warm winter. Climate refers to the average of weather conditions over 30 years or more. When describing southwest Alberta as typically windy, you describe an aspect of its climate. Weather can change dramatically in a place or region from day to day (e.g., hot and dry one day, followed by cold, wet conditions the next day). Climate, in contrast, changes more slowly since it represents the average weather over the long term.

Climate change

A change in climate (average weather patterns) that lasts for an extended period. Climate change includes significant changes in average annual and average seasonal temperature or precipitation patterns in, say, central Alberta, that persist for decades or longer. Climate change also refers to long-term changes in the variability of climate. Climate change arises from human activity (i.e., greenhouse gas emissions) that alters the composition of the atmosphere, over and above what would be expected with natural climate variability.

Climate extremes

Weather extremes viewed over seasons (e.g., drought or heavy rainfall over a season), or longer periods. Weather extremes are individual events that are unusual in their occurrence (at a minimum, the event lies in the upper or lower tenth percentile of the distribution) or have destructive potential, like tornadoes, strong wind gusts, short-duration high-intensity rainfall events, etc.

Climate phenomenon (also called climate parameters)

An atmospheric condition or related hydrologic process that results in a specific set of generally known or characterizable impacts. Climate phenomena include both (rapid onset) shocks, such as heat waves, drought, lightning strikes, freezing rain, tornados, strong winds, heavy snow, hail, low flows in rivers, short-duration intense rainfall, flooding, and (slow onset) stresses, such as changes to seasonal temperatures and rainfall patterns. Climate change may affect the character, magnitude and likelihood of specific climate phenomena occurring in a place.

Climate variability

Average weather patterns show variation within short timeframes (e.g., a month, a season, one or more years). For example, this year may be significantly drier than an average year in Alberta, whilst the preceding couple of years may have been slightly wetter than the average year. Climate variability refers to these deviations – or anomalies – from the average. The term "natural climate variability" refers to variability in the climate that is not attributable to, or influenced by, any activity related to humans.

Co-benefits

The added benefits of adaptation, over and above the benefits of moderating potential harm or exploiting potential opportunities that arise from current and expected climate conditions. For example, the increased use of distributed energy technologies to provide electricity not only reduces a community's vulnerability to power outages by diversifying supply, but it also reduces emissions of greenhouse gases (contributes to climate mitigation goals) and increases job opportunities (contributes to economic development goals). Co-benefits can often be at least as equally important as the direct benefits of adaptation.

Community

A group of Indigenous people who are linked by social ties, share a common identity and geographical locations or settings, and on this basis, engage in joint action. People who are, or perceive themselves to be, affected by a decision, strategy, or process. A community partner can be an individual, an organization or a group within an organization. Community partners can change at different stages in a process.

Consequence

The result or effect from climate impacts to people, society, infrastructure, or the environment.

Exposure

Exposure refers to people, livelihoods, buildings, infrastructure, cultural assets, environmental resources, services, etc., being in places where they could be affected by climate phenomena. Communities in semi-arid regions, for example, may be exposed to drought and water shortages.

Greenhouse gas

A greenhouse gas (GHG) is a compound found in the Earth's atmosphere – for example, carbon dioxide, methane, water vapour, and other human-made gases. These gases allow solar radiation to enter the atmosphere and strike the Earth's surface, warming it. Some of this energy is reflected in space. A portion of this reflected energy, however, bounces off the GHGs and becomes trapped in the atmosphere in the form of heat. The more GHG molecules there are in the atmosphere, the more outgoing energy is trapped, and the warmer the Earth will become.

Hazard

A climate phenomenon that has the potential to cause harm to a community. A special type of hazard that is (at least partially) caused by climatic drivers, e.g., drought, high winds, extreme heat, etc. A potential source of harm.

Impacts

Adverse or beneficial effects on communities. For this Guide, impacts result only when a community is exposed to a climate phenomenon, to which that community has inherent vulnerabilities. An estimate of the harm that could be caused by an event or hazard.

Likelihood

The probability or chance of a hazard occurring, and how this likelihood changes in the future due to climate change.

Livelihoods

The capacity (capabilities, resources, and activities) of a community and its residents to generate and sustain their means of living, enhance their well-being, and the well-being of future generations. Livelihood resources include human, natural, social, physical, and financial capital. Livelihood activities include agriculture, trading, formal employment, etc.

Maladaptation

Maladaptation describes adaptation actions taken to reduce vulnerability to climate change that increase, rather than decrease, the vulnerability of a community. Maladaptation may occur when actions increase the vulnerability of people, groups, or sectors, increase GHG emissions, increase inequity in the community, decrease incentives to adapt, or place limits on the ability of future generations to adapt.

Mitigation

Actions that will reduce or prevent GHG emissions include using renewable energies like wind and solar, making buildings, vehicles, and equipment more energy efficient, and walking or cycling from time to time instead of using a car. It can also include planting trees to absorb and store carbon dioxide from the atmosphere.

Sensitivity

The degree to which people, livelihoods, buildings, infrastructure, cultural assets, environmental resources, and services, etc. could be affected, either adversely or beneficially, if exposed to climate phenomena. For example, newer buildings constructed to the latest code will be less sensitive to strong winds or heavy snow loads than older structures in need of repair. Furthermore, the elderly and people suffering from chronic respiratory and cardiovascular illness are more sensitive to heat stress than healthy adults.

Representative Concentration Pathway (RCP)

RCPs represent models that predict how concentrations of GHGs in the atmosphere will change in the future because of human activities. There are four RCPs (2.6, 4.5, 6.0 and 8.5) with a higher value representing higher GHG concentrations in 2100.

Resilience

The ability of a community to prepare for, resist, respond to, and recover from the impacts of climate phenomena in a timely and efficient manner, with minimum damage and disruption to the environment, and the social well-being and economic vitality of the community. Resilience and adaptive capacity are strongly linked. Thus, different groups within the community will be relatively more or relatively less resilient to climate phenomena, depending on their adaptive capacity.

Risk

A combination of likelihood and consequences of an adverse event or condition occurring. The expected consequences for people, livelihoods, buildings, infrastructure, cultural assets, environmental resources, and services of exposure to specific climate phenomena. Risk is thus a function of the likelihood of a climate phenomenon occurring in a place and the resulting impacts. In some instances, risk is categorized as:

Acute Risk: Rapid onset or event-driven risks such as high wind or intense rainfall events.

Chronic Risk: Slow onset risks and long-term shifts in climate patterns such as seasonal temperatures and precipitation changes, or species migration.

Vulnerability

The propensity or predisposition of people, livelihoods, buildings, infrastructure, cultural assets, environmental resources, services, etc., to be affected by specific climate phenomena. Vulnerability is a function of the nature and magnitude of the climate phenomenon to which people, livelihoods, etc. are exposed, their sensitivity to that phenomenon, and their adaptive capacity. Exposure of vulnerable people, livelihoods, buildings, infrastructure, cultural assets, environmental resources, and services, etc. to climate phenomena gives rise to impacts.

Weather

Short term day-to-day changes in atmospheric conditions like temperature and precipitation.

Appendix B: Project Timeline

March 2023	Application to MCCAC approved & contracts signed.
April	Project kick-off meeting.
May	Engagement meeting with Town of Hinton leadership to confirm the scope of the project.
June	The consequence scoring rubric and draft impact statements memo were shared with the Town of Hinton for review and comment.
July	The likelihood scoring memo was shared with the Town of Hinton for review and comment.
September	In-person engagement with the Town of Hinton senior leadership and Hinton Friendship Centre.
October	Additional and virtual community engagement was held.
December	Virtual presentation to the Hinton Youth Advisory Council.
January 2024	Draft the final climate risk assessment report and share it with the Town of Hinton for comment and review.

Appendix C: Climate Projections, Raw Data by Prairie Adaptation Research Collaborative

Data files provided separately by TRI.

Appendix D: Climate Risk Assessment by Associated Engineering

Associated
STRATEGIC ADVISORY SERVICES

TRI
THE RESILIENCE INSTITUTE

REPORT

Town of Hinton

Gateway to the Rockies
HINTON

Climate Risk Assessment

DECEMBER 2023

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GLOSSARY

Term	Definition
Acute Risks	Rapid onset or event-driven risks such as high wind or intense rainfall events.
Adaptation (to climate change)	Adjusting to actual or expected climate impacts to reduce negative effects on people, society, infrastructure, and the environment.
Chronic Risks	Slow onset risks and long-term shifts in climate patterns such as seasonal temperatures and precipitation changes, or species migration.
Climate	The weather of a place averaged over a period of time, typically 30 years.
Climate Change	Significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer.
Climate Parameters	Climate variables or indices that influence the hazard, e.g., a high intensity, short duration rainfall event.
Climate Hazard	A special type of hazard that is (at least partially) caused by climatic drivers, e.g., drought, high winds, extreme heat, etc.
Consequence	The result or effect from climate impacts to people, society, infrastructure or the environment.
Greenhouse Gas (GHG)	A gas that absorbs and emits radiant energy causing the greenhouse effect, which warms the atmosphere and changes the climate. The primary greenhouse gases are water vapour, carbon dioxide, methane, nitrous oxide and ozone.
Hazard	A potential source of harm.
Impact	An estimate of the harm that could be caused by an event or hazard.
Likelihood	The probability or chance of a hazard occurring, and how this likelihood changes in the future due to climate change.
Mitigation (of climate change)	Human interventions to reduce the sources and enhance the sinks, or absorption, of GHGs.
Representative Concentration Pathway (RCP)	RCPs represent models that predict how concentrations of GHGs in the atmosphere will change in the future as a result of human activities. There are four RCPs (2.6, 4.5, 6.0 and 8.5) with a higher value representing higher GHG concentrations in 2100.
Resilience	The capacity of a system, community, or society exposed to hazards to minimize damages by responding or changing to reach and maintain an acceptable level of functioning and structure.
Risk	A combination of likelihood and consequences of an adverse event or condition occurring.
Weather	Short term day-to-day changes in atmospheric conditions like temperature and precipitation.

1 INTRODUCTION

This report provides the details of the climate risk assessment (CRA) for the **Town of Hinton (the Town)** funded by the **Municipal Climate Change Action Centre's (MCCAC) Climate Resilience Capacity Building Program**. The intent of the CRA is to support the community in identifying and planning for climate hazards such as severe drought, high intensity rainfall, extreme heat, and severe storms. Action and implementation planning was outside the scope of this assessment and should be considered as next steps by the community to build on the results of this report.

Associated Engineering's Strategic Advisory Group (Associated) worked in collaboration with The Resilience Institute (TRI) to conduct the climate risk assessment (CRA). The CRA focuses on the built (i.e., buildings and infrastructure), natural (i.e., the land, water, and air), and social (i.e., health and wellbeing) systems of the Town.

Associated's scope for the CRA is as follows:

- Identify climate hazards relevant to the community.
- Research climate data projections and other data sources as necessary to determine the historic and future likelihood of the locally relevant climate hazards.
- Co-facilitate meetings to understand the Municipality's perspective on priority climate hazards and consequences.
- Calculate the community's risks from these hazards based on the likelihood of a climate impact occurring and the severity of the consequence.
- Develop high level considerations for adapting to the highest risks.
- Support TRI in engagement by preparing materials, co-facilitating discussions and integrating community feedback into the risk assessment.

1.1 Participatory Approach

A participatory approach was used throughout the project to integrate local perspectives and knowledge into the CRA. This included staff from the Town and conversations with the Hinton Friendship Centre. Understanding local experiences with climate impacts and what most concerns people about the future helps to produce a well-rounded CRA that is specific to the community. There are two key stages where local knowledge and input informed the project:

- **Identification of relevant climate hazards and current likelihood:** Representatives from TRI and Associated met with staff from the Town and a representative from the Hinton Friendship Centre to help the project team identify the climate hazards that are of greatest concern to the community. Discussions provided insight on which climate hazards are already being experienced and causing impacts.
- **Climate impact statements and consequence scoring:** Meetings were held with Town staff and the Friendship Centre to review climate impact statements. These conversations helped provide an understanding of the severity of consequences from climate impacts.

1.2 Acknowledgment

We would like to acknowledge the **Town of Hinton staff and Hinton Friendship Centre representative** whose insights were critical in the creation of this report. The project team appreciates their shared knowledge for the purpose of including local perspectives in this community project.

2 SCOPE OF CLIMATE RISK

This section provides a discussion on the boundaries that shaped the assessment and discussion. The boundaries defined the systems of the community, geographical boundaries, and climate parameters to help develop the climate impact scenarios that were used for risk assessments.

2.1 Community Systems

It is best practice in climate risk assessments to evaluate potential impacts on different "systems" that make up a community. Built, natural, and social systems are usually included in CRAs, with economic systems considered in some situations (outside the scope of this assessment). These are referred to as systems because they are interacting and interrelated so are considered collectively. This approach allows for a holistic consideration of the consequences of climate change and is particularly valuable for identifying impacts that may be less obvious (e.g., physical damage to infrastructure is more straightforward and visible than health impacts or changes in activities).

The risk assessment examined the impacts of climate change on built, natural, and social systems (see **Figure 2-1**).

Figure 2-1 Systems Impacted by Climate Change

2.2 Geographical Boundaries (or Spatial Scope)

The assessment was largely confined to climate-related hazards that have direct impacts within the Town's boundaries and the Town's control and influence. Within these boundaries, a community-wide approach is adopted, that considered impacts to private property, the local economy, the health and lifestyle of residents, social equity, and natural capital, as well as impacts within Hinton's boundaries that may impact regional economic systems.

2.3 Types of Climate-Related Impacts

In terms of climate-related hazards, both slow-onset (chronic) stresses and sudden-onset (acute) discrete events are within scope. The latter tend to be short duration events, that typically last minutes, hours, days, or weeks. These will generally occur irrespective of climate change—though their frequency, intensity, or distribution may alter because of climate change. Examples include windstorms, heavy snowfall events, freezing rain events, wildfire, and temperature extremes. Slow-onset stresses, in contrast, are caused entirely by climate change, with impacts unfolding gradually, building up over longer time frames—decades or more. Examples of slow-onset impacts include warming trends in air and surface water temperatures and ecosystem shifts.

2.4 Future Climate Scenarios

Projections of future climate change are available for a range of greenhouse gas emissions, concentrations, and radiative forcing scenarios—or Representative Concentrations Pathways (RCPs). When assessing climate-related risks it is prudent to consider the greatest plausible change scenario relative to the present, which in practice means working with projected changes for the region under the RCP 8.5 scenario, i.e., the most conservative of global “limited climate policy” scenarios (see the text box). The primary justification for using RCP 8.5 is that it means no risks are missed during the risk assessment. Uncertainties relating to whether the future unfolds along RCP 8.5 or along a different, lower emission RCP, are managed during the adaptation planning and implementation phase.

RCP 8.5

The magnitude and rate of change in the climate over the remainder of this century is uncertain and will largely depend on global efforts to reduce emissions of greenhouse gases and to protect and enhance carbon sinks. This uncertainty is captured using different emission scenarios, known as Representative Concentration Pathways (or “RCPs”). Each RCP is based on different levels of “radiative forcing” by the end of the century. Radiative forcing is a measure of how much energy inflows from the sun and outflows back out into space are out of balance because of different factors, including concentrations of greenhouse gases in the atmosphere. RCP 8.5 (indicating an end-of-century increase in radiative forcing of 8.5 watts per metre squared relative to pre-industrial times) is a high baseline emission scenario associated with higher levels of global warming. The mean annual temperature for Hinton, for example, is projected to average +5.8°C in the future (2051-2080), an increase of 3.6°C from its average value over the baseline period (1971-2000) (ClimateData.ca).

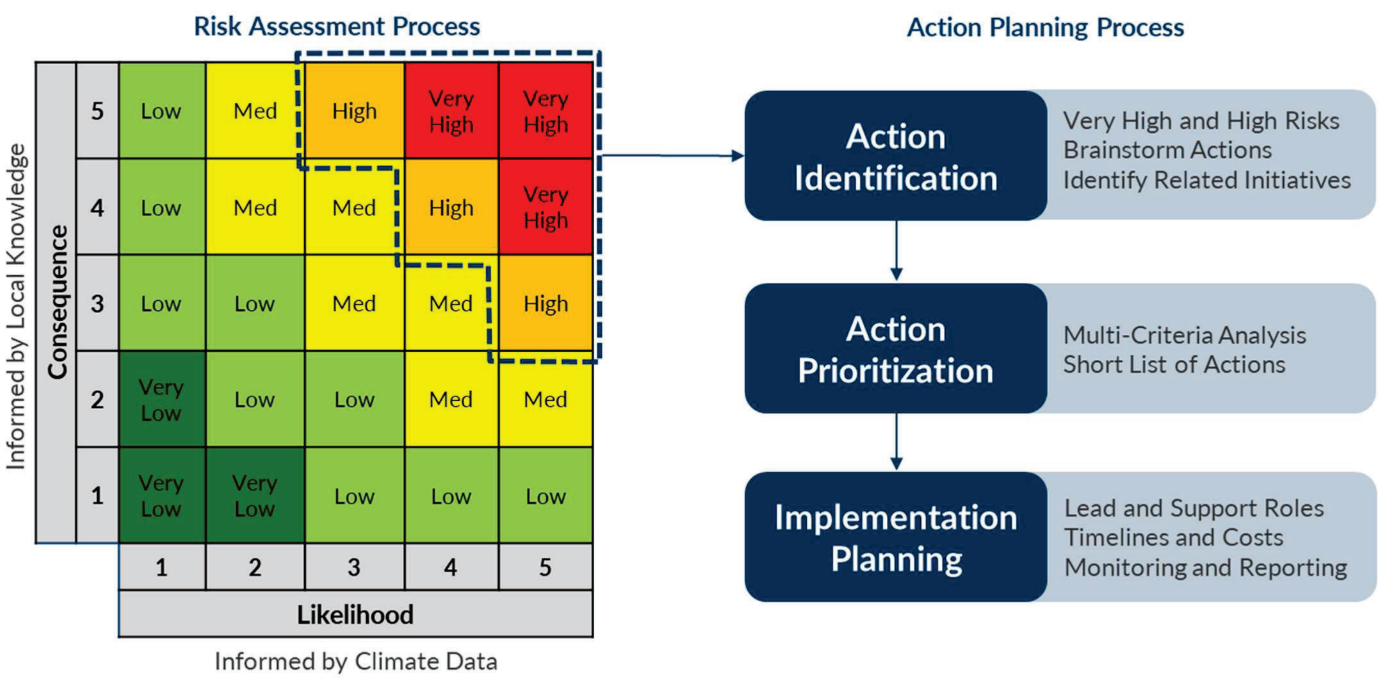
2.5 Time Horizon

The assessment considers impacts arising from projected climate and associated environmental changes out to a future, 30-year time period centered around the 2050s. **Section 3.3** specifies the time periods considered for each climate hazard based on available data sources.

3 RISK ASSESSMENT METHODOLOGY

Risk is evaluated as the product of **likelihood** of the hazard, events, or condition that could occur, and the level of the **consequence of the impact.** In terms of climate risk, we develop an understanding of how the variability of climate patterns impact the built and natural environment, and in turn, how this impacts the society and economy. **The purpose of a risk assessment is to identify the highest risks so that subsequent adaptation actions are focused on these highest risks.** This is illustrated in **Figure 3-1** below. The scope of this project is centered on the risk assessment and does not include action planning.

Figure 3-1 Climate Adaptation Risk Assessment and Planning Overview



3.1 International Standards for Risk Assessment

The risk assessment process used for this project is based on the **ISO 31000's principles of risk management**. The principles follow a systematic cycle of actions to create and protect the value of community assets. **Figure 3-2** illustrates the process starting from integration of organizational activities that requires the collaboration of groups, using a structured approach to assess risk that is customized for the appropriate context. The discussion is also inclusive and dynamic, drawing from evidence-based information. Finally, the risk management process identifies a continual improvement through learning and experience.

Figure 3-2 Principals of Risk Management (ISO 31000)

The approach to the climate risk assessment methodology also aligns with 'good practice' methodology including:

- **Public Infrastructure Engineering Vulnerability Committee (PIEVC) High Level Screening Guide (HLSG)** developed by Engineers Canada and assumed by the Institute for Catastrophic Loss Reduction (ICLR), the Climate Risk Institute (CRI) and Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ).
- "***Climate Resilience Express – Community Climate Adaptation Planning Guide***" (https://mccac.ca/app/uploads/CRE_Planning-Guide_Final.pdf), which was developed by All One Sky Foundation for the Municipal Climate Change Action Centre and the Climate Resilience Capacity Building Program.
- **International Standards Organization (ISO) guideline 14092**: Adaptation to Climate Change—Requirements and guidance on adaptation planning for local governments and communities, and with the Intergovernmental Panel on Climate Change's (IPCC) latest conceptualization of climate risk assessment methods.

3.2 Risk Assessment Process

As mentioned above, risk is a product of likelihood and consequence. The steps are summarized in **Figure 3-3** and outlined below:

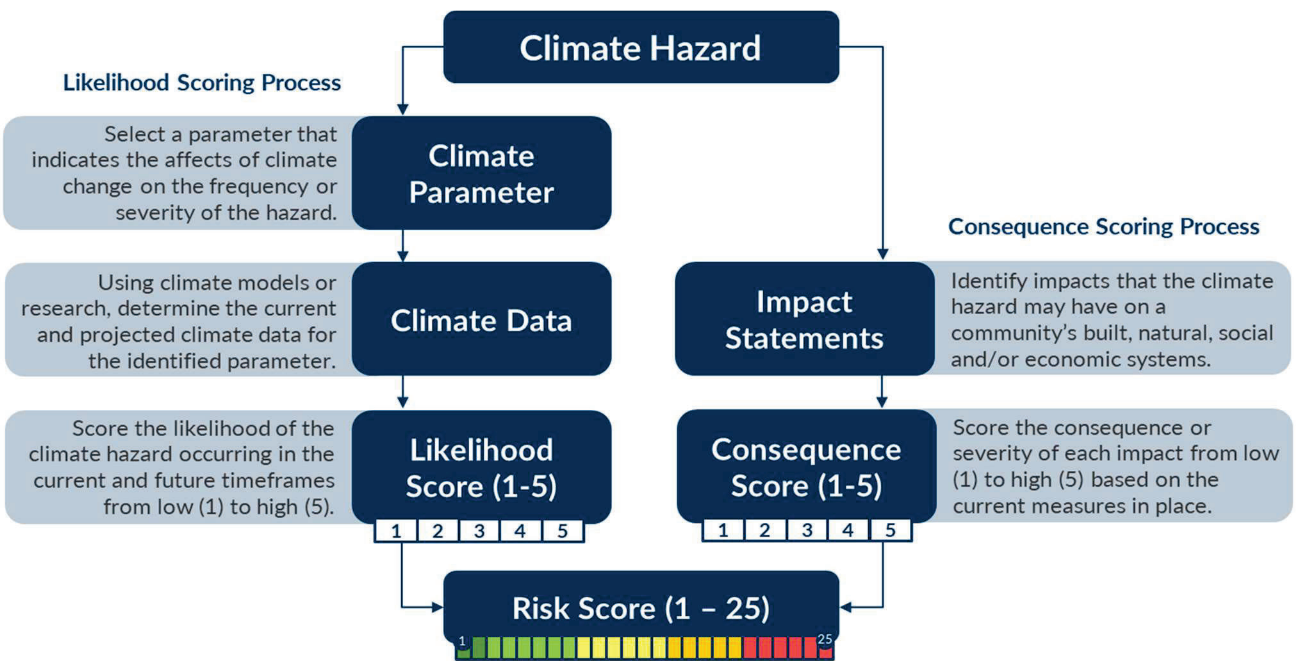
1. Identify **climate hazards** applicable for the study area (e.g., extreme heat, wildfire smoke or heavy rainfall. However, sea level rise is not appropriate for this site.)
2. Analyse the **likelihood** of each hazard (how frequent a hazard may occur)
    a. Identify a **climate parameter** from available climate data which is representative of the frequency and/or severity of each hazard (e.g., Number of days above 30 °C, 24 hour 100-year rainfall (mm/hr)). There could be multiple parameters to describe a hazard but only one is selected to represent the relative change in the hazard over time due to climate change.
    b. **Collect climate data** for a high emissions scenario looking at historic and future (2050s) timeframes and calculate the projected increase or reduction of the likelihood of each hazard. Climate models do

not capture all climate hazards, such as forest fire or hail, and therefore alternative data sources (research, national monitoring indices) are used, along with experience and good practice.

   c. Assign a **baseline likelihood score** (1 to 5) which indicates the historical and current frequency or severity of the hazard according to historic data and conversations with the Town of Hinton around the experiences with the hazard.
   d. Assign a **future likelihood score** (1 to 5) which indicates the projected frequency or severity of the hazard in the 2050's according to the calculated change in parameter likelihood.

3. Identify the various **impacts** of each hazard to the built, natural, and social systems within the scope of the assessment.
4. Assign a **consequence score** (1 to 5), with the community's input, to each impact considering severity such as cost of impacts, duration of interruption, significance of health impacts, etc.
5. Calculate the **baseline and future risk score** for each hazard and impact by multiplying the corresponding likelihood score and consequence score.

Figure 3-3 Risk Assessment Process



3.3 Risk Assessment Assumptions & Limitations

Key assumptions and limitations in the risk assessment methodology included:

Hazard Identification

- Climate hazards were chosen according to relevance to Hinton and project scope at the time of the assessment. The Town could consider the impacts from additional climate hazards as appropriate when more in-depth adaptation planning is conducted.

Likelihood

- A single climate parameter was selected for each hazard to represent the change in likelihood. Some hazards such as high winds, heavy snow, and forest fires are complex with several contributing factors not captured within available climate modelling and projections. In these cases, a climate parameter that was considered to most represent the hazard in context of the impacts was selected.
- Where climate data was unavailable for the exact geographic location, data for a nearby location (i.e., Edson) was used.
- Time periods considered for historic climate data varied across climate hazards depending on available data.
  - Data supplied by Prairie Adaptation Research Collaborative (PARC) (drought, heavy snow, extreme heat) is understood to span 1976-2005.
  - Data derived from Intensity-Duration-Frequency (IDF) curves for overland flooding and river/creek flooding spans 1970-2015.
  - Data from the Canadian Climate Atlas (lake flooding, freeze-thaw, glacial recession) spans 1976-2005.
  - Data for wildfires and wildfire smoke spans 1981-2010.
  - Data for hail spans 1971-2000.
  - Data for lightning spans 1999-2018.
  - Data for ecoregion shift spans 1969-1990.
- Likelihood scores for freezing rain and high winds looked at the projected percent change in parameter between 2020 and 2050.
- Time periods considered for future (2050s) climate data varied across climate hazards depending on available data.
  - Data supplied by PARC (drought, heavy snow, extreme heat) is understood to span 2035-2065.
  - Data derived from IDF curves for overland flooding and river/creek flooding spans 2051-2080.
  - Data from the Canadian Climate Atlas (lake flooding, freeze-thaw, glacial recession) spans 2021-2050.
  - Data for wildfires, wildfire smoke, hail, and ecoregion shift spans 2041-2070.
- Where representative climate parameters or projected data were unavailable, scores were assigned based on available research, studies and good practice.

Consequence

- Consequence scores were assigned with the Town's input considering the level of consequence that is expected to be seen from the climate hazard given the current understanding of the hazards and the current systems (built, natural, and social). It is possible that realized consequences could be more or less severe than anticipated in scoring because this assessment is based on the best available information at the time but is not a guarantee of what will happen in the future.

Risk Classification

Risks were classified from very low to very high using a standard risk matrix scored from 1 to 25. High and very high risks are used as the priority for action planning.

3.4 Relevant Hazards

Climate hazards are weather-related, hydrometeorological events which can cause harm, and may also be referred to as extreme weather events. There are multiple climate hazards, but some are only applicable to specific locations such as sea level rise along the coasts. The climate hazards identified to be applicable to Hinton are listed and described in **Table 3-1**.

Table 3-1 Climate Hazard Descriptions

Hazard	Description
Drought	A prolonged period of abnormally low rainfall, leading to a shortage of water.
Lightning	Occurrence of natural electrostatic discharges of short duration and high voltage within clouds, or between clouds and the ground.
Overland Flooding	Rapid increases in water level, particularly in low lying areas and along drainage networks, seen during periods of short-duration high-intensity rainfall or rapid melting of snow or ice. Also know as pluvial flooding.
River/Creek Flooding	River water levels exceeding the top of bank and spilling onto surrounding lands typically driven by longer duration heavy rainfall. Also know as fluvial flooding.
Lake Flooding	Lake water level rising to higher-than-normal levels and potentially overtopping banks and flooding surrounding lands. Typically driven by seasonal and cumulative precipitation conditions.
Wildfires	A large, destructive fire that spreads quickly over forests or grasslands.
Wildfire Smoke	A mix of gases and fine particles from burning trees and plants, buildings and other material.
Hail	Pellets of frozen rain which fall as showers.
Freezing Rain	Rain that freezes on impact with the ground or solid objects.
High Winds/ Tornadoes	A period of abnormally strong, sustained winds.
Extreme Heat	Summertime temperatures that are much hotter and/or humid than average.
Extreme Cold	Winter temperatures that are much colder than average
Heavy Snow	A period of intense, sustained snowfall.
Freeze-Thaw Cycle	The fluctuation of air temperature between freezing and non-freezing temperatures.
Ecoregion Shift	A change in the climatic conditions of an area, affecting the health and presence of native ecoregions (ecological features and plant and animal communities).
Glacial Recession	A shrink in glacier size because more material melts, evaporates, or erodes than is replenished

3.5 Climate Likelihood Scoring

Likelihood scores were assigned for the historic and future (2050s) time horizons according to climate parameter trends, with increasing/decreasing values reflecting increasing/decreasing occurrence or severity over the time horizon. **Climate projections consider a high-emissions scenario, with the earth reaching 2 degrees of global warming in the mid to late 2050s.**

Historic likelihood scores are assigned using feedback solicited during meetings and workshops. A historic (baseline) likelihood score of either 2 or 3 is assigned based on community experiences with the hazard up to present day. This approach is used to capture local knowledge and experience with climate hazards that may not be reflected in scientific datasets. The likelihood score is selected based on the following criteria:

- A historic **likelihood score of 2** indicates that, while the climate hazard may be occurring, it does not cause recurring issues or significant concern for the community at this time.
- A historic **likelihood score of 3** indicates that the climate hazard is already a problem for the Town and impacts have been experienced a number of times in the recent past.

From there, a future likelihood score is calculated according to the percent increase or decrease of the assessed climate parameter over time. Community feedback is not used to inform future likelihood because this assessment used specific climate data portals and research to evaluate the likelihood of certain conditions.

The scoring rubrics for likelihood are shown in **Tables 3-2** and **3-3** below.

Table 3-2 Likelihood Rubric, Baseline of 2 (Hazard Not a Current Concern)

Likelihood Score (L)	Historic Likelihood	Future Likelihood
1	↑	10-100% reduction in frequency of intensity with reference to Baseline Mean
2	Seldom occurs in current climate	Baseline mean conditions or a change in frequency or intensity of +/-10% with reference to baseline mean
3	↓	10-40% increase in frequency or intensity with reference to Baseline Mean
4		40-70% increase in frequency or intensity with reference to Baseline Mean
5		70-100% increase in frequency or intensity with reference to Baseline Mean

Table 3-3 Likelihood Rubric, Baseline of 3 (Hazard a Current Concern)

Likelihood Score (L)	Historic Likelihood	Future Likelihood
1	↑	50-100% reduction in frequency of intensity with reference to Baseline Mean
2		10-50% reduction in frequency of intensity with reference to Baseline Mean
3	Often occurs in current climate	Baseline mean conditions or a change in frequency or intensity of +/-10% with reference to the baseline mean
4	↓	10-50% increase in frequency or intensity with reference to Baseline Mean
5		50-100% increase in frequency or intensity with reference to Baseline Mean

3.6 Impact Statements

Climate hazards can have multiple types of impacts such as financial damages, increased operational needs, deterioration of health both physical and mental, interruption to key services, or temporary evacuations, to name a few. By looking at the impacts to each system (built, natural, and social), a broad and holistic understanding of the impacts s developed. The list of impact statements is informed by those that are commonly experienced in communities with similar climate projections and supplemented with local knowledge and experience. Some sample impact statements showing the different types of impacts across the systems are provided in **Figure 3-4.**

Figure 3-4 Sample Impact Statements

Hazard	System	Impact Statement
Extreme Heat	Built	Power outages due to overheated electrical systems
	Natural	Increase in algae blooms affecting water quality
	Social	Health risks for outdoor workers

3.7 Consequence Scoring

Not all impacts have the same severity of consequence and therefore each impact is assessed individually through the risk assessment process. Different criteria were used to assess impacts to built, natural, and social systems as shown in the consequence rubric, with a high or more severe consequence scored a 5 and a lower severity a score of 1 (see **Table 3-4**).

Table 3-4 Consequence Scoring Rubric

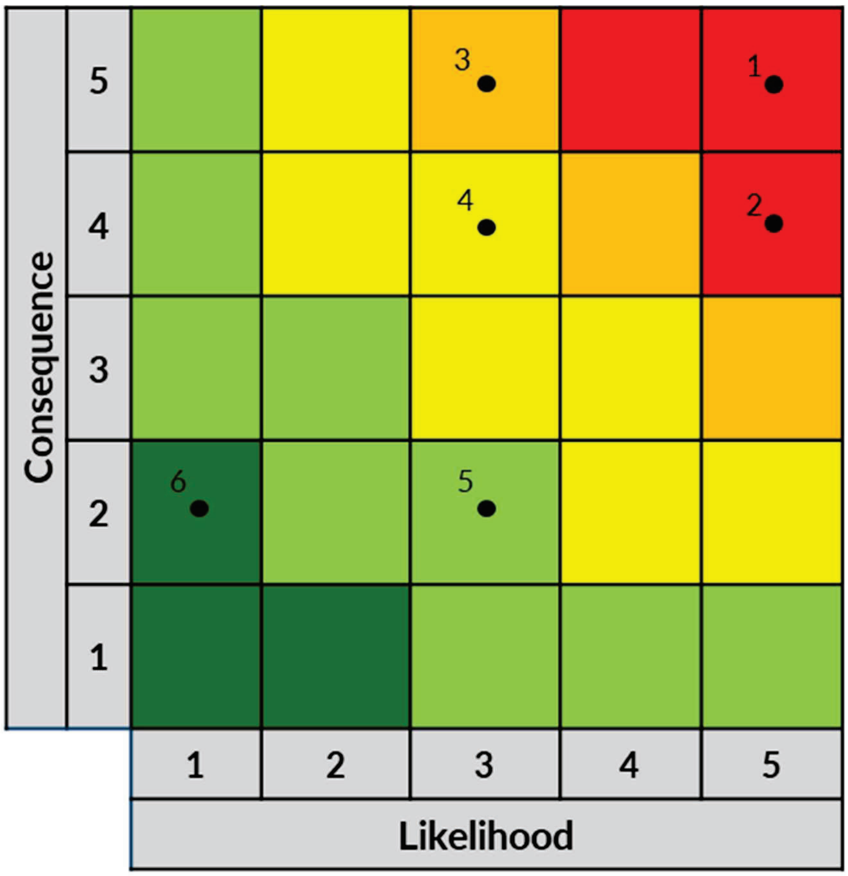
System	Very Low - 1	Medium - 3	Very High - 5
Natural	▪**Minimal or no environmental disruption or damage** to landscape, water resources, trees, and other natural infrastructure. ▪**Affected resources recover full functionality within days**, e.g., plants and wildlife only marginally affected.	▪**Isolated but eventually reversible damage** to wildlife, habitat or and ecosystems, or **short-term disruption** to environmental amenities. ▪**Full restoration of function possible** but could takes months or 1-2 years.	▪**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.** Ecoregions experience a **permanent shift,** with more invasive species, loss of medicinal plants & other valued species.
Built	▪**Little or no expected additional financial costs** to the Town. ▪**Minimal or no impact on operations** and delivery of services. ▪Community members' reaction is minimal - **little to no erosion of trust** in community administration.	▪Cost of damages **within Town's funding capacity.** ▪**Operation and services temporarily interrupted for weeks** before backlog is cleared. ▪Community members' **reaction is moderate** - negative views of community administration is held by **several** community members.	▪**Cost of damages far exceeds the Town's funding capacity.** ▪**Operation and services severely interrupted -** additional resources required to clear backlog taking **months.** ▪Community members' **reaction is significant** - negative views of community administration is **widespread.**
Social	▪**Minimal disruption to daily life**, minimal or no change in community cohesion ▪**Minimal health effects** ▪**No self-evacuations or displacement**	▪**Week-long disruption to daily life** with temporary feelings of fear and anxiety, moderate erosion of community cohesion ▪**Moderate health effects** with some injuries or illnesses ▪Small areas of Town seeing **temporary self-evacuations/ displacement**	▪**Months long disruption to daily life** (e.g., inability to access schools, recreation) with widespread psychological effects and erosion of community cohesion ▪Significant and **widespread** health effects including **fatalities, injuries, or illnesses** ▪Large areas of Town requiring temporary evacuations, with **some permanent displacement**

3.8 Risk Scoring

Using the likelihood and consequence scoring, the final **risk score** for each impact statement falls on a scale between **0 and 25** (refer to **Figure 3-5**):

- Between 0 and 2 are considered very low risk (**dark green**);
- Between 3 and 7 are considered low (**light green**);
- Between 8 and 14 are considered medium risk (yellow);
- Between 15 and 19 are considered high risk (**orange**); and
- Between 20 and 25 are considered very high risk (**red**) items.

Figure 3-5 Sample Risk Matrix



Typically, the **very high** and **high risks** are the focus area for adaptation action planning in the next phase (not part of the current project scope). As progress is made, the medium risks can then be considered. Often the low and very low risks are accepted, and actions may not be taken. The risk tolerance of a community may vary and therefore more or less risks may be considered as part of adaptation action planning.

4 RISK ASSESSMENT RESULTS

4.1 Change in Climate Hazard Likelihood

Risk is driven by both the consequence of different climate hazards and their likelihoods. Changes in likelihoods drive a large portion of risk, as rare events become more common.

Many hazards will see an increase in how likely they are to occur between historical data and 2050s projections. **The largest shifts in likelihood are for extreme heat (days above +30°C), wildfires, wildfire smoke, and freezing rain.** Of the hazards explored in this assessment, the annual number of extreme cold days and freeze-thaw cycles are projected to see a decrease in likelihood between historical data and 2050. The climate parameters assessed and their corresponding likelihood scores are shown in **Table 4-1**. The change in climate hazard likelihood scores is summarized in **Figure 4-1**.

Table 4-1 Climate Hazard Parameters and Likelihood Scores

Climate Hazard	Parameter	Historic Value	Future Value	% Change	Historic Likelihood	Future Likelihood	Data Source
Drought	Standardized precipitation evapotranspiration index (SPEI 3)[1]	0.71	0.53	-25%	3	4	PARC[2]
Lightning	Annual average number of days with lightning[3]	40.2	-	-	2	3	ECCC[4]; Paquin, et al (2024)[5]
Overland Flooding	15 min 25-year rainfall (mm/hr)	82.6	105	27%	3	4	Climate Data[6]
River/Creek Flooding	24 hour 100-year rainfall (mm/hr)	3.7	4.7	27%	2	3	Climate Data[6]
Lake Flooding	3 day rain (mm)	44	48	8%	2	2	Canadian Climate Atlas[7]
Wildfires	Annual average area burned (ha) within region	303,865	543,919	79%	2	5	Wang et al. (2022)[8]

[1] Values range from -5 to 5, with higher numbers indicating higher levels of moisture; a reduction in value indicates an increase in drought conditions.
[2] Prairie Adaptation Research Collaborative (PARC) supplied data
[3] While no projected values are available, research points towards a slight increase in lightning frequency.
[4] Environment and Climate Change Canada (ECCC) (2019), *Lightning Activity in Canadian Cities.* https://www.canada.ca/en/environment-climate-change/services/lightning/statistics/activity-canadian-cities.html
[5] Dominique Paquin, Ramón de Elía & Anne Frigon (2014) Change in North American Atmospheric Conditions Associated with Deep Convection and Severe Weather using CRCM4 Climate Projections, Atmosphere-Ocean, 52:3, 175-190, DOI: 10.1080/07055900.2013.877868
[6] Climate Data for a Resilient Canada: climatedata.ca Short-duration Rainfall IDF Data, Version 3.30 (2022-10-31)
[7] Climate Atlas of Canada: climateatlas.ca
[8] Wang, Xianli, Tom Swystun, and Mike D. Flannigan (2022). *Future wildfire extent and frequency determined by the longest fire-conducive weather spell*. Science of the total environment 830 (2022): 154752.

Climate Hazard	Parameter	Historic Value	Future Value	% Change	Historic Likelihood	Future Likelihood	Data Source
Wildfire Smoke	Annual average area burned (ha) within region	303,865	543,919	79%	3	5	Wang et al. (2022)[8]
Hail	Annual severe summer hail days	2.75	3.55	29%	2	3	Brimelow et al. (2017)[9]
Freezing Rain	Change in annual ice accretion (2020-2050)	-	-	39.90%	2	3	ECCC[10]
High Winds	Change in annual hourly wind pressure (1/50) (2020-2050)	-	-	1%	2	2	ECCC[10]
Heavy Snow	Annual winter precipitation (mm)	102.89	104.42	1%	2	2	PARC[2]
Extreme Heat	Annual days above +30°C	0.4	5.1	1175%	2	5	PARC[2]
Extreme Cold	Annual days below -15 °C	59.41	40.82	-32%	3	2	PARC[2]
Freeze-Thaw Cycles	Annual # of freeze-thaw events	127.1	114.5	-10%	2	2	Canadian Climate Atlas[7]
Ecoregion Shift	Ecoregion shift[11]	-	-	-	2	3	AdaptWest[12]
Glacial Recession	Freezing degree days	1116	857.8	-23%	3	4	Canadian Climate Atlas[7]; Science Daily[13]

[9] Brimelow et al. (2017). *The changing hail threat over North America in response to anthropogenic climate change.* Nature Climate Change, DOI: 10.1038/nclimate3321

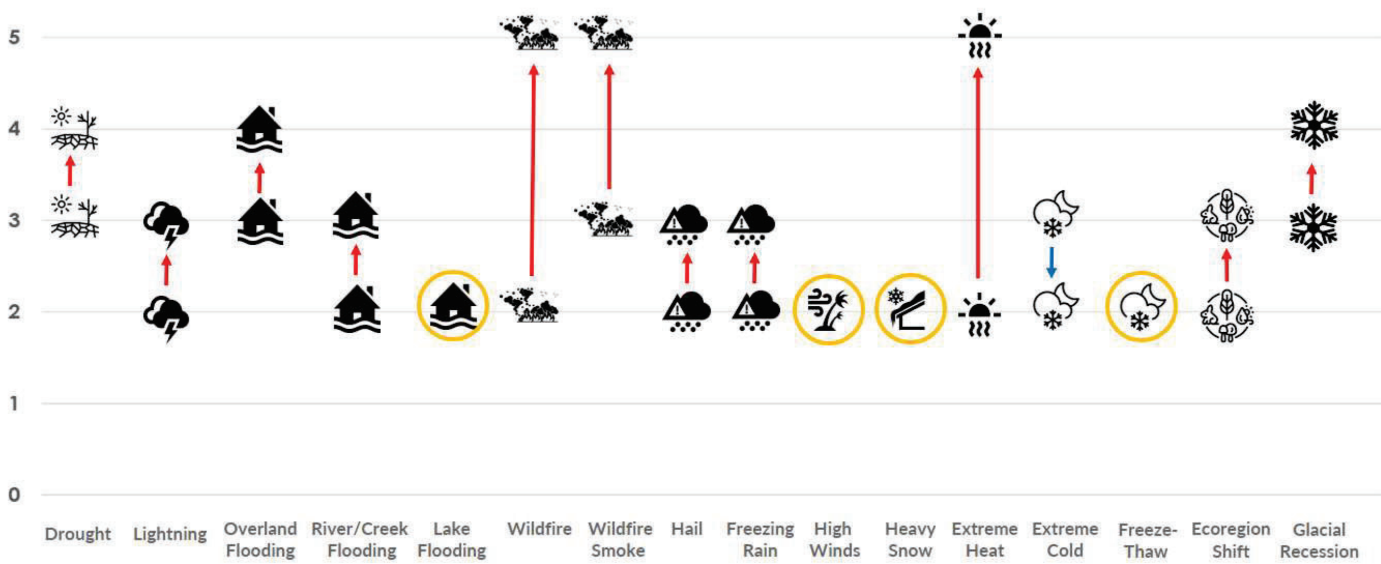
[10] Environment and Climate Change Canada (ECCC), *Climate-Resilient Buildings and Core Public Infrastructure - An Assessment of the Impact of Climate Change on Climatic Design Data In Canada - Annex 1.2.* https://publications.gc.ca/collections/collection_2021/eccc/En4-415-2020-eng.pdf

[11] Eco-region maps project a shift in ecoregion in the area.

[12] AdaptWest – A Climate Adaptation Conservation Planning Database for North America: adaptwest.databasin.org

[13] Science Daily (2005). *Most of Arctic's Near-surface Permafrost to Thaw by 2100*. Science News. *https://www.sciencedaily.com/releases/2005/12/051220085054.htm*

Figure 4-1 Change in Climate Hazard Likelihood (historic baseline to 2050)



4.2 Results by System

Risk scores for each of the **127 climate impact statements** (**Appendix A**) were calculated by multiplying the likelihood score (1 to 5) by the consequence scores (1 to 5), where the highest possible risk score is 25. Looking at the assessment holistically across all systems, the climate hazards presenting **very high risks** to the Town in the 2050s are **overland flooding, wildfires, extreme heat, wildfire smoke, and glacial recession**. A summary of some of the highest risk impacts of these hazards is shown in **Table 4-2**.

Table 4-2 Climate Impact Statements – Top Hazards

Top Hazards	Top Impacts
	Overland Flooding • Transportation delays and disruptions (access/egress routes) • Damage to buildings and community member homes
	Wildfire • Transportation delays and disruptions (access/egress routes) • Damage to buildings and community member homes • Residents displaced from their homes, temporarily or permanently. • Damage to infrastructure
	Extreme Heat • Health impacts or death, especially for vulnerable populations (chronic health conditions, elderly, children) • Potential power outages due to grid overload • Increased risk of wildlife-human interactions as animals seek out alternative resources
	Wildfire Smoke • Increased respiratory problems • Increased costs to upgrade and maintain buildings • Increased risk of wildlife-human interactions (traffic accidents) due to decreased visibility • Reduced tourism and outdoor recreation
	Glacial Recession • Reduced raw water supply • Reduced community population as people move to areas with more water

Results are summarized in the following sections according to **System: (Built, Natural, or Social)**:

- Risk matrix for each system including all impacts (very low to very high)
- Summary table of very high risks for each system
- Description of very high risks for each system
- High level insights to guide future adaptation planning for the area

Each impact statement within the risk matrices is labeled with the **hazard name** and a **unique impact statement ID for that hazard**. For example, overland flooding has 16 impact statements which are named from Wildfire (A) to Wildfire (L). Extreme heat has 10 impact statements which are named from Overland Flooding (A) to Overland Flooding (P). A full table of results across all impact statements is provided in **Appendix A**.

4.2.1 Built System

Built systems are man-made structures and facilities and may be owned by the Town or its residents. These encompass all constructed elements, including roadways, pathways, schools, the Dr. Duncan Murray Recreation

Centre, library, pool, and the West Fraser Guild Performing Arts Theatre. The Hinton Healthcare Centre and water treatment infrastructure are also included in this system.

Discussions with Town staff revealed that the current condition of infrastructure is a concern, and that there is great interest in understanding how climate change will affect the built environment. The Town completed an asset management study in 2018, which showed a decline in infrastructure quality along with insufficient resources to complete required maintenance and renewal. Increased stresses on built assets through the effects of climate change could further decline asset condition, increasing maintenance and renewal requirements.

A total of **55 impacts** to the built system were assessed and are shown in **Figure 4-2** below. Wildfires, overland flooding, extreme heat, and wildfire smoke were identified as very high risks. **Table 4-3** provides details on the impacts associated with these four risks.

Figure 4-2 Climate Risk Matrix – Built System

Consequences	Likelihood 1	Likelihood 2	Likelihood 3	Likelihood 4	Likelihood 5
5		Extreme Cold (A) Heavy Snow (D) High Winds/Tornadoes (A,B,D)	Freezing Rain (D) River/Creek Flooding (C,F)	Overland Flooding (B,C,Q)	Wildfires (A,L,M)
4		Heavy Snow (C) High Winds/Tornadoes (C,I) Lake Flooding (A)	Freezing Rain (A,B,C,F) Hail (A,B,C) Lightning (A,B) River/Creek Flooding (A,B,D,G)	Overland Flooding (A,L)	Extreme Heat (C,G) Wildfire Smoke (A,B) Wildfires (N)
3		Extreme Cold (D) Freeze-Thaw Cycles (A) Heavy Snow (E,F)	Freezing Rain (E) Rain/Creek Flooding (E)	Drought (A,B) Overland Flooding (D,H,K)	Extreme Heat (A,B)
2		Heavy Snow (A,B)		Drought (I)	
1					

Table 4-3 Very High Risk Climate Impacts – Built System

Hazard (Impact ID)	Impact
Wildfires (A)	Transportation delays and disruptions on major routes (access/egress routes)
Wildfires (L)	Damage to private property
Wildfires (M)	Damages to buildings and facilities
Overland Flooding (B)	Basement flooding due to storm and sanitary system surcharge
Overland Flooding (C)	Flooding of/damage to roads (access/egress, community services),
Overland Flooding (Q)	Increased soil erosion resulting in landslides that damage property and trails
Extreme Heat (C)	Power outages due to overheated electrical or increased energy usage leading to interruption of critical services
Extreme Heat (G)	Longer season's impact on park operations
Wildfire Smoke (A)	Increased wear on filtration systems & AC units
Wildfire Smoke (B)	Increased costs and effort to reduce smoke infiltrating buildings (i.e., air tightness of buildings, type of filters on HVAC)
Wildfires (N)	Damage to electrical infrastructure

Wildfires

Engagement with the community identified that wildfires and overland flooding are perceived to be the greatest hazards to the Town. For example, if a wildfire is in proximity of the Town, safe access and egress to/from the area could be compromised. Highway 16 is the major transportation corridor for Hinton. Wildfire related damage or closures of the highway would result in significant traffic delays and congestion. Engagement noted that there are future plans to have a bypass (Highway 16X) around the Town, which would alleviate some of the strain on the existing transportation network. If a mandatory evacuation were required (or residents felt compelled to leave prior to a public directive), there is the risk of increased motor vehicle accidents or automobile/pedestrian interactions due to the increased traffic. This would be exacerbated if people are scared, and judgement becomes impaired in their haste to leave the area. The rail line that runs through the Town was identified as another option for passenger transport. During engagement it was noted that an extreme wildfire event would exceed Hinton's existing capacity to respond to the emergency. Difficulties moving throughout the community due to blocked roads would compound this impact.

A wildfire in the community itself could damage infrastructure, requiring significant repairs or full replacement depending on the extent of the damages. Community member homes could be impacted damaged or destroyed. Critical (water treatment, medical, etc.) and less critical buildings and facilities (library, schools) are also at risk from wildfires. Conversations with the town identified that there is not firebreak around the town, which leaves the community at risk. The potential of wildfire destroying part of the town was particularly top of mind for local stakeholders.

Electrical infrastructure (e.g., above ground powerlines, transformers) could also be damaged in a wildfire. Subsequent power outages would affect the lives of everyone in the community, but vulnerable populations (e.g., people in the healthcare centre) would experience the most severe impacts if they do not have a backup generator available. There appears to be a gap in communication and emergency planning between the Town and private entities supplying power utilities. During engagement, it was explained that the municipality does not spend a lot of time thinking about the resilience of the power grid because that is a service provided by private entities. During previous outages, the Town has had to externally source because they do not own their own equipment. There have not been emergency planning or response meetings between the local government and utilities, which may mean there are missed opportunities for resource sharing and communications flow.

Overland Flooding

Overland flooding was the other top priority hazard for the Town. This type of flooding is often caused by periods of intense precipitation, where the water cannot be collected by stormwater infrastructure or absorbed by soil fast enough. During engagement, it was noted that the Town has seen unprecedented flooding in recent years, with two flash floods in less than 24 hours in one case.

Locally, residents have observed increased flood-related erosion after wildfire events. This occurs because wildfires can destroy plants and trees that provide ground stability and char soil so that it cannot absorb rainfall. It was also noted that the Town has very few flood mitigation measures making it particularly vulnerable. The recent 1 in 50-year rainfall event caused some home basement flooding in the College Road area, left homeowners with repair costs of around $70,000 each. Stormwater and sanitary system surcharge are also more likely to occur as part of overland flooding. During recent high precipitation events, maintenance hole were overflowing with water and gravel providing evidence of significant sedimentation associated with these intense rainfall events.

Ground instability and erosion, brought on by intense precipitation and overland flooding was also identified as a significant concern by the community. The Town is built on a slope, which may create the risk of buildings being damaged by falling debris or, in extreme cases, being physically displaced during a landslide. This potential impact was raised during engagement when participants expressed concern about development (homes and private retaining walls) that has occurred in steep areas. It was noted that many private retaining walls are not adequately maintained by private homeowners due to limited knowledge of drainage. Flooding could impact the integrity of these walls. Erosion from overland flooding has also damaged trail systems (entire systems have been destroyed before) and river access.

The Town's stormwater drainage system was identified as undersized and easily inundated, meaning these systems cannot be relied upon to manage future extreme rainfall events. It was specifically noted that there are no backflow preventers at outfalls, which can result in backups. Slope erosion and the potential for structural damage to these systems may exacerbate the risk of backup.

Flood waters can wash away roads or saturate road foundation resulting in subgrade deterioration and damage. Damaged or destroyed roads can impact access/egress impacting emergency services. The Town's representatives noted that there has not been a history of roads and services being disrupted due to flooding, but it was recognized that it is a possibility in the future. Damaged or flooded roads can pose a barrier to reaching vulnerable populations (such as people with certain medical conditions and the elderly).

Extreme Heat

An increase in extreme heat days will lead to increased electricity consumption for space cooling. The collective increase in energy demand could lead to overheated electrical equipment leading to outages/damage, or mandatory electricity rationing via brownouts. The Alberta Electric System Operator (AESO) has had to issue an increasing number of grid alerts (indicating that the power system is under stress and the use of emergency reserves may be required) over the past few years. Locally, there is no widespread concern about the increased load on the grid due to air conditioning (AC), but this could become a concern as the Town grows. Solar photovoltaic panels were noted to offset some of the demand.

Community members expressed concern about extreme heat and the impact of longer summer conditions on outdoor operations. There may not be enough seasonal workers if the summer season is extended, and extreme heat reduces working hours. Engagement identified a concern that there may be a decreased level of service, especially because many seasonal workers are school-aged and will be returning back to school. There is also concern that physical infrastructure and equipment, such as pumps and HVAC systems, will be under additional strain due to extreme heat. This may result in additional maintenance costs or early equipment replacement.

Wildfire Smoke

More frequent wildfire smoke events will increase wear on building HVAC systems. This may lead to more frequent equipment replacement and maintenance costs. Town staff expressed concerned about smoke infiltrating buildings, so the air tightness of buildings and type of ventilation filters are very important. While air tightness upgrades (e.g., caulking, weatherstripping) and installation of high efficiency HEPA filters can be straight forward and relatively cost effective, the cost of these items and required resources for installation may not have been accounted for in capital and operating plans. These types of upgrades could be coordinated with other building works to maximize efficiency.

4.2.2 Natural System

Natural systems found within the Town include riparian areas, forests, grasslands, landscaping, animals, aquatic life and natural water features (rivers, streams, wetlands).

A total of **31 impacts** to the natural systems were assessed and are summarized in **Figure 4-3** below. There are six “very high” risk hazards, specifically extreme heat, wildfire smoke, wildfires, glacial recession, and overland flooding. **Table 4-4** provides details on these “very high” risks.

Figure 4-3 Climate Risk Matrix – Natural System

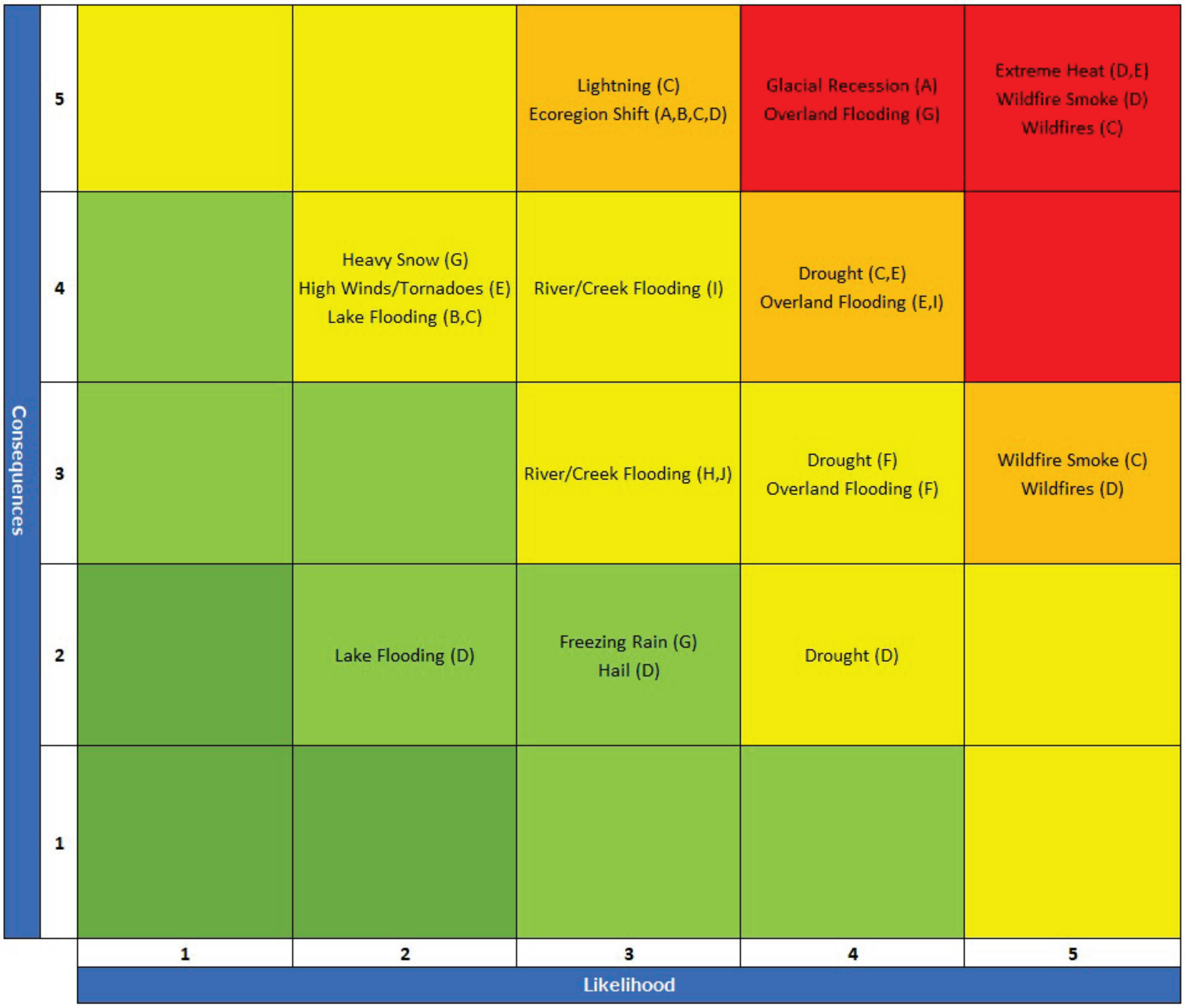


Table 4-4 Very High Risk Climate Impacts – Natural System

Hazard (Impact ID)	Impact
Extreme Heat (D)	Increased heat stress for wildlife and aquatic populations
Extreme Heat (E)	Increase in algae blooms affecting water quality (i.e., reservoirs, lakes)
Wildfire Smoke (D)	Increased risk of wildlife and human interactions due to decreased visibility (i.e., car accidents, wildlife accessing water sources and fleeing the fire)
Wildfires (C)	Damage to terrestrial habitat
Glacial Recession (A)	Reductions in water availability and drinking water supply
Overland Flooding (G)	Increased soil erosion resulting in landslides that disrupt local habitat

Extreme Heat

Extreme heat could increase the presence of algal blooms in local water bodies. Community engagement identified that an increase of algae in Beaver Lake could have severe impacts throughout the ecosystem. More broadly, the presence of blooms in water bodies throughout the Town could impact wildlife health, water quality, and quality of recreation in affected areas.

Extreme heat effects on wildlife can result in heat stroke, inability to forage and/or reduced weight gain, or even death. Wildlife behaviour may change as they try to adapt to extreme heat. This could be seen through changes in habitat range, adjustment in active hours (e.g., hunting/grazing during cooler periods), or more frequent human-animal interactions as they seek out alternative food and water sources.

Wildfire Smoke

Wildfire smoke in the area could increase the risk of wildlife and human interactions, potentially leading to injuries or fatalities in certain situations. Vehicle collisions due to poor visibility is one way this may occur. Wildlife will experience health impacts from wildfire smoke, resulting in an expansion of habitat range as they flee the fire and seek out more comfortable living conditions. There is the risk that animals, such as bear, moose, and cougars will enter more populated areas as they expand their territory. The chance of human-wildlife encounters will increase as people and animals spend more time in the same spaces. During engagement, it was noted that this risk is a serious concern for the safety of humans and wildlife.

Wildfires

The Town has a strong local awareness of wildfire risk. During the community engagement, it was noted that while pine beetle populations are on the decline, the dead falls have resulted in increased forest fuel for increased fire potential. Representatives from the Town explained that the municipality utilizes various fire and vegetation management practices to address wildfire risk.

Lost of habitat due to wildfire could induce local ecosystems change. While ecosystems will adapt, the length of time to recover and the types of species that will stay in the area will depend on the extent of damage.

Water quality will decline with soil erosion, ash, and contamination from fire fighting agents. Chemicals from fire retardant can increase chemical levels in soil and water, such as phosphate, nitrate, and nitrite. Wildlife would have negative health impacts associated with consumption of contaminated water.

Glacial Recession

Glaciers serve as an important raw water source for both the Town and downstream communities. Glaciers contribute to groundwater volume as well as surface water baseflow. During engagement, the community was concerned that the impacted Columbia Icefields could in turn impact the Athabasca River, which is the Town's main source of water. The Town noted that it has not had issues with seasonal changes in water availability up to this point since glacial baseflow has sustained fall and winter low flow conditions appropriate for water supply. Baseflow will be impacted by melting glaciers and long-term impacts should be assessed.

Glacial recession has contributed to a broader conversation about water supply and security. The town relies on a 3rd party (West Fraser Mills Ltd.) to supply potable water to the town from its pulp and paper mill ("the Mill"). **The Town does not hold its own water license, which has resulted in a perceived risk that water rights could be retracted if there is a shortage.** Since 2015, the Town and West Fraser have been working on the Water Treatment Plant Transfer Project, which would transition the responsibility of water treatment to the Town (through the development of a new waterworks system), to which the Mill would supply untreated water. The Mill is in the process of being sold to another company (Mondi Group), who has contributed to the Town's interest in improving its water self-sufficiency. In the event water cannot be pumped to the Town, there is a water reservoir with a 3-day backup supply. Wells may be an alternative water source should glacial water become a less reliable option, but it is unclear if it is a viable solution (municipal staff noted that Edson is on wells but is not happy with that source).

It was also discussed that residents have high water usage due to a lack of water meters. The lack of metering means people may not understand their individual consumption, which contributes to high use and no incentive to fix leaks. A Water Meter Strategy is on Council's agenda, but the high cost (approximately $4M in 2023 dollars) may result in delays. There is also discussion around pushing this cost onto developers or offering lower rates to consumers who voluntarily install meters. The initiative is also being considered as part of a larger stormwater system upgrade.

Overland Flooding

Overland flooding could result in erosion, reduced ground stability, and slumping. While these processes contribute to creating habitats that support biodiversity, the frequency and intensity of flooding could cause more harm than good for ecosystems. The shape and stability of the land will be changed, which could impact the areas that animals choose to inhabit.

Landslides due to overland flooding could wipe out sources of vegetation relied upon by terrestrial species. Mass movement of debris and sediment could also impact aquatic habitats, including the quality and quantity of water. These changes to the physical environment can have cascading effects on ecosystems and may result in declining populations or emigration if animals cannot survive in the new conditions.

4.2.3 Social System

Social systems relate to people as they spend time in the Town either as residents of the community, employees, or visitors. The social system considers health (physical and mental) and safety implications, as well as any disruptions to day-to-day life in the community.

Engagement indicated that the community is tightknit with strong social supports. The Town collaborate closely with the local Indigenous community including non-for-profit programs with the Friendship Centre. The Friendship Centre has been involved in emergency response planning, recently participating in a school shooter mock scenario with the RCMP. The Friendship Centre has partnered with the Town to share some of their resources, including a large hall and commercial kitchen for local events and gatherings.

A total of **41 impacts** to social systems were assessed and are summarized in **Figure 4-4** below. **Table 4-5** provides details on the 13 risks which were found to be "very high" risks.

Figure 4-4 Climate Risk Matrix – Social System

Consequences	1	2	3	4	5
5		Extreme Cold (B) High Winds/Tornadoes (H)	Hail (E) Ecoregion Shift (E)		Extreme Heat (F,J) Wildfire Smoke (H) Wildfires (E,F,J)
4		Extreme Cold (E) High Winds/Tornadoes (K)	Freezing Rain (I) River/Creek Flooding (L)	Overland Flooding (O)	Extreme Heat (H) Wildfire Smoke (E,G) Wildfires (B,G,H)
3		Heavy Snow (H,J) High Winds/Tornadoes (G) Lake Flooding (E)	Freezing Rain (H) River/Creek Flooding (K)	Drought (G) Overland Flooding (J,M,N,P)	Wildfire Smoke (F) Wildfires (I)
2		Extreme Cold (C) High Winds/Tornadoes (J,L)	River/Creek Flooding (M)	Drought (H)	Extreme Heat (I)
1		Heavy Snow (I)			
	Likelihood				

Table 4-5 Very High Risk Climate Impacts – Social System

Hazard (Impact ID)	Impact
Extreme Heat (F)	Health impacts, including mortality, especially for vulnerable community (elders, children, medical issues)
Extreme Heat (J)	Increased wildlife interactions (wildlife seeking water)
Wildfire Smoke (H)	Serious health implications, especially for those with respiratory problems
Wildfires (E)	Residents displaced from their homes, temporarily or permanently
Wildfires (F)	Safety risks for unprepared/uninformed community members
Wildfires (J)	Livestock and business impacts
Extreme Heat (H)	Risk to people working outdoors or indoors with out air conditioning
Wildfire Smoke (E)	Risk to people working outdoors
Wildfire Smoke (G)	Livestock impacts for guides and outfitters
Wildfires (B)	Poor mental health and PTSD from fire events
Wildfires (G)	Hosting evacuees from neighbouring communities
Wildfires (H)	Interruptions to critical community services (schools, medical centers, daycares, senior homes, etc.)

Extreme Heat

Extreme heat can result in heat-related illnesses (e.g., heat stroke) and even death in some cases. Elders, children, people who are pregnant, and people with medical conditions are all vulnerable populations at greatest risk of heat-related discomfort and medical issues. There are also risks to outdoor workers and indoor workers without access to air conditioning. The health impacts can also lead to lost time and absenteeism.

Community members expressed concern about the risk of increased human-wildlife interactions at the Town's area. Water features, pools, stormwater ponds, garbage bins, picnic sites, and fruit bearing vegetation in Town are a few examples of areas wildlife may frequent. Public safety (including fatalities in extreme situations) may be compromised with increased human-wildlife interactions.

Wildfire Smoke

Increased and/or prolonged exposure to wildfire smoke could impact the respiratory wellbeing of people, particularly the elderly or those with pre-existing respiratory conditions such as asthma. During smoke events in 2023, it was noted that the Friendship Centre supported the evacuation of Elders from the Town and surrounding areas.

It was discussed that the local government is somewhat limited in what can be done to reduce the risk of wildfire smoke (smoke is a cross boundary issue meaning external fires could impact the Town). There has been minimal work done to address this risk beyond considering Standard Operating Procedures (SOPs). It was emphasized that any policies or SOPs need to ensure that emergency response and maintenance crews are still available regardless of smoky conditions.

Outdoor activities are an important part of life in the Town and contribute to the local economy. Poor air quality has the potential to impact social and economic activity. Livestock will see similar health impacts including disorientation, eye irritation, difficulty breathing, and malaise. This is relevant to the social system because there are residents who rely on horses for their guiding and outfitting ventures. There is also a great risk of tourists cancelling trips due to poor air quality, safety, thus contributing to socio-economic stress described below.

Wildfires

Wildfires in the region could result in residents being displaced from their homes, either temporarily or permanently. The length of time and number of residents displaced will depend on the extent of the fire. A large-scale evacuation would require a corresponding amount of emergency housing and transportation logistics, with additional supports made available for vulnerable populations. Wildfires can be unpredictable and change directions quickly based on wind speed and direction. During engagement it was noted that the Town may need to house evacuees from neighbouring communities as fires become more frequent.

There is a concern for the safety of residents who are unprepared or uninformed about the risk of fires (and emergency response at large). The recent active shooter drill revealed that there are challenges in providing fast and clear information during an emergency particularly with Indigenous communities, and that evacuation locations (i.e., the Royal Legion) were not adequately set up for large groups of people.

Mental health could also be impacted. The stress of fire damaging or destroying property, evacuation, and fear decrease mental and emotional wellbeing. Lack of personal preparedness, confusion, and displacements could exacerbate these mental health impacts.

While a consideration of the economic/tourism section was outside the scope of this report (as per discussion with Town staff), Associated identified that wildfire poses a very high risk to livestock and other businesses. Business owners may see a shortened tourism season with road closures and resources are directed for recovery. Businesses associated with livestock see impacts such as supply chain issues, damage to property, or declining health in animals. These impacts are likely to put increased socio-economic stress on residents.

Wildfires could damage critical infrastructure that is essential for the operation of community services (schools, medical centers, daycares, assisted living facilities, etc.). Damaged powerlines could disrupt the sustained operation of lifesaving and quality of life enhancing equipment, maintaining healthy living conditions (e.g., indoor temperature control), and standard expected building conditions/indoor environment (e.g., lighting).

Physical damage to water and wastewater infrastructure and treatment facilities could compromise access to potable water and sanitary systems. These utility services are critical to the Town’s various services, residents and businesses.

6 CONSIDERATIONS FOR FUTURE ADAPTATION PLANNING

Climate change will, and already is, affecting the region in a multitude of ways which can often feel overwhelming. The Town of Hinton will need to continue to respond to more severe and frequent extreme weather events, such as those described in the CRA. Based on the results of the assessment, it is recommended that the Town undertake the following next steps to aid in the community's resilience journey:

- **Develop a Climate Change Adaptation Action Plan** specifically targeting the highest risks as identified in this assessment. Ideally, local government staff, community organizations, knowledge holders, and citizens should work collaborative to co-create a plan that can realistically be implemented. Support the development of adaptation strategies that generate co-benefits and can be incorporated into existing processes and funding sources. Implementation planning to operationalize the action should include:
  - Targets and indicators to drive action and accountability, to be communicated publicly.
  - Roles and responsibilities to carry out each of the actions including partnerships with community groups.
  - Identification of existing initiatives and resources best suited to drive and align each of the actions.
  - Develop a timeline and resource plan for implementation of the actions.
- **Continue and expand on the work already underway.** The community's existing policies and procedures provide a strong foundation to build upon. The expansion of these initiatives could include:
  - Adjusting to accommodate future climate conditions,
  - Broadened to consider multiple climate hazards and maximize benefits, or
  - Reprioritized to target the highest risks as identified in this plan.

Below are some potential actions to consider for future climate adaptation planning for each of the impacted systems. The considerations provided are only for the "very high" risks identified in this CRA and is not an exhaustive list. As previously mentioned, it is recommended that the Town undertakes a more in-depth climate adaptation exercise to further identify and prioritize actions continuing to integrate community input.

6.1.1 Built System

High level adaptation considerations for built systems:

- Initiate and maintain ongoing dialogue between the Town and utilities as it relates to risks to power infrastructure. Create a partnership to discuss concerns/challenges and collaborate on coordinated efforts (e.g., resource pooling) to address vulnerabilities.
- Review the existing asset management studies and incorporate consideration of climate impacts relating to short- and long-range funding needs, asset risk, and level of service considerations into future revisions and asset management plans. Incorporate findings from this assessment into asset management practices moving forward (e.g., building ventilation may require more maintenance due to increased smoke events).
- Complete air sealing upgrades on priority buildings, such as those that serve as points of refuge (e.g., cooling spaces) for the public.
- Conduct regular sedimentation cleaning of maintenance holes to ensure stormwater systems have the capacity for which they were designed.
- Share information with homeowners on proper maintenance of their properties (e.g., walls, landscaping) in sloped areas. Provide information on the danger of erosion and pooling water.

- Review evacuation plans and identify ways to reduce the number of vehicles on the road or coordinate in a manner to reduce congestion on the limited transportation infrastructure.
- Lobby for timely construction of the Hinton bypass (Highway 16X), which would improve traffic flow and expedite evacuations that may be required in the future.
- Investigate opportunities to install on-site renewables, battery storage, or backup generators that would improve the self-sufficiency of critical infrastructure during a power outage. During engagement it was noted that there is private sector interest in bringing geothermal and additional electricity capacity to Hinton.

6.1.2 Natural System

The following are considerations in adaption for natural systems:

- Investigate ways to conserve water, thereby reducing demands on the natural environment and leaving more water available for and animals and wild and cultivated plans.
- Launch a public campaign on the importance of water conservation.
- Collaborate with water users and interest groups (residents, commercial sector, environmental groups) to create dialogue on water conservation and sharing.
- Investigate water sources that the town could use to diversify its supply and reliance on the sole water license (e.g., wells, water reuse, additional licenses).
- Install signage to bring awareness to increased potential of wildlife-human interactions on roadways in smoky conditions. This signage could be temporary and only displayed when smoky conditions exist and should be included as an action in the emergency response plan.
- Review operating procedures for using vehicles during period of low visibility, to reduce risk of wildlife collisions.

6.1.3 Social System

Social systems could consider the following adaptations:

- Share information with the public on how to avoid heat and smoke related illnesses and respond to distress.
- Promote existing resources on emergency preparedness and evacuation plans. Consider making updates to those materials based on findings from this climate risk assessment (i.e., climate risk and strategies to improve resilience).
- Upgrade air exchange systems for Town buildings, particularly those that are accessible to the public. Share information on how people can access cooling and clean air spaces, with special consideration for vulnerable populations (e.g., the elderly, people with medical conditions, unhoused).
- Review evacuation plans, including transportation routes, emergency accommodations and supplies, and considerations for vulnerable populations. Meet with surrounding communities to share information and confirm mutual aid agreements.
- Continue to develop a relationship with the Hinton Friendship Centre and collaborate to improve resilience by sharing space, resources, and supporting information sharing in the community.
- Develop standard operating procedures (SOPs) for extreme heat or wildfire smoke conditions for outdoor workers. Modify working schedules, equipment, and processes to reduce the risk to workers who need to be outdoors to complete their jobs.
- Continue to increase outdoor cooling amenities (e.g., water misters, water stations, shade structures) to make it more comfortable to spend time outside, even despite the extreme heat.

  Review communication protocols that are used during evacuations. Make updates as required to ensure clear information flow between Town departments, residents, and other relevant entities.

CLOSURE

The objective of this climate risk assessment is to identify and prioritize the potential impacts climate change may have within the Town of Hinton. This will help guide the town's climate adaptation action planning to focus on the highest risks to the built, natural, and social systems.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering Alberta Ltd.

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Appendix E: Fully Scored Risk Assessment

APPENDIX - RISK ASSESSMENT RESULTS BY SYSTEM

This Appendix provides the detailed results of the risk assessment for all impact statements. These include all climate impact risks ranked from "Very High" to "Very Low" to show the breadth of consequences assessed. The intent of the risk assessment was to identify the highest risks, so the climate impacts are displayed in descending order to highlight which climate impacts pose the greatest risk in the future.

Table A-1 Risk Score Details for 2050s – Built System

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
5	5	25	Wildfires (A)	Transportation delays and disruptions on major routes (access/egress routes)
5	5	25	Wildfires (K)	Damage to private property
5	5	25	Wildfires (L)	Damages to buildings and facilities
5	4	20	Extreme Heat (C)	Power outages due to overheated electrical or increased energy usage leading to interruption of critical services
5	4	20	Extreme Heat (G)	Longer season's impact on park operations
4	5	20	Overland Flooding (B)	Basement flooding due to storm and sanitary system surcharge
4	5	20	Overland Flooding (C)	Flooding of/damage to roads (access/egress, community services), including impacted slopes
5	4	20	Wildfire Smoke (A)	Increased wear on filtration systems & AC units
5	4	20	Wildfire Smoke (B)	Increased costs and effort to reduce smoke infiltrating buildings (i.e., air tightness of buildings, type of filters on HVAC)
5	4	20	Wildfires (M)	Damage to electrical infrastructure
4	5	20	Overland Flooding (Q)	Increased soil erosion resulting in landslides that damage property and trails
4	4	16	Overland Flooding (A)	Damages to private property and public buildings
4	4	16	Overland Flooding (L)	Storm/sanitary backup compromising pump/lift stations
5	3	15	Extreme Heat (A)	Increased usage of building mechanical systems (i.e., cooling)
5	3	15	Extreme Heat (B)	Increased water demand may exceed reservoir capacity

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	5	15	Freezing Rain (D)	Road traffic accidents and transportation delays, including active transportation
3	5	15	River/ Creek Flooding (C)	Flooding of/damage to roads (access/egress, community services)
3	5	15	River/ Creek Flooding (F)	Flooding of water or wastewater treatment plant due to river flooding resulting in service disruption
4	3	12	Drought (A)	Increased pressure on pumps at water network
4	3	12	Drought (B)	Longer season's impact on infrastructure operations
3	4	12	Freezing Rain (A)	Damages to private property from fallen trees
3	4	12	Freezing Rain (B)	Damages to buildings and facilities
3	4	12	Freezing Rain (C)	Power outages from fallen trees or ice accretion
3	4	12	Freezing Rain (F)	Fallen debris blocking catch basins, culverts leading to localized flooding
3	4	12	Hail (A)	Damages to private property
3	4	12	Hail (B)	Damages to buildings and facilities
3	4	12	Hail (C)	Fallen debris and hail blocking catch basins, culverts and leading to localized flooding
3	4	12	Lightning (A)	Power outages for critical facilities/services
3	4	12	Lightning (B)	Community-wide power outage
4	3	12	Overland Flooding (D)	Flooding of electrical infrastructure for critical services
4	3	12	Overland Flooding (H)	Increased pipe maintenance due to increase in sediments in drainage system
4	3	12	Overland Flooding (K)	Inflow and infiltration of sanitary sewers resulting in sewage surcharges
3	4	12	River/ Creek Flooding (A)	Damages to private properties on riverbank
3	4	12	River/ Creek Flooding (B)	Damage to future development areas along river

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	4	12	River/ Creek Flooding (D)	Damage to buildings and facilities
3	4	12	River/ Creek Flooding (G)	Damages to, closures of parks & park infrastructure
2	5	10	Extreme Cold (A)	Water line breaks in infrastructure above frost line
2	5	10	Heavy Snow (D)	Road traffic accidents and transportation delays, including active transportation
2	5	10	High Winds/ Tornadoes (A)	Damages to private property from fallen trees, tornadoes
2	5	10	High Winds/ Tornadoes (B)	Damages to facilities and infrastructure from fallen trees, tornadoes
2	5	10	High Winds/ Tornadoes (D)	Road traffic accidents and transportation delays, including active transportation
3	3	9	Freezing Rain (E)	Increased salt use and sanding
3	3	9	River/ Creek Flooding (E)	Flooding of electrical infrastructure for critical services
4	2	8	Drought (I)	Impact on mill water treatment system
2	4	8	Heavy Snow (C)	Power outages from downed trees or snow load on powerlines
2	4	8	High Winds/ Tornadoes (C)	Power outages (i.e., downed trees near powerlines)
2	4	8	High Winds/ Tornadoes (I)	Fallen debris blocking catch basins, culverts, leading to localized flooding
2	4	8	Lake Flooding (A)	Flooding of/damage to boardwalks and paths
2	3	6	Extreme Cold (D)	Increased load on power and gas systems
2	3	6	Extreme Cold (F)	Water line breaks in infrastructure above frost line
2	3	6	Freeze-Thaw Cycles (A)	Damage to, and decreased service life of, buildings and infrastructure
2	3	6	Heavy Snow (E)	Snow clearing requirements exceeding resources resulting in reduced level of service
2	3	6	Heavy Snow (F)	Maintenance and operational costs for snow clearing
2	2	4	Heavy Snow (A)	Damages to private property (i.e., snow load, fallen trees)

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
2	2	4	Heavy Snow (B)	Damages to buildings and facilities (i.e., snow load on buildings, fallen trees)

Table A-2 Risk Score Details for 2050s – Natural System

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
5	5	25	Extreme Heat (D)	Increased heat stress for wildlife and aquatic populations
5	5	25	Extreme Heat (E)	Increase in algae blooms affecting water quality (i.e., reservoirs, lakes)
5	5	25	Wildfire Smoke (D)	Increased risk of wildlife and human interactions due to decreased visibility (i.e., car accidents, wildlife accessing water sources and fleeing the fire)
5	5	25	Wildfires (C)	Damage to terrestrial habitat
4	5	20	Glacial Recession (A)	Reductions in water availability and drinking water supply
4	5	20	Overland Flooding (G)	Increased soil erosion resulting in landslides that disrupt local habitat
4	4	16	Drought (C)	Increased tree mortality
4	4	16	Drought (E)	Increased stress on aquatic and terrestrial ecosystems
4	4	16	Overland Flooding (E)	Damage to riparian areas increasing erosion
4	4	16	Overland Flooding (I)	Restricted access to, closure of trails, parks, playing fields
3	5	15	Lightning (C)	Lightning strikes causing wildfires
3	5	15	Ecoregion Shift (A)	Damages to forest management area
3	5	15	Ecoregion Shift (B)	Invasive species and pests
3	5	15	Ecoregion Shift (C)	Changes in habitat resulting in changes in wildlife in the area
3	5	15	Ecoregion Shift (D)	Changes to wetlands impacting beaver populations
5	3	15	Wildfire Smoke (C)	Decreased health to wildlife due to air quality
5	3	15	Wildfires (D)	Decreased water quality due to runoff from wildfire areas
4	3	12	Drought (F)	Reductions in water availability and drinking water supply
4	3	12	Overland Flooding (F)	Impacts to wildlife habitats and populations
3	4	12	River/ Creek Flooding (I)	Damage to riparian areas increasing erosion
3	3	9	River/ Creek Flooding (H)	Increased stress on aquatic habitat

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	3	9	River/ Creek Flooding (J)	Impacts to wildlife habitats and populations
4	2	8	Drought (D)	Increased blowing dust
2	4	8	Heavy Snow (G)	Damage to trees / tree branches – loss of habitat, increased deadfall
2	4	8	High Winds/ Tornadoes (E)	Damage to trees / tree branches
2	4	8	High Winds/ Tornadoes (F)	Increased blowing dust removing topsoil
2	4	8	Lake Flooding (B)	Increased stress on aquatic habitat/beaver population
2	4	8	Lake Flooding (C)	Damage to riparian areas increasing erosion
3	2	6	Freezing Rain (G)	Damage to trees and shrubs leading to debris cleanup
3	2	6	Hail (D)	Damage to trees and shrubs leading to debris cleanup
2	2	4	Lake Flooding (D)	Impacts to wildlife habitats and populations

Table A-3 Risk Score Details for 2050s – Social System

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
5	5	25	Extreme Heat (F)	Health impacts including mortality especially for vulnerable community (elders, children, medical issues)
5	5	25	Extreme Heat (J)	Increased wildlife interactions (wildlife seeking water)
5	5	25	Wildfire Smoke (H)	Serious health implications, especially for those with respiratory problems
5	5	25	Wildfires (E)	Residents displaced from their homes, temporarily or permanently
5	5	25	Wildfires (F)	Safety risks for unprepared/uninformed community members
5	5	25	Wildfires (J)	Livestock and business impacts
5	4	20	Extreme Heat (H)	Risk to people working outdoors or indoors without air conditioning
5	4	20	Wildfire Smoke (E)	Risk to people working outdoors
5	4	20	Wildfire Smoke (G)	Livestock impacts for guides and outfitters
5	4	20	Wildfires (B)	Poor mental health and PTSD from fire events
5	4	20	Wildfires (G)	Hosting evacuees from neighbouring communities
5	4	20	Wildfires (H)	Interruptions to critical community services (schools, medical centers, daycares, senior homes, etc.)
4	4	16	Overland Flooding (O)	Residents displaced from their homes, temporarily or permanently
3	5	15	Hail (E)	Possible displacement from homes if windows become damaged
3	5	15	Shifting Ecoregion (E)	Negative health outcomes from vector-borne diseases
5	3	15	Wildfire Smoke (F)	Disruption to outdoor activities/events
5	3	15	Wildfires (I)	Food insecurity due to being cut off from surrounding communities
4	3	12	Drought (G)	Damage to trails, parks, playing fields
3	4	12	Freezing Rain (I)	Gas line and power line interruption
4	3	12	Overland Flooding (J)	Restricted access to transportation corridors (roads)
4	3	12	Overland Flooding (M)	Poor mental health and PTSD from repeated flooding
4	3	12	Overland Flooding (N)	Increased risk of illness due to mold from flooded buildings, basements

4	3	12	Overland Flooding (P)	Interruptions to critical community services (schools, medical centers, daycares, senior homes, etc.)
3	4	12	River/ Creek Flooding (L)	Residents displaced from their homes, temporarily or permanently
2	5	10	Extreme Cold (B)	Health impacts including mortality especially for vulnerable community (elders, children, unhoused, medical issues)
5	2	10	Extreme Heat (I)	Decline in use of outdoor recreation spaces
2	5	10	High Winds/ Tornadoes (H)	Injuries and potential fatalities
3	3	9	Freezing Rain (H)	Injuries from falls on icy surfaces
3	3	9	River/ Creek Flooding (K)	Increased risk of illness due to mold from flooded buildings, basements
4	2	8	Drought (H)	Public perception and reactions to water conservation
2	4	8	Extreme Cold (E)	Impacts on outdoor workers
2	4	8	High Winds/ Tornadoes (K)	Possible displacement from homes if roofs become damaged
2	3	6	Heavy Snow (H)	Health risks from isolation or inability to access services, particularly for vulnerable populations (elderly, mobility impaired)
2	3	6	Heavy Snow (J)	Fatigue in outdoor workers
2	3	6	High Winds/ Tornadoes (G)	Trees falling in parks leading to closures
2	3	6	Lake Flooding (E)	Inaccessibility by the public
3	2	6	River/ Creek Flooding (M)	Interruptions to critical community services (schools, medical centers, daycares, senior homes, etc.)
2	2	4	Extreme Cold (C)	Decline in use of outdoor recreation spaces
2	2	4	High Winds/ Tornadoes (J)	Chinook wind events increasing anxiety within community
2	2	4	High Winds/ Tornadoes (L)	Increased blowing dust affecting health and outdoor activities
2	1	2	Heavy Snow (I)	Food insecurity due to being cut off from surrounding communities

THE RESILIENCE INSTITUTE

The Resilience Institute (TRI) is a national charity based in Alberta. Our team works locally and globally with diverse partners to minimize the suffering caused by climate impacts.