THE RESILIENCE INSTITUTE

Climate Risk Assessment Report

January 18, 2024

Fort McKay First Nation

FORT McKAY
FIRST NATION

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

Associated Strategic Advisory Services
PARC
MCCAC

Gratitude

We are grateful for the opportunity to partner with Fort McKay First Nation on this important step towards in strengthening the community's position to address climate change challenges. 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 assessing Fort McKay's climate risks was made possible thanks to the open engagement and generous guidance of numerous people in the community. Your stories, concerns, and ideas for addressing local climate threats are reflected in this report.

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

Table of Contents

Introduction

On behalf of the Resilience Institute and our partners on this project, the **Prairie Adaptation Research Collaborative** and **Associated Engineering**, we are pleased to provide Fort McKay First Nation with a **Climate Risk Assessment Report.** A suite of tools including PowerPoint slides and a Summary Document to communicate with various audiences can be provided in the future at the community's request.

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

It is our recommendation that the scoring and impact statements in this report (including the appendices) be revisited on an annual or biennial basis to ensure that the rationale is **still relevant in the context of current circumstances.** We would be happy to provide additional guidance to how this might be done.

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, and capacity building, changes to infrastructure, creating new policies and regulations, developing economic, and other incentives, and ensuring governance takes into account 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 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.

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 carbon dioxide from the atmosphere.

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.

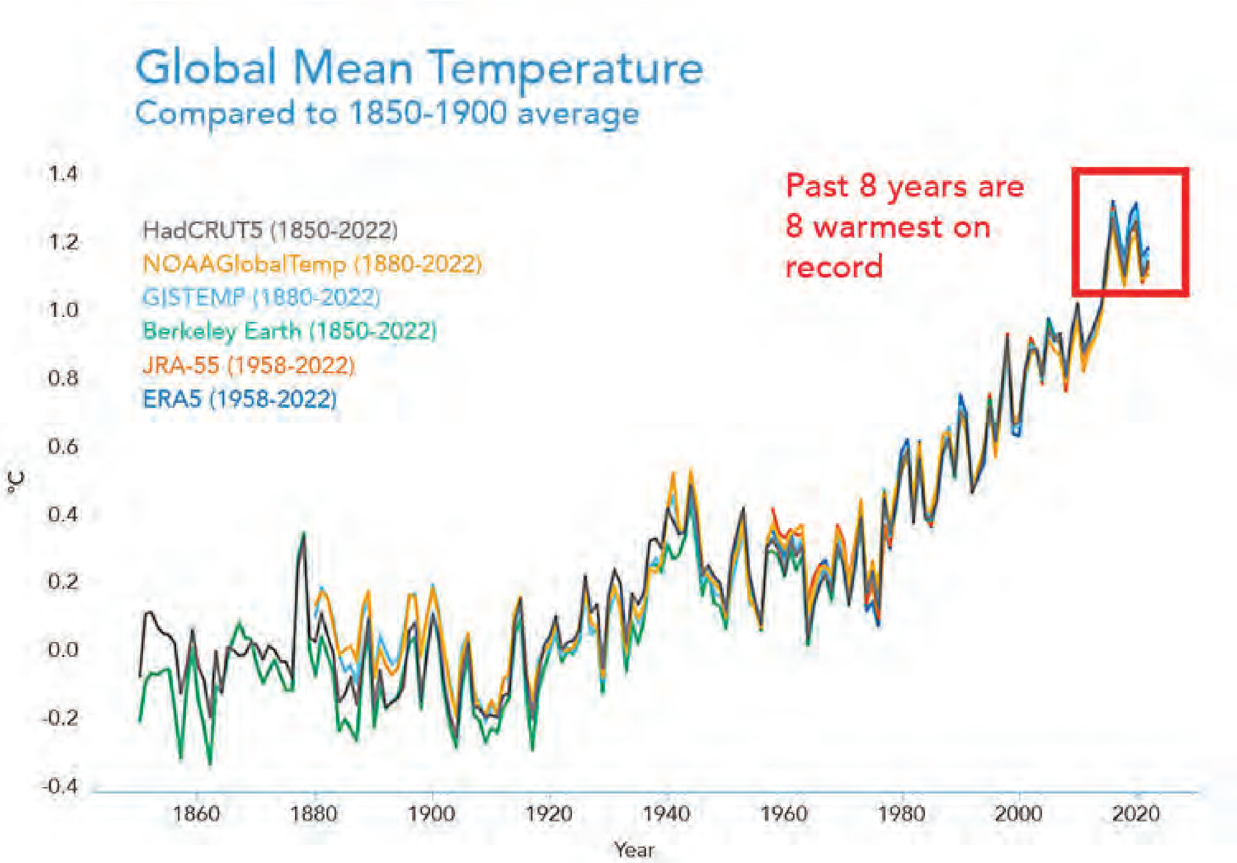
Climate refers to the average of weather conditions over 30 years or more. When describing southern Alberta as typically windy, you are describing an aspect of its climate. Weather can change dramatically in a place or region from day-to-day (e.g., hot and dry one day, followed by cold, wet conditions 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 weather and climate extremes in every region across the globe.

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 given 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.



Global mean temperature in 2022 was 1.15°C above the 1850-1900 average. The years 2015 to 2022 were the eight 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 is uncertain and will largely **depend on global efforts to reduce emissions** of GHGs 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 GHGs 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 Scope of this Assessment

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

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

Climate-Related Hazards

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

Chronic and Acute Stresses

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.

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 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.

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.

Key Findings

Annual temperatures for all seasons are projected to increase over the next 30-years and into the end of the century. The most significant temperature increases are expected to occur in winter months. By the end of this century, modelled climate data projects that there will be on average thirty days per year when the mean daily temperature exceeds 30°C.

The risk of wildfire and wildfire smoke is likely to increase with increased annual temperatures, and erratic and sporadic precipitation events leading to a generally drier environment.

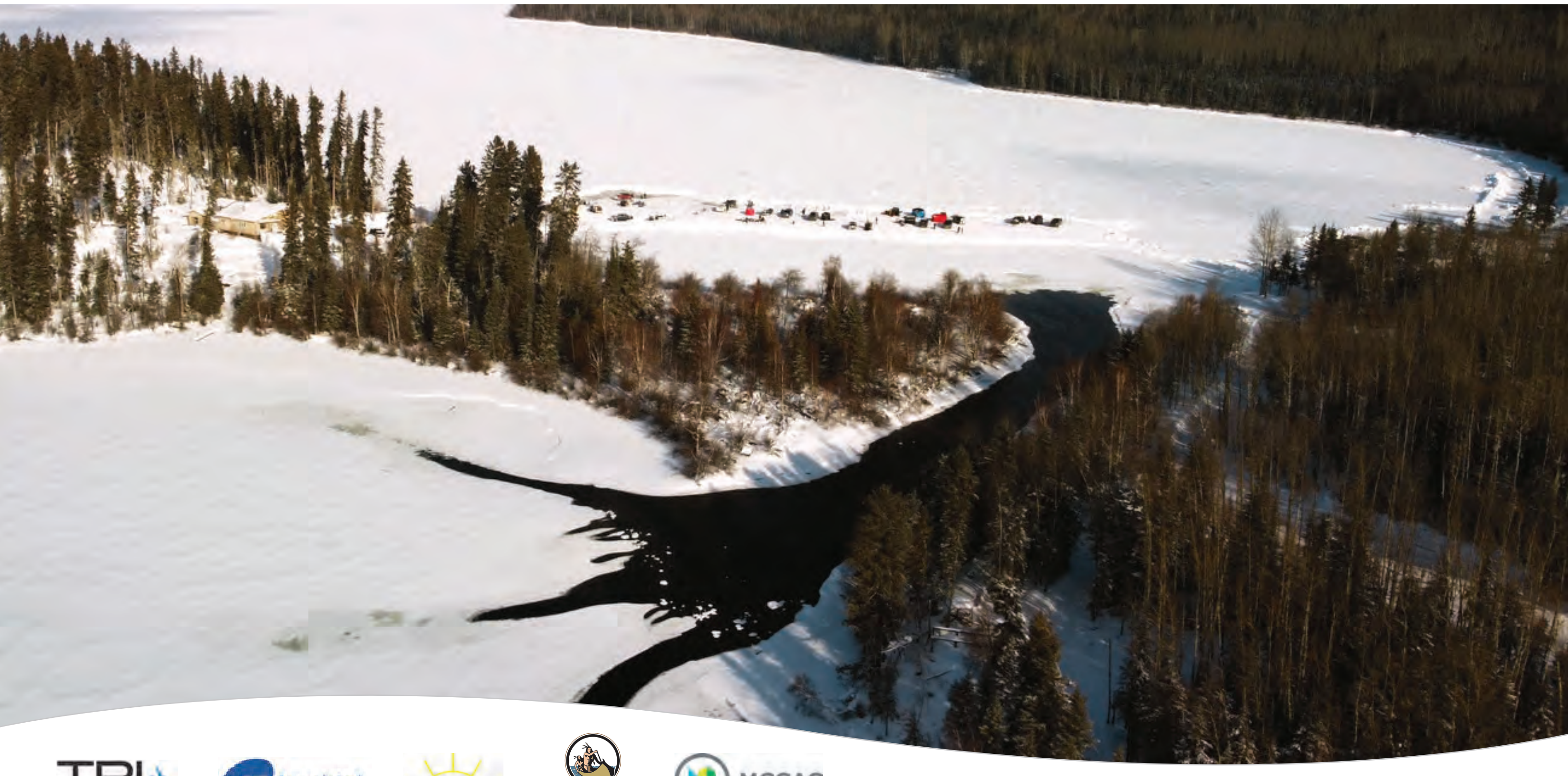
By the end of the century, the number of frost-free days is projected to increase by 30% to 225 days during an average each year.

Existing rainfall and storm patterns that are currently experienced by the community are projected to continue. Heavy snow is expected to increase and cause significant risk.

Opportunities

Discussions with the Lands and Leasing department found that changing land purchasing approaches could help reduce some of the risk. There could be a shift towards purchasing land that is high priority for protection and management to reduce ecosystem change. This acquisition could help with cultural preservation.

There are extensive opportunities to expand the Environmental Guardian program to increase monitoring efforts to understand changes on the land. Fort McKay First Nation can use results to advocate for increased funding for management programs and setting up protected areas.



Next Steps

Considerations for future climate adaptation planning efforts are provided for each of the systems (natural, built, cultural/social). This is not an exhaustive list, but is intended to share some of the types of opportunities that are explored during adaptation planning. A full adaptation plan could be considered as a next step to develop a comprehensive adaptation approach and timeline.

Natural System

Fort McKay could consider the following for natural systems:

- Expand the Environmental Guardian program to increase monitoring efforts to understand changes on the land. Use results to advocate for increased funding for management programs and setting up protected areas.
- Explore opportunities to document traditional knowledge and values related to ecoregion conditions and how the land is changing.
- Work with Elders and knowledge holders to evaluate the appropriateness of growing cultural plants and medicines in a greenhouse or garden.

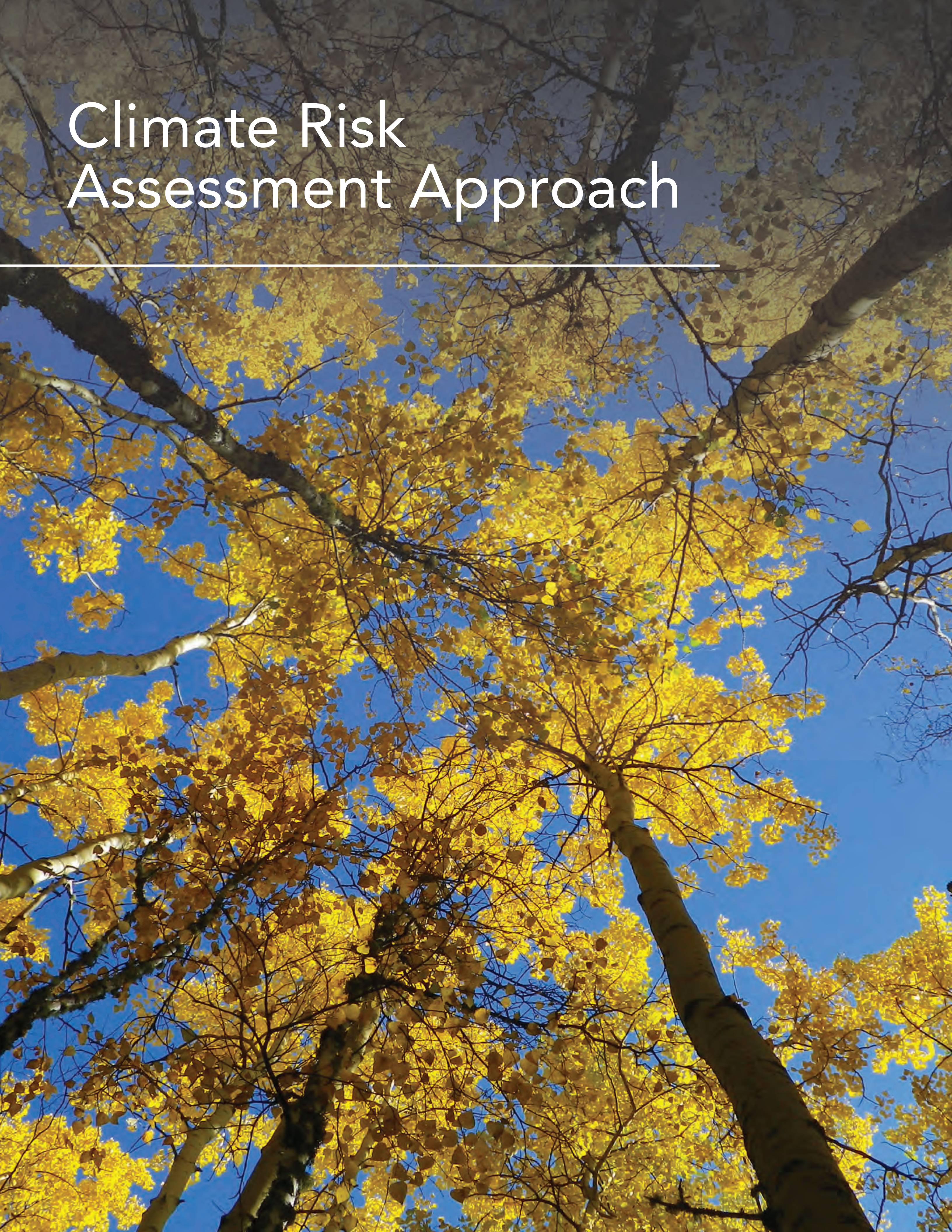
Built System

- Consider maintenance cost and capacity to complete repairs on air conditioning units and air filters. This could include also completing air sealing upgrades on priority buildings. Fire and air resistant materials, particularly for roofs, should be considered as well.
- Review evacuation plans and identify ways to reduce the number of vehicles on the road to reduce congestion on the limited road infrastructure.

Social/Cultural System

- Create opportunities for people to access cooling and clean air spaces, with special consideration for Elders, children, and other vulnerable groups.
- Anticipate that there may be a future need to provide extreme heat and wildfire smoke personal protective equipment and education to Nation members who want to spend time on the land for cultural purposes. This could focus on mitigating health risks (e.g., cooling vests to prevent heat stroke, masks for respiratory conditions) to reduce the number of emergency medical events.
- Work with Elders and knowledge holders to explore how findings from this risk assessment can be incorporated into cultural programming, including the broader effects of natural system change as it relates to peoples' ability to engage in culture and traditional knowledge sharing.
- Consider updating lands purchasing criteria to include sensitive habitat and make acquisition decisions that support traditional knowledge and cultural tradition preservation.
- Share information on vector-borne illnesses, such as Lyme disease from ticks, including symptoms and when to get help.

Climate Risk Assessment Approach



Determining Climate Risk: 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, our approach is to develop an understanding of how the variability of climate patterns impact the built, natural, and societal/cultural systems. We then describe each as systems to recognize the interconnected and tangled nature of each impact 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.

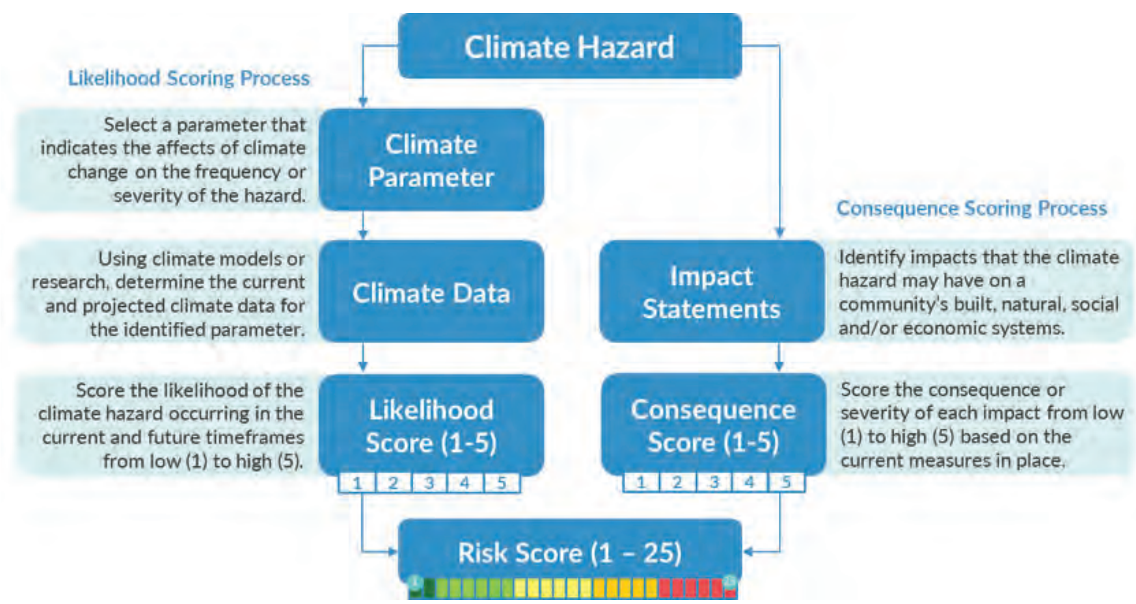
Our project partners at **Associated Engineering's Strategic Advisory Services** have used a blended approach to the risk assessment process used for this project which is based on the **ISO 31000's principles of risk management.** The principles follow a systematic cycle of actions to create and protect the value of 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 for the study area**
2. **Analyse the likelihood of each hazard, or how frequently a hazard may occur**
   - 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.
   - 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.
   - Agree on a baseline likelihood score (1 to 5) according to historic 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 of 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:



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** which 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 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, drought and **ecosystem shifts.**

The assessment considers impacts arising from projected climate and associated environmental changes over at 30-year time period centered 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 12) [1]	PARC [2]
Lightning	Annual average number of days with lightning [3]	ECCC[4]; Paquin et al. (2019) [5]
Flash Flooding	15 min 25-year rainfall (mm/hr)	Climate Data [6]
River 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 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]
Freeze-Thaw Cycles	Annual # of freeze-thaw events	Canadian Climate Atlas [7]
Shifting Ecoregion	Eco-region shift [10]	AdaptWest [12]
Permafrost Thaw	Global permafrost reduction	Science Daily [13]
Shorter Ice Road Season	Freezing degree days [14]	Canadian Climate Atlas [7]

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
14 Freezing degree days are the accumulation of daily mean temperatures below 0°C. A reduction in value indicates a reduction in snow and ice accumulation.

While this risk assessment projects a number of climate-related hazards that could impact Fort McKay First Nation, here we focus on projection data for climate hazards that relate to wildfire (and wildfire smoke), extreme cold, and rainfall and storms. The interconnectedness of these climate hazards overlay their impacts and the key findings of this report.

1. Wildfires & Wildfire Smoke

> *"Landscape is a lot drier. Two years ago there was significant rain, but nothing really since then. At Moose land, "the narrows" are very low and hard to navigate."*
>
> Fort McKay First Nation Environmental Guardian

Global climate change is anticipated to escalate fire activity in the coming decades around the world, including Canada. Alongside continuously warming climate, generally North America has seen increasing annual number of fires, fire size, and annual area burned in recent decades. These increases coincide with an increasing fire season and increasing severity of fire-conducive weather conditions.

Weather is arguably the best predictor of regional fire activity for time periods of one month or longer, and temperature is proven to be the most important variable, with warmer temperatures leading to increased fire activity. At least two components are required for a wildfire to occur: sufficient fuels to sustain the fire and extreme fire weather: hot, dry, and windy.[15]

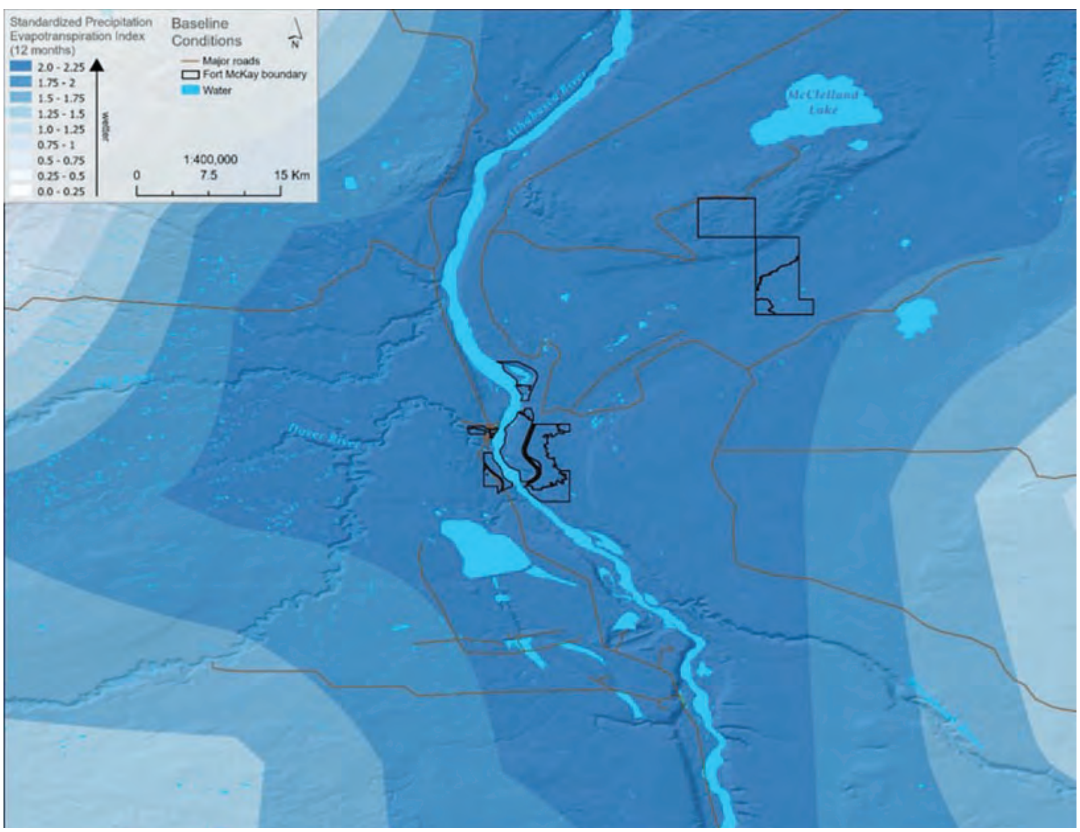


Figure 1A

Figure 1a: Projection map showing 25 sq km, 12-month historical (or baseline) Standardized Precipitation Evapotranspiration Index (SPEI) values across Fort McKay First Nation traditional territory.

[15] 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.

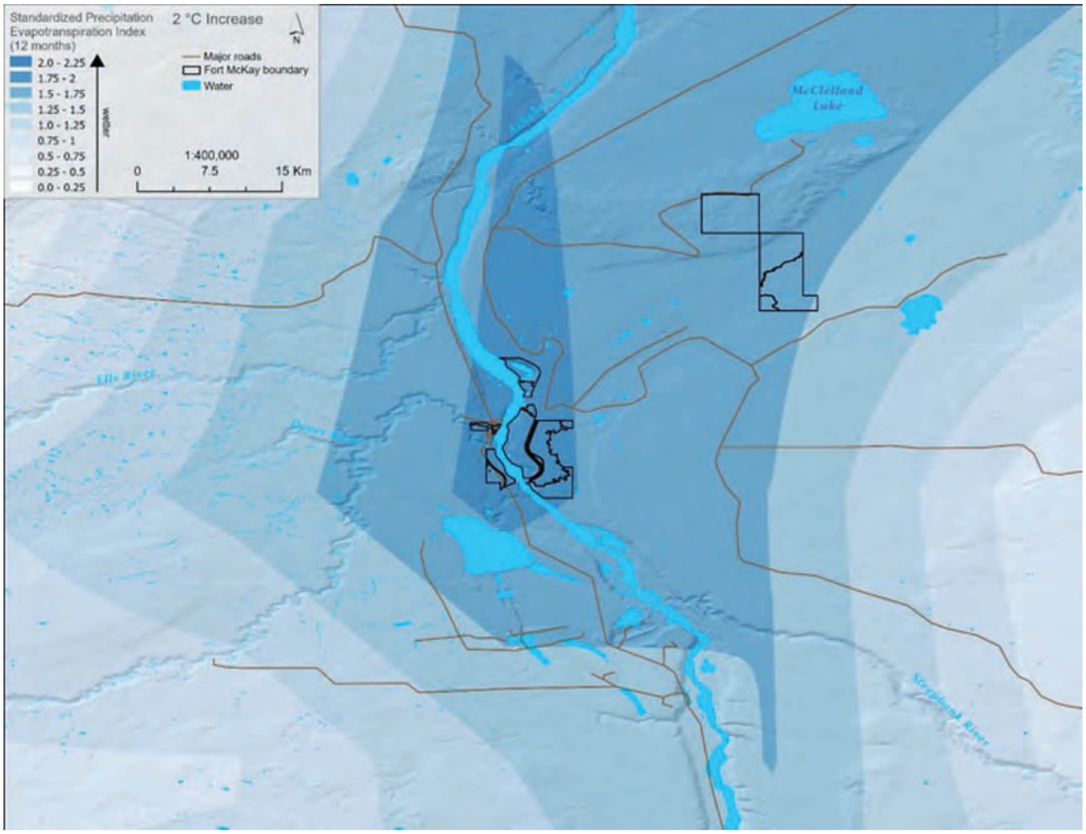


Figure 1B

Figure 1b: Projection map showing 25 sq km, 12-month projected (in a 2°C warming future scenario) Standardized Precipitation Evapotranspiration Index (SPEI) values across Fort McKay First Nation traditional territory.

Drought condition is described by the 12-month Standardized Precipitation Evapotranspiration (SPEI) Index values is show in Figure 1. The SPEI-12 is a commonly used drought index, which evaluates the differences of moisture loss calculated as the difference between precipitation (figures 7) and potential evapotranspiration (based by temperature, see figures 3 to 6). The values are standardized, so a negative SPEI-12 number represents drier than normal conditions and positive values corresponding to wetter than normal conditions.

While the in overall SPEI-12 index number (see Figure 1) over long time periods, is very marginal, likely not statistically significant relative to the variability, and covers a wide geographical area, there are key findings from this dataset. Figure 1 demonstrates a general drying in the landscape around the Athabasca River, and there are likely to be years, and event decades, of low SPEI-12 in specific areas. It is in these dry periods and locations that are likely to represent the significant fire hazard.

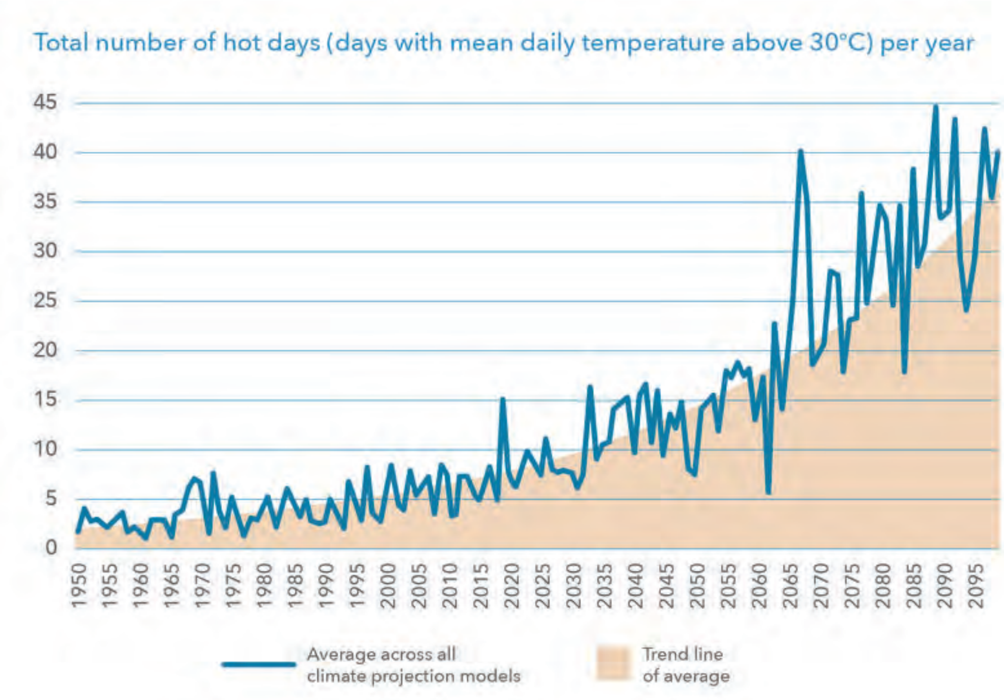


Figure 2

Figure 2: Graph of the total number of days for each year where the average daily temperature is greater than 30°C.

Based on historical climate data, provided to this assessment by the Prairie Adaptation Research Collaborative (PARC), in the 1950s there were on average 3 days per year when the mean daily temperature exceeded 30°C (Figure 2). By the end of this century, modelled climate data projects that there will be on average 30 days per year when the mean daily temperature exceeds 30°C. Importantly, a year is described by its seasons, and these extreme temperature (mean daily temperature over 30°C) is only one feature of them.

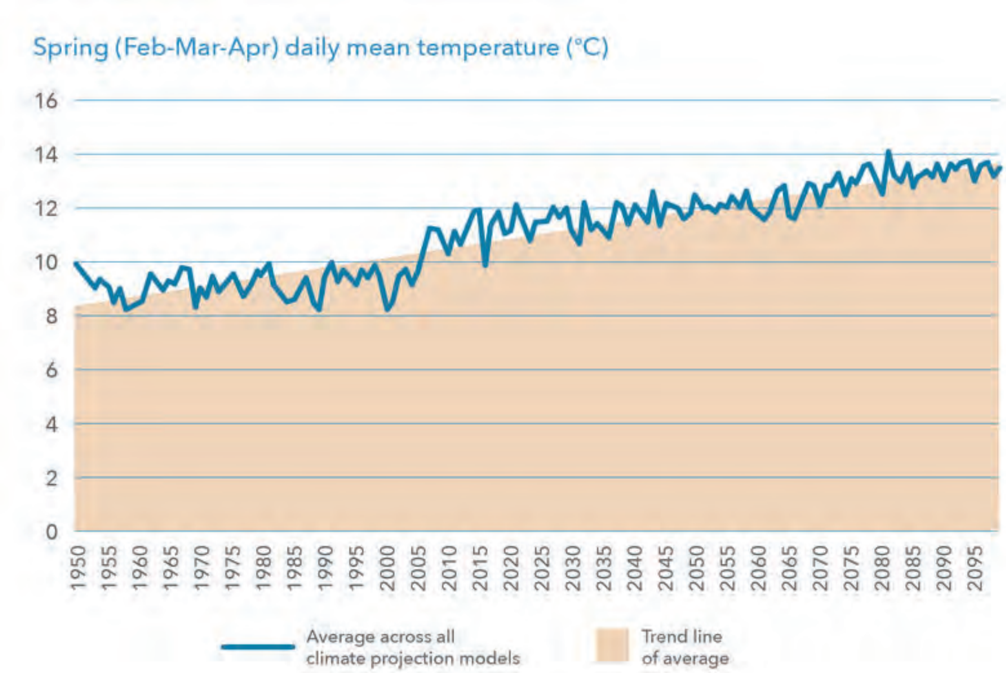


Figure 3

Figure 3: Mean daily temperature for Spring (February – April) each year. (PARC data source)

Figure 4

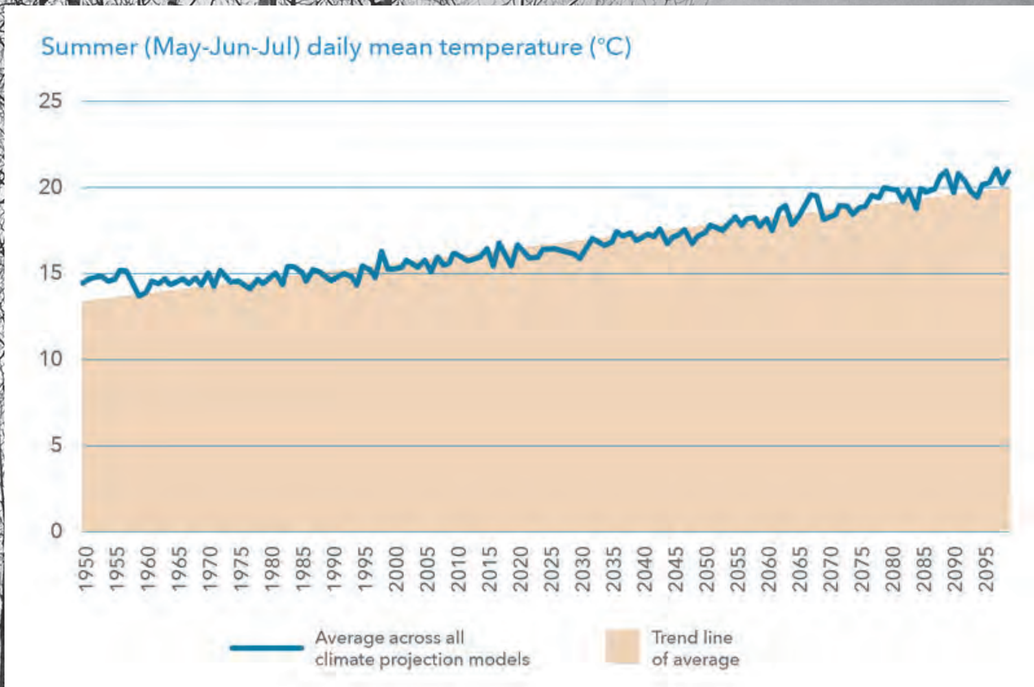


Figure 4: Mean daily temperature for Summer (May – July) each year.

Figure 5

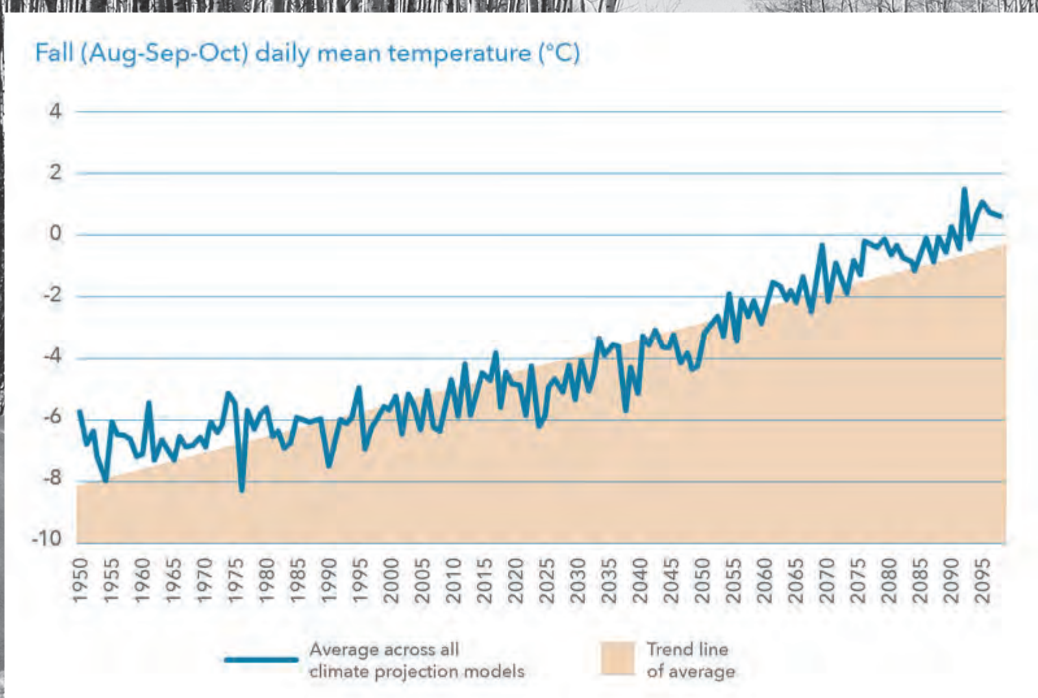


Figure 5: Mean daily temperature for Fall (August – October) each year.

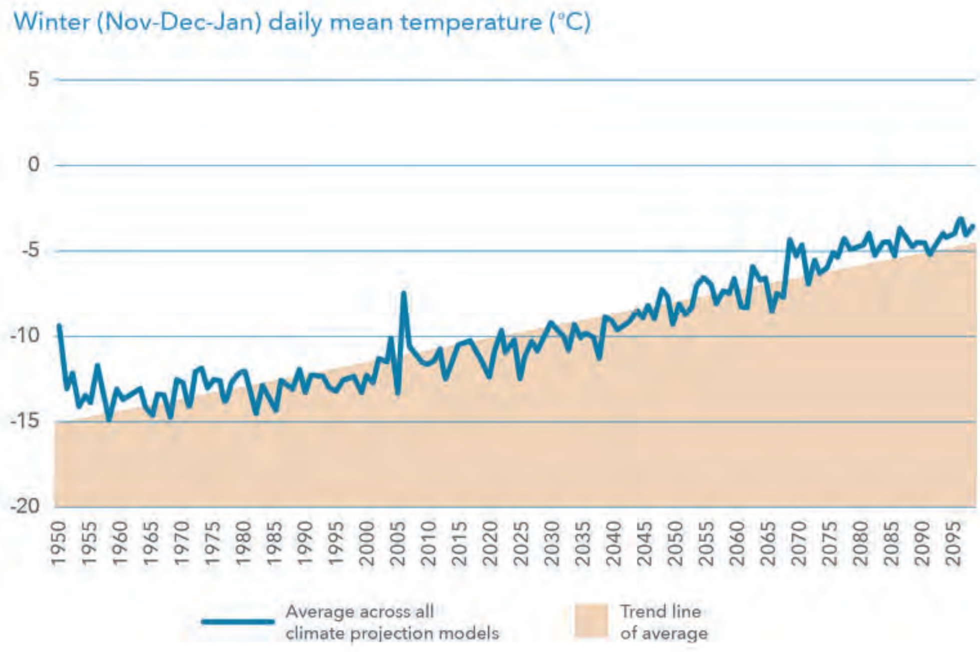


Figure 6

Figure 6: Mean daily temperature for Winter (November – January) each year.

Figures 3-6 all show that annual temperatures for all seasons are projected to increase over the next 30-years and onto the end of the century. The most significant temperature increases are expected to occur in winter months (November, December, and January). For the climate projection data analysed for this report, and alongside the risk assessment, Table 1 summaries the temperature increases for each season comparing the earliest historic decade and the decade at the end of the century and shows a projected 67% increase in winter temperatures.

Table 1

Season	1950-1959 Mean Temperature (°C)	2090-2099 Mean Temperature (°C)	Percentage Change
Spring	9.1	13.5	+33%
Summer	14.6	20.3	+28%
Fall	-6.8	0.4	+18%
Winter	-12.9	-4.2	+67%

Warming trends in winter are particularly significant from a wildfire perspective because such conditions are linked to their being much dryer ground conditions in Springtime, reduction in snow cover, and reduced levels of precipitation released into the ground.

This winter and post-winter ground moisture level is also important when considering annual projections in precipitation. Figure 7 shows total annual precipitation of all forms (i.e., snow and rain) mm per year. While there is a subtle increase in annual precipitation projected over the years to the end of the century, any increases do not immediately translate into increased protection from wildfires because of the sporadic and erratic nature of the rainfall events. This is discussed further later in the report.

Figure 7

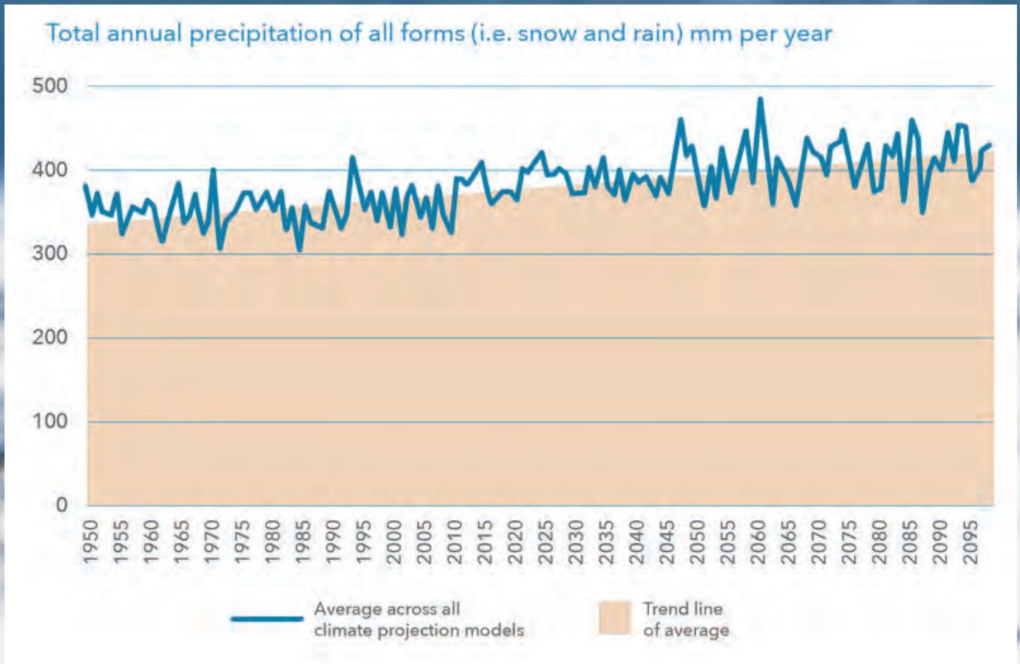


Figure 7: Total annual precipitation of all forms (i.e. snow and rain) mm per year.

2. Extreme Cold

During discussions with Fort McKay community members, concerns about extreme cold where shared. Separate to the risk assessment provided by Associated, this report considered extreme cold to be days with a daily mean temperature of minus-30°C or below. This is the average temperature for the whole day, not just the coldest point in the day. This temperature was determined in part through discussions with Fort McKay public works leadership who considered minus-30°C to be a threshold temperature after which the risk of infrastructure damage increased notably. Based on data provided by PARC, in the 1950s, an average year would experience 20 days with a daily mean extreme temperature (Figure 8). Using extended climate data, by the 2090s, the climate data projects that there will be an average of only 1 day per year with a daily mean extreme temperature (Figure 8).

Figure 8

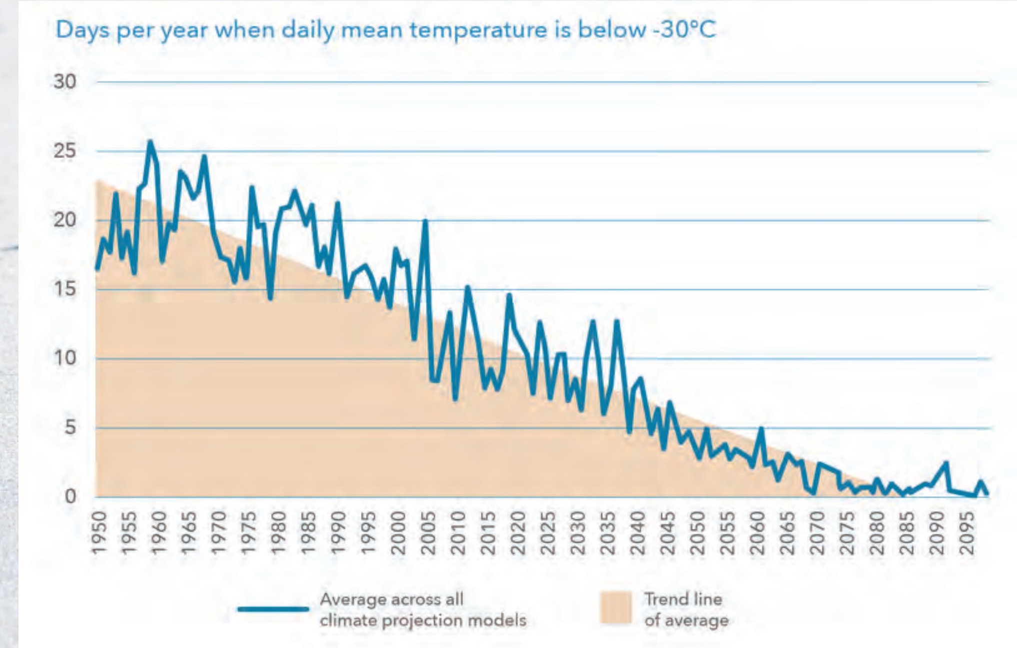


Figure 8: Days each year of extreme cold temperatures, which are characterised as days with a daily mean temperature of -30°C or lower.

Similarly, frost free days describe the number of days between the date of the last spring frost and the date of the first fall frost, equivalent to the number of consecutive days during the 'summer' without any daily minimum temperatures equal to or below 0 °C (Figure 9). In the 1950s this time-period was 158 days. By the 2090s, the number of frost-free days is projected to increase by 30% to 225 days on average each year.

These descriptions suggest that the winters on Fort McKay's traditional territory will be much shorter than historically experienced, up to 10°C warmer on average (Figure 6) and with dramatically less extreme temperatures.

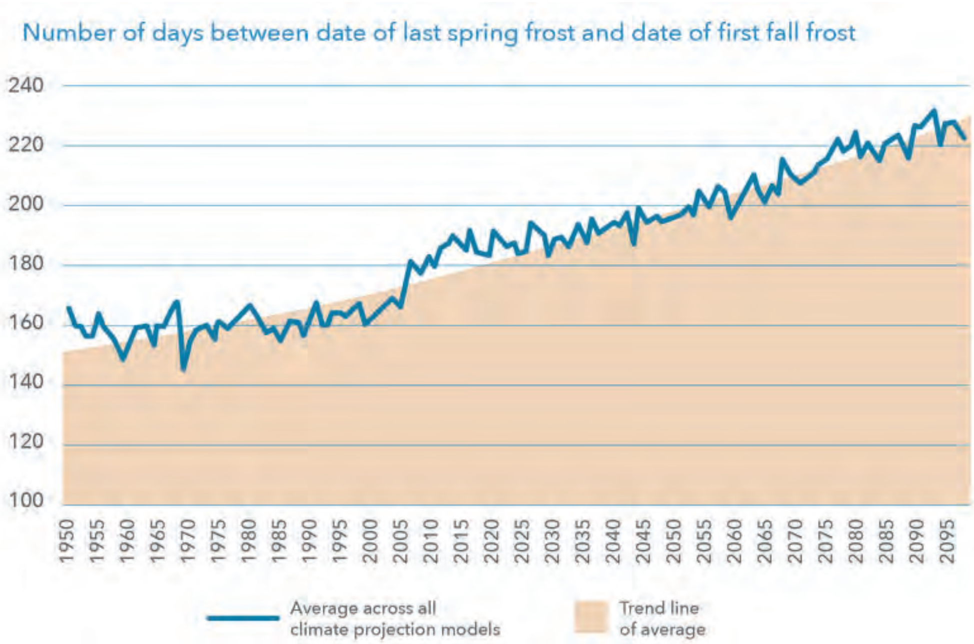


Figure 9

Figure 9: The number of days between the date of the last spring frost and the date of the first fall frost, equivalent to the number of consecutive days during the 'summer' without any daily minimum temperatures equal to or below 0 °C.

3. Storms and "Funny Weather"

Community members discussed their concerns about rainfall events and storms (including freezing rain and heavy snow) during in-person engagements. Many expressed that the duration of rain events has changed. For example, storms used to move quickly through Fort McKay, but now sit over the community (or in one place generally) and last for hours.

Storms – rainfall, thunder, and lightening intensity – are difficult to capture in climate projection data because they require a level of data granularity (i.e., a very short time frame like hourly data, which typically is not available). We commonly associate lighting with thunder. But as many will know, lightning can occur without thunder and the storms can be dry in that they don't produce any rain. For example, in the prairies, there can be thunderstorms that produce little or no rain.

A common climate change scenario, however, is that a warmer climate is associated with more intense rainfall when conditions (moist rising air) are right for rainstorms. Figures 3-6 propose a steadily warming climate for the community, and Figure 7 identifies a marginal increase in total annual precipitation. Broadly speaking however, rainfall and storm patterns that are currently experienced by the community are projected to continue (Figure 10).

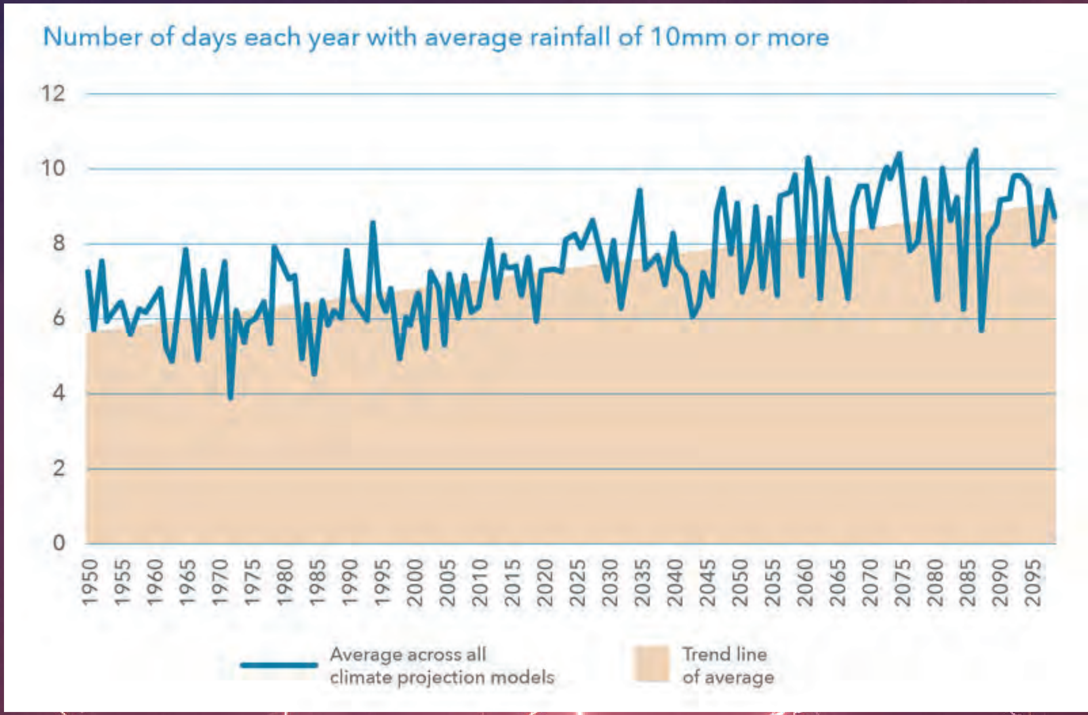


Figure 10

Figure 10: The number of very wet days on average each year. A very wet day is described as a 24-hour period during which 10mm or more of rain falls.

"...It's surprising that there is little change in wind speeds. [Our] expectation is that winds would increase."

Fort McKay First Nation Community Member

Community members 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.

Based on the analysis of maximum daily wind speed provided by PARC, the historical (1950 to present) mean wind speed has been 6.26 m/s. The future (present to 2099) mean wind speed is projected to be 6.35 m/s. This represents a difference of 0.09 m/s or a marginal increase of 1%.

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 correct that local and community knowledge is valid and needs to be considered. Regardless of what the modelling says, there will be fluctuating winds and extreme events in the future.

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 a score of **1** (see appendix D). Recognizing that some impacts affect multiple systems, consequences were scored looking at multiple criteria where necessary. The final consequence score given indicates the highest consequence 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 **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.** 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 **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

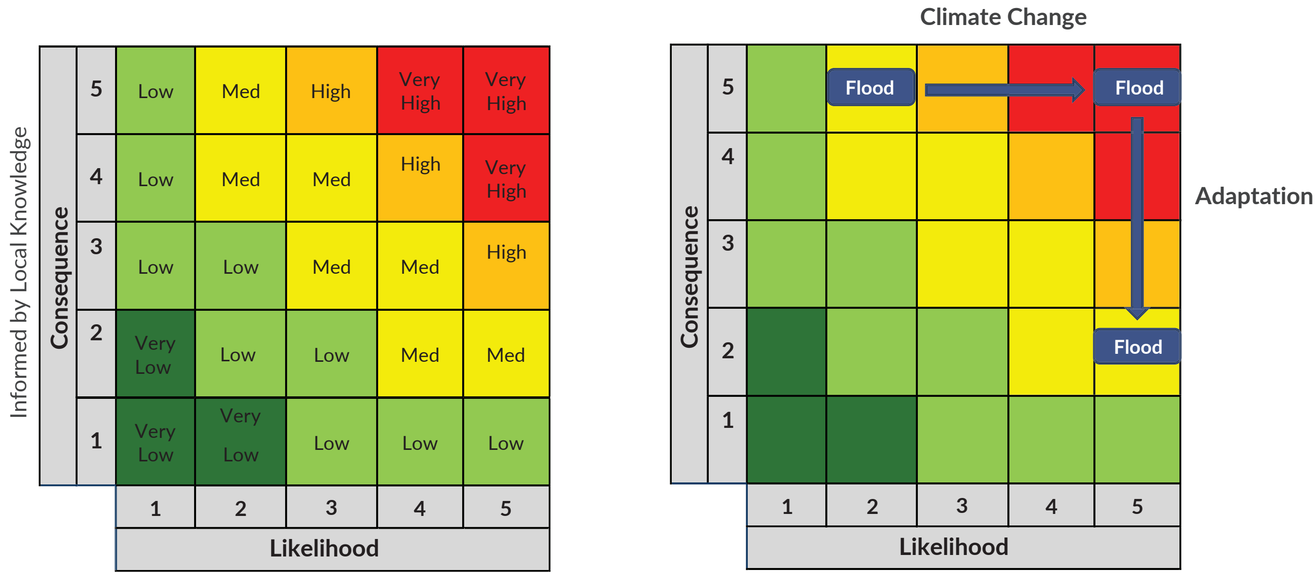
...indicates that, while the climate hazard may be occurring, it does not cause recurring issues or significant concern for the community at this time;

A historic likelihood score of 3

...indicates that the climate hazard is already a problem for the community and impacts have been experience a number of 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 **most represent the hazard in context of the impacts.**

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



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

Fort McKay First Nation members expressed concern about the impacts of nearby industrial activities on the community. However, the scope of this assessment is focused specifically on climate hazards rather than a broad evaluation of environmental risk. The risk of additional exposure to tailings pond contaminates due to increased evaporation was assessed because of the direct connection to climate change (i.e., more evaporation is expected because of rising temperatures). If Fort McKay wishes to develop further understanding of industry-related risks that are outside of the scope of this report, it is recommended that the community undertake a separate assessment. The outcomes of an industry-related risks assessment could then be combined with climate risks to develop a comprehensive risk planning approach.

Built System	Social/Cultural System	Natural System
Built systems are human-made structures and facilities and may be owned by Fort McKay First Nation or its residents. These encompass all constructed elements including roadways, pathways, and utilities, as well as community housing and cabins, the Riverside continuing care centre, health centre, Dorothy McDonald Business Centre, Fitness Centre, community school, playgrounds, and the Caribou Energy Park.	Social/cultural systems relate to people as they interact spend time in the community either as residents of the community, employees, or visitors. The system considers health (physical and mental) and safety implications, as well as any disruptions to day to day lives or traditional/cultural practices. Some of the activities that could be impacted by climate risk include outside work, children's play/recreation, and participation in community events and cultural practices.	Natural systems are the nature-based elements found within Fort McKay, including riparian areas, forests, grasslands, landscaping, animals, aquatic life, and water features (rivers, streams, wetlands, lakes, shorelines) which exist in or interact with the lands. While humans are also part of the natural system, the risks with direct impacts on people are discussed in the social/cultural system section. The project team recognizes the interconnectedness of all life but opted to make a separate "social/cultural" section for the ease of policy, planning, and investment decisions Fort McKay may wish to make in the future.

Ecoregion Shift

"If shifting ecoregions are expected, then this could change how land purchasing is approached. A shift maybe needed to purchase land that could be protected from and managed to avoid an ecosystem change. Land acquisition for cultural preservation."

Fort McKay First Nation Lands and Leasing Department

Community members shared observations about changes in wildlife habitat which raise concerns about the vulnerability of ecosystems to invasive species and pests:

- In 2023, community members observed a drastic reduction of birds in the area and a change in migratory patterns.
- Rabbit populations seem to be declining.
- There are fewer and smaller berries.
- There is an observed increased sickness in wildlife populations (e.g., bovine tuberculosis in deer, chronic wasting disease) which further illustrates increased risk of disease in the ecosystem generally.
- There is increase in "funny weather," such as freezing rain and sudden drastic changes in temperature.

Climate-sensitive infectious diseases are anticipated to benefit from warmer climate conditions and will migrate north with milder winters resulting in the introduction of new diseases or the re-emergence of others. Vector-borne illnesses are transmitted by organisms such as mosquitoes, flies, ticks. West Nile virus and Lyme disease have already emerged as health concerns in Canada.

The overall increase in vector borne diseases resulting from an ecoregion shift could adversely affect the health of those living in Fort McKay.

Community members expressed great concern about the potential loss of traditional knowledge due to ecoregion shift. This risk assessment categorizes this shift as a high risk.

- There is a risk that traditional knowledge will be lost, and people will not learn ceremony and on-the-land skills if culturally significant plants are unavailable.
- The loss of traditional food sources and harvests resulting from changing conditions and competition from invasive or non-native species, such as plants, berries, or animals, could have both natural and social/cultural impacts for Fort McKay First Nation.
- Culturally significant species dying off or leaving the area would reduce opportunities for Elders and knowledge holders to pass-on stories and skills.
- There is concern that Elders will not live long enough to learn about the ecoregion changes and be able to share that information.
- Increasing barriers to accessing the land would further hinder Elder and youths' ability to learn as ecoregions change.
- Community members could also see changes in diet because of the changing availability of cultural foods. Invasive species damaging traplines and habitat for native species would contribute to the problem. As a result, people may experience poorer health and increased costs due to the need to purchase more pre-made foods.

Water Quality

Extreme climate change driven weather events have the potential to threaten both water quality and quantity i.e. availability. Reduced water quality can have an impact upon the health of a community, surrounding environment and the viability of a business, fishing, and recreational activities. While this finding is not included in Associated's risk assessment, community members expressed concern for the long term sustainability of their water sources. Fort McKay water sources could be affected by changes in water quality due to low flows from decreased snow melt and less snow cover on surrounding lands. Lower water levels and higher temperatures in general will lead to higher nutrient levels in the water and increase the likelihood of water-borne diseases. Sporadic and erratic rainfall events could produce areas of localised flooding that may contaminate water sources and surface waters.

Water quality could also decrease because of wildfires. A build up of ash, soil erosion, and fire debris in water sources could contaminate the groundwater and Ells River (source for the water treatment plant). Changes in taste, colour, and smell of drinking water could also be expected. If fire retardant is used, this could lead to increased chemical levels in soil and water, such as phosphate, nitrate, and nitrite. All of these changes put strain on potable water treatment plant infrastructure and could result in boil water advisory, as was seen in the aftermath of the 2016 Horse River Wildfire.

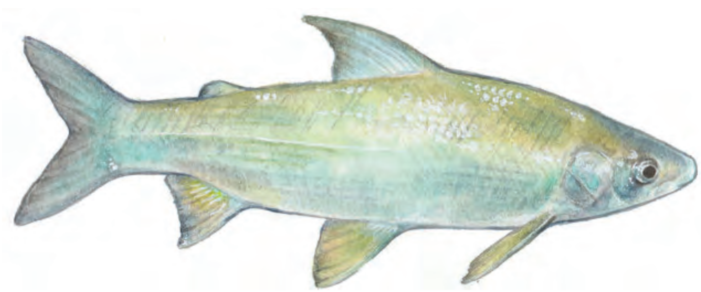
Extreme Heat

The health impacts of extreme heat were identified by the climate project data as a significant risk to Fort McKay First Nation. Risks to outdoor workers was a primary concern identified during engagement. It was noted that outdoor workers increase the number of breaks and shift work indoors whenever possible during extremely hot days.

Fort McKay community members also identified people spending time indoors without air condition as a top concern.

Extreme heat could increase the presence of blue-green algae or other algal blooms in local water bodies.

During engagement it was noted that water quality at Moose Lake has been monitored for the past 10 summer seasons and that winter sampling collection began in 2022. Results are showing a high algae content. People have also noted that the "narrows" are very low and hard to navigate, which is particularly concern as it is a white fish spawning area. Lower water levels and declining quality could impact fish populations which is notable because decreasing fish populations is a change already observed. Plant health, especially those adapted to wetland habitat, may decline due to increased evaporation and lower water levels.



Wildlife behaviour may change as they try to adapt to extreme heat. This could be seen through changes in habitat range, and adjustment in active hours (e.g., hunting/grazing during cooler periods).

Extreme heat could result in heat stroke, death, inability to forage, and/or reduced weight gain for wildlife, and/or more frequent human-animal interactions as they seek out alternative food and water sources.

Extreme heat could result in a decline in the use of outdoor recreation spaces.

These spaces could include metal playgrounds that get too hot to play on in the summer or spending time on the land for harvesting or cultural purposes. This was a concern highlighted during engagement. 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. Understanding how these groups spend time outdoors and what supports can reduce their risk is important.

Evaporation increases with temperature and given the rises Fort McKay is projected to experience, there is a risk that the community could be affected by evaporation associated with the tailings ponds/industrial activity.

Chemicals and material within the tailings ponds could be evaporated into the air and carried by wind to where community members live, work, and play. During engagement it was noted that watering roads could be a way to mitigate some of the dust blowing. Community members raised dust from mines as a major public health concern, so additional work needs to be done to understand the impact of this risk, especially as it relates to changing winds.

Wildfires

The occurrence of a wildfire in or near the community could impact safe access and egress to/from the area. While a significant impact to transportation/evacuation has not been experienced by the community to date, it was identified as a priority risk due to the disruptions that could be seen in an evacuation.

- Highway 63 is the only ground access route, and fast and reliable evacuation could be impacted by fires.
- The Mildred Lake air strip would be challenging to rely on during a wildfire event due to unpredictable conditions and poor visibility.
- Community members identified the new road being built to Grand Prairie, which as a new connection to Fort McKay, will help to reduce this risk.

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 and cabins could be impacted damaged or destroyed. Critical infrastructure such as Riverside Continuing Care Centre, health care centre, water infrastructure etc., and non-critical buildings and facilities such as the fitness Centre, school, playgrounds) are also at risk from wildfires. Overall, there is a large concern about roofs catching on fire.

The damage wildfires cause to terrestrial habitat is visual and striking. Wildfire will destroy whatever is in its path without prejudice, and natural areas without fire breaks or active monitoring for fire are particularly at risk. The viability and suitability of the habitat could change as a result, making the area more difficult for plants, animals and other species to inhabit because they are not adapted to living in areas without trees, grass, and healthy soil, etc.

During engagement, community members expressed that the loss of grave sites would be a significant impact for Fort McKay. Wildfire can damage or destroy cultural heritage sites, both natural and built. These can include ceremony spaces, historically significant places, sites used for teaching, special harvesting locations, among others. Traplines can also be damaged which could be detrimental to trappers and the people who may rely on the animals harvested. While Fort McKay residents explained that trapping is mostly a hobby these days, the loss of that activity and knowledge would still be felt throughout the community.

Wildfire Evacuees from Fort Chipewyan

Wildfires in the region could result in residents being displaced from their homes, either temporarily or permanently. Fort McKay community members expressed concern about this because mental health is already a struggle without the added challenges of a wildfire. The length of time and number of residents displaced from their homes will depend on the extent of the fire. A large-scale evacuation would require a corresponding amount of emergency housing, and special attention would need to be paid to ensure Elders are supported during an evacuation. Mental health impacts of evacuation or having one's home damaged/destroyed could last long after the physical impacts, increasing stress and anxiety of residents.

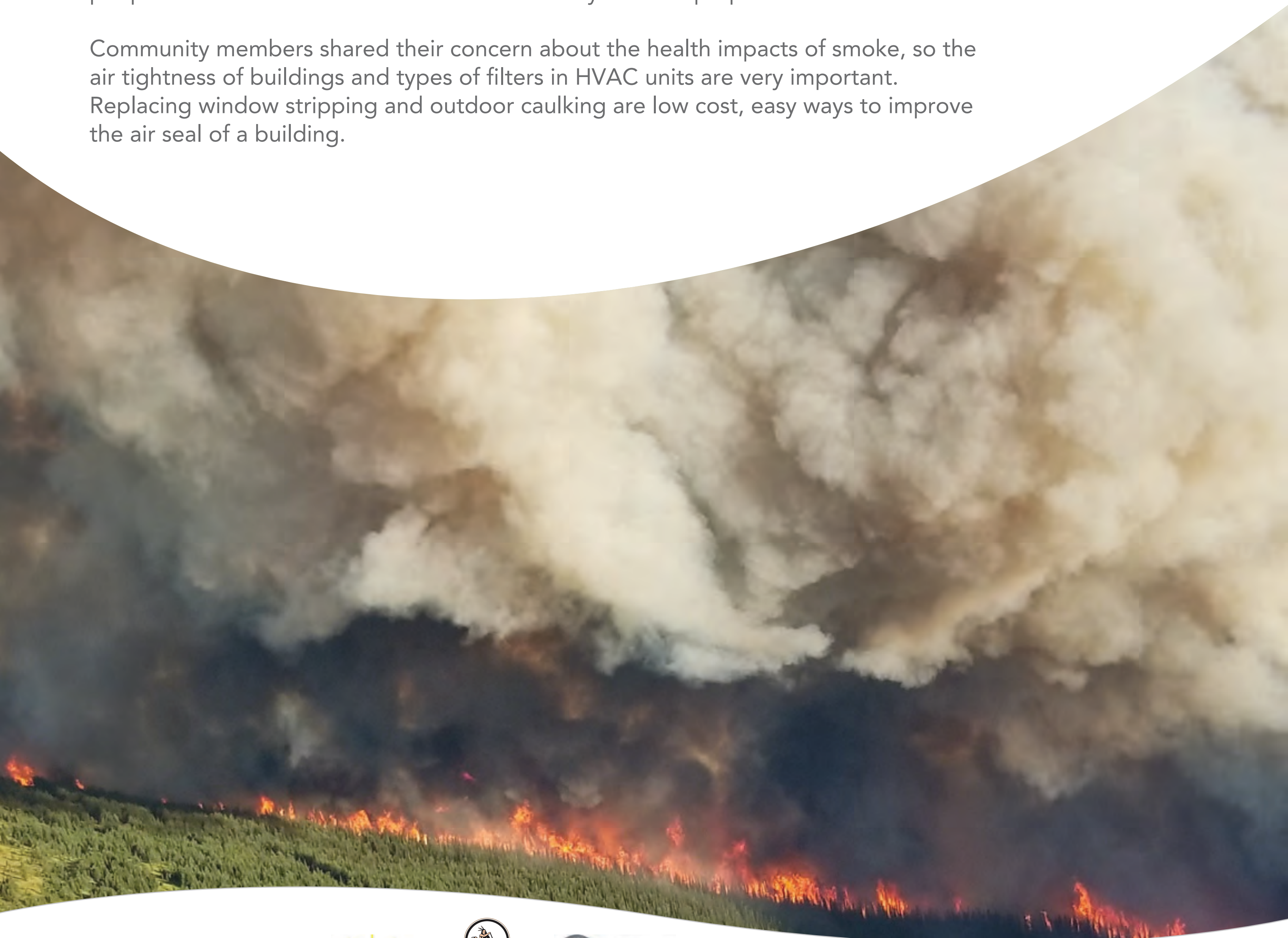
Community members shared their concerns about increased sightings and interactions with wildlife in town (specifically with moose and bear). Wildfire smoke in the area would reduce visibility of people driving vehicles. While this impact affects a natural system (wildlife behaviour), the impacts could result in increased human-wildlife interactions, such as car accidents or other dangerous interactions. Reduced visibility from wildfire smoke, coupled with wildlife expanding their territory to access water sources and fleeing the fire, will increase the risk of collisions or other encounters.

Wildfire Smoke

During engagement it was noted that when people were evacuated to Fort McKay from Fort McMurray due to the 2016 wildfire, those who were evacuated eventually ran out of food and had to leave the community. If a fire blocks road access in/out of the community or disrupts the supply chain, there could be disruption to everyday life. Food shortages are a significant impact which could be experienced. There is an awareness of the risks associated with blocked access to external supplies and services, such as those in Fort McMurray.

During the engagement sessions, we learned that Suncor Energy is planning to provide all households with air conditioning units featuring HEPA filters. The maintenance and repair of units will be the responsibility of individuals, and the amount of work and money required of people to take care of these systems will increase with more wildfire smoke. It would be good assess local capacity and train people who are interested in HVAC and HEPA systems to prepare for this.

Community members shared their concern about the health impacts of smoke, so the air tightness of buildings and types of filters in HVAC units are very important. Replacing window stripping and outdoor caulking are low cost, easy ways to improve the air seal of a building.



Wildlife will experience health impacts from wildfire smokes just as humans will. Smoke can disorient animals, irritate their eyes, and cause difficulty breathing. Similar to people, smoke can make wildlife sluggish, and this can have severe consequences as it reduces their chance of escaping fire. Burns, pain, and mass mortalities can result and land animals are particularly at risk. The ability of wildlife to survive and thrive over longer periods is also put at risk because habitat, food, water, and shelter are affected by smoke and fire.

Plant life will also be impacted by smoke. While plants can manage some stress from environmental conditions, it is expected that particulate matter will have a significant impact on photosynthesis due to reduced sunlight. Poor air quality will also make plants more susceptible to injuries caused by insects and microorganisms. Overall, increased wildfire smoke will affect the growth and health of plant life and could lead to die off in cases of prolonged or extremely poor air quality.

During engagement with Fort McKay, it was noted that local air quality is already poor due to industrial activity. Increased and/or prolonged exposure to wildfire smoke could impact the respiratory wellbeing of residents, particularly Elders or those with pre-existing respiratory conditions such as asthma. A five-year long dust monitoring study has begun and they have already found that there have been six dust events in the first nine months of 2023 that have exceeded Albert Health Standards. Community members are experiencing widespread asthma and eczema which they attribute to being caused by dust blowing from mines. People find that their health noticeably improves when they leave community for a few days, but it is not clear if it’s due to water, air, or other factors. Regardless, increased wildfire smoke will exacerbate existing health issues.

Like extreme heat risk, wildfire smoke may disrupt outdoor activities and events. This could include spending time on-the-land, community gatherings, sports, and even children’s ability to enjoy outdoor play structures. The importance of supporting youth and sharing cultural knowledge with them was expressed during engagement, and wildfire smoke may make it more difficult for youth to engage in productive activities. Thankfully, the school has a gym that can be used as a large recreation space during periods of poor air quality. Fort McKay will need to consider how vulnerable populations will experience greater risk from wildfire than other demographics. For example, Elders, children, and people with certain medical conditions may be unable to participate in community gatherings and develop feelings of isolation.

Freezing Rain

Increased winter temperatures, and a general increase in annual precipitation will increase the likelihood of freezing rain events, including winter rains, heavy snow, and rain-on-snow events.

Freezing rain can result in dangerous driving conditions because roads and active mobility (walking, cycling) paths can become slippery. There is also a risk that visibility will be reduced, depending on the intensity of the rain. These factors may lead to an increase in single vehicle collisions, multi-vehicle collisions, or collisions/damage to transportation infrastructure (e.g., signage).

Community engagement revealed that school buses are prevented from running during freezing rain events, although the school itself does not close. Additionally, the community could see additional slip-related injuries which pose a risk to the health and wellbeing of people on the reserve.

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 from 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 are describing 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 identify 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, and 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 vapor, 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 towards 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 for causing 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

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 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 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, etc. 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, and 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 scope of project.
June	Consequence scoring rubric and draft impact statements memo shared with Town of Hinton for review and comment.
July	Likelihood scoring memo share with Fort McKay Sustainability Department for review and comment.
September	Two days in person engagement with community members in Fort McKay.
October	Additional and virtual community engagement held.
December	Virtual presentation to the Hinton Youth Advisory Council
January 2024	Draft final climate risk assessment report shared with Fort McKay Sustainability Department 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

REPORT

Fort McKay First Nation

Climate Risk Assessment

DECEMBER 2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PAGE NUMBER

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.
Community Partner	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.
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 **Fort McKay First Nation** (the Nation) as part of 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.

The work was led by The Resilience Institute (TRI) with the support of Associated Engineering's Strategic Advisory Services (Associated). The CRA focuses on the built (i.e., buildings and infrastructure), natural (i.e., wildlife and the land), and social/cultural (i.e., health and wellbeing) systems of the Nation.

Associated's scope for the CRA is as follows:

- Identify climate hazards most relevant to the community.
- Researched climate data projections and other data sources as necessary to determine the historic and future likelihood of the locally relevant climate hazards.
- Co-facilitated meetings to understand the Nation's perspective on priority climate hazards and consequences of impacts.
- 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 community perspectives and knowledge into the CRA. This included engagement with staff from the Nation, as well as conversations with Elders, youth, and community members. 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. Climate projections form the foundation for the report, but it is the community's participation and engagement with the data that maximizes the value of the CRA. There were two key stages where local knowledge and input informed the project:

- **Identification of relevant climate hazards and current likelihood:** Representatives from TRI and Associated held in-person workshops with staff, focus groups with Elders and community members, and a focus group with youth to review and discuss which climate hazards are already being experienced.
- **Climate impact statements and consequence scoring:** Insights from the community discussions, as well as Nation staff feedback on memorandums, helped provide an understanding of the severity of consequences from climate impacts.

1.2 Acknowledgment

We would like to acknowledge the **Fort McKay First Nation staff, Elders, youth, and community members** whose insights were critical in the creation of this report. The project team appreciated their shared knowledge for the purpose of including local perspectives in this community project.

2 SCOPE OF CLIMATE RISK

It is best practice in climate risk assessments to evaluate potential impact on different "systems" that make up a community. Built, natural, and social/cultural 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 Nation's risk assessment examines the impacts of climate change on the built, natural, and social/cultural systems (see **Figure 2-1**).

Figure 2-1 Systems Impacted by Climate Change

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

Spatial Scope

The assessment was largely confined to climate-related hazards that have direct impacts within Fort McKay First Nation's boundaries and the Nation's control and influence. Within these boundaries, a community-wide approach was adopted, that considered impacts to private property, the health and lifestyle of residents, social equity, and natural capital. Local and regional economic systems were considered indirectly, particularly as it relates to oil sands developments upstream of Fort McKay.

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.

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.

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.

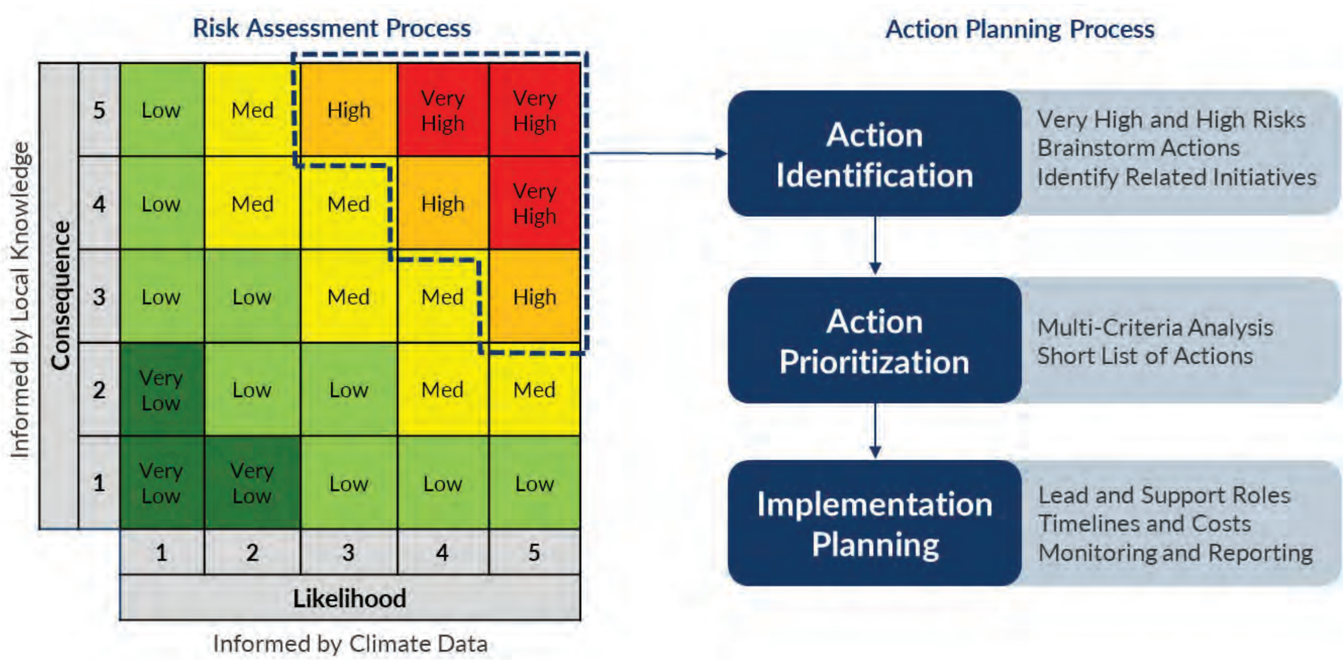
RCP 8.5

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 Fort McKay, for example, is projected to average +4.9°C in the future (2051-2080), an increase of 4.1°C from its average value over the baseline period (1971-2000) (ClimateData.ca).

3 RISK CONCEPTS AND 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

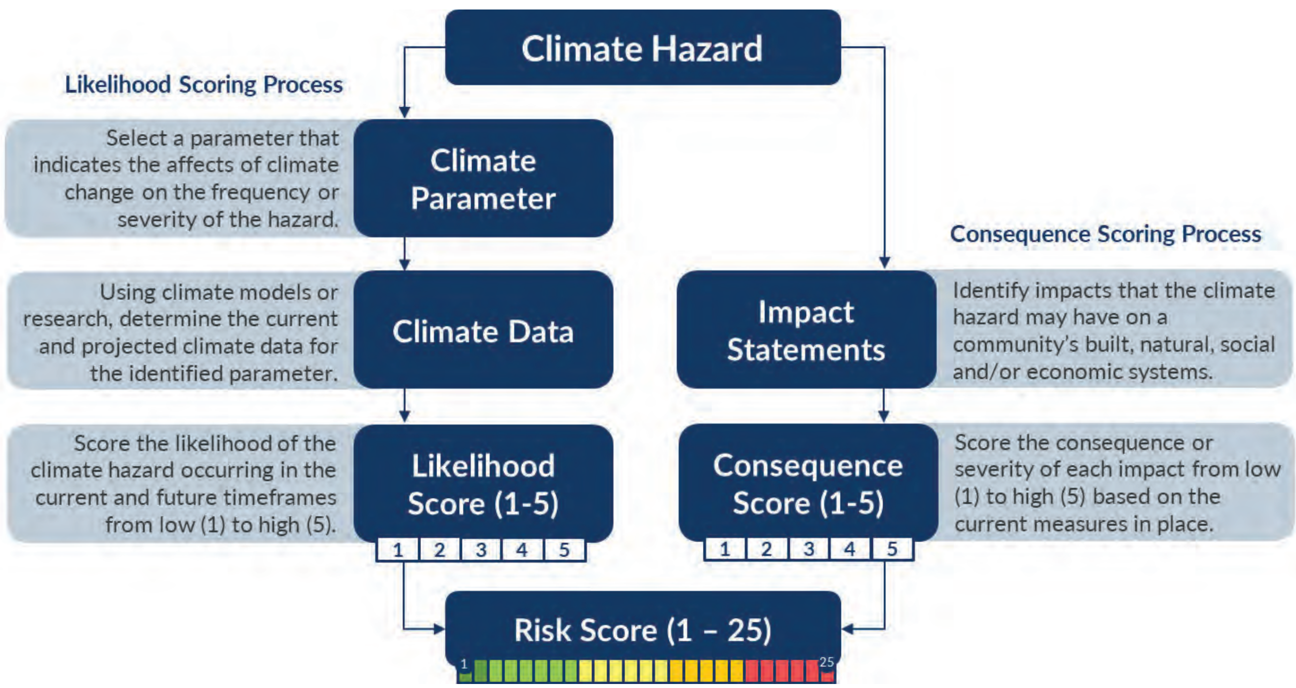
not capture all climate hazards, such as forest fire or hail, and therefore alternative data sources (research, national monitoring indices) are used, along with experience and good practice.

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 Fort McKay First Nation conversations 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/cultural 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 include:

Hazard Identification

- Climate hazards were chosen according to relevance to Fort McKay First Nation and project scope at the time of the assessment. Fort McKay 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 was selected 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., Fort McMurray, Mildred Lake) was used.
- Time periods considered for historic climate data varied across climate hazards depending on available data.
  - Data supplied by the 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 flooding spans 1974-2015.
  - Data from the Canadian Climate Atlas (lake flooding, freeze-thaw, shorter ice road season) 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 flash flooding and river flooding spans 2051-2080.
  - Data from the Canadian Climate Atlas (lake flooding, freeze-thaw, shorter ice road season) spans 2021-2050.
  - Data for wildfires, wildfire smoke, hail, and ecoregion shift spans 2041-2070.
- Where representative climate parameters or projected data were unavailable (i.e., lightning, permafrost melt, scores were assigned based on available research, studies and good practice.

Consequence

- Consequence scores were assigned with Fort McKay'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, social/cultural). 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 were used as the priority for action planning. However, Fort McKay may have a different risk tolerance and could choose a different subset of risk to focus of 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 Fort McKay First Nation 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.
Flash 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 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	A period of abnormally strong, sustained winds.
Extreme Heat	Summertime temperatures that are much hotter and/or humid than average.
Heavy Snow	A period of intense, sustained snowfall.
Freeze-Thaw Cycle	The fluctuation of air temperature between freezing and non-freezing temperatures.
Permafrost Thaw	Soil or sediment which remains frozen for two years or longer.
Shifting Ecoregion	A change in the climatic conditions of an area, affecting the health and presence of native ecoregions (ecological features and plant and animal communities).
Shorter Ice Road Season	Decreasing duration of when an ice road (human-made structure that runs on a frozen water surface) is safe for use.

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.**

Each climate hazard was assigned a historic (baseline) likelihood score of either 2 or 3 based on whether or not the community currently experiences challenges with the climate hazard. This approach was used to capture local knowledge and experience with climate hazards that may not be reflected in scientific datasets. The likelihood score was 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 Nation and impacts have been experienced a number of times in the recent past.

From there, a future likelihood score was calculated according to the percent increase or decrease of the assessed climate parameter over time. Community feedback was not used to inform future likelihood but rather the climate data projection was used.

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/cultural), a broad and holistic understanding of the impacts is developed. The list of impact statements was 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/Cultural	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 are used to assess impacts to built, natural and social/cultural 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**). Recognizing that some impacts affect multiple systems, consequences were scored looking at multiple criteria where necessary (e.g., damage to roads has a broader impact on access to emergency services).

Table 3-4 Consequence Scoring Rubric

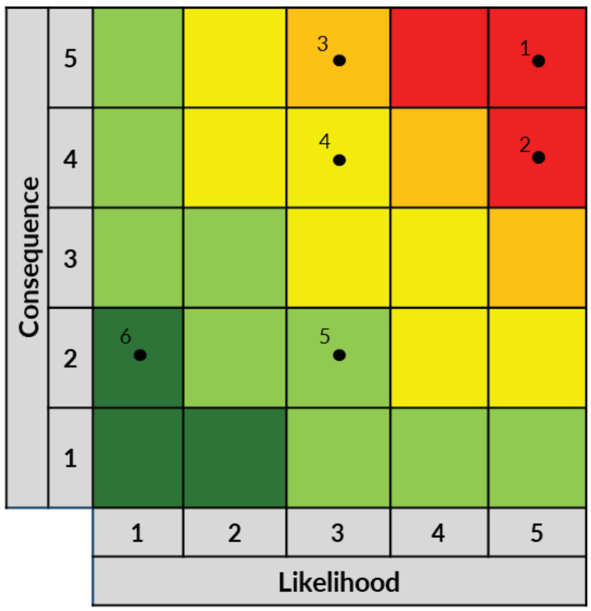
System	Very Low - 1	Medium - 3	Very High - 5
Natural	▪**Minimal or no environmental disruption or damage** to landscape, water resources, trees and other natural infrastructure. ▪Affected **resources recover full functionality within days**, e.g., plants and wildlife only marginally affected.	▪**Isolated 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 community. ▪**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 community'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 community'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/ Cultural	▪**Minimal disruption to daily life**, minimal or no change in community cohesion ▪**Minimal health effects** ▪**No self-evacuations or displacement** ▪**Minimal or no impact on cultural resources**, recovering full functionality within days	▪**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 community seeing **temporary self-evacuations/ displacement** ▪**Moderate damage to cultural resources**, with full recovery taking months	▪**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 community requiring temporary evacuations, with **some permanent displacement** ▪**High damage to cultural resources**, full recovery may not be possible or could take years

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 2050. **The largest shifts in likelihood are for extreme heat (days above +30°C), wildfires, wildfire smoke, ecoregion shift, and permafrost thaw.** Of the hazards explored in this assessment, only the number of freeze-thaw cycles annually 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]	1.31	1.06	-19%	2	3	PARC[2]
Lightning	Annual average number of days with lightning[3]	-	-	-	2	3	ECCC[4]; Paquin et al. (2019)[5]
Flash Flooding	15 min 25-year rainfall (mm/hr)	63.6	84	32%	2	3	Climate Data[6]
River Flooding	24 hour 100-year rainfall (mm/hr)	3.4	4.5	32%	2	3	Climate Data[6]
Lake Flooding	3-day rain (mm)	42	43	4%	2	2	Canadian Climate Atlas[7]
Wildfires	Annual average area burned (ha) within region	303,865	543,919	79%	3	5	Wang et al. (2022)[8]
Wildfire Smoke	Annual average area burned (ha) within region	303,865	543,919	79%	3	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
Hail	Annual severe summer hail days	1.4	-	26%	2	3	Brimelow et al. (2017)[9]
Freezing Rain	Change in annual ice accretion (2020-2050)	-	-	30.40%	3	4	ECCC[10]
High Winds	Change in annual hourly wind pressure (1/50) (2020-2050)	-	-	1%	3	3	ECCC[10]
Heavy Snow	Annual winter precipitation (mm)	40.8	46.14	13%	2	4	PARC[2]
Extreme Heat	Annual days above +30°C	5.19	15.23	193%	2	5	PARC[2]
Freeze-Thaw Cycles	Annual # of freeze-thaw events	71.7	63	-12%	3	2	Canadian Climate Atlas[7]
Shifting Ecoregion	Ecoregion shift[11]	-	-	-	2	5	AdaptWest[12]
Permafrost Thaw	Global permafrost reduction			75%	2	5	Science Daily[13]
Shorter Ice Road Season	Freezing degree days[14]	2023	1263	-38%	3	4	Canadian Climate Atlas[7]

[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

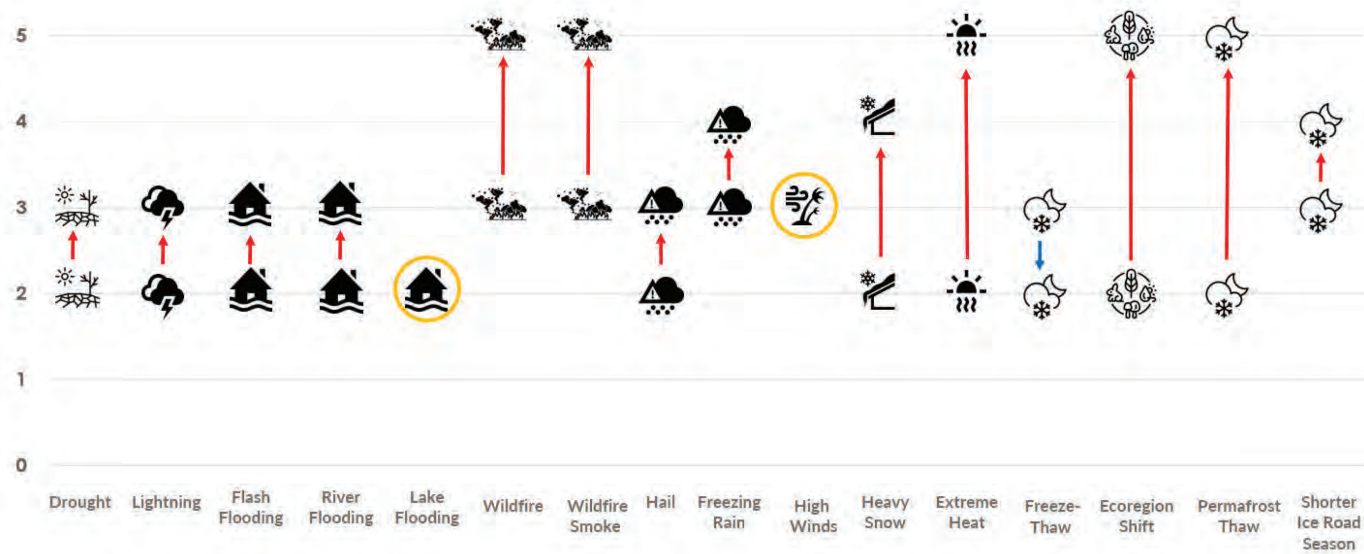
[11] Eco-region maps project a shift in ecoregion in the area.

[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*

[14] Freezing degree days are the accumulation of daily mean temperatures below 0°C. A reduction in value indicates a reduction in snow and ice accumulation.

Figure 4-1 Change in Climate Hazard Likelihood (Historic Baseline to 2050s)



4.2 Results by System

Risk scores for each of the **124 climate impact statements** 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 Fort McKay First Nation in the 2050s are **wildfire, wildfire smoke, extreme heat, shifting ecoregion, and permafrost thaw**. 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

Wildfire • Residents displaced from their homes, temporarily or permanently • Transportation delays and disruptions (access/egress routes) • Damage to buildings and community member homes	**Wildfire Smoke** • Serious health implications, especially for those with respiratory problems • Increased risk of wildlife-human interactions (traffic accidents) due to decreased visibility	**Extreme Heat** • Health impacts or death, especially for vulnerable populations (chronic health conditions, elderly, children) • Risk to people indoors without air conditioning • Risk to outdoor workers
Ecoregion Shift • Loss of culturally significant foods/medicine, including harvesting plants and animals • Loss of Traditional Knowledge and engagement with cultural activities • Increased health risk of vector-borne disease	**Heavy Snow** • Physical damage to community buildings and essential services due to increased snow load and fallen trees • Increased reliance on private automobiles for transportation	**Freezing Rain** • Increased traffic accidents and damage to transportation infrastructure • Reduced transportation options (buses, active mobility) for people who do not drive a vehicle

Results for each system are summarized in the following sections according to system: (Built, Natural, or Social/Cultural):

- 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, wildfire has 12 impact statements which are named from Wildfire (A) to Wildfire (L). Extreme heat has 10 impact statements which are named from Extreme Heat (A) to Extreme Heat (J). 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 Fort McKay First Nation or its residents. These encompass all constructed elements including roadways, pathways, and utilities, as well as community housing and cabins, the Riverside continuing care centre, health centre, Dorothy McDonald Business Centre, Fitness Centre, community school, playgrounds, and the Caribou Energy Park.

A total of **43 impacts** to the built system were assessed and are shown in **Figure 4-2** below. The majority of the impacts are a medium risk (yellow) with wildfires, hail, and wildfire smoke standing out as very high risks. **Table 4-3** provides details on the nine risks which were found to be very high for the built system.

Figure 4-2 Climate Risk Matrix – Built System

Consequences	1	2	3	4	5
5		Freeze-Thaw Cycles (B) Lake Flooding (B)	Drought (A) Flash Flooding (A,B) High Winds (D)	Freezing Rain (D) Heavy Snow (A,B,D)	Wildfires (A,B,C)
4		Freeze-Thaw Cycles (A) Lake Flooding (A)	Drought (B,D,E) Flash Flooding (C,D) Hail (A,B) High Winds (A,B)	Freezing Rain (A,B) Shorter Ice Road Season (A)	Wildfire Smoke (A,B)
3			Drought (C) High Winds (C) Lightning (A)	Freezing Rain (C,E,F) Heavy Snow (C,E)	Extreme Heat (A) Permafrost Thaw (C)
2			Hail (C) Lightning (B)		
1			River Flooding (A,B)		Extreme Heat (B)

Likelihood

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

Hazard (Impact ID)	Impact
Wildfires (A)	Transportation delays and disruptions (access/egress routes)
Wildfires (B)	Damage to community member homes, cabins
Wildfires (C)	Damages to buildings and facilities (critical: water treatment, medical, etc.)
Wildfire Smoke (A)	Increased wear on filtration systems & AC units
Wildfire Smoke (B)	Smoke infiltrating into buildings (i.e., air tightness of buildings, type of filters on HVAC)
Freezing Rain (D)	Road traffic accidents and transportation delays, including active transportation
Heavy Snow (A)	Damages to community member homes, cabins (i.e., snow load, fallen trees)
Heavy Snow (B)	Damages to buildings and facilities (critical: water treatment, medical, etc.)
Heavy Snow (D)	Road traffic accidents and transportation delays, including active transportation

Wildfires

The occurrence of a wildfire in or near the community could impact safe access and egress to/from the area. With Highway 63 being the only ground access route, fast and reliable evacuation could be impacted by fires. The Mildred Lake air strip would be challenging to rely on during a wildfire event due to unpredictable conditions and poor visibility. While a significant impact to transportation/evacuation has not been experienced by the community to date, it was identified as a priority risk due to the disruptions that could be seen in an evacuation. During engagement it was noted that there is a new road being built to Grand Prairie, so this new connection to Fort MacKay will help to reduce this risk.

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 and cabins could be impacted damaged or destroyed. Critical (Riverside continuing care centre, health care centre, water infrastructure, etc.) and less-critical buildings and facilities (Fitness Centre, school, playgrounds) are also at risk from wildfires. Overall, there is a large concern about roofs catching on fire. Fort McKay expressed a commitment to rebuild after a disaster. This is due to community desire to stay in the area and the need to avoid industry further encroaching on their territory.

Wildfire Smoke

Buildings are also expected to be impacted by wildfire smoke. Community members noted that they are concerned about the health impacts of smoke, so the air tightness of buildings and types of filters in HVAC units are very important. Replacing window stripping and outdoor caulking are low cost, easy ways to improve the air seal of a building. During engagement, it was also found that Suncor is going to provide all households with air conditioning units featuring HEPA filters. The maintenance and repair of units will be the responsibility of individuals, and the amount of work and money required of people to take care of these systems will increase with more wildfire smoke. Depending on the type of air conditioning provided by Suncor, Fort McKay may or may not have the local expertise to complete maintenance and repairs. Now is a good time to assess local capacity and train people who are interested in HVAC systems.

Freezing Rain

Freezing rain can result in dangerous driving conditions because roads and active mobility (walking, cycling) paths can become slippery. There is also a risk that visibility will be reduced, depending on the intensity of the rain. These factors may lead to an increase in single vehicle collisions, multi-vehicle collisions, or collisions/damage to transportation infrastructure (e.g., signage). Community engagement revealed that school buses are prevented from running during freezing rain events, although the school itself does not close. Additionally, the community could see additional slip-related injuries which pose a risk to the health and wellbeing of people on the reserve. This is an especially high risk for people that do not have their own automobile and rely on active transportation.

Heavy Snow

Heavy snow poses a threat to buildings, such as community member homes, cabins, critical infrastructure including water systems and medical facilities. This is primarily due to increased snow load (the burden placed on the ground or on a structure by snow and ice that has accumulated) that can be seen during sustained periods of snowfall. While buildings in Canada can accommodate some snow load, current building code requirements are insufficient to accommodate the increased snow load expected in future climate scenarios, so structures in the community may be at risk of damage (e.g., roof caving). Trees and vegetation are at risk of falling if too much snow accumulates at once. There is the additional risk that trees can fall onto community buildings and cause damage like broken windows, penetrated walls, or roof collapse.

Risks to transportation, including increased traffic accidents due to road poor road conditions and reduced visibility are also possible. Community members explained that most people have vehicles with 4-wheel drive and/or skidoos, so this does provide some flexibility during heavy snow. However, people with reduced mobility, such as Elders, children, and people without personal transportation, will have a more difficult time getting around the community without a ride appropriate for heavy snow.

4.2.2 Natural System

Natural systems are the nature-based elements found within Fort McKay, including riparian areas, forests, grasslands, landscaping, animals, aquatic life, and natural water features (rivers, streams, wetlands, lakes, shorelines) which exist in or interact with the lands. While humans are also part of the natural system, the risks with direct impacts on people are discussed in the social/cultural system section. The project team recognizes the interconnectedness of all life but opted to make a separate “social/cultural” section for the ease of policy, planning, and investment decisions Fort McKay may wish to make in the future.

A total of **35 impacts** to the natural systems were assessed and are summarized in **Figure 4-3** below. There are 13 very high-risk hazards and only one high risk. This is due to the community assigning hazards with consequence scores of 4 and 5, indicating that the risks to natural systems are very high priority in the minds of those engaged. **Table 4-4** provides details on the 13 risks which were found to be very high.

Figure 4-3 Climate Risk Matrix – Natural System

Consequences	1	2	3	4	5
5		Freeze-Thaw Cycle (C) Permafrost Thaw (B)	Lightning (C)		Extreme Heat (C,D) Permafrost Melt (B) Ecoregion Shift (B,C) Wildfire Smoke (C,D) Wildfires (D)
4			Drought (F,G,H,I,J) High Winds (E,F)	Freezing Rain (G) Heavy Snow (F)	Extreme Heat (E) Ecoregion Shift (A) Wildfire Smoke (E) Wildfires (E)
3		Freeze-Thaw Cycle (D) Lake Flooding (C,D,E)	Flash Flooding (E,F,G) High Winds (G) River Flooding (C,D,E)		
2			Hail (D)		Permafrost Thaw (A)
1					
	Likelihood				

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

Hazard (Impact ID)	Impact
Extreme Heat (C)	Increased heat stress for wildlife
Extreme Heat (D)	Increase in algae blooms affecting water quality
Permafrost Thaw (B)	Anthrax released due to permafrost thaw with associated health risks to wildlife
Ecoregion Shift (B)	Loss of medicinal plants and other culturally significant traditional foods
Ecoregion Shift (C)	Changes in habitat resulting in changes in wildlife in the area
Wildfire Smoke (C)	Increased risk of wildlife and human interactions due to decreased visibility (i.e., car accidents, wildlife accessing water sources and fleeing the fire)
Wildfire Smoke (D)	Decreased health to wildlife due to air quality
Wildfires (D)	Damage to terrestrial habitat
Extreme Heat (E)	Increased evaporation decreasing plant health (especially wetland-dependent) and water levels
Ecoregion Shift (A)	Invasive species and pests
Wildfire Smoke (E)	Vegetation die off or degradation due to air quality
Wildfires (E)	Decreased water quality due to runoff from wildfire areas

Extreme Heat

Extreme heat could increase the presence of blue-green algae or other algal blooms in local water bodies. During engagement it was noted that water quality at Moose Lake has been monitored for the past 10 summer seasons and that winter sampling collection began in 2022. Results are showing a high algae content. People have also noted that the "narrows" are very low and hard to navigate, which is a particular concern as it is a white fish spawning area. Lower water levels and declining quality could impact fish populations which is notable because decreasing fish populations is a change already observed. Plant health, especially those adapted to wetland habitat, may decline due to increased evaporation and lower water levels. Additionally, declining water quality and supply is detrimental to both wildlife and people who rely on those natural sources.

Extreme heat will also result in heat stroke, death, inability to forage, and/or reduced weight gain for wildlife. Wildlife behavior 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.

Permafrost Thaw

There is a high risk of permafrost thaw due to increased warming. While permafrost can refer to frozen rock, it can also be soil and organic matter that has absorbed water and subsequently frozen. When this material melts, harmful viruses can be released into the environment which can be detrimental to wildlife health. One example of this is the release of anthrax. During engagement, community members expressed concern about the risk of this disease to buffalo populations, which is known to have a high fatality rate in herbivores.

Ecoregion Shift

A shift in ecoregion could result in a loss of medicinal plants and other culturally significant foods. This could be seen through a shift in animal range, plant growing season or animal "fatness", or change in abundance. In 2023, community members observed a drastic reduction of birds in the area and a change in migratory patterns. Rabbit populations also seem to be declining, as well as observations of fewer and smaller berries. Community members have also observed increased sickness in wildlife populations (e.g., bovine tuberculosis in deer, chronic wasting disease) which further illustrates increased risk of disease in the ecosystem generally. During engagement it was also highlighted that there is increasing "funny weather", such as winter rain and sudden drastic changes in temperature. These experiences have raised concern about changes in wildlife habitat and the vulnerability of ecosystems to invasive species and pests.

These impacts also have social/cultural connections. There is a risk that traditional knowledge will be lost and people will not learn ceremony and on-the-land skills if culturally-significant plants are unavailable. As culture is closely linked to identity and positive outcomes, recognizing the broader risks of ecoregion shift is important. This risk is discussed further in the social/cultural section.

Wildfire Smoke

Wildfire smoke in the area would reduce visibility of people driving vehicles. While this impact affects a natural system (wildlife behaviour), the impacts could result in increased human-wildlife interactions, such as car accidents or other dangerous interactions. During engagement it was noted that there is concern about increased sightings and interactions with wildlife in town (specifically moose and bear). Reduced visibility from wildfire smoke, coupled with wildlife expanding their territory to access water sources and fleeing the fire, will increase the risk of collisions or other encounters.

Wildlife will experience health impacts from wildfire smokes just as humans will. Smoke can disorient animals, irritate their eyes, and cause difficulty breathing. Similar to people, smoke can make wildlife sluggish, and this can have severe consequences as it reduces their chance of escaping fire. Burns, pain, and mass mortalities can result, and land animals are particularly at risk. The ability of wildlife to survive and thrive over longer periods is also put at risk because habitat, food, water, and shelter are affected by smoke and fire.

Plant life will also be impacted by smoke. While plants can manage some stress from environmental conditions, it is expected that particulate matter will have a significant impact on photosynthesis due to reduced sunlight. Poor air quality will also make plants more susceptible to injuries caused by insects and microorganisms. Overall, increased wildfire smoke will affect the growth and health of plant life and could lead to die off in cases of prolonged or extremely poor air quality.

Wildfires

The damage wildfires cause to terrestrial habitat is visual and striking. Wildfire will destroy whatever is in its path without prejudice, and natural areas without fire breaks or active monitoring for fire are particularly at risk. The viability and suitability of the habitat could change as a result, making the area more difficult for local plants and animals to inhabit because they are not adapted to live in areas without trees, grass, high carbon content in soil, etc. Wildfires are a natural occurrence, and the ecosystem will adapt, but the length of time to recovery and the types of plants and animals that choose to stay or return to the area will depend on the extent of the damage.

Water quality could decrease because of wildfires. A build up of ash, soil erosion, and fire debris in water sources could contaminate the groundwater and Ells River (source for Water Treatment Plant). Changes in taste, colour, and smell of drinking water could also be expected. If fire retardant is used, this could lead to increased chemical levels in soil and water, such as phosphate, nitrate, and nitrite. All of these changes put strain on potable water treatment plant infrastructure and could result in boil water advisory, as was seen in the aftermath of the Fort McMurray wildfire. Unfortunately for wildlife who rely on natural water sources, they are forced to consume the contaminated water or risk dehydration.

4.2.3 Social/Cultural System

Social/cultural systems relate to people as they interact and spend time in the community either as residents of the community, employees, or visitors. The system considers health (physical and mental) and safety implications, as well as any disruptions to day to day lives or traditional/cultural practices. Some of the activities that could be impacted by climate risk include outside work, children's play/recreation, and participation in community events and cultural practices.

A total of 46 impacts to the social/cultural systems were assessed and are summarized in **Figure 4-4** below. **Table 4-5** provides details on the 12 risks which were found to be very high.

Figure 4-4 Climate Risk Matrix – Social/Cultural System

Consequences	Likelihood 1	Likelihood 2	Likelihood 3	Likelihood 4	Likelihood 5
5			Drought (K) Flash Flooding (I,J) High Winds (H,J) River Flooding (F,G,N)		Extreme Heat (G,H) Ecoregion Shift (D,F,H) Wildfire Smoke (F) Wildfires (F,G,H,I,L)
4			Drought (M,N) Flash Flooding (H,K,L) High Winds (I) River Flooding (L)	Freezing Rain (H,I) Shorter Ice Road Season (B)	Extreme Heat (I,J) Ecoregion Shift (E,G) Wildfire Smoke (G) Wildfire (J,K)
3			Drought (L) Hail (E) River Flooding (M)		Extreme Heat (F)
2				Heavy Snow (G,H)	
1			River Flooding (H,I,J,K)		

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

Hazard (Impact ID)	Impact
Extreme Heat (G)	Risk to people working outdoors
Extreme Heat (H)	Risk to people indoors without air conditioning
Ecoregion Shift (D)	Negative health outcomes from vector-borne diseases
Ecoregion Shift (F)	Loss of traditional food and harvesting sources
Ecoregion Shift (H)	Loss of Indigenous Knowledge
Wildfire Smoke (F)	Serious health implications, especially for those with respiratory problems
Wildfires (F)	Damage to (natural and built) sites of cultural heritage
Wildfires (G)	Damage to traplines
Wildfires (H)	Poor mental health & PTSD from fire events
Wildfires (I)	Residents displaced from their homes, temporarily or permanently
Wildfires (L)	Physical health impacts (e.g., asthma, respiratory)
Extreme Heat (I)	Decline in use of outdoor recreation spaces
Extreme Heat (J)	Increased evaporation from tailings ponds contributing to poor air quality
Ecoregion Shift (E)	Damage to traplines from invasive species
Ecoregion Shift (G)	Health impacts from dietary changes as traditional food sources disappear
Wildfire Smoke (G)	Disruption to outdoor activities/events
Wildfire (J)	Interruptions to schooling
Wildfire (K)	Food insecurity due to being cut off from surrounding communities

Extreme Heat

The health impacts of extreme heat are identified as a very high risk to Fort McKay First Nation. Extreme heat can result in heat-related illnesses (e.g., heat stroke) and even death in some cases. Risks to outdoor workers was a primary concern identified during engagement. It was noted that outdoor workers increase the number of breaks and shift work indoors whenever possible during extremely hot days. Conversations with Fort McKay community members also identified people spending time indoors without air condition as a top concern. Thankfully, Suncor will provide air condition units to all households which will address the risk to people in private residences. Risks still remain for those with poorly maintained AC units and people in buildings without cooling.

Extreme heat could result in a decline in the use of outdoor recreation spaces. These spaces could include metal playgrounds that get too hot to play on in the summer or spending time on the land for harvesting or cultural purposes. This was a concern highlighted during engagement, and it is good that Fort McKay is aware of the risks caused by extreme heat. 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. Understanding how these groups spend time outdoors and what supports can reduce their risk is important.

Risk associated with the nearby tailings ponds could be exacerbated by extreme heat. Evaporation increases with temperature and given the rises Fort McKay is projected to experience, there is a risk that the community could be affected by evaporation associated with the tailings ponds/industrial activity. Chemicals and material within the tailings ponds could be evaporated into the air and carried by wind to where community members live, work, and play. Community members raised dust from mines as a major public health concern.

Extreme heat may increase the amount of dust from roadways. During engagement it was noted that watering roads could be a way to mitigate some of the dust blowing, but this could be challenging as most dust usually comes from the mines. A 5-year long dust monitoring study has begun and has already found that there have been six dust events in the first nine months of 2023 that have exceeded Albert Health Standards. Community members are experiencing widespread asthma and eczema which they attribute to dust blowing from mines. People find that their health noticeably improves when they leave community for a few days, but it is not clear if it’s due to water, air, or other factors.

Ecoregion Shift

Vector-borne illnesses are transmitted by organisms such as mosquitoes, flies, ticks. West Nile virus and Lyme disease have emerged as health concerns in Canada. Climate-sensitive infectious diseases are anticipated to benefit from warmer climate conditions and will migrate north with milder winters resulting in the introduction of new diseases or the re-emergence of others. The incidence of endemic, mosquito-borne diseases has already increased 10% across Canada15, due largely to climate change. Tick-borne diseases have also been seen expanding their range across Canada. The overall increase in vector borne diseases resulting from an ecoregion shift could adversely affect the health of those living in Fort McKay.

The loss of traditional food sources and harvests resulting from changing conditions and competition from invasive or non-native species, such as plants, berries, or animals, could have several impacts for Fort McKay. Community members expressed great concern about the potential loss of Traditional Knowledge due to ecoregion shift. Culturally significant species dying off or leaving the area would reduce opportunities for Elders and Knowledge Holders to pass on stories and bush skills. There is concern that Elders will not live long enough to learn about the ecoregion changes and be able to share that information. Additionally, increasing barriers to accessing the land (described above) would further hinder Elder and youth’s ability to learn as ecoregions change. Community members could also see changes in diet because of the changing availability of cultural foods. Invasive species damaging traplines and habitat for native species would contribute to the problem. As a result, people may experience poorer health and increased cost due to the need to purchase more pre-made foods.

Impacts to the loss of Traditional Knowledge could have broader social implications. Sharing and learning Traditional Knowledge, on-the-land skills, and stories are important ways of connecting to culture and community. If opportunities to engage in cultural activities like these are lost, it may lead to a disconnect between individuals and their communities. Culture and community are healing, so reduced ability to partake in these experiences could be detrimental to wellbeing within Fort McKay. Discussions with the Lands department found that changing land purchasing approaches could help reduce some of the risk. There could be a shift towards purchasing land that is high priority for protection and management to make the areas less sensitive to ecoregion shift. This acquisition could also help with cultural preservation as it would provide an opportunity to spend time on the land and contribute to a community goal of environmental management.

[15] Ludwig A, Zheng H, Vrbova L, Drebot MA, Iranpour M, Lindsay LR. Increased risk of endemic mosquito-borne diseases in Canada due to climate change. Can Commun Dis Rep 2019;45(4):91–7. https://doi.org/10.14745/ccdr.v45i04a03

Wildfire Smoke

Increased and/or prolonged exposure to wildfire smoke could impact the respiratory wellbeing of residents, particularly Elders or those with pre-existing respiratory conditions such as asthma. Given community members already experience health impacts associated with poor air quality (i.e., mine dust), increased wildfire smoke will exacerbate existing health issues.

Like extreme heat risk, wildfire smoke may disrupt outdoor activities and events. This could include spending time on-the-land, community gatherings, sports, and even children's ability to enjoy outdoor play structures. The importance of supporting youth and sharing cultural knowledge with them was expressed during engagement, and wildfire smoke may make it more difficult for youth to engage in productive activities. Thankfully, the school has a gym that can be used as a large recreation space during periods of poor air quality. Fort McKay will need to consider how vulnerable populations will experience greater risk from wildfire than other demographics. For example, Elders, children, and people with certain medical conditions may be unable to participate in community gatherings and develop feelings of isolation.

Wildfires

Wildfire can damage or destroy cultural heritage sites, both natural and built. These can include ceremony spaces, historically significant places, sites used for teaching, special harvesting locations, among others. During engagement, community members expressed that the loss of grave sites would be a significant impact for Fort McKay. Traplines can also be damaged which could be detrimental to trappers and the people who may rely on the animals harvested. The impact of damaged traplines could be seen through a smaller harvest which reduces the meat or pelts available for sharing or sale. While Fort McKay residents explained that trapping is mostly a hobby these days, the loss of that activity and knowledge would still be felt throughout the community.

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 from their homes will depend on the extent of the fire. A large-scale evacuation would require a corresponding amount of emergency housing, and special attention would need to be paid to ensure Elders are supported during an evacuation. Mental health impacts of evacuation or having one's home damaged/destroyed could last long after the physical impacts, increasing stress and anxiety of residents. Fort McKay First Nation community members expressed concern about this because mental health is already a struggle without the added issue of wildfire.

If a fire blocks road access in/out of the community or disrupts the supply chain, there could be disruption to everyday life. Food shortages are a significant impact which could be experienced. During engagement it was noted that when people were evacuated to Fort McKay from Fort McMurray, they eventually ran out of food and had to evacuate the community. There is an awareness of the risks associated with blocked access to external supplies and services, such as those in Fort McMurray. Also important, blocked or congested roadways could make it difficult for students to get to school. It was noted that 95% of students travel by bus in the winter and 80% in the summer. If buses are unable to navigate roadways or needed to be used for evacuations in or near Fort McKay, this would make it challenging for students to get to school.

4.2.4 OTHER RISKS OF CONCERN

Fort McKay expressed concern about the impacts of nearby industrial activities on the community. This assessment discusses the risks of wind and dust blowing from industrial sites because they were deemed to be "very high risk". Other impacts, such as heavy rainfall leading to erosion or (in severe cases) overtopping, were discussed during the project, but these were deemed to be lower risk. Climate-related risk to dykes would be better managed by the owners of those industrial assets because the community itself does not have control over that infrastructure. If Fort McKay wishes to understand climate change related risks to tailings ponds and industrial processes more broadly, it is recommended that a separate assessment be completed. Additional analysis should also be done to better understand the impact of industrial activity on health more generally.

5 CONSIDERATIONS FOR FUTURE ADAPTATION PLANNING

Considerations for future climate adaptation planning efforts are provided for each of the systems. This is not an exhaustive list and is intended to share some of the types of things that are explored during adaptation planning. The considerations provided are only for the “very high” risks discussed above. It is recommended that Fort McKay First Nation undertake more in-depth climate adaptation exercises to prioritize actions and develop an implementation plan to increase resilience to the climate risks presented in this report.

Table 5-1 High Level Adaptation Considerations by System Type

System Type	High Level Adaptation Considerations
Built System	• Consider maintenance cost and local capacity to complete repairs on air conditioning units and air filters. • Complete air sealing upgrades on priority buildings, such as Elders homes. • Fire resistant materials, particularly for roofs, should be considered as well. • Review evacuation plans and identify ways to reduce the number of vehicles on the road so as to reduce congestion on the limited road infrastructure. • Prioritize completion of other road projects that increase Fort McKay’s connectivity to other communities, essential services, and resources.
Natural System	• Expand Environmental Guardian program to increase monitoring efforts to understand changes on the land. Use results to advocate for increased funding for management programs and setting up protected areas. • Explore opportunities to document Traditional Knowledge related to ecoregion conditions and how the land is changing. • Share information within the community about the increased risk of human-wildlife interactions/vehicle collisions during smoky events. Share advisories for when people should avoid travel. • Consider how Fort McKay’s working procedures/plans for using vehicles can be modified during period of low visibility, so as to reduce risk of wildlife collisions. • Install signage to bring awareness to increased potential of wildlife-human interactions on roadways or in the town site. This signage could be temporary and only displayed when smoky conditions exist and should be included as an action in the emergency response plan. • Work with Elders and Knowledge Holders to evaluate the appropriateness of growing cultural plants and medicines in a greenhouse or garden.

System Type	High Level Adaptation Considerations
Social/Cultural System	• Maintenance requirements and cost-sharing opportunities for air conditioning units should be discussed with Suncor. Ensure operations and maintenance considerations are included in the Nation's socio-economic and budget plans. • Create opportunities for people to access cooling and clean air spaces, with special consideration for Elders, children, and other vulnerable populations (e.g., people with medical conditions, unhoused). • Continue to evaluate modifications needed for working schedules, equipment, and processes to reduce the risk to workers who need to be outdoors to complete their jobs. • Anticipate that there may be a future need to provide extreme heat and wildfire smoke personal protection equipment (PPE) and education to Nation members who want to spend time on the land for cultural purposes. This could focus on mitigating health risks (e.g., cooling vests to prevent heat stroke, masks for respiratory conditions) to reduce the number of emergency medical events. • Work with Elders and Knowledge Holders to explore how findings from this risk assessment can be incorporated into cultural programming. Programming should be created and led by Fort McKay, but could include discussing risks to built, natural, and social/cultural systems when Elders are sharing knowledge. This could help community members to think about how Traditional Knowledge can aid in future climate adaptation efforts. • Consider broader effects of natural system change as it relates to peoples' ability to engage in culture and Traditional Knowledge sharing. • Consider updating lands purchasing criteria to include sensitive habitat and make acquisition decisions that support traditional knowledge and cultural tradition preservation. • Educate people on the importance of fire safe practices (totally extinguishing fires, putting out cigarettes) to reduce risk of inadvertent fire starting. • Share information on vector-borne illnesses, including symptoms and when to get help. • Assess existing procedures for evacuating people during wildfire or other events. Share information within the community so people know supports are available. • Complete an additional assessment to understand any health impacts associated with mine dust/industrial activity in the area.

CLOSURE

The objective of this climate risk assessment is to identify and prioritize the potential impacts climate change may have within Fort McKay First Nation. This will help guide the Nation's climate adaptation action planning to focus on the highest risks to the built, natural, and social/cultural 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,

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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 (access/egress routes)
5	5	25	Wildfires (B)	Damage to community member homes, cabins
5	5	25	Wildfires (C)	Damages to buildings and facilities (critical: water treatment, medical, etc.)
4	5	20	Freezing Rain (D)	Road traffic accidents and transportation delays, including active transportation
4	5	20	Heavy Snow (A)	Damages to community member homes, cabins (i.e., snow load, fallen trees)
4	5	20	Heavy Snow (B)	Damages to buildings and facilities (critical: water treatment, medical, etc.)
4	5	20	Heavy Snow (D)	Road traffic accidents and transportation delays, including active transportation
5	4	20	Wildfire Smoke (A)	Increased wear on filtration systems & AC units
5	4	20	Wildfire Smoke (B)	Smoke infiltrating into buildings (i.e., air tightness of buildings, type of filters on HVAC)
4	4	16	Freezing Rain (A)	Damages to community member homes, cabins from fallen trees
4	4	16	Freezing Rain (B)	Damages to buildings and facilities (critical: water treatment, medical, etc.)

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
4	4	16	Shorter Ice Road Season (A)	Shorter season for winter roads
3	5	15	Drought (A)	Water availability during prolonged dry spells
5	3	15	Extreme Heat (A)	Increased usage of building mechanical systems (i.e., cooling)
3	5	15	Flash Flooding (A)	Damages to community member homes
3	5	15	Flash Flooding (B)	Flooding of/damage to roads (access/egress, community services)
3	5	15	High Winds (D)	Road traffic accidents and transportation delays, including active transportation
5	3	15	Permafrost Thaw (C)	Ground slumping damaging roads, buildings, other infrastructure
3	4	12	Drought (B)	Reduced water availability for ice roads
3	4	12	Drought (D)	Increased pressure on pumps at water network
3	4	12	Drought (E)	Longer season's impact on infrastructure operations
3	4	12	Flash Flooding (C)	Damage to community buildings and facilities
3	4	12	Flash Flooding (D)	Flooding of electrical infrastructure for critical services
4	3	12	Freezing Rain (C)	Power outages from fallen trees or ice accretion
4	3	12	Freezing Rain (E)	Increased salt use and sanding
4	3	12	Freezing Rain (F)	Fallen debris blocking catch basins, culverts
3	4	12	Hail (A)	Damages to community member homes, cabins
3	4	12	Hail (B)	Damages to buildings and facilities (critical: water treatment, medical, etc.)
4	3	12	Heavy Snow (C)	Power outages from downed trees of snow load on powerlines

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
4	3	12	Heavy Snow (E)	Maintenance and operational costs for snow clearing
3	4	12	High Winds (A)	Damages to community member homes, cabins
3	4	12	High Winds (B)	Damages to buildings and facilities
2	5	10	Freeze-Thaw Cycles (B)	Damage to ice roads
2	5	10	Lake Flooding (B)	Flooding of tailings 'ponds'
3	3	9	Drought (C)	Scale build up in pipes, faucets from buildup of calcium and magnesium
3	3	9	High Winds (C)	Power outages (i.e., downed trees near powerlines)
3	3	9	Lightning (A)	Power outages for critical facilities/services
2	4	8	Freeze-Thaw Cycles (A)	Damage to, and decreased service life of, buildings and infrastructure
2	4	8	Lake Flooding (A)	Damages to cabins
3	2	6	Hail (C)	Fallen debris and hail blocking catch basins, culverts
3	2	6	Lightning (B)	Community-wide power outage
5	1	5	Extreme Heat (B)	Power outages due to overheated electrical or increased energy usage leading to interruption of critical services
3	1	3	River Flooding (A)	Damages to community member homes
3	1	3	River Flooding (B)	Flooding of electrical infrastructure for critical services

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 (C)	Increased heat stress for wildlife
5	5	25	Extreme Heat (D)	Increase in algae blooms affecting water quality
5	5	25	Permafrost Thaw (B)	Anthrax released due to permafrost thaw with associated health risks to wildlife
5	5	25	Shifting Ecoregion (B)	Loss of medicinal plants and other culturally significant traditional foods
5	5	25	Shifting Ecoregion (C)	Changes in habitat resulting in changes in wildlife in the area
5	5	25	Wildfire Smoke (C)	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	Wildfire Smoke (D)	Decreased health to wildlife due to air quality
5	5	25	Wildfires (D)	Damage to terrestrial habitat
5	4	20	Extreme Heat (E)	Increased evaporation decreasing plant health (especially wetland-dependent) and water levels
5	4	20	Shifting Ecoregion (A)	Invasive species and pests
5	4	20	Wildfire Smoke (E)	Vegetation die off or degradation due to air quality
5	4	20	Wildfires (E)	Decreased water quality due to runoff from wildfire areas
4	4	16	Freezing Rain (G)	Damage to trees and shrubs leading to debris cleanup
4	4	16	Heavy Snow (F)	Damage to trees / tree branches – loss of habitat, increased deadfall
3	5	15	Lightning (C)	Lightning strikes causing wildfires

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	4	12	Drought (F)	Increased tree mortality
3	4	12	Drought (G)	Increased stress on aquatic and terrestrial ecosystems
3	4	12	Drought (H)	Drying of culturally significant springs
3	4	12	Drought (I)	Drying of wetlands impacting traditional resources
3	4	12	Drought (J)	Loss of muskeg
3	4	12	High Winds (E)	Damage to trees / tree branches
3	4	12	High Winds (F)	Increased blowing dust removing topsoil
2	5	10	Freeze-Thaw Cycles (C)	Changes in natural systems dependent on freeze-thaw cycles (e.g., germination, dormancy)
5	2	10	Permafrost Thaw (A)	Ground slumping impacting wildlife habitat
3	3	9	Flash Flooding (E)	Increased stress on aquatic habitat
3	3	9	Flash Flooding (F)	Damage to riparian areas increasing erosion
3	3	9	Flash Flooding (G)	Impacts to wildlife habitats and populations
3	3	9	High Winds (G)	Increase wave size on lakes leading to bank erosion or flooding
3	3	9	River Flooding (C)	Increased stress on aquatic habitat
3	3	9	River Flooding (D)	Damage to riparian areas increasing erosion
3	3	9	River Flooding (E)	Impacts to wildlife habitats and populations
2	3	6	Freeze-Thaw Cycle (D)	Impacts to ecological restoration of industrial disturbance (planting takes place in frozen conditions)

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	2	6	Hail (D)	Damage to trees and shrubs leading to debris cleanup
2	3	6	Lake Flooding (C)	Increased stress on aquatic habitat
2	3	6	Lake Flooding (D)	Damage to riparian areas increasing erosion
2	3	6	Lake Flooding (E)	Impacts to wildlife habitats and populations

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

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
5	5	25	Extreme Heat (G)	Risk to people working outdoors
5	5	25	Extreme Heat (H)	Risk to people indoors without air conditioning
5	5	25	Shifting Ecoregion (D)	Negative health outcomes from vector-borne diseases
5	5	25	Shifting Ecoregion (F)	Loss of traditional food and harvesting sources
5	5	25	Shifting Ecoregion (H)	Loss of Indigenous Knowledge
5	5	25	Wildfire Smoke (F)	Serious health implications, especially for those with respiratory problems
5	5	25	Wildfires (F)	Damage to (natural and built) sites of cultural heritage
5	5	25	Wildfires (G)	Damage to trap lines
5	5	25	Wildfires (H)	Poor mental health & PTSD from fire events
5	5	25	Wildfires (I)	Residents displaced from their homes, temporarily or permanently
5	5	25	Wildfires (L)	Physical health impacts (e.g., asthma, respiratory)
5	4	20	Extreme Heat (I)	Decline in use of outdoor recreation spaces
5	4	20	Extreme Heat (J)	Increased evaporation from tailings ponds contributing to poor air quality
5	4	20	Shifting Ecoregion (E)	Damage to traplines from invasive species
5	4	20	Shifting Ecoregion (G)	Health impacts from dietary changes as traditional food sources disappear

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
5	4	20	Wildfire Smoke (G)	Disruption to outdoor activities/events
5	4	20	Wildfires (J)	Interruptions to schooling
5	4	20	Wildfires (K)	Food insecurity due to being cut off from surrounding communities
4	4	16	Freezing Rain (H)	Injuries from falls on iced surfaces
4	4	16	Freezing Rain (I)	Disruption to outdoor activities/events
4	4	16	Shorter Ice Road Season (B)	Reduced access to places where traditional land uses and rights are practiced
3	5	15	Drought (K)	Increased blowing dust
5	3	15	Extreme Heat (F)	Health impacts including mortality especially for vulnerable community (elders, children, medical issues)
3	5	15	Flash Flooding (I)	Increased risk of illness due to mold from flooded buildings, basements
3	5	15	Flash Flooding (J)	Residents displaced from their homes, temporarily or permanently
3	5	15	High Winds (H)	Injuries and potential fatalities
3	5	15	High Winds (J)	Increased blowing dust affecting health and outdoor activities
3	5	15	River Flooding (F)	Flooding of/damage to roads (access/egress, community services)

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	5	15	River Flooding (G)	Damage to buildings and facilities (critical: water treatment, medical, etc.)
3	5	15	River Flooding (N)	Reduced access to places where traditional land uses and rights are practiced
3	4	12	Drought (M)	Less snow in winter changes access on the land (e.g., skidoos need certain snow depth)
3	4	12	Drought (N)	Lower river levels impact access to important sites
3	4	12	Flash Flooding (H)	Poor mental health and PTSD from repeated flooding
3	4	12	Flash Flooding (K)	Interruptions to schooling
3	4	12	Flash Flooding (L)	Food insecurity due to being cut off from surrounding communities (access roads, supply chain)
3	4	12	High Winds (I)	Possible displacement from homes if roofs become damaged
3	4	12	River Flooding (L)	Food insecurity due to being cut off from surrounding communities
3	3	9	Drought (L)	Damage to trails, parks, playing fields
3	3	9	Hail (E)	Possible displacement from homes if windows become damaged

Future Likelihood Score	Consequence Score	Future Risk Score	Hazard	Climate Impact / Consequence
3	3	9	River Flooding (M)	Environmental/health concerns related to oil sands pollutants, sediment in floodwater
4	2	8	Heavy Snow (G)	Health risks from isolation or inability to access services, particularly for vulnerable populations (elderly)
4	2	8	Heavy Snow (H)	Food insecurity due to being cut off from surrounding communities
3	1	3	River Flooding (H)	Poor mental health and PTSD from repeated flooding
3	1	3	River Flooding (I)	Increased risk of illness due to mold from flooded buildings, basements
3	1	3	River Flooding (J)	Residents displaced from their homes, temporarily or permanently
3	1	3	River Flooding (K)	Interruptions to schooling

Appendix F: Community Verification Response (January, 2023)

We are grateful for the opportunity to partner with Fort McKay First Nation on this important step towards in strengthening the community's position to address climate change challenges. On January 22-23, 2024 Fort McKay community members, Elders, youth, and leaders reviewed and provided feed back and input on the key outcomes of the Climate Risk Assessment with the Resilience Institute.

The report continues to be strengthened and enriched thanks to the open engagement and generous guidance of numerous people in the Fort McKay community. In this Appendix, your questions, feedback, concerns, and ideas for addressing local climate threats are responded to. **Thank you.**

Weather vs Climate vs Climate Change

"…there is no single future climate, but rather a very large number of possibilities that all represent, more or less, the same amount of climate change."

Sauchyn, Dave, Jon Belanger, Muhammad Rehan Anis, Soumik Basu and Sheena Stewart (2022). Understanding and Accommodating Uncertainty in Climate Change Data: A ClimateWest Primer

Yesterday was cold, what happened to global warming?

Just because a given day is cold, it doesn't mean that conditions over the long term (the climate) aren't getting warmer. When you ask "How cold is it today?" or "Is it raining out?", you're asking about the weather. Weather changes day to day, or even hour to hour. Climate, on the other hand, is the average weather a place experiences over a long period of time, like decades or a lifetime. Average global temperature is on the rise, with temperatures in the north rising twice as fast as other regions.

Weather

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

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.

Weather can change dramatically in a place or region from day-to-day.

Climate

Climate refers to the average of weather conditions over 30 years or more.

Climate changes 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 also refers to **long-term changes in the variability of climate.**

What's the difference between global warming and climate change?

Global warming is the rapid rise in global temperature that's happening because human activities are adding greenhouse gases (GHGs) to the atmosphere. The added GHGs are amplifying the Earth's natural greenhouse effect, causing the planet to warm 30x faster than it did before the year 1900. Climate change is the change in climate happening because of global warming. As the Earth gets warmer, the air patterns and ocean currents that drive climate can change, affecting things like how hot or cold places are, how much rain or snow falls, how severe storms are, or how often and where storms happen.

How Accurate is the Climate Data?

The most robust climate risk assessments and adaptation plans are based on information from a variety of sources: observations of the recent past, reconstructions of pre-instrumental climate, traditional knowledge, and model simulations. **But what about the uncertainty of modelling projections of future climate? Modelling is the most scientifically valid approach to understanding and projecting future climate change.** But, extrapolating trends in weather records into the future makes invalid assumptions about the stationarity and linear trajectory of climate, and it does not account for the changing composition of the atmosphere as the concentration of GHGs from human sources continues to increase.

Principally there are **three sources of uncertainty** in the modelling of climate change:

- **Greenhouse gas emission scenario uncertainty.** The future concentrations of GHGs are not predictable from physical laws and must be estimated based on analyses of the social, political and economic factors that determine GHG emissions and land-use changes.

- **Climate model uncertainty.** Even though technology such as environmental sensors and satellite remote sensing has enabled scientists to generate massive amounts of data, there will never be enough observations to completely describe natural systems at all scales of time and space. Therefore, scientists use computer models to numerically simulate complex systems and thereby better understand them by testing hypotheses and generating outcomes.

- **Internal climate variability.** A response to interactions and feedback among internal components of the climate system. In many parts of the world, including western Canada, short term (interannual) climate variability is linked to the El Niño Southern Oscillation. Other internal variability is the result of the chaotic behaviour of the climate system.

A climate model is able to replicate the climate repeatedly to generate a large sample of statistically realistic time series of weather, enabling the computation of probabilities— including extremes that lie outside the range of recorded weather, but could occur in the future, either under natural conditions and especially under anthropogenic global warming. A very large number of time series of daily weather conditions can represent the same climate, as long as they conform to similar annual and seasonal statistics. Thus, **there is no single future climate, but rather a very large number of possibilities that all represent, more or less, the same amount of climate change.**

Extreme Extreme Cold Days

During discussions with Fort McKay community members (July 2023), concerns about extreme cold where shared. Using climate projection data provided by PARC, and separate to the risk assessment provided by Associated, this report considered extreme cold to be days with a daily mean temperature of minus-30°C or below. This is the average temperature for the whole day, not just the coldest point in the day. While this temperature was determined in part through discussions with Fort McKay public works leadership during consultation on the draft final report, community members identified that even colder temperatures – the extreme extremes – can dramatically impact Fort McKay and pose a significant hazard.

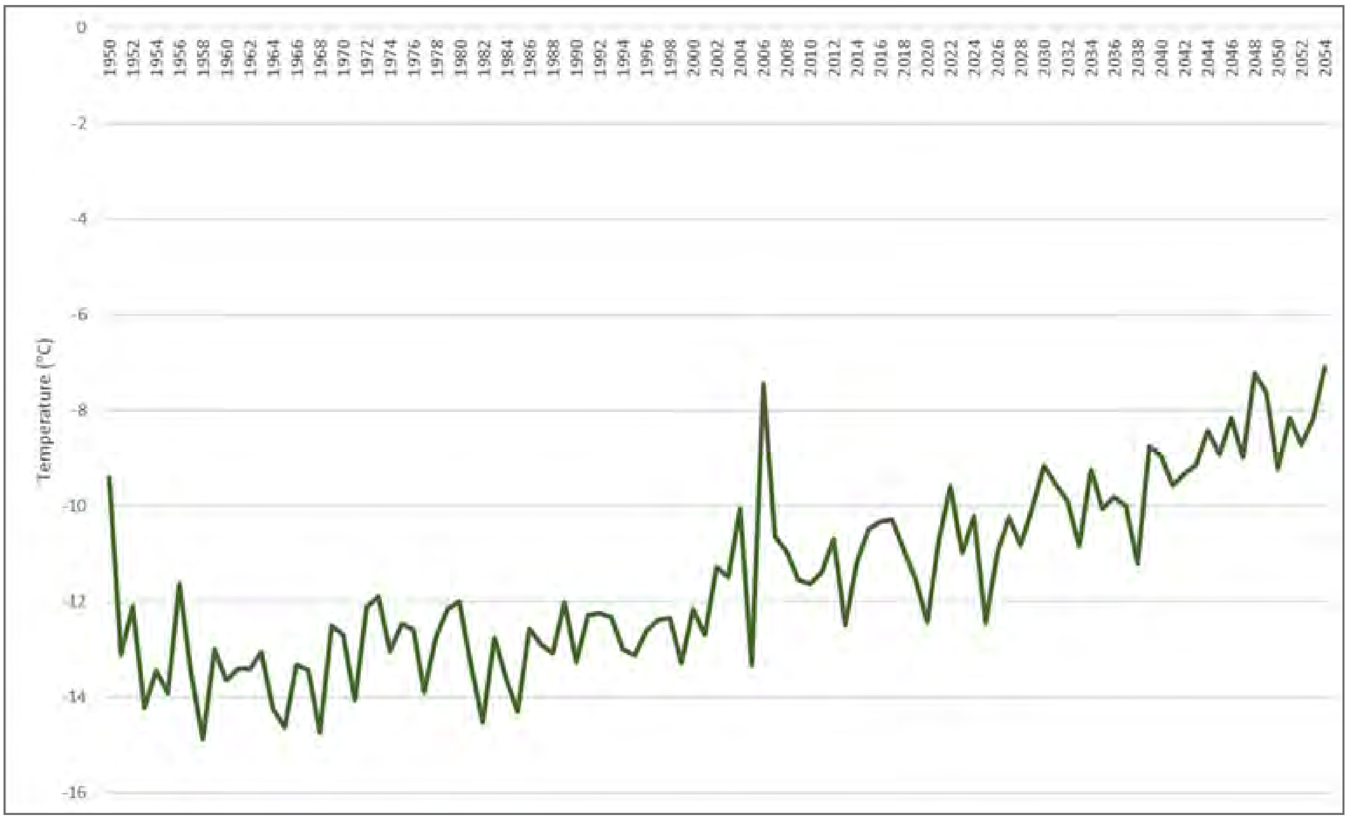

Figure: Annual average winter temperature from 1950 to 2054. Data is based on daily average temperature, which is then averaged over the three winter months (Nov, Dec, Jan) for each year.

This climate risk assessment has been provided data from Prairie Adaptation Research Collaborative (PARC) based on the best practices of climate modelling and using the best data available, downscaled to the Fort McKay First Nation traditional territory. **This data does not include hourly or daily data, only data averaged over months or years.** Therefore, this project is unable to comment on how often, when and for how long temperatures will be colder than minus-30°C.

The figure presented above shows predicted data for the winter months. While individual daily data is not shown (though it is captured in the data) two features should be noted:

- **The data trends** are more important than any one year or one data point. This is the same for all data presented in this report.
- **Extremes** beyond the data show will exist and can be expected.

What is Happening with Wind?

Community members 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.

In this report, we do not propose climate projection data as a substitute for local and community-based knowledge, rather, data is one resource that can provide some insight into current and future climate. It is correct that local and community knowledge is valid and needs to be considered. **Regardless of what the modelling says, there will be fluctuating winds and extreme events in the future.**

During January 2023 engagement, community members identified that while wind speeds have increased in the Fort McKay townsite, they have not increased (at least to the same extent) at Moose Lake. This difference could be significant and implies that **the cause of the increased wind speed could be connected to changes in the landscape around Fort McKay rather than changes in any climatic conditions.**

In this report we recognize that climate models are questionable sources of wind data because wind speed is extremely variable from place to place and hour to hour. Equally, **daily wind data averaged over a 30-year period will undergo such smoothing** (or averaging) of noisy (i.e. highly variable) data that little change over time is the likely outcome (as shown in the report).

Community members identified that industry surrounding Fort McKay have clear cut large areas but have not undertaken work on those sites. It is very likely to expect higher wind speeds near the ground (head level) with the removal of local forest cover. Therefore, one possible explanation for the increased wind speeds in Fort McKay could be that **the community is more greatly exposed to winds** (including understand the prevailing wind direction), rather than any change in climatic conditions driving wind.

We recommends that further research is undertaken to fully understand what is, and could happen with the wind in Fort McKay and the reasons why.

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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.