Rural Municipality of East St. Paul Climate Change Risk and Vulnerability Assessment

September 2020

RM OF EAST ST. PAUL

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Definitions

Climate: how the atmosphere behaves over relatively long periods of time.

Climate Change: A change in global or regional climate patterns, attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

Cooling Degree Days: equal to the number of degrees Celsius a given day's mean temperature is above 18 °C. For example, if the daily mean temperature is 21 °C, the CDD value for that day is equal to 3 °C. If the daily mean temperature is below 18 °C, the CDD value for that day is set to zero.[1]

Drought: A period of abnormally dry weather long enough to cause a serious hydrological imbalance.[2]

Ensemble: A group of climate models, each using various approaches to projecting future climate. Provides a plausible range of outcomes for analysis and decision-making. [1]

Extreme Weather Event: an event that is rare at a particular place and time of year. [2]

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

Greenhouse Gases: Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary greenhouse gases in the Earth's atmosphere.[2]

Max 1-day Precipitation: Amount of precipitation that falls on the wettest day of the year. [1]

Mean Temperature: the average of the daily maximum temperature and the daily minimum temperature.[1]

Precipitation: The total amount of precipitation (rain, drizzle, snow, sleet, etc.) Frozen precipitation is measured according to its liquid equivalent.[1]

RCP4.5- An emissions scenario in which greenhouse gas emissions are greatly reduced. GHG emissions increase until 2050, and then decline rapidly. This leads to less severe global warming. [1]

RCP8.5 – An emissions scenario in which emissions continue to increase at current rates through the end of the century. High greenhouse gas emissions result in more severe global warming.[1]

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. The term risk is often used to refer to the potential, when the outcome is uncertain, for adverse consequences on lives, livelihoods, health, ecosystems and species, economic, social and cultural assets, services (including environmental services) and infrastructure.[2]

[1] Prairie Climate Centre. 2020. Climate Atlas of Canada. https://climateatlas.ca/

[2] IPCC. 2014. Annex II: Glossary. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. IPCC, Geneva, Switzerland, pp. 117-130

Tropical Nights: occurs when the lowest temperature of the day does not go below 20 °C.[1]

Very Cold Days: a day in which the temperature drops to at least -30 C.[1]

Very Hot Days: a day in which the temperature rises to at least 30 C.[1]

Vulnerability: With respect to climate change, refers to the degree to which a system is susceptible to, and unable to cope with, adverse effects resulting from climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its capacity to adapt.[3]

Weather - conditions of the atmosphere (temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure) over a short period of time.

[3] Pacific Climate Impacts Consortium. 2020. Glossary. https://www.pacificclimate.org/resources/glossary

1 Executive Summary

In 2017, the Rural Municipality (RM) of East St. Paul (ESP) made the important step of becoming a Federation of Canadian Municipalities Partners for Climate Protection community[4], developing and endorsing its Climate Action Plan. This plan sets emissions reductions targets for municipal government operations and the community as a whole. Since then, the RM has initiated climate actions under the plan and updated its emissions calculations with an assessment of how the reduction targets could be met. With a view of maintaining the high quality of life the RM offers and its natural assets, the RM has also taken the next step by embarking on a plan to prepare the community for a changing climate. This *Climate Change Risk and Vulnerability Assessment* is a strategic platform from which the RM has used to identify and plan the implementation of adaptation and resilience measures that will be documented in an upcoming Resiliency Plan and Implementation Strategy. While the risk assessment was underway and vulnerabilities were identified, RM staff identified opportunities and initiated various actions to increase ESPs resiliency. These actions will be reflected in the pending Resiliency Plan.

The Covid 19 pandemic has played a role in the assessment of climate change related risks and vulnerabilities for the RM of East St. Paul. The focus of staff participating in the evaluation of risks and identification of adaptation measures was shifted to Covid related matters, and the original public engagement plan was curtailed. However, the pandemic also reinforced how climate events have a significant potential to create multiplier effects. That is, the effects of these events are long lasting and can interact with each other as well as other emergency events like pandemics to reduce our resiliency as individuals and as a community.

Climate Change is occurring at an unprecedented rate, and is making the climate more variable and less predictable across Canada and within the RM. Changes to precipitation patterns and temperature patterns are expected to result in more extreme weather events, including floods, droughts and severe winds. Research suggests that climate change is likely to impact the nature of these natural hazards, by influencing the intensity, duration and magnitude of these events in unexpected ways.[5]

Climate related disaster events often extend beyond environmental effects, with profound socio-economic impacts. Climate events across the world, such as floods and droughts "contribute to tens of thousands of deaths, hundreds of thousands of injuries, and billions of dollars in economic losses each year."[4] In addition, the impact and vulnerabilities created by climate change and climate related disasters are not uniform, but influenced by a complex variety of social, political, economic and environmental factors. Thus, when evaluating risk and vulnerability, it is important to recognize that "some individuals, households, or groups are likely to be disproportionately affected by climate change or disaster."[4] In particular, increased vulnerability of two demographic groups, the elderly and children is linked to many climate related disaster events.

[4] Members of PCP are municipal governments that have agreed to implement GHG reductions through a process of emissions inventories, setting reduction targets, develop local action plans based on measurable actions to reduce emissions.
[5] O'Brien, K. et al. 2008. Disaster Risk Reduction, Climate Change Adaptation and Human Security. Report prepared for the Royal Norwegian Ministry of Foreign Affairs by the Global Environmental Change and Human Security (GECHS) Project, GECHS Report 2008:3.

ESP's Climate Change Risk and Vulnerability Assessment is grounded in a value-based framework that represents the community. These values are encapsulated in the Resiliency Vision and Goals (Appendix 2) that provide a reference point for considering the potential impacts of a changing climate on those attributes considered important by the community. The Vision and Goals will also provide context for the next stages; formalizing the Resiliency Plan and Implementation Strategy.

2 Background

2.1 Description of the Municipality

The RM of East St. Paul is a rural urban community located north of Winnipeg, with a population of 9,372 permanent residents.[6] The total area of the municipality is 42.1 km^2, with the south portion primarily comprised of urban residential neighborhoods along with land slated for future development. The majority of commercial businesses such as restaurants, a grocery store and other related services are located in nodes along the provincial highways. The municipality has 3,265 private dwellings, and the majority of residences are detached single family homes with an average household size of 2.9 individuals.[5] In the population aged 25 to 64 years, 69.1% have achieved a postsecondary certificate, diploma or degree, with 34.1% achieving a university certificate, diploma or degree at bachelor level or above.[5] The average total household income in 2015 was $179,485.[5]

The main mode of transportation for residents of the RM is private vehicle, as there is no public transportation or car-share service with the exception of a handy transit service accessed by less than 1% of the population. Of the 5,340 residents over the age of 15 that are active in the labor force (37% of population), 80% commute in private vehicles, with the majority working in Winnipeg.[6] Less than 5% commute via other methods such as active transportation or connect with the City of Winnipeg transit system (via drop off or park and ride).[5] The RM is governed by a Council and with professional administrative operational management staff to run the municipality on a day to day basis. As part of this the RM has in place an emergency response plan that is based on its experience with historic emergency and disaster events.

2.2 Climate Action and Preparedness

In 2017, the RM of East St. Paul made the important step of becoming a Federation of Canadian Municipalities Partners for Climate Protection community[7], developing and endorsing its Climate Action Plan. This plan sets emissions reductions targets for municipal government operations and the community as a whole. Since then, the RM has initiated climate actions under the plan and updated its emissions calculations with an assessment of how the reduction targets could be met. With a view of maintaining the high quality of life the RM offers and its natural assets, the RM has also taken the next step by embarking on a plan to prepare the community for a changing climate through the development of a community adaptation plan that is grounded in an assessment of vulnerabilities and risks faced by ESP.

[6] Statistics Canada. 2017. 2016 Census of Population – East St. Paul, Manitoba.

[7] Members of PCP are municipal governments that have agreed to implement GHG reductions through a process of emissions inventories, setting reduction targets, develop local action plans based on measurable actions to reduce emissions.

3 Approach and Method

The Climate Change Risk and Vulnerability Assessment (RVA) for the Rural Municipality of East St. Paul has been developed with regards to the milestones and requirements as established by the funding agency, the Federation of Canadian Municipalities (FCM) as well as applicable government and industry policy, standards, and guidance. This RVA considers potential effects from a changing climate on the ecological, social and economic aspects of the RM of East St. Paul including effects on its natural resources and ecosystem, its residents and businesses and municipal government (hereafter referred to as the "municipality" or RM).

The RVA is intended to address the following objectives:

- Outline the climate changes that are anticipated for the municipality;
- Identify possible risks to the municipality and residents and business of East St. Paul from a changing climate;
- Provide a framework for engagement and input into the identification of risks; and
- Lay the foundation for a Resiliency Plan and its implementation for the municipality.

The RM has framed its approach to climate resiliency as a defined three-staged activity.

Figure 1: Stages of East St. Paul's Planning for Climate Adaptation and Resiliency

3.1 Objective of Each Stage

1. Risk and Vulnerability Assessment

This stage is defined by the following activities:

- Understanding and contextualizing likely trends in climate conditions over a 10 to 30-year time horizon;
- Assessing the potential impacts of changes in climate conditions on the municipality; and
- Identifying risks and vulnerabilities that these changes may have on the municipality and the larger region may face.

2. Resiliency Plan

This stage is defined by the following activities:

- Reflecting on the community risks and vulnerabilities in relation to climate change; and
- Identifying actions to mitigate risks and vulnerabilities.

These actions may include the development of policy, capital undertakings, operational measures, adjusting or developing plans or training of municipal staff. It will also including raising awareness and educating residents, institutions and businesses in the community, developing partnerships with surrounding communities and other levels of government.

3. Implementation Strategy

This stage is defined by the following activities:

- Prioritizing actions; and
- Identifying how resiliency and adaptation measures can be implemented, including responsible parties, timelines and budgets.

3.2 Method

The assessment of potential climate changes and associated effects on ESP included the following components:

1) Framing of a Resiliency Vision and Goals for the municipality based on engagement with council, staff and community representatives;
2) Identifying potential climate changes for ESP and surrounding region referencing scientific and peer-reviewed information sources;
3) Characterizing predicted changes as 'Climate Events' to assist in the assessment of impacts and implications for ESP;
4) Identifying potential interactions between aspects and assets of value to ESP and Climate Events; and
5) Developing assessment criteria to provide for consistent evaluation of identified risks and vulnerabilities and applying the criteria to the identified interactions.

Framing the RVA within a values-based framework provided by ESP's Resiliency Vision and Goals provides a means of contextualizing and prioritizing the potential effects the community may experience. This approach promotes a comprehensive and focused assessment that reflects the specific attributes of the community, the climate risks it is likely to face and the areas it is most vulnerable.

3.3 Scope

The scope of RVA for the RM of East St. Paul has been developed with regards to the milestones and requirements as established by the funding agency (FCM) as well as applicable government and industry policy, standards, and guidance. This RVA considers potential effects of a changing climate on the ecological, social and economic aspects of the RM of East St. Paul.

The RVA has been developed considering the expected interactions from changes in climate and the existing environmental and land use conditions. This includes direct effects on the natural and man-made biophysical environment and potential indirect effects on socio-economic conditions within the RM for residents, business and the municipality itself. Effects that are assessed in relation to human health, socio-economic conditions, and physical and cultural heritage are those effects that are linked to a changing climate.

3.4 Assessment Boundaries

3.4.1 Area Boundaries

For the purpose of assessing the geographic extent of potential effects that are expected to occur, the following spatial and geographic boundaries have been defined:

- Localized – Direct and indirect effects that will be contained within a defined area of ESP, such as a single neighborhood;
- Rural Municipality – Direct and indirect effects that are projected to extend across all or affect a significant portion of ESP; and
- Regional – The direct and indirect effects of a changing climate that will be felt across the region and include the ESP.

3.4.2 Temporal Boundaries

For the purpose of the risk and vulnerability assessment, the following temporal boundaries have been defined:

- Now to 2030 where predicted climate changes will continue to be observed
- 2031- 2050 where climate will change with the rate and extent dependent on global greenhouse gas emissions.[8]

3.5 Engagement

Community representatives and RM staff were engaged during the project to discuss their visions for a resilient East St. Paul and identify goals to achieve that vision. RM Staff were also engaged in identifying climate change related risks to municipal assets and operational activities. Both staff and community representatives provided feedback on the implications of the predicted climate on the community as a whole and individual residents, business, and institutions.

The Climate Change Adaptation Steering Committee was the primary contact for staff engagement. The committee is comprised of a cross-section of RM staff members from both Administration and Operations, as well as a Council Representative. Staff engagement also occurred with select RM individuals who are not members of the Steering Committee but may have useful knowledge on risk areas. During workshops, staff were asked to evaluate the impacts of hazards on areas of RM responsibilities using a risk matrix, including transportation infrastructure, water treatment, emergency response, and land development. They also looked at the impacts on areas that were not necessarily RM responsibility, but have an overarching implication on ESP, such as energy supply, communications and the highways leading to the community.

Community engagement (Appendix 1) involved the Climate Change Adaptation Advisory Committee, a nonpolitical body of RM residents and business owners. The Advisory Committee represents a cross-section of the community (residential, rural residential, commercial/industrial, agricultural, recreation, and youth). The committee aided the Climate Change Adaptation unit by providing a community view on potential risk areas, as well as vulnerabilities that residents and businesses would face in terms of a changing climate.

[8] Without a “sharp decline in greenhouse gas emissions by 2030, global warming will surpass 1.5°C in the following decades, leading to irreversible loss of the most fragile ecosystems, and crisis after crisis for the most vulnerable people and societies.” (IPCC. 2018. Global Warming of 1.5°C.An IPCC Special Report)

The original engagement strategy was to provide the community an opportunity to participate through in-person workshops and open houses, but this was set aside due to the pandemic.

3.6 Information Sources for the Risk and Vulnerability Assessment

Sources of information used to identify and assess potential climate change and the related risks and vulnerabilities for the RM of East St. Paul included the following:

- Risks identify from the experiences and knowledge of RM staff;
- The RM's Emergency Response Program;
- Engineering and other studies such as those evaluating utilities and infrastructure assets;
- Local area reports;
- Community planning documents;
- Ongoing input from the Climate Adaptation Advisory Committee; and
- Input from Public Engagement Program regarding this project

The full details on the sources of information as well as details on the engagement sessions used for the assessment can be found in Appendix 1.

3.6.1 Other Information Sources

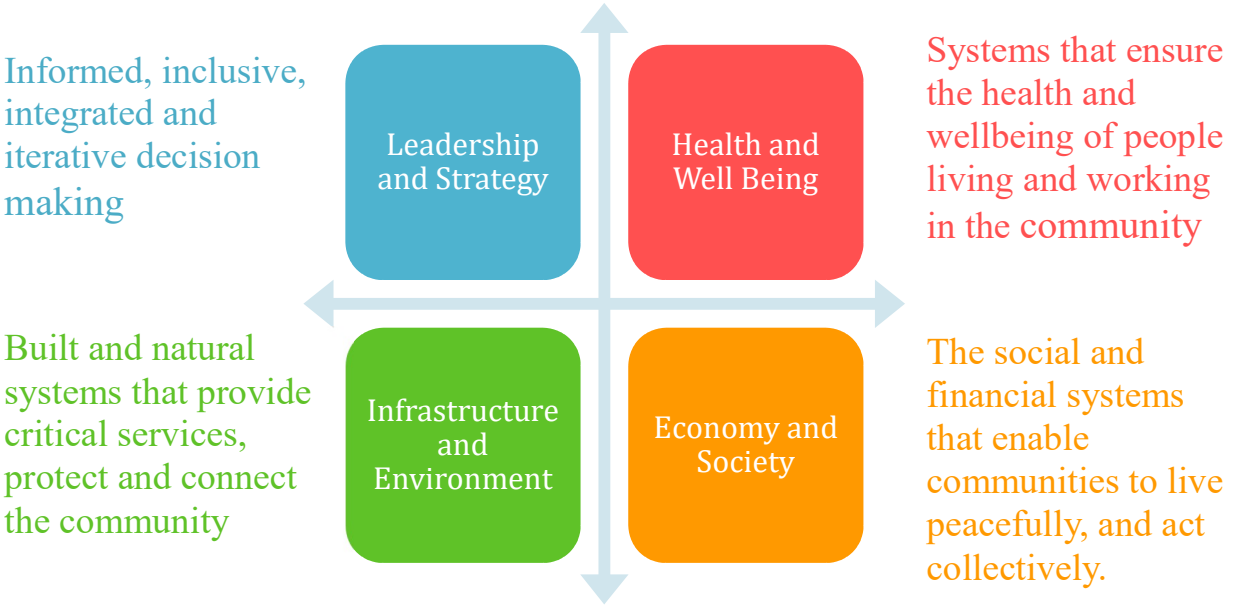
Information from studies listed above has been supplemented with additional information generated from GeoView, the RM's Geographic Information System database.

4 East St. Paul's Resiliency Vision and Goals

4.1 Context

ESPs resiliency vision statements and goals (Appendix 2) were co-developed with the RM's Climate Change Adaptation Steering Committee and public Advisory Committee, with input from Council. They draw inference from our partners, our network, and global frameworks. [9] In doing so they help anchor ESPs actions with those of others building a broader framework of resiliency that reflects back on us, making our community even stronger. The goals acknowledge that choices today have long-term impacts on our quality of life, the environment, and the economy. The needs and interests of the residents, businesses, and institutions of East St. Paul were a core element in their framing. These goals also recognize our interdependencies with the natural environment and neighboring municipalities and reflect that ESP is a member of a broader provincial, national, and world community.

Figure 2: Rockerfeller Foundation's 4 dimensions of community resilience (Arup 2015):



4.1.1 Scope and Purpose

The goals are based on three vision statements that frame the climate resiliency objectives for ESP. They reflect that resilience is based on the idea that adaptability and resiliency is a foundational characteristic of a vibrant and healthy community. A changing climate is likely to bring unprecedented risks and new opportunities for our community - affecting our people, our assets, the economy, our natural environment, access to resources, the dependability of our utilities, and influence our capacity to respond to emergencies. Setting goals for resiliency will help the community as a whole to be best positioned for the future.

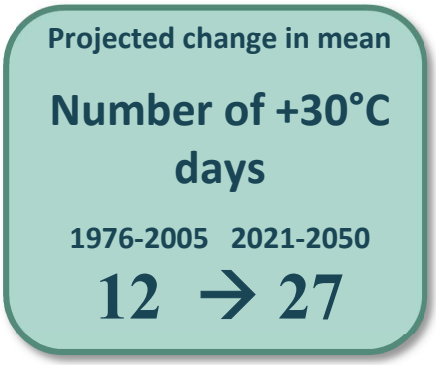
[9] The Resiliency Vision and Goals for ESP draw on the work of the Rockerfeller Foundation in defining the key characteristics of resilient cities. The goals also draw on the UN Sendai Framework for Disaster Reduction 2015-2030 that both Canada and Manitoba reference for disaster reduction planning. The Federation of Canadian Municipalities. Guide for Integrating Climate Change Considerations into Municipal Asset Management is also referenced.

The Resiliency Vision and Goals provide a frame of reference to plan for the future of our community within the context of a changing climate. They provide a context from which to consider and evaluate climate risks for the community. At the next stage they will provide a basis for the climate adaptation and resiliency plans and priorities, design, and at the last stage guide the evolution of the emergency response program.

5 Predicted Climate Changes in East St. Paul

Climate models are used to predict the changes in climate which may occur in the future. There are many types of climate models, using multiple models provides a range of future projections rather than one specific outcome. Typically, scientists work with several models at once, called an ensemble, that provide them with a range of effects and takes into account the natural variability of climate. This is used to reduce some effects of model uncertainty. "Climate models are considered successful only if they can recreate to a high degree the averages, extremes, and seasonal patterns that match up with observed climate."[10] While there is variability in the projections between the models, they all are consistently predicting that there will be changes in our climate as GHG emissions continue accumulating in the atmosphere. For the purpose of the RVA, climate data for ESP was primarily sourced from the Prairie Climate Centre's *Climate Atlas of Canada.* The Climate Atlas provides a dataset using a 24 model ensemble with the BCCAQv2 statistical method provided by the Pacific Climate Impacts Consortium (PCIC). The ensemble used by the *Climate Atlas of Canada* is the same that is used by Environment and Climate Change Canada (ECCC).

Although climate and weather are interconnected, when looking at the risk and vulnerabilities that come with climate change, it is important to recognize the difference between the two. Weather is how the atmosphere behaves over a short period. It can change often and sometimes rapidly. In contrast, climate stays relatively stable. Climate instead shows us the long-term patterns and trends that are relatively predictable and steady, compared to weather.



5.1 Temperature

Mean temperatures are expected to increase by an average of 2◦C from 2021-2050. Higher temperatures year round will result in an increased number of frost-free days, and it is likely that freezing weather will occur later and thawing earlier in the year. It is projected that the number of very hot days (+30 ◦C) will increase substantially, resulting in increased heat waves and implications for heat related health impacts such as heat stroke. The number of very cold days (-30) is projected to decrease substantially, by an average of 10 days per year. This can have implications regarding pest and virus spread, which typically are eradicated during the coldest winter months.

[10] Climate Atlas of Canada. 2020. *Climate Change Projections. https://climateatlas.ca/climate-change-projections*

Table 1: Predicted Temperature Changes for ESP and Surrounding Region

Variable	Period	Historic Mean (1976-2005)	Predicted Mean (2021-2050)	Change
Mean Temperature (◦C)	Annual	2.7	5	↑ 2.3 ◦C
Mean Temperature (◦C)	Spring	2.6	4.8	↑ 2.2 ◦C
Mean Temperature (◦C)	Summer	18.4	20.5	↑ 2.1 ◦C
Mean Temperature (◦C)	Fall	4.7	6.9	↑ 2.2 ◦C
Mean Temperature (◦C)	Winter	-15.3	-12.5	↑ 2.8 ◦C
Cooling Degree Days (days)	Annual	186.7	348.4	↑ 161.7
Very Hot Days (+30 ◦C days)	Annual	12	27	↑ 15 days
Very Cold Days (-30 ◦C days)	Annual	17	7	↓ 10 days
Tropical Nights (days)	Annual	2	7	↑ 5 days

Note. Data for Predicted Temperatures adapted from Prairie Climate Centre (2019).

5.2 Precipitation

The average precipitation rate is expected to increase in all seasons. It is anticipated that precipitation patterns will change, resulting in larger amounts of precipitation at once rather than scattered throughout a season. There is increased likelihood of more drought and longer periods without rain in the summer months (Table 2).

Table 2: Predicted Precipitation Changes for ESP and the Surrounding Region

Variable	Period	Historic Mean (1976-2005)	Predicted Mean (2021-2050)	Change
Precipitation (mm)	Annual	522	553	↑ 31 mm (6%)
Precipitation (mm)	Spring	114	125	↑ 10 mm (10%)
Precipitation (mm)	Summer	227	231	↑ 4 mm (2%)
Precipitation (mm)	Fall	117	125	↑ 9 mm (7%)
Precipitation (mm)	Winter	64	72	↑ 7 mm (12%)
Max 1-Day Precipitation (mm)	Annual	40	43	↑ 3mm (6%)

Note. Data for Predicted Precipitation Changes adapted from Prairie Climate Centre (2019).

5.3 Climate Events

Changes to temperature and precipitation patterns can provide favorable conditions for the development of extreme weather events. It is predicted that rain is more likely to be released in fewer larger events. This can result in flash or localized flooding. Too much precipitation at once can also result in water stress to plants, creating conditions for fungi and mold, destroying crops and vegetation. Longer, hotter summers lead to warmer surface temperatures, providing better conditions for convective thunderstorms. These conditions often generate destructive winds such as straight-line winds or tornadoes that can occur alongside thunderstorms.

In terms of winter storms, it is projected that there will be a decrease in blizzards or snowstorms and an increase in winter rain events, ice storms, and hail. These conditions can combine with frozen soils to create potential for local winter flooding. Rains cannot be absorbed by frozen soils, increasing runoff rates which may not properly drain due to infrastructure being blocked by snow or ice.

Looking at the predicted changes in climate resulted in extrapolation into nine related Climate Events (Table 3). These events were defined so that RM staff and the community could easily reflect on and think about possible risks and vulnerabilities associated with various interactions between predicted climate changes.

Table 3: Climate Events and Pattern Changes

Climate Events	Impacting Variables			
	Increased Annual temperature	Changing Temperature Patterns	Increased Precipitation Rates	Changing precipitation patterns
Drought	✓	✓		✓
Wildfire	✓	✓		✓
Heatwave	✓	✓		✓
Blizzard/Ice Storm		✓	✓	✓
Heavy Rain/Flooding		✓	✓	✓
High Winds/Tornados	✓	✓		✓
More Freeze/Thaw Cycles	✓	✓		✓
More frost-free days	✓	✓		✓
Shorter Periods of -30 degree days	✓	✓		

5.3.1 Signs of Changing Climate Patterns East St. Paul

The scope of the risk assessment focused on changes that are expected to be seen between now and 2050. However, there are signs that many of the predicted changes are beginning. In the past few years the RM has experienced increased winter rain and ice storms. The event in October of 2019 caused serious damage to the existing tree canopy. The RM experienced extended droughts in the summers of 2019 and 2020, both of which had implications for terrestrial and aquatic vegetation survival and invasive weeds. Slumping of slopes on private and public lands has been noticed in Silver Springs Park. The effect of drought on the shallow root turf grasses covering the slopes and loss of cohesion in dry soils increases the likelihood and magnitude of subsequent events. Extended freeze thaw cycles and a fall ice storm in 2019 have been noted by staff, contributing to increased maintenance requirements and costs associated with managing icy roads and sidewalks as well as extensive tree damage. The RM is also seeing increased prevalence of invasive species that are that are surviving due to shorter periods of extreme cold (air temperatures below -30°C). The northward migration of the Green Ash Borer and the high rates of tree mortality that result is a case in point. Ash trees make up 30-40% of the tree canopy in the RM.

6 Risk and Vulnerability Assessment

The identification of potential risks is a two-part process. The first part involves identifying how specific Climate Events can interact with various assets and attributes of the community. The second part considers the types of changes that can occur. Potential changes to the environmental and socio economic effects to the RM were considered within the context of ESP's Resiliency Vision and Goals.

6.1 Initial Screening of Potential Interactions

The initial screening step was used to evaluate the potential interaction between various climate change scenarios and assets and aspects of value to the community (Appendix 3). The assets and aspects of value were identified with the assistance of public Advisory Committee, the Steering Committee and individual staff members. These interaction tables were used to help focus more detailed discussion and analysis of the potential impacts of a changing climate on ESP.

6.2 Identification of Potential Changes

Through research and community discussions, potential changes that might arise from a changing climate include those to the natural environment (aquatic and terrestrial) and the socio-economic environment (includes the man-made physical setting e.g. land use). Table 4 describes the range of potential changes that were identified through literature reviews and discussions with community members and staff.

Table 4: Potential Changes

Changes to the Natural Environment	Changes to the Socio-economic environment
• Degradation of the atmospheric environment (i.e., air quality) • Changes to groundwater including quality and/or quantity; • Changes to surface water including quality and/or quantity and seasonal timing • Loss of aquatic habitat for invertebrates, fish, reptiles and aquatic mammals; • Changes to the terrestrial landscape, including vegetation and wildlife habitat; • Direct and indirect effects on wildlife including potential for disturbance and mortality; and • Increased presence of invasive species that damage the native environment.	• Changes in current uses of land and resources; • Effects to human health and safety related to changes in the environment such as to atmospheric conditions, water quality and quantity, or the availability of foods; • Adverse effects on land use / loss of value • Adverse impacts to private and public property that result in damage, maintenance, repair restoration or replacement; • Changes to socio-economic conditions directly or indirectly related to changes in the environment including loss of employment and increased living costs. • Loss of use of infrastructure or resources; and • Loss of enjoyment of place such as the degradation of parks and natural areas and cultural resources;

6.3 Characterizing the Effects of a Changing Climate

Based on the evaluation of potential interaction between the various climate scenarios and aspects of importance for ESP, the effects were evaluated. Criteria used to characterize and consider the significance of the possible effects were:

- Direction of change (i.e., type of effect) either positive or negative;
- Duration of time that the effect occurs;
- Magnitude or intensity of the effect;
- Spatial extent of the effect;
- Frequency of the effect (i.e., how often the effect occurs);
- Reversibility of the effect (i.e., if the effect can be reversed);
- Ecological context (degree of adverse influence on the ecosystem); and
- Likelihood of the significant effect occurring, which refers to the probability of occurrence (i.e., the risk of an event occurring) and is described as very unlikely, unlikely, likely, or very likely.

Each of these criteria were qualified by applying a three-level ranking system to distinguish between: short-term and long-term effects; less intense and more intense effects; localized and widespread effects; infrequent and frequently occurring effects; effects that are reversible and effects that are permanent; and effects that have little impacts on the ecosystem and effects that disrupt ecological functions and relationships. Definitions for the three-level ranking of each assessment criterion are provided in Table 6. The characterization of effects in relation to each Climate Event are detailed in Appendix 4.

6.3.1 Key Risks and Vulnerabilities Identified

The assessment of risks and vulnerabilities stemming from each Climate Event was derived from various sources, with staff, Steering Committee, and Advisory Committee members providing input. Each Climate Event was considered in relation to external factors, RM infrastructure and assets, RM operations and programs including its existing emergency response program and impacts on RM residents, businesses, and institutions.

'*Climate Events*' are various weather-related scenarios that are likely to occur in ESP as a result of a changing climate.

They were identified to help think about what the impacts of climate change are for the community.

External factors were considered such as the potential effect of the Climate Event on energy supply, communications, transportation (highways and railways) corridors that connect the community to the surrounding region, and other external factors (fuel farm and schools). RM Assets and Implications of the Climate Event on operational capacity of the RM were reviewed in relation to each Climate Event. The implications for RM buildings, roads and the active transportation network, land drainage systems, water and wastewater systems, and natural assets including ponds, streams, recreational areas, and vegetation were considered. The implications for RM operational activities were also considered including the effects on staff. Other matters such as insurance and fiscal capacity were also evaluated. The implications on residents, business, and institutions within the RM were looked at from the perspective of the reliability of utilities, impacts on assets such as property damage, health and wellness, the economy, and resources highly valued by the community. The analysis also considered the implications on emergency services during a Climate Event. Key risks from the individual Climate Events are outlined in Table 5.

Vulnerabilities to ESP stem from the fiscal capacity of individuals, institutions, and governance as well as geophysical properties such as groundwater availability and the capacity of the water treatment system. Other identified vulnerabilities include the capacity of the land drainage system and local runoff conditions (i.e. in-between individual properties), the lack of a public transportation system and disconnected active transportation system, adaptability of existing vegetation, the steepness of slopes in various public and private locations (i.e. Silver Spring Park), and the implications regarding demographics of the community (young and elderly populations). In addition, the aging conditions of transportation infrastructure throughout the RM and the condition and capacity of transportation and communication infrastructure outside the municipality offer more complex and poorly defined vulnerabilities.

Table 5: Key Risks from Climate Events

Climate Events	Key Risks
Drought	• Stress on vegetation leading to loss of ground cover and/or trees • Bank slumping and erosion causing further loss of vegetation • Reduced water levels in ponds concentrates nutrient levels leading to excessive algae and other aquatic plant growth, decaying water quality and aesthetics • Potential for increased water demand
Wildfire	• Damage to wildlife habitat and green space • Air quality problems • Potential for property damage and safety risks • Loss of life
Heatwave	• Brown outs due to power demand • Adverse health response from heat stroke and other heat related illnesses • Increased aquatic plant growth in ponds and streams, decaying water quality and aesthetic values • Loss of life
Blizzard/Ice Storm	• Raised insurance rates or inadequate insurance causing financial hardship for individuals and the RM. • Loss of service due to downed power lines and potential for property damage • Inability to access services and supplies
Heavy Rain/Flooding	• Raised insurance rates or inadequate insurance causing financial hardship for individuals and the RM • Overwhelming storm and/or wastewater systems (public and private) leading to infrastructure and property damage • Health and safety risks including those from compromised wells

Climate Events	Key Risks
High Winds/Tornados	• Loss of life • Infrastructure and property damage • Loss of power and/or communications service
More Freeze/Thaw Cycles	• Reduced lifespan of infrastructure and increasing maintenance costs due to frost heave • Icy surfaces leading to increased motor vehicle accidents, slips and falls
More frost-free days	• Increased risks of pests, viruses due to less winter kill • Opportunities for longer growing season
Shorter Periods of -30 degree days	• Increased risks of pests, viruses due to less winter kill

In general terms, ESP is an affluent community, however individual households may be at risk from increased economic challenges due to rising insurance rates, damage repairs or increased maintenance costs that are likely to stem from most of the Climate Events identified. Extensive research has identified that individuals can be more vulnerable to a changing climate than the population as a whole due to particular circumstances. Older and health-compromised individuals in our community as well as children are more vulnerable to extreme weather events such as heat waves. The elderly and those with physical limitations are more at risk of serious injury from slips and falls, which may increase with the icy surfaces accompanying winter rain events and increased freeze thaw cycles. These kinds of Climate Events can also increase isolation in this cohort by reducing their ability to interact in the community.

Increased magnitude of precipitation events such as heavy rains pose risks for flooding and damages. While southern Manitoba has invested heavily in flood protection with the Floodway, this system is primarily designed for flooding during open water season. It is not well suited for early spring floods when ice flows are present and it does not prevent back flooding caused by downstream ice jams. Compromised or under-capacity local land drainage systems are also at risk to the impacts of Climate change. Systems can be compromised through a variety of means such as culvert icing and woody debris blockages. ESPs systems were designed prior to climate change considerations and may not have capacity for more severe future rain events. Land drainage systems will be further tested under conditions where soils are frozen during winter or pan hardened from an extended drought. The lack of absorptive capacity of such soils, will further increase run-off rates, resulting in larger volumes of water entering the land drainage systems in a shorter period of time.

6.3.2 Compounding Factors Influencing ESP's Vulnerability

One key observation from the risk assessment discussions was that more than one Climate Event occurring within a close time horizon or within physical proximity to each other could result in compounding effects. In such a scenario, there is a greater likelihood that the level of vulnerability of the community would be increased after each event.

It was noted that as insurance rates rise, this may adversely affect the municipality's and the resident's capacity to access private insurance as a risk mitigation strategy. This may cause more individuals to be under-insured and the RM to elect to self-insure and thus be more vulnerable. Repeated damage costs could also limit the economic capacity to implement resiliency measures such as retrofitting homes and properties in order to reduce risks from Climate Events.

Another identified factor in the level of vulnerability to the effects of a changing climate was the impact of individual vulnerability on the overall community vulnerability. It was noted in discussions that the less vulnerable individual residents, business, and institutions are, the more resilient the community as a whole will be. In other words, the most vulnerable residents of the RM heavily determine the overall vulnerability of the community.

Factors that may influence vulnerability would be the capacity for individual change i.e.) the individual's ability to consider new risks and accept new approaches to problems. Stage of life, education, and personal experience were thought to potentially influence an individual's capacity and interest in adapting to change.

Table 6: Description of Assessment Criteria and Levels of Potential Effect

	Assessment Criteria	Range of Criteria	Level of Effect and Definition
Severity	**Duration** (period of time the effect occurs)	Short-Term	**S** - The potential effect results from short-term events or activities such as the time required to complete a discrete component (e.g., culvert installation), seasonal or annual construction, maintenance, or rehabilitation activities (i.e., a timeframe of hours or days).
		Medium-Term	**M** - The potential effect is likely to persist until the completion of construction and rehabilitation activities (i.e., a timeframe several weeks to months).
		Long-Term	**L** -The potential effect is likely to persist beyond the completion of construction and rehabilitation activities into the operations and maintenance phase of the Project (i.e., a timeframe of multiple years).
	Magnitude (degree or intensity of the change)	Negligible or Small	**S** - A change that is not likely to have a definable, detectable or measurable potential effect above baseline (i.e., potential effect is within a normal range of variation) or is below established thresholds of acceptable change (e.g., water quality guideline).
		Medium	**M** – A change that will have a potential measurable effect that can be detected with a well-designed monitoring program; but is only marginally beyond standards/guidelines or established thresholds of acceptable change.
		Large	**L** – A change that will have potential effects that are easily observed, measured, and described (i.e., readily detectable without a monitoring program) and are well beyond guidelines or established thresholds of acceptable change.
	Extent (Spatial Boundary)[4]	Localized	**Localized** - The physical space or directly affected area in which the change occurs is a small portion the RM
		RM	**RM** – The change and its effects are limited to the RM or large sections of the RM
		Regional Area	**Regional** – The change and its effects occur on a regional basis.
	Reversibility	Reversible (short- term)	**Y** – Potential effect is readily reversible over a relatively short period of time (days to weeks)
		Reversible (long- term)	**Y (Long Term)** - Potential effect is potentially reversible but over a longer period of time (weeks to months)
		Irreversible	**N**- Potential change results in permanent effects. (years or no change)

	Assessment Criteria	Range of Criteria	Level of Effect and Definition
Severity	**Direction of Change** (type of effect)	Negative	**-** Net loss (adverse or undesirable change) to the component.
		Positive	**+** Net benefit (or desirable change) to the component.
	Socio-ecological Context (degree of adverse influence on the social and ecological ecosystem)	Small	**S –** Effect results in minimal disruption of ecological functions and social well-being in the RM.
		Medium	**M –** Effect results in some disruption of ecological functions and social well-being in the RM.
		Large	**L –** Effect results in disruption of critical ecological functions and social well-being in the RM
Likelihood	**Likelihood** (the probability or change of the event occurring)	Small	**S** - The potential effect seldom occurs, or is unlikely to occur
		Medium	**M** – The potential effect is common, and likely to occur
		Large	**L** – The potential effect is almost certain to occur

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Appendix 1– Information Sources for the RVA

Information	Source	Description
Engagement	RM of East St. Paul's Climate Adaptation Steering Committee – Staff and Council representative	The committee provided guidance for the development of the Vision and Goals, the identification of risks and vulnerabilities particularly from the standpoint of municipal assets and operations.
	RM of East St. Paul's public Climate Change Adaptation Advisory Committee	The committee provided guidance for the development of the Vision and Goals, the identification of risks and vulnerabilities from the standpoint of the broader community.
	Staff Workshops	One on one staff workshops and working meetings
	Council	Council approved the Adaptation/Resiliency Plan project, the terms of reference for the Climate Change Adaptation Steering Committee and the public Climate Change Adaptation Advisory Committee to guide the process. Council also provide input into the ESP Climate Resiliency Vision and Goals
	Community	Outreach through communications (Community News, E-Blasts)
RM Studies	Emergency Response Plan	RM East St. Paul Municipal Emergency Plan RM East St. Paul Emergency Response Plan Water Utility
	Infrastructure Studies	RM of East St. Paul Sewage Treatment Plant Upgrade/Expansion RM of East St. Paul Water System Re-Assessment
	Stormwater water quality studies	RM East St Paul's Surface Water Quality Monitoring Report (2019)
	GHG Inventory	RM East St. Paul 2018 Greenhouse Gas Emissions Inventory
Climate Adaptation Frameworks	Association of Bay Area Governments	Regional Resilience Toolkit July 2019
	Quest	Building Community Resilience: Key Considerations and Lessons Learned from Twelve Canadian Communities.
	The Summit Foundation	Essential Capacities for Urban Climate Adaptation: A Framework for Cities. Innovation Network for Communities.
	Association of Bay Area	Regional Resilience Toolkit July 2019
	Rockerfeller Foundation	City Resilience Framework.

Information	Source	Description
	United Nations; Canada	Sendai Framework for Disaster Reduction 2015-2030
	Federation of Canadian Municipalities.	Guide for Integrating Climate Change Considerations into Municipal Asset Management
	Government of Manitoba	Climate and Green Plan
Climate Model Data	Climate Atlas of Canada	Projected climate for ESP and region
	Pacific Climate Impacts Consortium (PCIC)	Downscaled projections of daily precipitation and temperature data from 24 climate models using two carbon emission scenarios
	Prairie Climate Centre	City of Selkirk Climate Change Adaptation Strategy
Other Information Sources	Statistics Canada	Demographic data
	Statistics Canada	Transportation data
	Cooks Creek Conservation District	Master Plan
	Red River Planning District	RRPD Development Plan
	ESP Planning Documents	R.M of East St. Paul Zoning By-law 2009-04 Lot Grade Drainage By-law

Engagement Sessions Dates:

RM of East St. Paul's Climate Adaptation Advisory Committee

Meeting	Date
Meeting #1	October 30, 2019
Meeting #2	December 4, 2019
Meeting #3	January 29, 2020
Meeting #4	March 11, 2020
Meeting #5	May 27, 2020
Meeting #6	July 23, 2020

RM of East St. Paul's Climate Adaptation Steering Committee

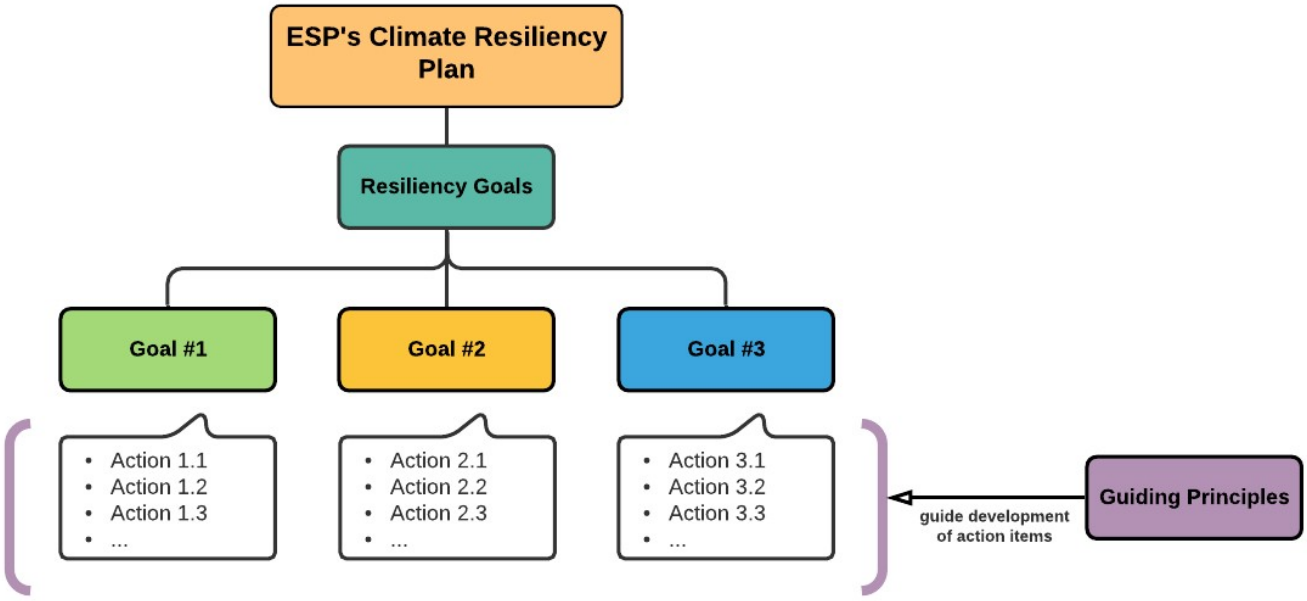
Meeting	Date
Meeting #1	October 28 2019
Meeting #2	December 2, 2019
Meeting #3	February 4, 2020
Meeting #4	May 21, 2020
Meeting #5	August 27, 2020

Appendix 2–
ESP's Resiliency Vision and Goals

Overview

Our Resiliency Vision and Goals help us consider our climate risks, identify our climate adaptation priorities, design our resiliency plans and priorities, and guide the evolution of our emergency response program. They ultimately help us plan and make decisions on the future of our community. Resiliency Vision and Goals were not framed in isolation; they draw inference from our partners, our network and global frameworks. In doing so they help anchor ESPs actions with those of others building a broader framework of resiliency that reflects back on us, making our community even stronger.

To further support the implementation of the goals, Guiding Principles provide context for the development and implementation of action items that comprise the Plan.



ESP's Resiliency Vision and Goals

The ESP Climate Resiliency Plan is guided by the following strategic goals.

Vision/Goals #1

We are proactive in our resiliency, considering the effects of a changing climate and the potential for impacts on our community, our neighbours and our families. Thus we will:

- Help our community grow sustainably by being well-managed, taking an integrated and long-term decision-making approach that considers health, safety, the economy and the environment.
- Engage with our community and incentivize the behaviors of our residents and businesses to reduce exposure and vulnerability to risks and build resilient infrastructure.
- Continue to build strong collaborative networks with residents, business, neighbouring municipalities and other levels of government to best serve the community so we are prepared and can rebound from events and changes.

Vision/Goals #2

Our community is more resilient when we are mentally and physically strong so we;

- Engage and educate our residents on a changing climate to foster awareness, empower preparedness, and boost self-sufficiency.
- Build a strong community by supporting active recreation and mental well-being through our cultural and social networks.
- Curate partnerships and promote inclusivity and resourcefulness so that we are all resilient together.

Vision/Goals #3

Our natural environment is an important asset that can both help to reduce risks and be adversely affected by changes. To that end we will:

- Plan our community for a sustainable future by protecting and enhancing the natural ecosystems within our boundaries.
- Strategically invest in green spaces and choose our vegetation wisely so that is resilient to drought, storm and diseases.
- Leverage natural landscapes to support infrastructure capacity, recognizing that this investment also provides natural areas for our community to enjoy, quality habitat for a variety of species and other ecosystem benefits.

Guiding Principles

Guiding principles provide direction on implementation of action items and reflect municipal values.

Integrated approach – A science-based planning approach that takes a multi-stakeholder perspective and assesses socio-economic, health and safety, and environmental outcomes from decisions and actions.

Co-benefits – Along with potential impacts of decisions, consider associated benefits like health and well being, energy efficiencies, emissions reductions and ecosystem gains from the choices made.

Reflective - Constructive flexible thinking on how we conduct our business considering climate change implications, assessing when and how to adapt, transform and evolve systems or strengthen processes to support robust outcomes.

Build better - whether it be new builds, upgrades or replacement of existing infrastructure we will look to build for appropriate redundancy, resiliency and thus benefit from the long-term savings and service continuity this will bring.

Continual Improvement - Invoke continual improvement practices to improve our planning and capacity to ensure we are able to respond to natural disasters and other events.

Collaborate – Build trust to build cooperative ventures and partnerships within our community, with all levels of government, and with other stakeholder groups to improve our preparedness and resiliency.

Resourceful –Think long-term and apply our available resources efficiently and effectively, while taking advantage of partnerships and programs to enable widespread resiliency.

Monitor- Measure and track progress towards goals, and reflect for well managed, and evidence based policy and decision-making. Adapt and change approaches based on performance feedback.

Appendix 3– Interaction Matrix: Climate Change Projections and Potential Interaction with Infrastructure and Operations

Climate change projections have been distilled into 9 climate Events

	1	2	3	4	5	6	7	8	9
Key Projected Climate Changes – events and long-term trends	**Spring blizzard creating icy conditions**	**Summer heatwave with little precipitation**	**Heavy rain over a short period of time with frozen soils**	**High winds/tornados**	**Droughts creating risk of grass fire**	**More annual moisture with longer hotter summer dry spells**	**Longer period of frost free days**	**Longer periods of hovering freeze/thaw cycles (icing)**	**Higher winter temperatures (shorter periods of -30 degree days)**
RM Infrastructure									
Transportation									
• Road structure		x	x	x		x		x	
• Road surface	x	x	x	x		x	x	x	
• Sidewalks	x	x	x	x			x	x	
• Active Transportation Trails	x	x	x	x	x		x	x	
Waste Water									
• Sewer lines						x			
• Lift stations	x		x	x		x			
• Sewage treatment plant			x	x		x			
• Digester			x	x		x			
• Back up power system	x		x	x					
• Outfall	x		x			x			
Storm Sewer systems									
• Retention ponds	x	x	x			x	x	x	x
• Drains	x		x			x	x	x	
• Culverts	x		x			x	x	x	
• Outfalls (into ponds)	x	x	x			x	x	x	
Water supply									
• Wells & aquifer		x	x			x			
• Water plant + reservoir	x			x					
• Water distribution lines									
Recreation Facilities / Other Assets									
• Arena	x	x	x	x		x	x		
• Outdoor rinks	x		x	x	x		x	x	
• Daycare (including operations)	x	x	x	x		x			x
• Seniors (including operations)	x	x	x	x		x			
• Admin Building	x		x	x		x			
○ Back up power system	x		x	x					
• Fire Hall	x		x	x		x			
○ Back up power system	x		x	x					
• Operations Building	x		x	x		x			
• Former Operations Building			x	x		x			

	1	2	3	4	5	6	7	8	9
Key Projected Climate Changes – events and long-term trends	**Spring blizzard creating icy conditions**	**Summer heatwave with little precipitation**	**Heavy rain over a short period of time with frozen soils**	**High winds/tornados**	**Droughts creating risk of grass fire**	**More annual moisture with longer hotter summer dry spells**	**Longer period of frost free days**	**Longer periods of hovering freeze/thaw cycles (icing)**	**Higher winter temperatures (shorter periods of -30 degree days)**
Community Green Space									
• Parks	x	x	x	x	x	x	x	x	
• Public green spaces (boulevards etc)	x	x	x	x	x	x	x	x	
• Play equipment	x		x	x	x			x	
• Landscaped areas and street trees	x	x	x	x	x	x	x	x	x
• Natural areas - Riparian forests	x	x	x	x	x	x	x	x	x
• Biodiversity	x	x	x			x	x	x	x
Operations									
Engineering (ie Design rqmts)		x	x	x	x	x	x	x	x
Planning (land dev. considerations)		x	x	x		x	x	x	
Emergency response incl. equipment	x	x	x	x	x			x	
Maintenance & construction	x		x	x		x	x	x	
Snow clearing	x		x	x			x	x	
Recreational programs	x	x	x	x		x	x	x	x
Communications	x	x	x	x	x			x	
Heavy equipment	x		x		x				
Other non-RM infrastructure									
Energy supply									
- Natural gas									
- Electrical	x			x		x			
- Vehicle & other fuels	x		x	x					
Telecommunications & internet	x		x	x					
Highways leading to and from RM	x		x	x	x			x	
Rail line	x	x	x	x	x	x		x	
Fuel farm				x	x				
Schools	x	x	x	x	x	x		x	x

* (climate change on this infrastructure these can directly or indirectly affect the RM and influence severity or likelihood of an impact)

Appendix 4: Climate Event Tables

Hazard**: Blizzard/Ice Storm** (blizzard creating icy conditions with loss of power (i.e. spring, fall))

Description: Event lasts 24-36 hrs. Clean-up 1-3 days with residual cleanup over next several weeks/months. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	Loss of service from downed power towers (regional)	I	-	M	L	Regional	Y (long term)	M	S	
	Loss of service from service from downed power lines (localized)	D	-	S	S-M	Local	Y	S	M	
	Intermittent power from ice on lines	D	-	S	S	RM	Y	S	L	Based on past experience
- Vehicle & other fuels	If highways closed fuel supplies may diminish with limited ability to resupply	I	-	S	M	RM-Regional	Y	S-M	S	Fuel storage within RM (gas station) Refueling capacity in Winnipeg
Telecommunications & internet	Loss of service (RM does not have internet service, residents lose access to cell tower service)	D	-	S-M	M-L	RM-Regional	Y	M-L	M	Impedes information exchange between residents and RM, regional communication systems (weather warnings) unavailable
Highways leading to and from RM	Inaccessible due to road conditions	D	-	S	M	RM	Y	S-M	M	Could impede timeliness of access to health services
Rail line	Damage to line, derailment, other	I	-	S-M	S-L	Localized	Y (long term)		S	Dependant on nature of accident.
Fuel farm	Fuel spill from ice damage	D	-	S	M-L	Localized	Y (long term)		S	
Schools	Accessibility, damage to	D	-	S	S-M	RM	Y (long term)		M	
RM infrastructure & assets										
Buildings[1]	Damage to RM owned buildings	D	-	S-M	M	RM	Y (long term)	S-M	M	Projected changes to climate are anticipating more ice events
Road Surface	reduced lifespan of infrastructure due to use of de-icing chemicals (road salt)	I	-	M-L	M	RM	Y	S-M	L	Pitting of surfaces, damage during clearing, salting. Reduces the lifespan of the road surface causing early failure.
	Impassible due to ice	D	-	S	S	RM	Y	S	L	Reduced road safety
Storm sewers (ditches and drains)	Potential to block culverts and drains that could impede drainage later and cause localized flooding.	I	-	S	M	RM	Y	S	S	Individual properties could be effected.
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	Power loss	I	-	S	L	RM	Y	M-L	S	Loss of treatment capacity at plant and risk of sewage backup from failure of lift stations. 16-24 hr back up gen set for STP. Mobile gen set for 3 smaller lifts stations and mobile gen set for larger station.
Water Treatment Plant	Power loss	I	-	S	M	RM	Y	M-L	S	Back up power in place to run plant and well #7. Loss of power results in failure of chlorine and UV treatment systems. Fuel supply is 48 hrs. Loss of power could result in untreated water but water supply unlikely to be affected.
Sidewalks and Trail (surface)	Impassible	D	-	S	M	RM	Y	S	L	-
	Pitting or surfaces, damage during clearing, reduced lifespan of infrastructure due to salt	I	-	M-L	M	RM	Y	S-M	L	-
Recreational Parks and Green Spaces	Icing causing damage to play equipment and outdoor rinks	D	-	S	S	RM	Y	S	S	Low likelihood of damage to play equipment, but temporary damage to rink surfaces.

Street trees, parks and green spaces, riparian areas	Downed branches and trees	D	-	M	M	RM	Y	M	L	
	Damage to wildlife habitat in naturalized areas, potential risk of injury or property damage	I	-	M	M	RM	N	M	M	Damage to trees can reduce their resiliency making them susceptible to pests and potentially reducing diversity within the RM
RM Operations										
RM fuel tanks	Loss of access to fuel from loss of power	I	-	S	L	RM	Y	M	L	If fuel is not available for snow removal and operating equipment then storm cleanup cannot occur in a timely fashion.
RM Internet	Communications – loss of access to server (email and information)	I	-	S	L	RM	Y	M	L	Without internet service the RM cannot communicate and provide updates to residents and cannot access critical infrastructure information.
RM Staff	Staff unable to get to work	D	-	S	M	RM	Y	S-M	L	Staff unavailable to manage utilities and undertake operational activities.
Roads, sidewalk and park maintenance	Increased operational demand Snow clearing of impassable roads Ice removal - Slippery pathways and roads Clogged drains	D	-	S	S	RM	Y	S-M	L	Increased snow and debris removal costs, wear and tear on equipment, overtime costs,
Snow storage	Additional hauling (time and costs) because of build up of previous snow	I	-	M	S	RM	Y	S	L	
Emergency response	Reduced response time, access limitations	D	-	S	L	RM	Y	M-L	L	Potential of adverse outcomes for individual residents.
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	L	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M	M	RM	Y	M	M	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Power outages resulting from ice build-up leading to adverse impacts for individuals	I	-	S-M	M	Localized	Y	S-M	M	
	Loss of building heat resulting in damage (pipes freezing)									
	No water for those on well service									
	Inability to charge phones/electronics which limits communication.									
Assets	Ice damage to properties requiring repairs.	D	-	S-M	M	Localized	Y	S	M	
	Damages private trees – safety and loss of enjoyment	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
	Damages private trees – increased energy use	I	-	S-M	M	Localized	Y (Long Term)	M	S	loss of summer shade and winter wind block increasing energy costs for home owners

Resources	Loss of access to goods and services.	I	-	S	S	RM	Y	S	L	
Economy	School and services closed leading to loss of economic activity.	I	-	S	S	RM	Y	S	L	
	Higher insurance rates due to increased damages.	I	-	L	M-L	Regional	N	M-L	M	
	People unable to leave their homes to go to work	I	-	S	S	RM	Y	S	M	
People	People unable to leave their homes for goods/services, higher impacts on the elderly and children.	I	-	S	S	RM	Y	S	L	
	People unable to leave their homes results in feelings of isolation	I	-	S	S	RM	Y	S	L	
	Concern during event and impacts of property damage result in increased stress/mental health issues.	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Slower response leads to reduced health outcomes	I	-	M-L	L	Localized	Y	M-L	L	
	Unsafe responses to lack of power-propane heating, carbon monoxide.	I	-	M-L	L	Localized	Y	M-L	L	
	Could trap people in residences, schools, businesses.	I	-	S	S	Localized	Y	S	S	
	Could cause traffic accidents due to poor road conditions.	I	-	S	S-M	Localized	Y	S-M	L	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: Wildfire**

Description: Event lasts a few hours to a few days. Localized event. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	No impact projected									
	(possible) Loss of service from downed power lines (localized)	D	-	S	S-M	Local	Y	S	S	Depending on location/spread of grass fire
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	May be inaccessible depending on location of fire	D	-	S	M	RM	Y	S-M	M	Could impede timeliness of access to health services
Rail line	No impact projected									
Fuel farm	Fuel spill/explosion from fire	D	-	S	M-L	L	Y (long term)		H	
Schools	Accessibility, damage to	D	-	S	S-M	RM	Y (long term)		M	Depending on location/spread of grass fire
RM infrastructure & assets										
Buildings[1]	No impact projected									
Road Surface	May be inaccessible depending on location of fire	D	-	S	S	RM	Y	S	L	
Storm sewers (ditches and drains)	No impact projected									
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	No impact projected									
Water Treatment Plant	No impact projected									
Sidewalks and Trail (surface)	Impassible, fire damage	D	-	S	M	RM	Y	S	L	-
Recreational Parks and Green Spaces										
Street trees, parks and green spaces, riparian areas	Fire damage to trees, parks and green spaces areas.	D	-	M	M	RM	Y	M	L	
	Damage to wildlife habitat in naturalized areas, potential risk of injury or property damage	I	-	M	M	RM	N	M	M	Damage to trees can reduce their resiliency making them susceptible to pests and potentially reducing diversity within the RM
RM Operations										
RM fuel tanks	No impact projected									
RM Internet	No impact projected									
RM Staff	No impact projected									
Roads, sidewalk and park maintenance	No impact projected									
Snow storage	No impact projected									
Emergency response	Emergency response needed to control fire and prevent from spreading to developed areas	D	-	S	L	RM	Y	M-L	L	
RM Other										

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	L	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M	M	RM	Y	M	M	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Power outages if fire takes down electrical lines	I	-	S-M	M	Localized	Y	S-M	M	
Assets	Fire/smoke damage to residents	D	-	S-L	M	Localized	Y	M	M	Depends on location of grass fire, extent of damage
	Damages private trees – safety and loss of enjoyment	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
	Damages private trees – increased energy use	I	-	S-M	M	Localized	Y (Long Term)	M	S	loss of summer shade and winter wind block increasing energy costs for home owners
Resources	Loss of agricultural/farming land limiting yield	I	-	S	S	RM	Y	S	L	
Economy	Local farmers/agriculture lose resources	I	-	S	S	RM	Y	S	L	
	Higher insurance rates due to increased damages.	I	-	L	M-L	Regional	N	M-L	M	
People	Possible need for evacuation	I	-	S	S	RM	Y	S	L	
	Concern during event and impacts of property damage result in increased stress/mental health issues.	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Possibility for evacuation	I	-	M-L	L	Localized	Y	M-L	L	
	Could trap people in residences, schools, businesses.	I	-	S	S	Localized	Y	S	S	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: Heavy Rain/Flooding**

Description: Event lasts a few hours. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply	No impact projected									
- Natural gas	No impact projected									
- Electrical	No impact projected									
- Vehicle & other fuels	If highways inaccessible fuel supplies may diminish with limited ability to resupply	I	-	S	M	RM-Regional	Y	S-M	S	Fuel storage within RM (gas station) Refueling capacity in Winnipeg
Telecommunications & internet	Loss of internet service	D	-	S-M	M-L	RM-Regional	Y	M-L	M	Impedes information exchange between residents and RM, regional communication systems (weather warnings) unavailable
Highways leading to and from RM	Inaccessible/dangerous due to road conditions	D	-	S	M	RM	Y	S-M	M	Could impede timeliness of access to health services
Rail line	Damage to line, derailment, other	I	-	S-M	S-L	L	Y (long term)		S	Dependant on nature of accident.
Fuel farm	No impact projected									
Schools	Accessibility, damage to, flooding conditions	D	-	S	S-M	RM	Y (long term)		M	
RM infrastructure & assets										
Buildings[1]	Accessibility, damage to, flooding conditions RM owned buildings	D	-	S-M	M	RM	Y (long term)	S-M	M	Projected changes to climate are anticipating more ice events
Road Surface	Accessibility concerns due to overflowing street drainage system	I	-	M-L	M	RM	Y	S-M	L	Pitting of surfaces, damage during clearing, salting. Reduces the lifespan of the road surface causing early failure.
Storm sewers (ditches and drains)	Overflow due to high water load	I	-	S	M	RM	Y	S	L	Individual properties may be effected.
Sewer Infrastructure	Overflow/backup due to high water load	I	-	S	M	RM	Y	S	L	Individual properties may be effected.
Sewage Treatment Plant	Power loss	I	-	S	L	RM	Y	M-L	S	Loss of treatment capacity at plant and risk of sewage backup from failure of lift stations. 16-24 hr back up gen set for STP. Mobile gen set for 3 smaller lifts stations and mobile gen set for larger station.
Water Treatment Plant	No impact projected									
Sidewalks and Trail (surface)	Accessibility, damage to, flooding conditions	D	-	S	M	RM	Y	S	L	
Recreational Parks and Green Spaces	Accessibility, damage to, flooding conditions	D	-	S	S	RM	Y	S	S	Low likelihood of damage to play equipment, but temporary damage to rink surfaces.
Street trees, parks and green spaces, riparian areas	Flooding conditions	D	-	M	M	RM	Y	M	L	
	Destabilization of banks due to erosion, flooding	I	-	M	M	RM	N	M	M	
RM Operations										
RM fuel tanks	Loss of access to fuel from loss of power	I	-	S	L	RM	Y	M	L	If fuel is not available for operating equipment then storm cleanup cannot occur in a timely fashion.

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
RM Internet	Communications – loss of access to server (email and information)	I	-	S	L	RM	Y	M	L	Without internet service the RM cannot communicate and provide updates to residents and cannot access critical infrastructure information.
RM Staff	No impact projected									
Roads, sidewalk and park maintenance	Increased operational demand Clogged drains	D	-	S	S	RM	Y	S-M	L	Increased debris removal costs, wear and tear on equipment, overtime costs,
Snow storage	No impact projected									
Emergency response	Reduced response time, access limitations	D	-	S	L	RM	Y	M-L	L	Potential of adverse outcomes for individual residents.
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	L	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M	M	RM	Y	M	L	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Power outages leading to adverse impacts for individuals	I	-	S	M	Localized	Y	S-M	M	
	Pressure on drain/sewage systems	D	-	S	M	Localized	Y	S-M	L	
Assets	Flood damage to residences	D	-	S-M	M	Localized	Y	S	M	
	Flood damage to vehicles	I	-	S-M	M	Localized	Y (Long Term)	M	S	
	Property damage due to poor drainage	I	-	S-M	M	Localized	Y (Long Term)	M	S	
Resources	Impact spring planting season, delay crop planting	I	-	S	S	RM	Y	S	L	
Economy	Flooding and damage to businesses, public services making services inaccessible	I	-	S	S	RM	Y	S	L	
	Higher insurance rates due to increased damages.	I	-	L	M-L	Regional	N	M-L	M	
People	Concern during event and impacts of property damage result in increased stress/mental health issues.	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Road closures limiting emergency response	I	-	M-L	L	Localized	Y	M-L	M	
	Could cause traffic accidents due to poor road conditions.	I	-	S	S-M	Localized	Y	S-M	M	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1]Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: More annual moisture with longer summer dry spells**

Description: Event will last years, is a slow change. Regional. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	Increased energy usage for air conditioning.	D	-	M	S-M	Regional	Y	S	L	
	Overload of energy grid causing power loss/brownout	I	-	S	S-M	Local/Regional	Y	M	M	
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	Damaged road surface due to extreme heat	D	-	S	M	RM	Y	S-M	M	
Rail line	Railway track expansion, causing tracks to expand, stretch and deform	I	-	S-M	S-M	Local	Y (long term)		S	
Fuel farm	No impact projected									
Schools	Damage to foundation/structural integrity, accessibility and flooding conditions	D	-	M	M	Localized	Y (long term)	S-M	S	
RM infrastructure & assets										
Buildings[1]	Damage to foundation/structural integrity of RM owned buildings	D	-	M	M	RM	Y (long term)	S-M	S	
Road Surface	Damaged road surface due to extreme heat (buckling)	D	-	S	M	RM	Y	S-M	M	
Storm sewers (ditches and drains)	Overflow due to high water load during heavy precipitation events	I	-	S	M	RM	Y	S	L	Individual properties may be effected.
Sewer Infrastructure	Overflow/backup due to high water load during heavy precipitation events	I	-	S	M	RM	Y	S	L	Individual properties may be effected.
Sewage Treatment Plant	Overflow/Overcapacity due to stormwater entering the wastewater system	I	-	S	M	RM	Y	S-M	S	The plant can run at lower capacity- will result in effluent that is more concentrated. Low risk of flooding.
Water Treatment Plant	Increased demand of water usage	D	-	M	M	RM/Regional	Y	M-L	S	
Sidewalks and Trail (surface)	Damage to sidewalks/trails due to extreme heat Accessibility, damage to, flooding conditions, erosion	D	-	S	M	RM	Y	S	L	-
Recreational Parks and Green Spaces	Accessibility, damage to, flooding conditions	D	-	S	S	RM	Y	S	S	Low likelihood of damage to play equipment, but temporary damage to rink surfaces.
Street trees, parks and green spaces, riparian areas	Drought causing vegetation loss	D	-	M	M	RM	N	M	L	Decrease biodiversity within the RM
	Low water levels in stormwater retention ponds	I	-	M	M	RM	Y	M	L	Can impact aquatic life, cause fluctuations in water quality (ie raise pH levels)

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
RM Operations										
RM fuel tanks	No impact projected									
RM Internet	No impact projected									
RM Staff	Reduce number of hours by outdoor workers/reduced productivity	I	-	S	M	RM	Y	S-M	L	Staff unavailable to manage utilities and undertake operational activities.
Roads, sidewalk and park maintenance	Reduced productivity of maintenance work	I	-	S	S	RM	Y	S-M	L	Increased snow and debris removal costs, wear and tear on equipment, overtime costs,
	Restrictions on water usage to maintain green space	I	-	M-L	M	RM/Regional	Y	S-M	M	
Snow storage	No impact projected									
Emergency response	Increased demand for emergency response resulting from heat-related illness as well as exacerbating pre-existing conditions	D	-	S	L	RM	Y	M-L	L	Potential of adverse outcomes for individual residents.
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	L	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M	M	RM	Y	M	M	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Increased energy demands	I	-	S	M	Localized	Y	S-M	L	
	Loss of power due to increased demand on the grid (brownouts)									
	More A/C needed to keep house cool									
	Increased water demand									Could lead to well depletion for some residents
	Pressure on drain/sewage systems	D	-	S	M	Localized	Y	S-M	L	
Assets	Dry ground causing foundation issues for homes.	I	-	M-L	M	Localized	Y (Long Term)	M	M	
	Damage to landscaping/trees on private property due to drought conditions	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
	Flood damage to residences	D	-	S-M	M	Localized	Y	S	M	
	Flood damage to vehicles	I	-	S-M	M	Localized	Y (Long Term)	M	S	
	Property damage due to poor drainage	I	-	S-M	M	Localized	Y (Long Term)	M	S	

Risk Identification and Assessment Risk Assessment of Hazards

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
Resources	Decrease to farming crop yields by up to 70%.	D	-	M-L	M-L	Localized	N	M-L	L	
	Impact spring planting season, delay crop planting	I	-	S	S	RM	Y	L	L	
Economy	Reduced work hours of workers	I	-	S	S	RM	Y	L	L	
	Local farmers and agriculture business loss of yield	I	-	L	M-L	Regional	N	M-L	M	
Environment	Grass fires	I	-	S-M	M	Localized	Y (Long Term)	M	M	
	Loss of vegetation	I	-	M-L	M	Regional	Y (Long Term)	M	L	Introduction of native plantings will help limit vegetation loss
People	Health impacts such as heat stroke, particularly affecting vulnerable populations.	I	-	S	S	RM	Y	S	L	
	Restrictions on recreational activities (i.e outdoor sports)	I	-	S	S	RM	Y	S	L	
	Concern during event and impacts of crop damage result in increased stress/mental health issues for Farmers/Local Agriculture	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Slower response leads to reduced health outcomes	I	-	M-L	L	Localized	Y	M-L	L	
	Could cause traffic accidents due to poor road conditions.	I	-	S	S-M	Localized	Y	S-M	L	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: Summer heatwave with little precipitation**

Description: Event lasts several weeks across the region. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	Increased energy usage for air conditioning.	D	-	M	S-M	Regional	Y	S	L	
	Overload of energy grid causing power loss/brownout	I	-	S	S-M	Local/Regional	Y	M	M	
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	Damaged road surface due to extreme heat	D	-	S	M	RM	Y	S-M	M	
Rail line	Railway track expansion, causing tracks to expand, stretch and deform	I	-	S-M	S-M	Local	Y (long term)		S	
Fuel farm	No impact projected									
Schools	Damage to foundation/structural integrity	D	-	M	M	Localized	Y (long term)	S-M	S	
RM infrastructure & assets										
Buildings[1]	Damage to foundation/structural integrity of RM owned buildings	D	-	M	M	RM	Y (long term)	S-M	S	
Road Surface	Damaged road surface due to extreme heat (buckling)	D	-	S	M	RM	Y	S-M	M	
Storm sewers (ditches and drains)	No impact									
Sewer Infrastructure	No impact									
Sewage Treatment Plant	Power loss due to brownout	I	-	S	S-M	Local/Regional	Y	M	M	The plant can run at lower capacity- will result in effluent that is more concentrated. Potential for wastewater not meeting standards to be released is low.
Water Treatment Plant	Increased demand of water usage	D	-	M	M	RM/Regional	Y	M-L	S	
	Potential drawdown of reservoir?									Sustained regional drought with high temperatures driving water usage across the aquifer.
Sidewalks and Trail (surface)	Damage to sidewalks/trails due to extreme heat	D	-	S	M	RM	Y	S	L	
Recreational Parks and Green Spaces		D	-	S	S	RM	Y	S	S/L	Low likelihood of damage to play equipment, but temporary damage to rink surfaces.
Street trees, parks and green spaces, riparian areas	Drought causing vegetation loss	D	-	M	M	RM	N	M	L	Decrease biodiversity within the RM
	Low water levels in stormwater retention ponds	I	-	M	M	RM	Y	M	L	Can impact aquatic life, cause fluctuations in water quality (ie raise pH levels)

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
RM Operations										
RM fuel tanks	No impact projected									
RM Internet	No impact projected									
RM Staff	Reduce number of hours by outdoor workers/reduced productivity	I	-	S	M	RM	Y	S-M	L	Staff unavailable to manage utilities and undertake operational activities.
Roads, sidewalk and park maintenance	Reduced productivity of maintenance work	I	-	S	S	RM	Y	S-M	L	Increased snow and debris removal costs, wear and tear on equipment, overtime costs,
	Restrictions on water usage to maintain green space	I	-	M-L	M	RM/Regional	Y	S-M	M	
Snow storage	No impact projected									
Emergency response	Increased demand for emergency response resulting from heat-related illness as well as exacerbating pre-existing conditions	D	-	S	L	RM	Y	M-L	L	Potential of adverse outcomes for individual residents.
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage (heat damage to structures, overheating of equipment)	I	-	M-L	M	RM	Y	M	S	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs (heat damage to structures, asphalt heave, overheating of equipment)	I	-	M	M	RM	Y	M	M	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Increased energy demands	I	-	S	M	Localized	Y	S-M	L	
	Loss of power due to increased demand on the grid (brownouts)									
	More A/C needed to keep house cool									
	Increased water demand									Could lead to well depletion for some residents
Assets	Dry ground causing foundation issues for homes.	I	-	M-L	M	Localized	Y (Long Term)	M	M	
	Damage to landscaping/trees on private property due to drought conditions	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
Resources	Decrease to farming crop yields by up to 70%.	D	-	M-L	M-L	Localized	N	M-L	L	
Economy	Reduced work hours of workers	I	-	S	S	RM	Y	S	L	
	Local farmers and agriculture business loss of yield	I	-	L	M-L	Regional	N	M-L	M	

Risk Identification and Assessment Risk Assessment of Hazards

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
Environment	Grass fires	I	-	S-M	M	Localized	Y (Long Term)	M	M	
	Loss of vegetation	I	-	M-L	M	Regional	Y (Long Term)	M	L	Introduction of native plantings will help limit vegetation loss
People	Health impacts such as heat stroke, particularly affecting vulnerable populations.	I	-	S	S	RM	Y	S	L	
	Restrictions on recreational activities (i.e outdoor sports)	I	-	S	S	RM	Y	S	L	
	Concern during event and impacts of crop damage result in increased stress/mental health issues for Farmers/Local Agriculture	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Slower response leads to reduced health outcomes	I	-	M-L	L	Localized	Y	M-L	L	
	Long duration brownouts	I	-	M-L	L	Localized	Y	M-L	S	Numerous cases of heat exposure due to lack of air conditioning that overwhelms emergency services

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: High Winds/Tornadoes**

Description: Event is sudden, and lasts a few minutes – an hour. Cleanup lasting days-weeks depending on damage. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	Loss of service from downed power towers (regional)	I	-	M	L	Regional	Y (long term)	M	M	
	Loss of service from service from downed power lines (localized)	D	-	S	S-M	Local	Y	S	M	
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	Loss of service (RM does not have internet service, residents lose access to cell tower service)	D	-	S-M	M-L	RM-Regional	Y	M-L	M	Impedes information exchange between residents and RM, regional communication systems (weather warnings) unavailable
Highways leading to and from RM	Inaccessible due to road conditions (i.e downed power lines blocking roads)	D	-	S	M	RM	Y	S-M	M	Could impede timeliness of access to health services
Rail line	Damage to line, derailment, other	I	-	S-M	S-L	L	Y (long term)		S	Dependant on nature of accident.
Fuel farm	Fuel spill from wind/tornado damage	D	-	S	M-L	L	Y (long term)		M	
Schools	Accessibility, damage to	D	-	S	S-M	RM	Y (long term)		M	
RM infrastructure & assets										
Buildings[1]	Damage to RM owned buildings	D	-	S-M	M	RM	Y (long term)	S-M	M	Projected changes to climate are anticipating more ice events
Road Surface	No impacts projected									
Storm sewers (ditches and drains)	No impact projected									
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	Power loss	I	-	S	L	RM	Y	M-L	S	Loss of treatment capacity at plant and risk of sewage backup from failure of lift stations. 16-24 hr back up gen set for STP. Mobile gen set for 3 smaller lifts stations and mobile gen set for larger station.
Water Treatment Plant	Power loss	I	-	S	M	RM	Y	M-L	S	Back up power in place to run plant and well #7. Loss of power results in failure of chlorine and UV treatment systems. Fuel supply is 48 hrs. Loss of power could result in untreated water but water supply unlikely to be affected.
Sidewalks and Trail (surface)	Impassible due to debris	D	-	S	M	RM	Y	S	L	
Recreational Parks and Green Spaces	Damage to play equipment/structures	D	-	S	S	RM	Y	S	M	
Street trees, parks and green spaces, riparian areas	Downed branches and trees	D	-	M	M	RM	N	M	L	
	Damage to wildlife habitat in naturalized areas, potential risk of injury or property damage	I	-	M	M	RM	N	M	M	Damage to trees can reduce their resiliency making them susceptible to pests and potentially reducing diversity within the RM
RM Operations										
RM fuel tanks	Loss of access to fuel from loss of power	I	-	S	L	RM	Y	M	L	If fuel is not available for operating equipment then storm cleanup cannot occur in a timely fashion.

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
RM Internet	Communications – loss of access to server (email and information)	I	-	S	L	RM	Y	M	L	Without internet service the RM cannot communicate and provide updates to residents and cannot access critical infrastructure information.
RM Staff	Safety concerns for RM staff working, particularly those outdoors	D	-	S	M	RM	Y	S-M	L	Staff unavailable to manage utilities and undertake operational activities.
Roads, sidewalk and park maintenance	Increased operational demand for storm clean up	D	-	S	S	RM	Y	S-M	L	Increased debris removal costs, wear and tear on equipment, overtime costs,
Snow storage	No impact projected									
Emergency response	Reduced response time, access limitations	D	-	S	L	RM	Y	M-L	L	Potential of adverse outcomes for individual residents.
	Individuals trapped in homes, vehicles	I	-	S	M	Localized	Y	M	M	
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	L	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M	M	RM	Y	M	M	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Power outages leading to adverse impacts for individuals No water for those on well service Inability to charge phones/electronics, which limits communication.	I	-	S-M	M	Localized	Y	S-M	M	
Assets	Damage to properties requiring repairs.	D	-	S-M	M	Localized	Y	S	M	
	Damages private trees – safety and loss of enjoyment	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
	Damages private trees – increased energy use	I	-	S-M	M	Localized	Y (Long Term)	M	S	loss of summer shade and winter wind block increasing energy costs for home owners
Resources	Loss of access to goods and services due to damage	I	-	S	S	RM	Y	S	L	
Economy	School and services closed leading to loss of economic activity if extremely damaged	I	-	S	S	RM	Y	S	L	
	Higher insurance rates due to increased damages.	I	-	L	M-L	Regional	N	M-L	M	
People	People needing to evacuate quickly or shelter in place	I	-	S	S	Localized /RM	Y	S	M	
	Concern during event and impacts of property damage result in increased stress/mental health issues.	I	-	S	S	RM	Y	S	L	
Emergency Conditions	Slower response leads to reduced health outcomes	I	-	M-L	L	Localized	Y	M-L	L	
	Could trap people in residences, schools, businesses.	I	-	S	S	Localized	Y	S	S	

Risk Identification and Assessment Risk Assessment of Hazards

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
	Could cause traffic accidents due to poor road conditions.	I	-	S	S-M	Localized	Y	S-M	L	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: Increased freeze thaw cycles** (i.e spring, fall)

Description: Event lasts 24-36 hrs and repeats over several weeks. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	No impact projected									
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	Inaccessible due to road conditions	D	-	S	M	RM	Y	S-M	M	Could impede timeliness of access to health services
Rail line	Damage to line, derailment, other	I	-	S-M	S-L	L	Y (long term)		S	Dependant on nature of accident.
Fuel farm	No impact projected									
Schools	No impact projected									
RM infrastructure & assets										
Buildings[1]	No impact projected									
Road Surface	Heaving, reduced lifespan of infrastructure due to shifting foundation.	I	-	M-L	M	RM	Y	S-M	L	Reduces the lifespan of the road surface causing early failure.
Storm sewers (ditches and drains)	Potential of heaving to change localized drainage conditions	I	-	S	S	RM	Y	S	S	Individual properties could be effected.
Storm sewers (ditches and drains)	Potential to block culverts and drains that could impede drainage later and cause localized flooding.	I	-	S	M	RM	Y	S	S	Individual properties could be effected.
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	No impact projected									
Water Treatment Plant	No impact projected									
Sidewalks and Trail (surface)	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	M-L	M	RM	Y	S	L	Increased infrastructure repair costs, increased infrastructure costs due to upsizing of standards
	Trip hazards	I	-	M-L	S	RM	Y	S	L	Increased infrastructure repair costs, increased infrastructure costs due to upsizing of standards
Recreational Parks and Green Spaces	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	S	S	RM	Y	S	L	May reduce lifespan of play surfaces, equipment and rinks and increase maintenance costs.
RM Operations										
RM fuel tanks	Heaving could shift fuel tanks	I	-	S	L	RM	Y	M	S	Increase maintenance costs
RM Internet	No impact projected	I	-	S	L	RM	Y	M	L	Without internet service the RM cannot communicate and provide updates to residents and cannot access critical infrastructure information.
RM Staff	Increased work load and more monitoring of surfaces required	D	-	S	M	RM	Y	S-M	L	Increase staffing demand
Roads, sidewalk and park maintenance	Increased operational demand Snow and ice clearing more difficult with uneven surfaces.	D	-	S	S	RM	Y	S-M	L	Increased costs, wear and tear on equipment, overtime costs
Snow storage	No impact projected									
Emergency response	No impact projected									

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
RM Other										
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	S	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M-L	M	RM	Y	M	L	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Private infrastructure	I	-	S-M	M	Localized	Y	S-M	M	
	Potential of shifting soils around wells									Increases opportunity for surface water infiltration and well contamination, increased maintenance demand
	Potential of heaving of septic fields, water and waste water lines									Increased maintenance demand
Assets	Potential of heaving to pavement conditions	D	-	S-M	M	Localized	Y	S	M	
	Potential of heaving at foundations increasing risk of cracking and water infiltration	I	-	S-M	M	Localized	Y (Long Term)	M	S	creating loss of aesthetics, reduced property value, safety issues
	Damages private trees – increased energy use	I	-	S-M	M	Localized	Y (Long Term)	M	S	loss of summer shade and winter wind block increasing energy costs for home owners
Resources	Change in growing season, increased crop kill	D	+/-	M-L	S	Regional	N	M	M	
Economy	Changes to agricultural seeding/harvest	D	+/-	M-L	S	Regional	N	M	M	
People	Higher impacts on those living rurally/farmers than those in urban areas	I	+/-	S	S	RM	Y	S	L	
	Ability to do more outdoor leisure and recreation activities	I	+	S	S	RM	Y	S	L	
Emergency Conditions	Could cause traffic accidents due to poor road conditions.	I	-	S	S-M	Localized	Y	S-M	L	

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: More frost-free days**

Description: Event is seasonal, regional. Slow change over many years. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	No impact projected									
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	M-L	M	RM	Y	S	L	Reduces the lifespan of the road surface causing early failure.
Rail line	Damage to line, derailment, other	D	-	S-M	S-L	L	Y (long term)		S	Dependant on nature of accident.
Fuel farm	No impact projected									
Schools	No impact projected									
RM infrastructure & assets										
Buildings[1]	Potential of heaving at foundations increasing risk of cracking and water infiltration	I	-	M-L	M	Localized	Y (Long Term)	M	S	
Road Surface	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	M-L	M	RM	Y	S	L	Reduces the lifespan of the road surface causing early failure.
Storm sewers (ditches and drains)	No impact projected									
Storm sewers (ditches and drains)	No impact projected									
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	No impact projected									
Water Treatment Plant	No impact projected									
Sidewalks and Trail (surface)	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	M-L	M	RM	Y	S	L	Increased infrastructure repair costs, increased infrastructure costs due to upsizing of standards
Recreational Parks and Green Spaces	Heaving, reduced lifespan of infrastructure due to shifting foundation.	D	-	S	S	RM	Y	S	S	May reduce lifespan of play surfaces, equipment and rinks and increase maintenance costs.
RM Operations										
RM fuel tanks	Heaving could shift fuel tanks	I	-	S	L	RM	Y	M	S	Increase maintenance costs
RM Internet	No impact projected									
RM Staff	Increased work load and more monitoring of surfaces required	I	-	S	M	RM	Y	S-M	L	Increase staffing demand
Roads, sidewalk and park maintenance	Increased operational demand, longer summer maintenance season	I	-	S	S	RM	Y	S-M	L	Increased costs, wear and tear on equipment, overtime costs
Snow storage	No impact projected									
Emergency response	No impact projected									
RM Other										

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
Infrastructure damage general	Insurance claims for infrastructure damage	I	-	M-L	M	RM	Y	M	S	Increase in insurances claims raises deductible costs and cost of insurance with potential financial implications for the RM
	Uninsured damage repairs	I	-	M-L	M	RM	Y	M	S	For items not covered under insurance. As insurance premiums rise the RM may elect to self-insure or not insure.
RM Residents, Businesses and Institutions										
Utilities	Private infrastructure	I	-	S-M	M	Localized	Y	S-M	M	
	Potential of shifting soils around wells									Increases opportunity for surface water infiltration and well contamination, increased maintenance demand
	Potential of heaving of septic fields, water and waste water lines									Increased maintenance demand
	Decreased heat use in winter months, more a/c in warmer weather	I	-	M-L	M	Regional	N	S	M	
Assets	Potential of heaving to pavement conditions	D	-	S-M	M	Localized	Y	S	M	
	Potential of heaving at foundations increasing risk of cracking and water infiltration	I	-	S-M	M	Localized	Y (Long Term)	M	S	
Environment	Longer growing season, for plants and vegetation.	D	+	M-L	S	Regional	N	M	M	
	Increased risk of pests, viruses due to less winter kill.	I	-	M-L	M	Regional	N	S-M	M	
Resources	Increased growing season for local agriculture, change in growing season leading to different crops	D	+/-	M-L	S	Regional	N	M	M	
Economy	Changes to agricultural seeding/harvest	D	+/-	M-L	S	Regional	N	M	M	
People	Higher impacts on those living rurally/farmers than those in urban areas	I	+/-	S	S	RM	Y	S	L	
	Ability to do more outdoor leisure and recreation activities	I	+	S	S	RM	Y	S	L	
Emergency Conditions	No impacts projected									

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant

Risk Identification and Assessment Risk Assessment of Hazards

Hazard**: higher winter temperatures (shorter periods of -30 days)**

Description: Event is seasonal, regional. Slow change over many years. Small (S), Medium (M), Large (L).

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
External										
Energy supply										
- Natural gas	No impact projected									
- Electrical	No impact projected									
- Vehicle & other fuels	No impact projected									
Telecommunications & internet	No impact projected									
Highways leading to and from RM	No impact projected									
Rail line	No impact projected									
Fuel farm	No impact projected									
Schools	Increased outdoor recreational opportunities	I	+	S	S	Regional	Y	S	M	
RM infrastructure & assets										
Buildings[1]	No impact projected									
Road Surface	No impact projected									
Storm sewers (ditches and drains)	No impact projected									
Storm sewers (ditches and drains)	No impact projected									
Sewer Infrastructure	No impact projected									
Sewage Treatment Plant	No impact projected									
Water Treatment Plant	No impact projected									
Sidewalks and Trail (surface)	No impact projected									
Recreational Parks and Green Spaces	Increased outdoor recreational opportunities	I	+	S	S	Regional	Y	S	M	
RM Operations										
RM fuel tanks	No impact projected									
RM Internet	No impact projected									
RM Staff	No impact projected									
Roads, sidewalk and park maintenance	No impact projected									
Snow storage	No impact projected									
Emergency response	No impact projected									
RM Other										
Infrastructure damage general	No impact projected									
	No impact projected									
RM Residents, Businesses and Institutions										

Risk Identification and Assessment Risk Assessment of Hazards

Topic (area that can be affected)	What can happen (impact)	Direct (D) or Indirect (I) effect	+ or - Change	Duration	Magnitude	Extent	Reversibility	Socio-Ecological Context	Likelihood	Comments
Utilities	Decreased heat use in winter months, more a/c in warmer weather	I	+/-	M-L	M	Regional	N	S	M	
Assets	No impact projected									
Environment	Longer growing season, for plants and vegetation.	D	+	M-L	S	Regional	N	M	M	
	Increased risk of pests, viruses due to less winter kill.	I	-	M-L	M	Regional	N	S-M	M	
Resources	Increased growing season for local agriculture, change in growing season leading to different crops	D	+/-	M-L	S	Regional	N	M	M	
Economy	Changes to agricultural seeding/harvest	D	+/-	M-L	S	Regional	N	M	M	
People	Higher impacts on those living rurally/farmers than those in urban areas	I	+/-	S	S	RM	Y	S	L	
	Ability to do more outdoor leisure and recreation activities	I	+	S	S	RM	Y	S	L	
Emergency Conditions	No impacts projected									

Consider Impact Areas: Financial, reputational, human resources, legal/policy, planning, stakeholder, insurance, communications, property/assets (including equipment)

[1] Administration, Operations Building, Fire Hall, Arena, Seniors, Day Care, Water Treatment Plant, Waste Water Treatment Plant