Village of New Maryland – Climate Change Adaptation Strategy

Final Report

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Prepared for:

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Your Environmental Trust Fund at Work

Glossary[1]

Adaptation	The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
CANGRD data	A meteorological data set for Canada based on a 10 km by 10 km grid, collected by Climate Change Hazards Information Portal.
Climate	Climate in a narrow sense is usually defined as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The classical period for averaging these variables is 30 years, as defined by the World Meteorological Organization. The relevant quantities are most often surface variables such as temperature, precipitation and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.
Climate Projection	A climate projection is the simulated response of the climate system to a scenario of future emission or concentration of greenhouse gases (GHGs) and aerosols, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realized.
Intergovernmental Panel on Climate Change	The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.
Mean Temperature	The mean temperature in degrees Celsius (°C) is defined as the average of the maximum and minimum temperature at a location for a specified time interval.
Mitigation	Used in relation to greenhouse gas (GHG) emissions, mitigation means implementing actions to reduce GHG releases to the atmosphere or increase carbon sequestration. For example, planting trees increases uptake of CO_2 (a GHG) from the atmosphere while reducing fossil fuel use decreases GHG releases.

[1] IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. 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* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

Protocol Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol	The Protocol provides guidance to systematically review historical climate information and project the nature, severity and probability of future climate changes and events. It also establishes the adaptive capacity of an individual infrastructure as determined by its design, operation and maintenance. It includes an estimate of the severity of climate impacts on the components of the infrastructure (i.e. deterioration, damage or destruction) to enable the identification of higher risk components and the nature of the threat from the climate change impact. This information can be used to make informed engineering judgments on what components require adaptation as well as how to adapt them e.g. design adjustments, changes to operational or maintenance procedures.
Representative Concentration Pathways (RCPs)	Scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover. The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios. Extended Concentration Pathways (ECPs) describe extensions of the RCPs from 2100 to 2500 that were calculated using simple rules generated by stakeholder consultations and do not represent fully consistent scenarios.

Abbreviations

°C	degrees Celsius
CCAS	Climate Change Adaptation Strategy
CCHIP	Climate Change Hazards Information Portal
CO_2	Carbon Dioxide
ECCC	Environment and Climate Change Canada
GHG	Greenhouse Gas
h	hour
IDF	Intensity-Duration-Frequency
IPCC	Intergovernmental Panel on Climate Change
km	kilometre
mm	millimeters
PIEVC	Public Infrastructure Engineering Vulnerability Committee
RSI	Risk Sciences International

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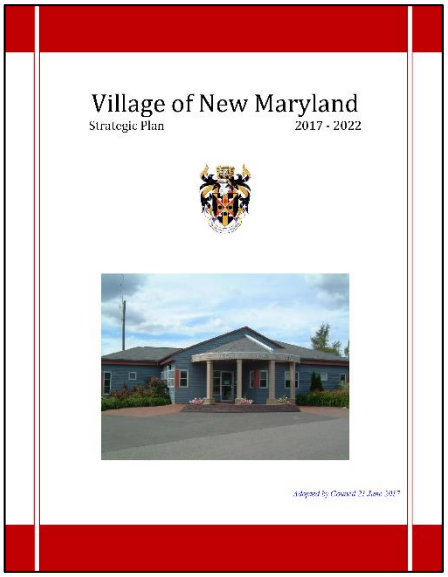
1.0 INTRODUCTION

The Village of New Maryland's (the Village) commitment to preparing for the climate of the future reached a new milestone with the Village of New Maryland Strategic Plan 2017-2022, which outlined the need to incorporate climate change considerations into the Village's planning and operations.



The Village Council set objectives to:

- To promote a green and energy efficient community that is resilient to climate change.
- To ensure policies and activities take into consideration issues of climate change, energy efficiency and water conservation.
- To ensure the Village serves as a role model to residents on issues of efficient energy use and water consumption practices.

As such, the Council committed to undertake development of a Climate Change Adaptation Strategy (CCAS) to identify, monitor and track its progress to mitigate and adapt to climate change.

Globally, greenhouse gas (GHG) emissions continue to climb and CO_2 continues to accumulate in our atmosphere at unprecedented rates. The Intergovernmental Panel on Climate Change (IPCC) released a special report in October of 2018 indicating that human activities have already caused approximately 1.0°C global temperature increase above pre-industrial levels, and we are likely to reach approximately 1.5°C by 2030 – 2052 (IPCC 2018). These changes sound relatively small however they are expected to cause significant changes in ecosystems and storm systems globally with a variety of secondary effects. The warming from human-caused GHGs will persist for centuries and even with reductions in GHGs in coming years; further long-term changes in the climate system, e.g., changes in precipitation, more freezing rain, or stronger/more frequent storms are expected. The IPCC special report confirmed that adaptation to climate change and improving resiliency of our communities to extreme climate events should be a priority to manage and reduce potential impacts.

This document is presented in 8 sections. Section 1 provides an overview and summary of climate data used in the analysis. Section 2 provides the methods and results of the vulnerability and risk assessment completed. Section 3 highlights existing plans and policies that interact with the Village's overall climate change strategy. Section 4 highlights key strategies for each of the high-risk climate change events identified. Section 5 provides GHG reduction opportunities (also known as mitigation) that can be investigated further by the Village. Section 6 provides an overview of monitoring and follow-up approach for the CCAS and Section 7 provides concluding remarks. References are summarized in Section 8.

1.1 APPROACH TO STRATEGY DEVELOPMENT

Stantec and the Village key stakeholders undertook an interactive approach to development of this CCAS for the Village. Development of the strategy included the following key interactive activities:

- Project initiation meeting to discuss and confirm objectives and relevant existing policies and plans;
- Interviews with local representatives to gain first hand insight into the local effects of climate change and gain their perspectives on the most important issues facing New Maryland;
- A 1-day workshop in August 2018 to review the Village's vision for the future and the risks to that vision from various climate events; and
- An open house on November 7, 2018 to provide an overview of the strategy and receive feedback from interested public and stakeholders.

Stantec completed research, data collection and review for the New Maryland CCAS, including the following:

- Review and consideration of existing Village plans and strategies;
- Historical review of local climate data and climate events (rain storms, floods, ice storms, hurricanes etc.) that have occurred, and the impacts that were experienced during those events;
- Potential climate change impacts that are possible in the New Maryland area;
- Review and summary of projected future climate in the New Maryland area, based on models endorsed by IPCC; and
- Review and analysis of the preliminary risk assessment completed during the workshop.

The CCAS incorporates this research, the Village's current priorities and best practice guidance for climate adaptation.

This document provides a framework for continued integration of adaptation in the evolution of the Village as well as a process for regular monitoring and follow-up on climate adaptation measures.

1.2 WHAT IS IMPORTANT TO THE VILLAGE OF NEW MARYLAND?

Overall, the Village has identified the vision of being a welcoming community that seeks to offer a progressive and healthy living environment and quality of life. The Village's values are highlighted in the Strategic Plan 2017-2022, as follows:

- Innovation;
- Environmental Friendliness;
- Safety;
- Neighborliness;
- Healthy Living; and
- Responsibility.

These values framed many of the conversations the Stantec team had with the Village Staff and are incorporated in the strategy.

1.3 CLIMATE ADAPTATION STRATEGY OVERVIEW

Overall, a community climate change adaptation strategy (CCAS) involves the following key steps:

- Defining the climate change (extreme weather events) scenarios the community will be exposed to.
- Identifying community values and priorities.
- Completing a vulnerability assessment of the community infrastructure, functions, and populations to evaluate how severe the impact from future climate events might be.
- Identifying adaptation policies and strategies to reduce vulnerability and increase resiliency of the community.

The two basic products of a climate change adaptation plan are a vulnerability assessment and adaptation strategies. The vulnerability assessment is an exercise to identify how climate change will impact the community and which elements are at risk.

The adaptation policies/strategies are developed through a collaborative process. In this case, there was the workshop with Village staff and Council and two public open house sessions. Ongoing consultation/collaboration is also envisioned going forward by integrating the strategy into future Village policies. The CCAS provides insight into how the community will address the impacts identified in the vulnerability assessment given its resources, goals, values, and needs considering regional context. The climate change adaptation strategies would be codified and implemented through several instruments that already exist in the community such as by-laws, municipal design and construction specifications and other strategic planning documents.

1.4 HISTORIC/CURRENT/PROJECTED CLIMATE PROFILE

1.4.1 Regional Overview

The Village of New Maryland falls in the Atlantic Maritime Ecozone shown in Figure 1. The Ecozone consists of Nova Scotia, Prince Edward Island, New Brunswick and the Gaspé region of Quebec. This Ecozone is the warmest in Atlantic Canada, with southern to mid-boreal climates. Mean winter temperatures range from -8°C to -2°C. Mean

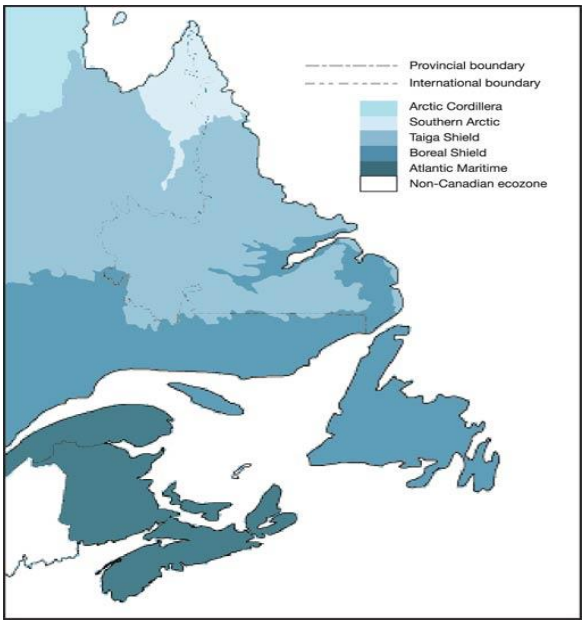


Figure 1 Terrestrial Ecozones of Atlantic Canada (Agriculture and Agri-Food Canada, 1999)

summer temperatures vary regionally between 13°C and 15.5°C. Mean annual precipitation ranges between 800 and 1500 mm. The New Brunswick climate varies with distance from the Gulf of St. Lawrence coastline, as both moist Atlantic air from the Bay of Fundy and humid winds blowing from the New England and Great Lakes – St. Lawrence Lowland regions influence the region. (Lemmen et al., 2008) The Village of New Maryland is in this region.

Stantec completed an overview of the current climate around New Maryland, how that climate has changed in recent decades, and how the climate is projected to change in the coming decades under the effects of global climate changes.

1.4.2 Local Climate Data Sources

The most valuable resource for defining an area's climate is to review local weather station data. New Maryland itself does not have a weather station that can be used to provide historical climate data. There are three nearby weather stations with historical data covering various time periods, as pictured in Figure 2.

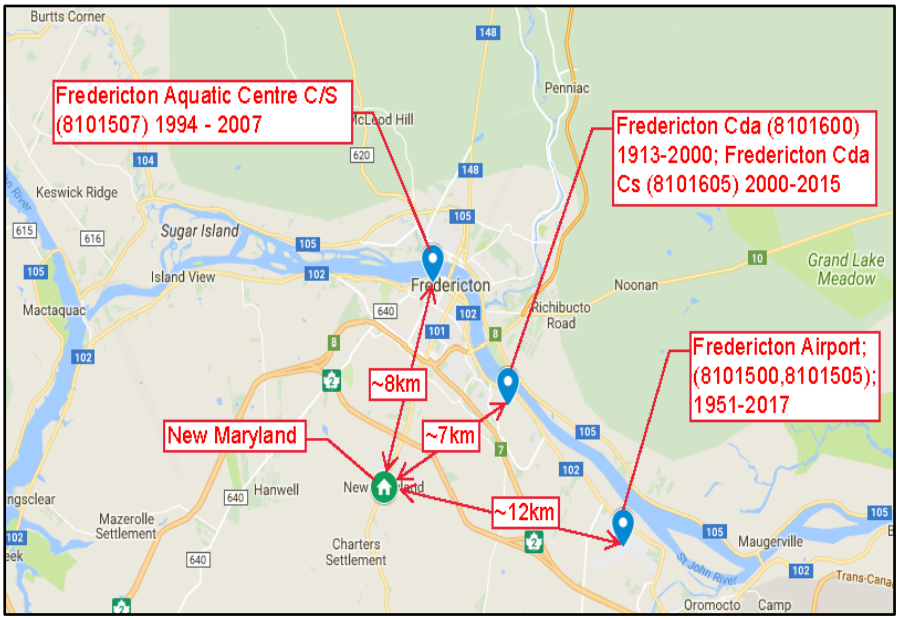


Figure 2 Site Location and Proximity to Closest Weather Stations

Climate data for these weather stations were obtained through the Climate Change Hazards Information Portal (CCHIP) created by Risk Sciences International (RSI). In addition to assembled climate data from weather stations, CCHIP also publishes data sets for the entire country, on a 10km by 10km grid – known as CANGRD data. This gridded data was developed in a collaboration between Natural Resources Canada and Environment and Climate Change Canada (ECCC), and although data from a real weather station is preferable, this CANGRD data interpolates data from nearby stations, and is well accepted and researched. Where available, the CANGRD data was used when investigating the historical climate and climate projections of New Maryland – supporting information from nearby weather stations was used where appropriate.

The future climate projections Stantec performs most often use IPCC GHG emission scenarios of Representative Concentration Pathways (RCP) 8.5 which presumes that current trends in GHG emissions continue and RCP 4.5 which presumes that some global reductions in GHG emissions occur in the future.

1.4.3 Current Climate

The current climate (as defined by the 1981 to 2010 Canadian Climate Normals data, Environment Canada) around New Maryland, includes cool winters and hot summers. In the summer, the average daytime high temperatures peak in July at around 25°C, the record high temperature was in August 1935 at nearly 39°C, and there is an average of 7.5 days per year where temperatures reach over 30°C. In the winter, the average daytime low temperatures are lowest in January at around -14°C, the record low temperature occurred in January 1925 at around -39°C, and there is an average of 17.5 days per year where temperatures fall below -20°C.

New Maryland receives fairly consistent levels of precipitation across the four seasons, with November, May and January being the months with the most precipitation. When considering annual precipitation, it should be noted that snowfall depth equates to a liquid depth of precipitation by a factor of about 10mm snow to 1 mm precipitation. The average annual precipitation around New Maryland is about 1,100 mm, with a record daily rainfall of about 110 mm.

There is an average of 200 frost free days in New Maryland each year. The average annual windspeed is around 12 km/h with spring being the windiest months. From 1980 to 2009 there have been seven confirmed tornadoes within 50 km of New Maryland, with two reaching F2 classification on the Fujita Scale – equating to windspeeds between 181 km/h and 253 km/h. The storm centers of fourteen tropical disturbances have come within 100 km of New Maryland since 1851-2017, one disturbance had hurricane intensity (1953), and two had tropical storm intensity (1991 and 2014).

Winter storms and particularly ice storms, have historically been some of the most damaging events in the New Maryland area, causing power outages and impacting the safety of roads. Large winter snowfalls of greater than 25 cm of accumulation have occurred at around 1 day per year based on the 1981 to 2010 weather station data from the Fredericton Airport station. The occurrence of notable ice storms is not as well tracked at weather stations, however a review of news articles and consultation with local representatives suggest that a notable damaging event might have an occurrence rate between one per year and one every ten years.

Droughts are of interest in the New Maryland area due to their effect on ground water availability and their contribution to increasing the risk of forest fires. Through review of precipitation and media records, and consultation with local representatives, the project team estimates that major droughts have an occurrence rate of between one every ten years and one every fifty years.

1.4.4 Recent Climate Changes

From 1984 to 2013, the annual mean daily temperature in New Maryland increased by approximately 2.0°C. This increase was consistent across all seasons. The annual mean daily maximum temperatures increased around 1.4°C, while the annual mean daily minimum temperatures increased around 2.7°C. The most pronounced change was for the mean daily minimum temperatures in the winter months, where the trend in this time-period showed an increase of almost 3.7°C

From 1984 to 2013, the trends for changes in levels of precipitation were not as uniform across the four seasons as the trends for temperature. In general, there was a modest decrease in winter and spring precipitation and a modest increase in summer and autumn precipitation - the net trend was that total annual precipitation remained about the same in this time-period.

Identifying a recent trend in the occurrence of ice storms is not as easy as identifying trends in temperature and precipitation due to a lack of available data. However, while conducting a review of news articles related to ice storms, Stantec found that there were at least three major events in New Brunswick since 2013. The media quoted power authority workers as describing all three events as the "worst in decades." (Jones, R., 2017). Although this streak of severe ice storms could be an anomaly, it could also point to a trend of increasing occurrences.

1.4.5 Local Confirmation

To confirm the findings of this research, Stantec conducted in-person interviews or received interview responses from twenty representatives from the community including Village staff, and current and former councilors. In these interviews/questionnaires, the local representatives were asked questions such as "What changes in local weather patterns have you witnessed here over time?". A copy of the questionnaire is provided in Appendix A. Personal experience with meteorological events can have a big impact on an individual's view of climate changing trends. For example, one response to the above question was that summers were getting drier, the interview response also indicated that this person believed this because in recent memory their well almost went dry. A well going dry could certainly be attributed to one very dry summer but it doesn't necessarily mean drier summers are an overall trend. Relying primarily on weather station data to develop climate change trends removes any bias individuals might have in their memories and it is still valuable to see if the trends in the data are consistent with local accounts. The climate changes over time indicated by local representatives through the interviews and questionnaires seemed to confirm the climate data based on responses such as:

- "Definitely more severe rain storms in both winter and summer."
- "The average temperature is certainly increasing."
- "More hurricanes."
- "Less snow, more rain in winter."
- "Definitely more severe storms, rains storms, combined with thaws."

The questionnaire and a list of interviewees are provided in Appendix A.

1.4.6 Projected Climate Changes

As detailed in Appendix B, Stantec completed a review of the climate changes that are projected for the New Maryland area in the coming decades. A large source of uncertainty in future climate projections is the uncertainty around global progress that will be made towards meeting GHG emissions targets. There are four Representative Concentration Pathways (RCP) scenarios adopted by IPCC that are based on various future greenhouse gas concentration scenarios. After consultation with the Village, the future scenarios selected for analysis of future climate projections were RCP 4.5 and RCP 8.5. The RCP 8.5 scenario is often referred to as the “business as usual” greenhouse gas concentrations scenario, wherein future development trends will follow those of the past and no changes in policy will take place. The RCP 4.5 scenario is characterized by GHG emissions peaking in 2040 and then declining.

The time horizons for the study were selected as current conditions (establishing the baseline risks) and 2020s (2011 to 2040), 2050s (2041 to 2070), 2080s (2071 to 2100) for future conditions. Climate is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of meteorological variables such as temperature, precipitation and wind over a period; typically, 30 years (World Meteorological Organization, 2017). The “2050s” projected climate, for example, is the projected average over the 30-year period from 2041 to 2070.

1.4.6.1 Temperature

The recent increases in temperatures experienced in New Maryland are projected to continue. By 2080, the annual mean daily temperature is projected to increase from the 1981 to 2010 baseline by 2.7°C under RCP 4.5, or 5.0°C under RCP 8.5 conditions. This increase is expected to be uniform across the seasons, with winter months experiencing the most warming and spring months the least warming.

Maximum daily temperatures follow a similar projected trend of an increase of roughly the same magnitude across the seasons for each RCP scenario. An increase in maximum daily temperatures is often easier to understand based on the change in the occurrence of days with a temperature higher than a certain threshold. For example, under RCP 8.5 conditions, it is projected that by the 2080s there will be 27.1 days per year with temperatures more than 32°C compared to the 1981-2010 baseline of 2.5 days per year.

Annually, minimum daily temperatures are projected to have an increase of similar magnitude as the mean daily temperatures, however there is more variability across the seasons. The greatest warming is projected to be in the winter. Under RCP 4.5 winters are projected to have an average increase of minimum temperature of 3.6°C from the 1981 to 2010 baseline. Similarly, under RCP 8.5 conditions, winters are projected to have an increase of 6.4°C from 1981 to 2010 baseline temperatures.

The warming winters will shorten the frost season for New Maryland, and under RCP 4.5 it is projected that by 2080 there will be 39 more frost free days per year than the 1987-2016 baseline. RCP 8.5 projects 68 more frost free days per year.

1.4.6.2 Precipitation

The Village of New Maryland is projected to see a modest annual increase in total precipitation under both the RCP 4.5 and RCP 8.5 scenarios of 6.9% and 10.7% respectively. Both scenarios project all seasons to experience an increase and winter to be the season with the greatest increase. An increase in total annual precipitation is often easier to understand based on the change in the occurrence of days with precipitation higher than a certain threshold. For example, under RCP 8.5 conditions, it is projected that by the 2080s there will be 1.5 days per year with precipitation more than 50 mm compared to the 1981-2010 baseline of 1 days per year.

In Stantec's experience, it is best to obtain precipitation Intensity-Duration-Frequency (IDF) information from gauged weather stations as opposed to interpolated locations. As such, IDF information was collected from the Fredericton Cda weather station (ID# 8101605). This station collected data from 1959 to 2013. IDF information presents the intensity of storms of various durations that can be expected at various frequencies. The IDF projections were obtained from the Facility for Intelligent Decision Support, at Western University, London, Ontario. The projections apply results from 24 Global Circulation Models that simulate future climate conditions. Since IDF data aims to describe precipitation that might occur on the scale of up to once every 100 years, projections are not available for the same 30-year time periods as the temperature and total precipitation projections. The projections obtained use a 50-year temporal period that centers around the middle period (2050s) by considering data from 2025 to 2075.

It was projected that in the period of 2025 to 2075 precipitation events are expected to get more intense and produce between 23.3% to 37.8% more precipitation, depending on the RCP scenario, the event duration, and event frequency selected. The smallest projected increase was for the 2-year return period events under RCP 8.5, while the largest increase was for the 50- and 100-year return period events under RCP 8.5. There were no projections available for prolonged rainfall accumulation under future climate conditions in the resources searched however, the trend of increased storm intensity for all events less than 24 hours can be extended to 3, 5, and 7-day accumulations with confidence.

The increase in precipitation, for both total accumulation and specific rainfall events logically leads to concern for the frequency and severity of flooding events. In 2011, the Government of Canada, Department of Fisheries and Oceans published a report on the projections for floods and droughts under different climate change scenarios in New Brunswick. "The frequency analyses show that flood magnitude would most likely increase by 11% to 21% towards the end of the century, depending on the emission scenario used." (Turkan, et al., 2011) Conversely, the overall trends of increased precipitation suggest river and stream flows will increase, indicating

less severe droughts (Turkan, et al., 2011). The increased precipitation trends also suggest the risk of forest fires may decrease in New Brunswick.

1.4.6.3 Wind

The projected climate changes with respect to wind are not as well understood as other climate variables and usable projections were not available for this investigation. However, in a report titled *Forecasting a Sea of Change: Lessons from Atlantic Canada* the Canadian Climate Forum explained "for the coasts of New Brunswick, Nova Scotia and Newfoundland there is no strong evidence that top annual wind speeds will increase significantly over the next century." (Canadian Climate Forum, 2014) Although New Maryland is not a coastal community, it can be assumed this trend would be somewhat consistent inland. Any reliance on this trend for decision making should not be made with a high level of confidence and monitoring the latest research in the field is recommended. Similarly, the link between tornadoes and climate change is currently unclear. (Center for Climate and Energy Solutions, n.d.) The occurrence of tornadoes in the New Maryland area is low so a statistically reliable increase or decrease in their occurrence would be difficult to measure.

Tropical disturbance events such as hurricanes have been shown to increase in the Atlantic Ocean over the past half century. Of course, not all tropical disturbances that originate in the Atlantic Ocean track to the New Maryland area; and many that would, see their severity reduced by the time they reach New Maryland. Nevertheless, historically some tropical disturbance type events have been noted to have severe impacts on New Maryland, so it is worth looking at the projected occurrence of Atlantic Hurricanes to determine if New Maryland will see an increase or decrease in these types of events under climate change. By late this century, models, on average, project an increase in the number of the strongest (Category 4 and 5) hurricanes. Models also project greater rainfall rates in hurricanes in a warmer climate, with increases of about 20% averaged near the center of hurricanes. (Center for Climate and Energy Solutions, n.d.).

1.4.6.4 Storms - Major Weather Events

Future occurrences of major winter snowfalls and ice storms are difficult to predict. Precipitation in the winter months is projected to increase however, as discussed, temperatures are expected to increase in winter months meaning a greater portion of the future precipitation will fall as rain instead of snow. For this reason, the occurrence of major snowstorms in the coming decades is not expected to drastically change. The projected increase in rain in the winter months does however lend one to consider another potentially damaging event; of winter rain on an existing snow accumulation. Rainfall on top of existing snow accumulation can cause the snow to become extremely heavy, putting building roofs at risk due to extreme snow loads. Available climate projections do not include data for this type of climate impact but the projected increase in winter precipitation and temperatures suggest this type of climate event may have greater severity and frequency.

Projecting the occurrence of ice storms is a complex process and not as well understood as projections for other climate variables. Research is being undertaken and there is some evidence that eastern Canada could possibly receive more freezing rain events in the future. (Cheng et al., 2011)

The perceived current and future probabilities of selected climate events were assigned numerical values and used to help complete the Vulnerability and Risk Assessment for the Village of New Maryland. In general, the Vulnerability and Risk Assessment was completed with the following trends:

- The climate of the Village of New Maryland is projected to get warmer and wetter; with more intense rainfalls leading to the possibility of more severe flooding events.
- Increased precipitation should lead to less frequent droughts and reduce forest fire risks however higher temperatures will speed drying therefore drought and fire risk may remain similar to current overall.
- The recent trend of increased occurrence of Atlantic Ocean tropical disturbances, is assumed to continue suggesting an increase in those events in the New Maryland area.
- Extreme winter snowfalls may increase in severity, but their rate of occurrence is expected to decrease as the winter season shortens.
- Some research suggests the occurrence of ice storms and rain/snow mix events may increase under future climate change scenarios.

1.5 LOCAL REPRESENTATIVE INTERVIEWS

As discussed in Section 1.4, Stantec conducted in-person interviews or received interview responses from 20 representatives from New Maryland, including Village staff, committee members and current and former councilors. These interviews provided an incredible amount of information that was valuable in developing the CCAS for the Village of Maryland.

Interviewees expressed concern about issues in the Village including but not limited to: ice storms, surface flooding, droughts, water supply, wastewater treatment, power outages, the aging local population, forest fires, recreational facilities and transportation access.

Towards the end of the set of interview questions, one question asked: What do you think are the most urgent issues facing the Village of New Maryland today with respect to climate change adaptation? The responses to that question were analyzed to look at which issues were mentioned most often by the interviewees; the results are shown below in Figure 3. The list of interviewees and questions posed are provided in Appendix A.

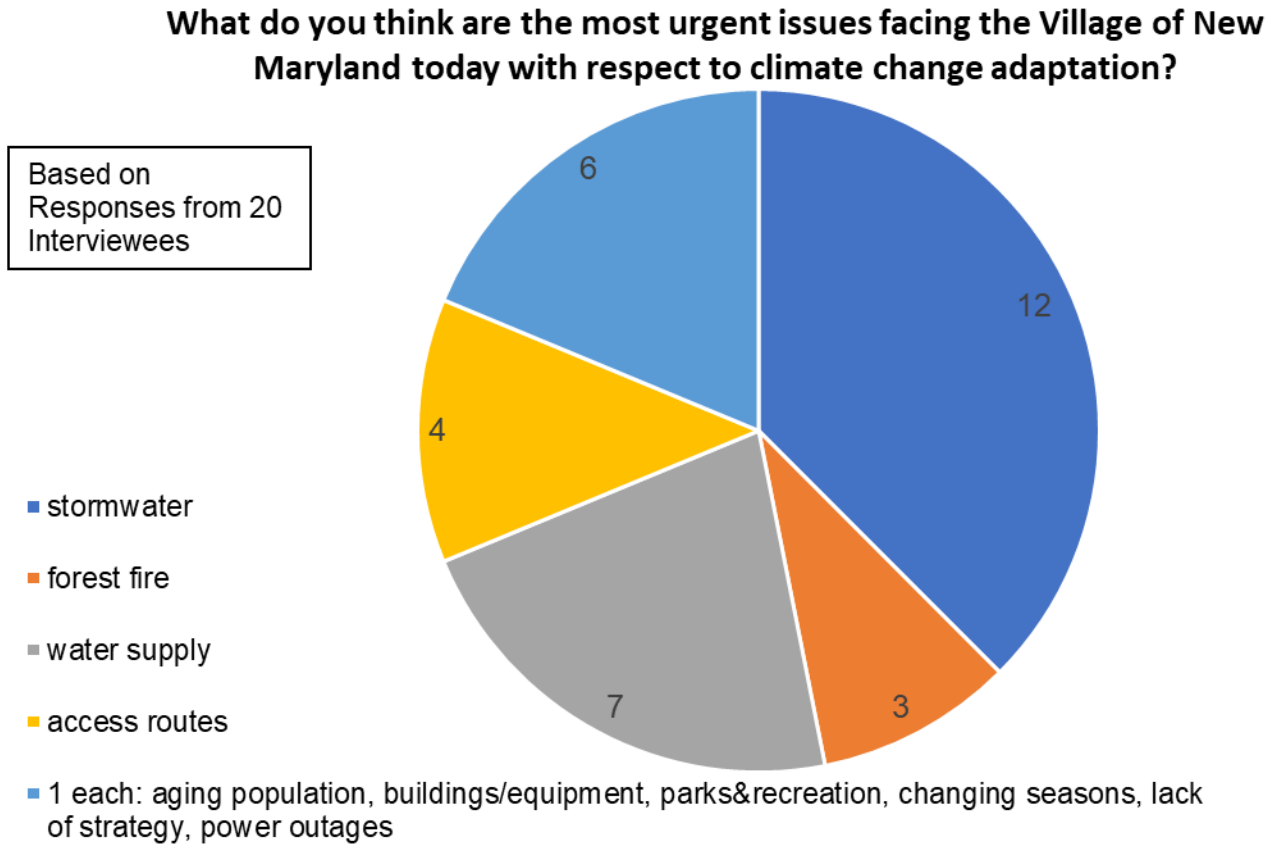


Figure 3 Mentions of Specific Climate Change Issues from Interviewees

The responses to this question set the stage for the main component of this climate change adaptation strategy; the vulnerabilty and risk assessment. The detailed and thoughtful responses indicate that the impacts of climate change on the Village of New Maryland are something that are on the mind of staff and residents. The fact that there are so many different ways in which climate change can affect a community make it difficult to prioritize efforts for climate change adaptation and mitigation. Furthermore, individuals often (understandably) shape their opinion about the most pressing impact of climate change based on personal experience. The vulnerability and risk assessment summarized in Section 2.0, attempts to remove this personal bias by considering input from a large group of people and applying numerical values to the probability of occurrence of climate events that impact the community.

2.0 VULNERABILITY AND RISK ASSESSMENT SUMMARY

On August 16, 2018, members of the Stantec project team travelled to the Village of New Maryland to meet with local representatives for a climate change adaptation workshop. The main objectives of the workshop were to:

- Share experiences and learn about climate change impacts.
- Validate the impacts identified in the one-on-one interviews and questionnaires.
- Identify which impacts are important to the community.
- Identify key risks of the impacts.
- Prioritize risks and opportunities to address them.

The processes and group activities undertaken at the workshop to complete these objectives were a key part of completing a risk and vulnerability assessment for the Village of New Maryland in relation to future climate change conditions.

2.1 SELECTION OF CLIMATE EVENTS FOR ASSESSMENT

Prior to the workshop, Stantec completed several tasks to help set the framework for the risk and vulnerability assessment. First Stantec completed a search of record setting meteorological events or meteorological events that are profiled in the media such as ice storms, snowstorms, floods and heat waves. This search helped identify what kinds of events have historically had the most impact on the residents of the Village of New Maryland. The results included such events as the ice storm of January 1998, the major rainfalls in September 1999 and post-tropical storm Arthur in 2014.

To confirm the findings of this research, Stantec conducted in-person and over the phone interviews and received interview responses from twenty representatives from the Village, including staff, committee members and current and former councilors. The respondents were asked questions such as “Do you recall a time when a specific weather event influenced the Village?” and “Do you recall weather events that have caused disruptions in services, damage to property, infrastructure, or facilities, or required additional resources?” When discussing in Section 1.4.5, the local representative interview responses regarding recent climate change trends it was noted that personal experience with meteorological events can cause a bias in an individual’s memory. Whereas in the case of these two questions above, those individual experiences are exactly what are needed to understand how certain meteorological events affect the Village of New Maryland. Responses to these questions confirmed that many of the events covered in the media had impacts on the community and its people. Responses included:

- Ice storms are the most frequent problem;
- One problem is the handling of storm water; and
- The most notable event was post-tropical storm Arthur.

Through the research conducted and the interviews held with local representatives, climate events were selected for the risk and vulnerability assessment as shown in Figure 4.

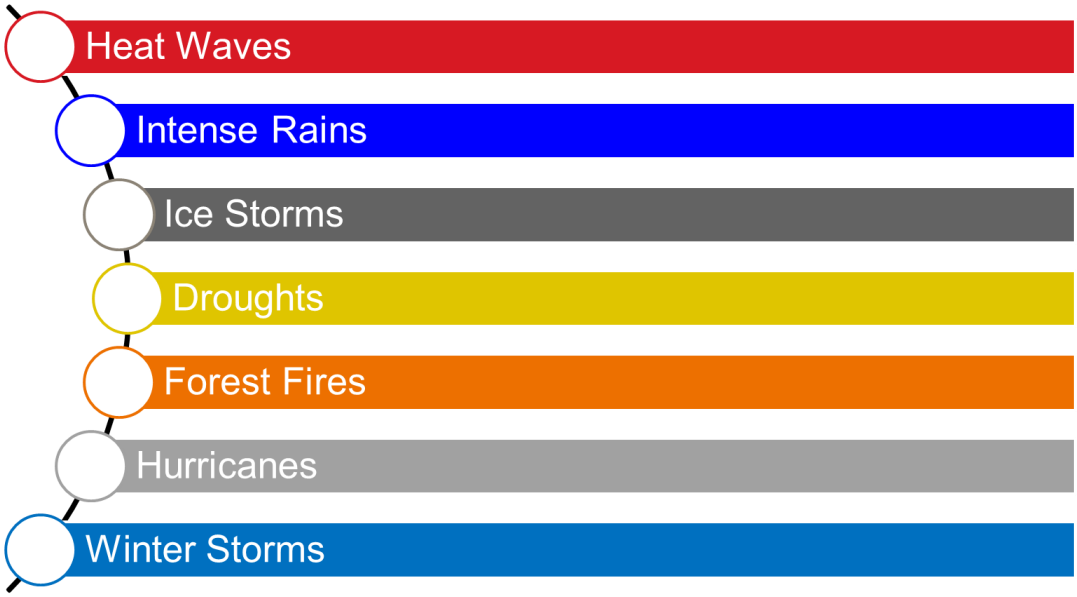


Figure 4 Climate Risks Assessed

2.2 SELECTION OF COMMUNITY COMPONENTS FOR ASSESSMENT

There is more to a community than just its physical infrastructure and buildings. A community is also comprised of people, the places they assemble, the places they play and the natural environment they value. Therefore, an assessment of a community's resilience to climate events must include environmental, social and cultural assets in addition to the physical infrastructure.

2.2.1 Community Assets

Stantec developed a list of the physical infrastructure that serve the Village of New Maryland such as storm water collection systems, water distribution systems and roadways. Much of the information regarding these assets is profiled in the recently completed Village of New Maryland Asset Management Plan (Village of New Maryland, 2018). The Asset Management Plan takes the first step of identifying some of the assets that may be vulnerable to climate change and suggests potential mitigation measures. The concerns identified included the water supply issues caused by drought, storm water and sanitary system infrastructure at risk during flooding/high intensity storms and buildings that might be at risk due to forest fire. The Asset Management Plan is an important element in planning for the future of the Village and the results of this Climate Change Adaptation Plan can be included in future updates of that report.

At the August 16, 2018 workshop, a review of the infrastructure and assets of the Village of New Maryland was completed. Local representatives were consulted, and Community Components shown in Figure 5 were identified as key important components of the community and sorted into five categories for the vulnerability and risk assessment. Many of the interviewees in Appendix A participated in the workshop.

Figure 5 Community Components Selected for Risk and Vulnerability Assessment

2.3 THE RISK AND VULNERABILTY ASSESSMENT

The objective of the risk and vulnerability assessment was to perform a high-level assessment of risks to the community components due to meteorological events based on future climate projections in the area. The methodology used for this assessment comes from Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol (see www.PIEVC.ca) which has been used in more than 50 risk assessments across Canada and internationally. The methodology focuses on the interaction between climate events and community components, and the magnitude of the climate event that can cause disruptions, malfunctions, or failures of the community components (assets). This process is illustrated in Figure 6.

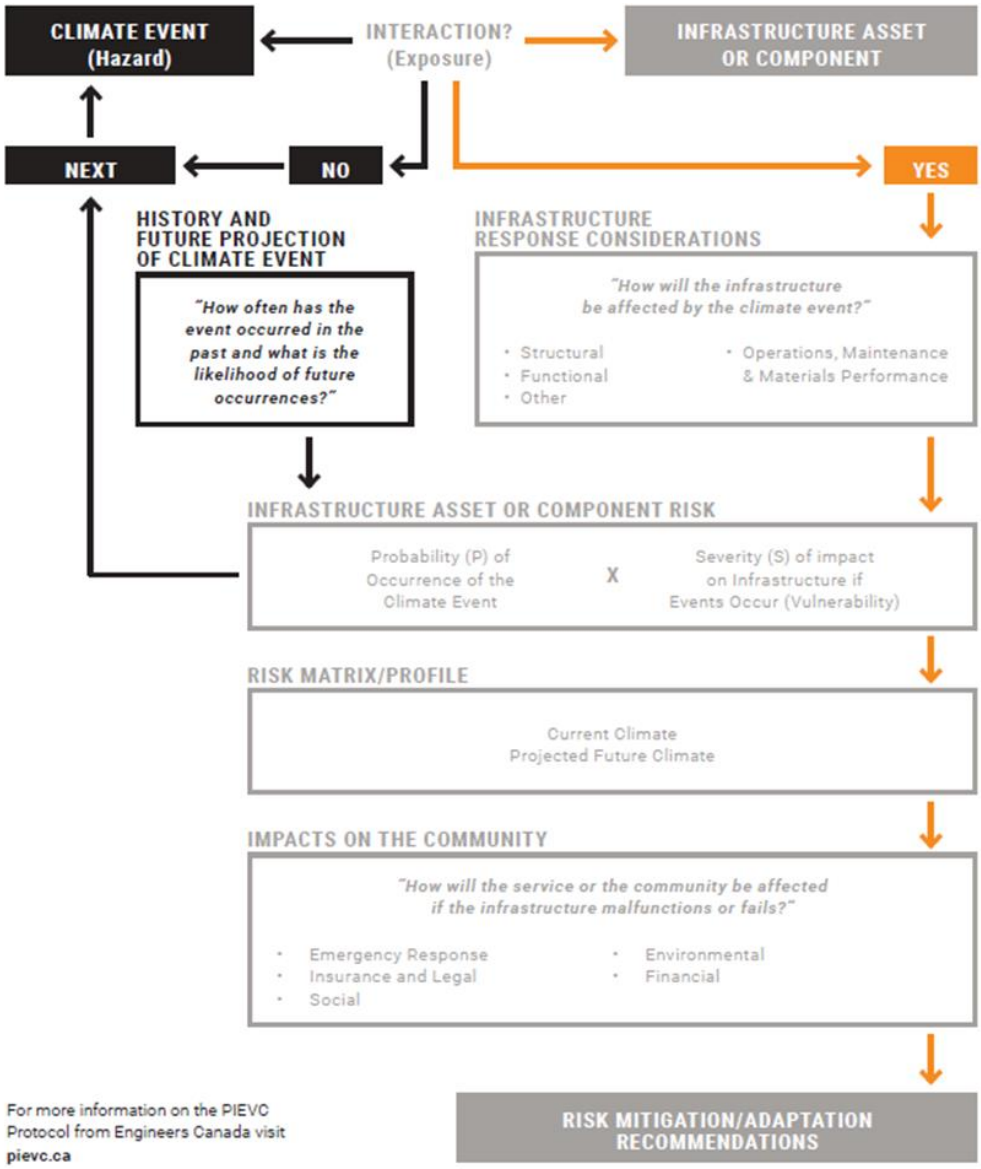


Figure 6 PIEVC Engineering Vulnerability Assessment Protocol Process

The process involves first generating a risk profile for the community under current climate conditions. This was completed at the August 16, 2018 workshop and was a collaborative exercise; taking input from all local representatives at the workshop. The workshop participants helped complete two major steps of the risk and vulnerability assessment process:

1. Identify which infrastructure components are affected by different climate events; and
2. Assess the severity of the impacts on the community component, on a scale of 1 to 5, should those climate events occur.

Stantec then assigned a probability rating to the selected climate events, on a scale of 1 to 5, under current climate conditions. This allows to calculate the risk score for each climate-infrastructure interaction, using a simple Probability x Severity = Risk formula.

2.3.1 Climate Event Probability

Assigning the climate event probability score followed the scale presented in Table 1 below, where the frequency of occurrence dictates the probability score.

Table 1 Climate Event Probability Rating Scale

Probability Score (1-5)	Frequency
1	One occurrence every 50 years or more
2	In the range of one every 10 years to one every 50 years
3	In the range of 1 per year to 1 every 10 years
4	In the range of 10 per year to 1 per year
5	More than 10 occurrences per year

Assigning the severity rating for a “climate event-community component” interaction followed the scale presented in Table 2. The input from local representatives about the impacts of past similar events is invaluable when describing the impacts on the community.

2.3.2 Climate Impacts on Community-Components

The risk and vulnerability assessments were completed by three separate groups at the workshop. The severity ratings assigned to the climate event-community component interactions can be seen in Appendix C. Also, in Appendix C, the final risk matrix for the current climate can be viewed. This risk matrix defines the current risk profile of the community; combining the severity scores of all groups with the climate event probability score, netting a Risk Rating.

Table 2 Climate-Community Component Impact Severity Rating Scale

Severity Rating	Descriptor	Criteria
0	No Effect	• There is no noticeable effect on the community component.
1	Insignificant	• Impacts are "annoyances" • Impacts are temporary • Little to no extra costs involved (e.g., Routine maintenance resolves issues) • No structure/property damage • No loss of service of function of component • No injuries or loss of life
2	Minor	• Impacts are noticeable and affect daily routines; they're more than "annoyances" • Impacts are temporary but take some time to resolve (days) • Some extra costs involved for repairs or extra effort • Some structural/property damage • Service or function may be affected but will be restored in days • Minor injuries/ health affects; no loss of life
3	Moderate	• Impacts are noticeable and affect the well-being of some residents • Impacts are temporary but take time to resolve (weeks) • Many extra costs involved for repairs or extra effort to remedy impacts • Moderate structural/property damage (small number of insurance claims) • Service or function affected but will be restored in weeks • Minor injuries/ health affects; no loss of life
4	Major	• Impacts are severe and affect the well-being of many residents • Impacts are temporary but take a long time to resolve (months) • Major extra costs involved for repairs or extra effort to remedy impacts • Major structural/property damage (large number of insurance claims) • Service or function severely affected or lost altogether • Major injuries/ health affects; potential for loss of life • External help required to help the Village "get back on its feet"
5	Catastrophic	• Impacts are life-changing • Impacts have destroyed the community component and it will take a long time to re-build or re-establish • Costs will affect the Village's finances for years to come • Major structural/property damage (large number of insurance claims) • Service or function has been lost altogether • Major injuries/ health affects; potential for loss of life • External help required to help community survive e.g., "State of Emergency"

2.3.3 Risk Rating

Using the two scales with values from 1 to 5 means the net Risk Rating score for any one "climate event-community component" interaction is on a scale from 0 to 25. For the purposes of this assessment, risk rating scores can be interpreted according to the following risk thresholds.

Table 3 Selected Risk Thresholds

Score	Description
1 to 5	**Low**: no action required
6 to 14	**Moderate**: monitoring recommended; action may be required if threat materialises; a more detailed analysis may be needed
15 to 25	**High**: Action required; immediate attention if risk occurs in current climate; adaptation planning necessary if risk occurs in future climate projections

The "climate event-community component" interaction severity ratings in the current climate matrix were then input to a future climate matrix. Stantec then changed the event probability rating to match the projected frequency of events under future climate change conditions. The changes in climate event probabilities from the current climate to the future climate are detailed in Table 4.

Table 4 Climate Events Probability Rating (Current and Future Climate)

Events	Comments/ Criteria	Current Climate	Future Climate	Probability Rating	
			RCP 8.5	Current	Future
(A) Heat Waves	Days with temperature >32°C	2.5 days per year*	2020's: 5.6 days/year	4	5
			2050's: 11.4 days/year		
			2080's: 27.1 days/year		
(B) Intense Rains	Days with rainfall >50mm	1 day per year*	2020's:1.2 days/year	3	4
			2050's:1.4 days/year		
			2080's: 1.5 days/year		
(C) Ice Storms	Notable storm causing damage; including downed tree limbs and/or power lines.	Research of events covered in the media leads project team to suggest occurrence between 1 per year and 1 every 10 years	Although research suggests possible 20% frequency increase, likely not enough to increase frequency to more than 1 per year.	3	3

Table 4 Climate Events Probability Rating (Current and Future Climate)

Events	Comments/ Criteria	Current Climate	Future Climate	Probability Rating	
			RCP 8.5	Current	Future
(D) Droughts	Difficult to quantify numerically. Lower than average annual precipitation, resulting in extremely low nearby stream flows can be considered a notable drought.	Research of historical droughts leads project team to suggest occurrence between 1 every 10 years and 1 every 50 years.	Total annual precipitation projected to increase; slight decrease in spring; increase in summer and autumn.	2	2
(E) Forest Fire	Occurrence of forest fire that can't be contained in a short period of time.	Historically, rare impact to communities	Increased summer precipitation suggests no significant increase	1	1
(F) Hurricanes	A Tropical Disturbance with a "Tropical Depression" intensity and higher	4 occurrences recorded 1851-2017	See Hurricane and Major Hurricane Occurrence (1966-2017) graph suggesting trend of increasing occurrences	1	2
(G) Winter Storms	Days with snowfall >25 cm. Snowfall not the only factor in determining the severity of winter storms but does have the most data available to determine occurrence.	1 day per year (1981-2010 Normals Fredericton Airport)	Winter precipitation projected to increase but warming winters mean more may be rain, so probability rating kept the same	3	3

Notes:
* CCHIP 1981-2010 CANGRD

2.4 THE RISK AND VULNERABILTY ASSESSMENT RESULTS

The results of the collaboratively developed risk matrices help identify components of the Village of New Maryland that are most at risk to the effects of climate change in a measurable way. The process attempts to remove individual bias towards climate change vulnerabilities by combining both the expected frequency and severity of impacts to the community to develop a community wide profile of risks.

Under the current climate conditions there are **eight** "climate event-community component" interactions that netted a "high" risk rating. They are:

Heat Waves:

1. Power infrastructure*
2. Senior Residents
3. Youth*
4. Extra needs residents

Intense Rains:

5. Power infrastructure*

Ice Storms:

6. Water infrastructure*
7. Power infrastructure

Winter Storms

8. Power infrastructure*

It should be noted that for this exercise there were often differences in the impact severity ratings between the workshop groups but for the risk matrix the highest score was selected. The climate event-community component interactions shown with an asterisk (*) indicate instances where the highest group's severity rating was 2 or more rating levels higher than the next highest group's rating. This suggests further research should be conducted before taking any action based on those "high" risk ratings to further validate the perceived risk level.

When the risk matrix was updated with the climate event probability ratings under future climate conditions there were **twenty-one** "climate event-community component" interactions that netted a "high" risk rating. The climate events that caused these "high" risks are shown in Figure 6 in a hierarchy based on increasing number of "high" risk ratings. The specific "high" risk ratings were as follows:

Heat Waves

1. Water infrastructure
2. Roadways (and sidewalks) *
3. Power infrastructure*
4. Adult Residents*
5. Senior Residents
6. Youth*
7. Extra needs residents
8. Chief/ Volunteer Firefighters
9. RCMP Staff*
10. Operations Staff

11. Village Office Staff*
12. Mayor & Council Members*
13. Service Clubs*
14. Churches*

Intense Rains

15. Storm Water Infrastructure
16. Roadways (and sidewalks) *
17. Wastewater
18. Power infrastructure*

Ice Storms

19. Water infrastructure*
20. Power infrastructure

Winter Storms

21. Power infrastructure*

Again, the "climate-community component interactions" above shown with an asterisk (*) indicate instances where the highest workshop group's severity rating was 2 or more higher than the next highest group's rating. This suggests further research should be conducted before taking any action based on those "high" risk ratings (to validate risk).

The increase in "high" risk ratings was caused by "climate event-community component" interactions with "Heat Waves" and "Intense Rains." This can be attributed to the projected increase in the "Probability" rating for heat waves and intense rains from the current climate to the future climate. Conversely, although analysis of climate projections for ice storms and winter storms did yield an increase in frequency of these events, these increases were not enough to change the probability rating for those events – thus risk ratings did not change in the risk matrix under future climate change conditions. That is not to say efforts to mitigate those risks should be ignored; rather that they are just some of the special cases that this assessment identified and deserve their own consideration (see below).

2.5 RISK ASSESSMENT CONCLUSIONS

The risk assessment procedure identified several "climate event-community component" interactions that show a "high" risk rating under current climate conditions and the effects of climate change are projected to create several new "high" risk interactions in the coming decades.

Heat waves and intense rains present the greatest risk to the community under current climate conditions, and under future climate conditions both these risks are expected to increase. Heat waves are projected to become hot enough and frequent enough to have an impact on all

demographics of the New Maryland population. Intense rainfalls are expected to increase so much that all built infrastructure except the water system are expected to have “high” risks.

The greatest threats to physical infrastructure in both the current and future climate are intense rains and ice storms. Although the risk ratings did not increase for ice storms in this exercise, it should be noted that the frequency and intensity of these events is expected to increase slightly under future climate conditions. Even this small increase of frequency for ice storms (which have historically been very damaging) will present challenges in the coming decades, therefore risk adaptation and mitigation strategies should be considered.

The research completed for the New Maryland risk assessment involved retrieving intensity-duration-frequency (IDF) projections for precipitation events under the future effects of climate change. The source of this information projected that precipitation events of varying duration are projected to have an increased intensity of between approximate 23% and 38% for all event frequencies, under the future effects of climate change. IDF information is used as “design storms” for the design of new development within the Village and as such, to ensure new infrastructure is resilient to climate change, this increase in rainfall intensity should be considered.

Climate events such as droughts, forest fires and hurricanes have too low a frequency of occurrence to create high risk ratings. Hurricanes are expected to continue to become more frequent, so it should be noted that most efforts made in the mitigation and adaptation to intense rainfalls will double as mitigation and adaption measures for the heavy precipitation that hurricanes bring. Although forest fires and droughts are concerning events that can be devastating if they occur, the projected increase of total precipitation in every season under future climate change conditions suggests that the risk of these events occurring could decrease. Temperatures will also increase, therefore continued vigilance around fire safety in the community is a good approach. Education of the community and fire department on the Fire Smart program could be considered to further reduce the risk of damage from nearby forest fires if they occur. This is a National program to reduce wildfire risk and help communities become fire adapted. Resource information can be found at https://www.firesmartcanada.ca/. The existence of the fire hall in the Village, the full time chief and distances from the hall for residences and businesses also contribute to forest fire risk management.

As the Village has already made building resilience into water supply and distribution systems a priority, including requiring new developments use the monitored municipal supply, undertaking ongoing wellfield exploration and monitoring current groundwater levels closely, further adaptation to potential drought conditions is not considered a priority of the CCAS.

During consultation with Village stakeholders, the risk of potentially increasing snow loads on building roofs was also identified as a concern due to climate change. The many variables that contributed to snow load on roofs (including snow depth, temperature and winter rain) make it difficult to create a projection for this event under climate change with reasonable confidence. It is noted that as winters warm and precipitation events become more intense, there is potential

for an increase of wet heavy snow on Village buildings' roofs. The National Building Code of Canada is in the process of reviewing building codes considering the concern of increasing snow loads. Localized public education efforts can also serve as a possible risk mitigation measure for damage from heavy snow loads.

3.0 SUMMARY OF EXISTING PLANS AND ADAPTION

The Village's Strategic Plan (2017-2022) includes the following objectives that directly link to climate change adaptation and mitigation:

- Increase attention and build policies and activities around - emerging issues, climate change, energy efficiency and water conservation.
- Promote a green and energy efficient community that is resilient to climate change.
- Ensure the Village serves as a role model to residents on issues of efficient energy use and water consumption practices.

Other guidance documents that will support climate adaption include:

- Stormwater Master Plan-2017 which includes a 20% increase in storm intensity factor to account for climate change when designing stormwater infrastructure. (Opus, 2017)
- Emergency Response Plan, while not specific to climate risks; it can be updated to include procedures to manage extreme weather events.
- The Village's Asset Management Plan that describes infrastructure assets, services, & work that will need to be done to now and 50 years into the future and incorporates climate change risks. (Village of New Maryland, 2018)
- The Municipal Plan that is climate change conscious. (Village of New Maryland, 2016)

4.0 STRATEGY GOALS AND KEY ACTIONS

The strategy is presented in consideration of the key vulnerabilities identified as well as in alignment with the Village's values, existing plans, and feedback from the workshop and open house sessions.

Those climate risks identified as high through the risk assessment process are the focus of the other specific strategies presented. These are shown in Figure 7.

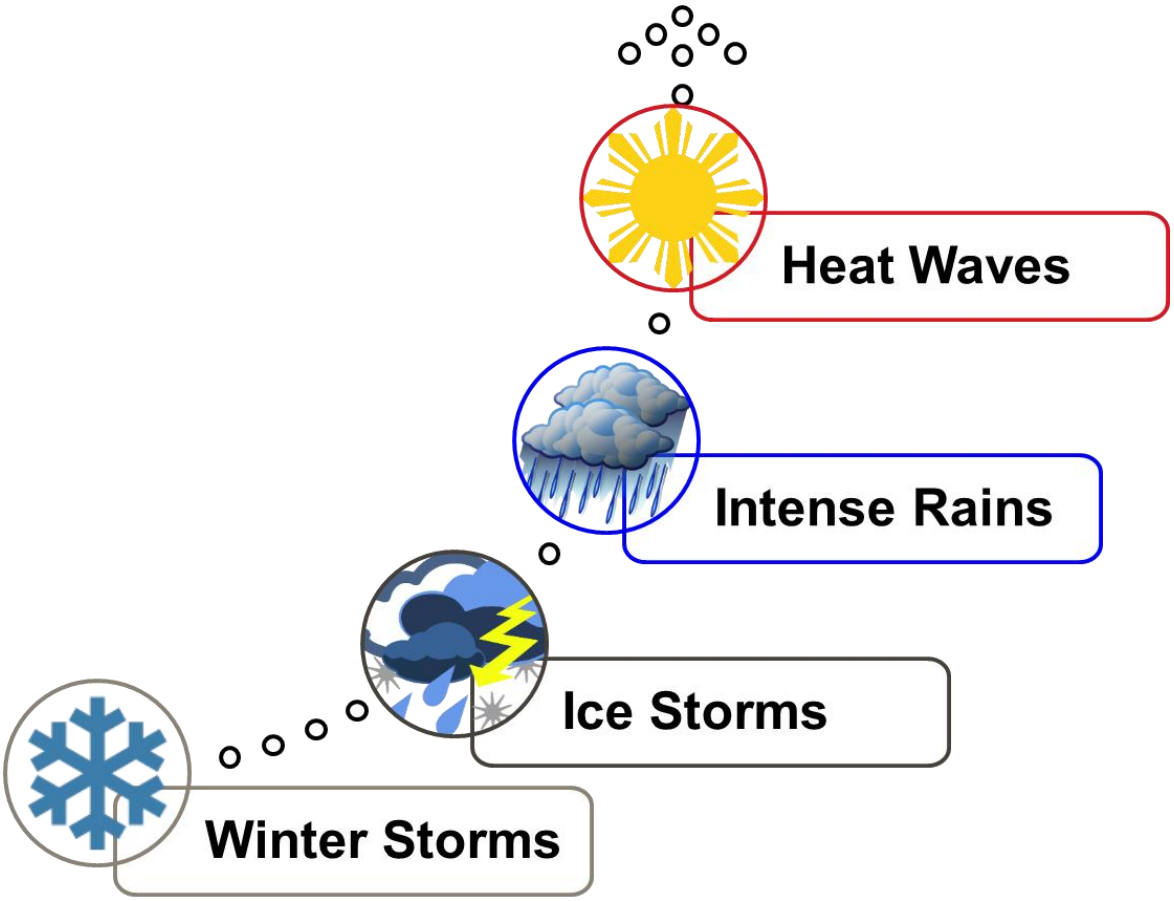


Figure 7 Climate Events with High Risk Rating for New Maryland

These risks are individually addressed in the following sections.

Overall, emergency preparedness planning is an action that will greatly improve the Village's ability to respond and bounce back from extreme climate events. The Village has already developed an Emergency Response Plan (ERP) and committed to reviewing and updating that plan annually. Climate risks could be considered and incorporated into the ERP directly, with some suggestions noted in the following risk specific sections.

The Village should continue to look for opportunities to partner in climate change mitigation and adaptation as well as attain funding for projects through provincial programs such as the Environmental Trust Fund or Gas Tax Fund as well as other emerging federal programs such as the Low Carbon Economy Fund.

4.1 HEAT WAVES

Key strategies in relation to managing the Village's susceptibility to heat waves include:

1. Continue to promote the Sentinel Emergency Alerts Assistance registry to provide increased support to vulnerable community members during extreme events;
2. Incorporate heat wave response and heat advisories into the Emergency Response Plan;
3. Implement cooling stations during heat waves - access to air-conditioned spaces and drinking water for community members;
4. Continue education in the community around the risks of heat exposure and available methods to take care during heat waves;
5. Consider recreational opportunities to incorporate additional shade, water stations, consider heat and drought resistant plants and trees in recreational planning;
6. Consider implementing the Fire Smart program.

These ERP strategies could similarly be applied to provide community support during winter storms causing power outages (warming stations as opposed to cooling).

Tree planting in the community can serve several functions in climate adaption and mitigation. Trees can provide shade to mitigate the effects of heat waves, reduce severity of flooding via biofiltration and sequester CO_2 from the atmosphere, mitigating GHGs. Consideration of tree species should include climate change forecasts and selection of locations should consider avoidance of power lines and placement and spacing to reduce fire risks as the trees mature.

4.2 INTENSE RAINS/HURRICANES

Key strategies in relation to improving resiliency to intense rains/hurricanes include:

1. Continue diligent preventative maintenance on storm water drainage system and implement a procedure to track frequency of maintenance and occurrences of any flood issues to better inform planning;
2. Continue to promote basement flood prevention;
3. Consider revised storm water management master plan to incorporate potential worst-case storm intensities based on current climate change predictions;
4. Encourage and educate the public and developers on low impact development;
5. Protect wetlands and the natural function of existing watercourses;
6. Prioritize additional roadways to improve access in and out of the Village for residents (in the event the main road is unavailable due to rain or tree fall or another event); and
7. Continue to enforce the Municipal Plan and the Storm Water Management Plan in future developments.

The land use planning guidance in the Municipal Plan (Village of New Maryland, 2016) provides a strong basis for adaptation to more intense rains as it includes climate change considerations to encourage development that will be resilient to more intense rains. The plan encourages minimizing tree clearing and encourages retention and planting to provide more shade to control temperatures and humidity levels and maximizing green space to decrease storm runoff and increase the rate at which groundwater will be replenished. The plan also indicates that development should avoid locating land uses in flood prone or low-lying drainage areas which can interfere with storm water flow and exacerbate flooding.

The Village should ensure that current climate change projections are considered and incorporated into future water distribution and storm water system designs. The current Storm Water Management Plan (Opus, 2017) shows great initiative to proactively manage storm water. Storm water management is a key mitigative action for climate change. The current Storm Water Management Plan does include consideration of future increases to storm intensity however it may not be sufficiently conservative in consideration of current projections. The criteria of a 1:100-year return period runoff (Q100) plus 20% in the design of major storm sewer systems and for the design of attenuation dry ponds has been applied recently however currently available data are indicating the 1 in 100-year storm could be up to 38% more intense under future climate conditions.

The tiered approach to the Storm Water Management Plan provided in the 2017 document is a strong guide for immediate and longer-term initiatives around improving resiliency (Opus, 2017). This approach works to address and mitigate existing risks first, and then implement strategies to ensure new and future development that will be constructed will be resilient to the effects of climate change. Although increasing design standards typically increases construction costs (which can be a deterrent to potential developers), it is believed that ensuring storm water infrastructure is resilient to climate change is in the best interest of the Village of New Maryland in the long term.

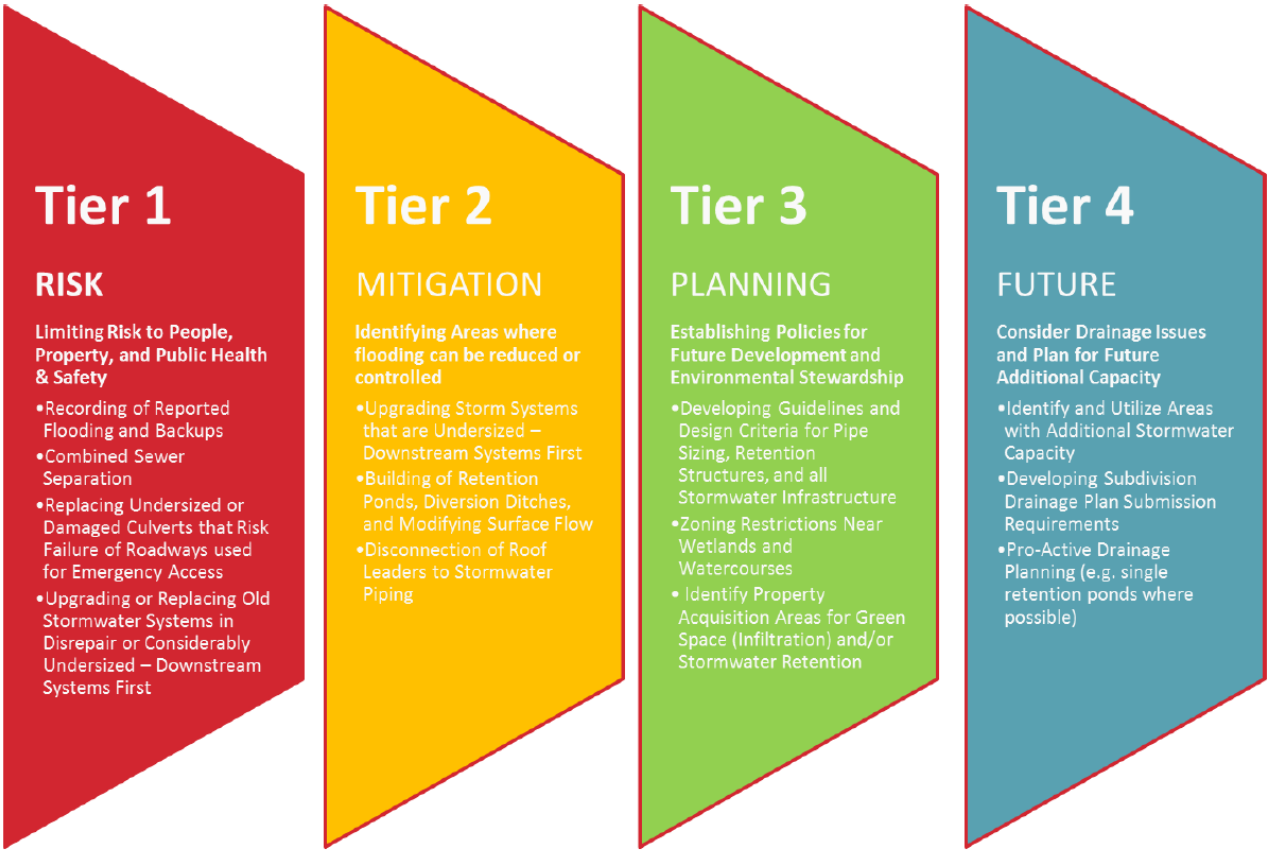


Figure 8 Tiered Approach to Storm Water Management

It was noted that Village staff have some knowledge of low impact development approaches such as rain gardens to provide bioretention of storm water and lessen potential for flooding. Further investigation of how low impact development techniques could benefit the Village's stormwater management and how these could be encouraged should be completed.

4.3 ICE STORMS/WINTER STORMS

Key strategies for improving resiliency of the Village to ice storms and winter storms include:

1. Consideration of increased snow loads from mixed snow/rain events in planning maintenance activities on buildings (consider inclusion in maintenance policy and procedures).
2. Keep informed on pending updates to building codes that are expected to increase roof load design requirements and plan a review of Village buildings once codes are revised.
3. Review the adequacy of emergency power systems in the Village to support essential services and provide comfort and safety to residents in the event of prolonged power outages. Consider options such as renewable systems which do not require fuel storage

and would lower GHG emissions, or consider propane or diesel systems which allow for more onsite fuel storage as compared to gasoline generators.

As the National Building Code of Canada continues its review of the potential increased snow loads on building roofs under the effects of climate change, it is recommended that the Village of New Maryland consider implementing strategies to mitigate this risk. For example, Village operations staff may consider clearing snow off building roofs if there is a large snowfall in the local weather forecast. Additionally, the same measure may be worth implementing if there is significant snow accumulation on roofs and there is a winter rainfall in the local forecast. Snow removal rakes are available from various manufacturers to help remove snow from sloped roofs and staff can remain on the ground. Removing snow form flat roofs can require more effort and requires additional safety considerations if staff are required to work from rooftops.

Many other risks identified in the risk assessment can also be mitigated through operations and maintenance practices. For example, the increased risks to built infrastructure due to the projected increased rainfall intensity may be mitigated by ensuring drainage conveyances such as catch basins and culverts are free from debris. This process will be especially important in mitigating risks in areas identified as medium and high-risk flooding areas in the current Stormwater Management Plan (2017). The Village Public Works Department has implemented procedures to mitigate these risks before and during rainfall events.

5.0 GHG MITIGATION

Demonstrating leadership in GHG mitigation (reductions) is important even for small demographics, both to contribute to the global reductions required as well as to demonstrate leadership to community members, especially the younger generation.

Key strategies include:

1. Establish baseline energy and fuel use to allow for completion of a Village GHG inventory to establish magnitude of GHG emissions from various sources;
2. Track energy and fuel use accurately, disaggregated to specific sources to allow for potential GHG reductions to be identified and quantified;
3. Set a GHG reduction target for the Village following the baseline inventory;
4. Evaluate reduction opportunities to meet the targets; and
5. Promote GHG reductions with community members.

The Municipal Plan (Village of New Maryland, 2016) incorporates land use planning to encourage more compact, dense and connected development to minimize land consumption and decrease travel times between uses. Uptake of this would reduce GHG emissions from vehicle travel while potentially increasing the carbon sink capacity in the Village via maintenance of more forested areas that can capture CO_2 from the atmosphere.

The Municipal Plan also looks to encourage higher density developments and active transportation options. Higher density, energy efficient residences as well as active transportation and public transportation are opportunities to reduce the GHG footprint of residents.

These strategies can be further encouraged through staff, public and contractor education campaigns as well as ongoing consideration of options for improved trail systems and affordable public transportation. Having key Village staff trained on the most current strategies for high density, energy efficient (as well as potential incorporation of passive and active renewable energy) residential developments will allow the Village to share that knowledge and guidance with developers and communicate not only the benefits to the Village but also potential benefits to developers in using these techniques. Although they may go above National Building Code and introduce some additional upfront costs; building for low carbon footprint and energy efficiency should be something developers can promote in the sale of their homes to people interested in lowering their GHG footprint. Both public and developer education is required to continue a trend toward lower GHG intensity living.

The Village has completed various initiatives already to manage their GHG footprint including an idling policy and some use of renewable energy in the Village. It is recommended that the Village complete a GHG inventory for Village infrastructure and vehicles to provide a baseline to evaluate and track future GHG reduction opportunities. There may be funding that the Village can access to implement GHG reductions and a well-documented baseline GHG inventory will

be needed to identify overall reduction opportunities and quantify the reduction potential of planned actions. There are also tools and resources available; for example, the Partners for Climate Protection (PCP) program administered by the Federation of Canadian Municipalities. This is a network of Canadian municipal governments that have committed to reducing greenhouse gases (GHG) and to acting on climate change. Since the program's inception in 1994, over 350 municipalities have joined PCP, making a public commitment to reduce GHG emissions. https://fcm.ca/home/programs/partners-for-climate-protection.htm

Opportunities for investigation could include improved fuel efficiency in vehicles, electric vehicles, energy efficiency and reduction in Village buildings as well as increased use of renewable energy (solar, wind).

6.0 MONITORING AND FOLLOW-UP

Overall, there is a recommendation to review updated climate predictions and related publications as they become available and consider how they may affect the Village's planning strategies and priorities. The next full IPCC report is scheduled for release in 2021 however several special reports are also planned between 2018 and 2022 (IPCC 2018).

The Key strategies for monitoring and reporting are:

1. Identify a champion within Village staff who will be responsible for climate change adaption and mitigation action monitoring;
2. Use a report card and action plan for the CCAS to track progress and review priorities on a regularly scheduled frequency; and
3. Plan for ongoing public and stakeholder engagement to communicate progress and provide opportunities for education and sharing of ideas.

In the Village's Municipal Plan (Village of New Maryland, 2016), a commitment was made to consider and plan for climate change impacts and where climate change impacts can be identified, policies will be presented which will enable Council to consider mitigative or adaptation measures to deal with climate change impacts in the future (Village of New Maryland, 2016).

Additionally, the Village commits to reviewing updated climate change data as it becomes available. Further, the Municipal Plan indicates that Council could undertake to compile a Climate Change Report Card to identify, monitor and track its progress in efforts to mitigate and adapt to climate change. A template of this report card is provided as part of the CCAS herein (Appendix D). The Report Card will enable the Village to:

- Identify and monitor local impacts associated with climate change; review and revise risk assessment for various aspects of the community's assets including buildings, infrastructure, parks, etc. based on most recent climate change data;
- Implement and revise strategies/actions to mitigate or adapt to climate change;
- Carry out a cost/benefit analysis for various measures and actions as needed;
- Identify priorities to be undertaken; and
- Identify responsibility for implementing aspects of the action plan and to set reasonable timelines for action items.

The Climate Change Report Card and Action Plan provided herein is a starting point which should be updated and modified as more information or technology becomes available, resources become available, emergency events occur, or priorities change.

The Report Card and Action Plan are tools to help the community record and track where it is at any given point in time with respect to its efforts to mitigate or to adapt to climate change.

7.0 CONCLUSION

The Village has progressed well in many aspects in consideration, adaptation and mitigation of climate change prior to the initiation of this strategy. With the addition of this strategy, the Village can further advance their preparation and planning for future climate change scenarios. The strategy provides supporting data and information around climate change events, contributed to and vetted by Village staff and participating community members. The strategy provides guidance for how future climate events may affect the Village that can be considered in subsequent strategic planning exercises. The priorities identified herein should serve to guide the Village in capturing climate change risks and opportunities in decision making and future policy development. By implementing a monitoring and follow up process around this strategy, the Village can ensure that planned actions and priorities remain relevant and consistent with the Village's overall vision; to be a welcoming community that seeks to offer a progressive and healthy living environment and quality of life.

8.0 REFERENCES

A National Ecological Framework for Canada: Attribute Data. Marshall, I.B., Schut, P.H., and Ballard, M. 1999. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research, and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull.

Canadian Climate Forum, 2014. Forecasting a Sea of Change: Lessons from Atlantic Canada. Vol. 2, No. 1 September 2014.

Center for Climate and Energy Solutions, (n.d.). Tornadoes and Climate Change. Retrieved from https://www.c2es.org/content/tornadoes-and-climate-change/ (accessed Oct.1,2018)

Chad Shouquan Cheng, Guilong Li & Heather Auld (2011) Possible Impacts of Climate Change on Freezing Rain Using Downscaled Future Climate Scenarios: Updated for Eastern Canada, Atmosphere-Ocean, 49:1, 8-21, DOI: 10.1080/07055900.2011.555728

IPCC 2018, summary of sixth assessment cycle schedule and planned reports; https://www.ipcc.ch/site/assets/uploads/2018/11/AR6_brochure_en.pdf, accessed December 1, 2018

IPCC 2018, Special Report on Global Warming of 1.5 °C, October 2018, accessed on November 2, 2018 at https://www.ipcc.ch/sr15/

Jones, Robert (2017, February 3). By the numbers: New Brunswick's worst storms. CBC News. Retrieved from https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-storms-historic-comparison-1.3963855

Lemmen, D.S., Warren, F.J., Lacroix, J., and Bush, E., editors (2008): From Impacts to Adaptation: Canada in a Changing Climate 2007: Government of Canada, Ottawa, ON, 448 p.

Turkkan, N., N. El-Jabi and D. Caissie. 2011. Floods and droughts under different climate change scenarios in New Brunswick. Can. Tech. Rep. Fish. Aquat. Sci. 2928: xii + 55p.

Village of New Maryland, 2018, Village of New Maryland Asset Management Plan, April 2018

Village of New Maryland, 2016, Village of New Maryland Municipal Plan By-law No. 03-2016

World Meteorological Organization, 2017: Commission for Climatology: Frequently Asked Questions. http://www.wmo.int/pages/prog/wcp/ccl/faqs.php (accessed Sept.28, 2018)

Appendix A Climate Change Adaptation Strategy: Informational Interviews Questionnaire, List of Interviewees

INTRODUCTION

The Village of New Maryland is a welcoming community that seeks to offer a progressive and healthy living environment and quality of life. Its mission is to make New Maryland a community of choice by providing services in a responsible and innovative manner. As such, the Village has retained Stantec Consulting Ltd, to assist in the development of a Climate Change Adaptation Strategy to meet these goals within the context of a changing climate. As part of the development of this strategy and to inform the Risk Analysis process, interviews will be conducted with key Village staff, stakeholders, and local community members ahead of a planned Risk Prioritization Workshop where impacts and events that a changing climate may bring can be identified and effectively managed.

INTERVIEW DESIGN

The interviews will be built on literature review and used to inform the preliminary analysis. Interviews should be designed to:

1. Understand the scope of the interviewees' role within a specific Village department, or within the community generally.

2. Identify any challenges/impacts that the Village is currently contending with and identify which of those are directly climate related.

3. Draw out information about climate change impacts on prioritized sectors and key result areas (KRAs) identified in the Village's Strategic Plan.

- Potential key sectors (and stakeholders) to consider:
  - Environment (Ecosystems, Urban Forests, and Parks)
  - Infrastructure
  - Transportation and Mobility
  - Buildings
  - Agriculture
  - Energy Supply
  - Economic Development
  - Health
  - Land-Use
  - Emergency Response

- The Village of New Maryland Strategic Plan 2017-2022 has identified eight KRAs:
  - Water Distribution System
  - Storm Water System
  - Wastewater System
  - Fiscal Responsibility
  - Active Living
  - Growth
  - Climate Change, Energy Efficiency, and Water Conservation, and
  - Effective and Efficient Administration & Council

4. Provide information about the possible impacts that climate could have on their work or interests.

5. Get an understanding of the level of control, influence, and resources that the Village has available to enact change and enhance climate change resiliency.

ADAPTATION 101

Climate change adaptation is distinct from climate change mitigation in that mitigation involves undertaking actions today that reduce greenhouse gas (GHG) emissions that would normally occur because of business as usual activities. Adaptation, on the other hand, "involves making adjustments in our decisions, activities and thinking because of observed or expected change in climate, in order to moderate harm".[1] Climate change adaptation is really about taking actions that limit the amount of harm or reduce the associated costs with climate related impacts. Important to note is that successful adaptation on any front does not mean that climate related impacts will no longer occur; rather, the impacts will still likely occur, but will be less severe in both harm and economic cost had no adaptation measures been undertaken.

There is also a positive side to adaptation in that by identifying risks associated with a changing climate, opportunities will also be revealed. For instance, an increase in growing degree days – i.e., the number of days where the air temperature is expected to exceed a minimum base temperature – can translate into an opportunity for farmers to plant higher value crops. Warmer summers may translate into greater tourism, etc. Thus, the concept of adaptation must not only be viewed with the lens of preparing for the worst, but also can be used to proactively seize new opportunities as they arise from a changing climate.

Adaptation planning has not yet received the same widespread recognition as mitigation in Canada. There has been considerable support from the general public Canada-wide and financial business cases for mitigation efforts (e.g. energy efficiency/renewable energy projects, energy prices, carbon costs). Adaptation differs from mitigation in that the return on investment falls largely where costs are expended, and the benefit can be intangible to the public or delayed for a period of time. As a result, there is often competition for funding between short-term priorities and long-term risk management. For instance, a city protecting itself from heat waves, storms, floods, etc., may spend a large amount of capital on each endeavour which does not result in an immediate return on investment. Rather, the benefit arises in that the risk of future possible damages is reduced and that the community well-being is better protected. Since the benefit associated with adaptive measures is largely intangible, funding is often

[1] Ref: NRCAN, 2015, Climate Change Impacts and Adaptation, http://www.nrcan.gc.ca/environment/impacts-adaptation/adaptation-101/10025

prioritized and distributed to deal with short-term publicly contentious issues instead, such as deteriorating infrastructure, etc. Unbalanced prioritizing of short-term issues over long-term vulnerabilities can leave a community vulnerable to climate related impacts.

Due to the complexity involved in understanding climate change and only the recent availability of climate modeling information, climate change adaptation planning has just recently become an area of focus for local and regional governments globally. Climate change adaptation planning is complex and a "one-size-fits-all" approach cannot be undertaken as each municipality, city, region and province are distinctly different and as a result, their assessment process, preparedness actions and ability to adapt will be different from one another. The following questions have therefore been prepared to gain an appreciation of potential climate change impacts to the Village of New Maryland.

INTERVIEW QUESTIONS

1. To start with, how long have you lived in or around the Village of New Maryland?

2. How long have you been affiliated with this particular Department (or community)?

3. Can you talk a little bit about your role, scope of work, or involvement with this particular Department (or community)?

4. What, if any, are your personal experiences with climate change in New Maryland up to this point?

   a) What changes in local weather patterns have you witnessed here over time?
   b) Do you recall a time when a specific weather event had an effect on the Village? For example, a flooding event, ice storm damage, or unusually heavy rains that may have led to blocked culverts or damage to roads, etc.
   c) Do you recall weather events that have caused disruptions in services, damage to property, infrastructure, or facilities, or required additional resources (e.g., staff overtime, call-out to external contractors) to maintain or restore services?
   d) How well do you think the community was able to respond to that event?
   e) What were the lessons learned from the Village response to those events and what improvements have been made to deal with future similar events?

5. Generally speaking, what other changes have you seen (big or small), particularly any that may have resulted in hazards or impacts, and how has your Department (or community) adapted to those changes?

6. What are some of the **non**-climate-related challenges (perhaps in terms of policy, or capital and resources, etc.) that you or your Department (or community) **face now,** and how would you rank these in terms low, mid, or high-level prioritization?

7. What are some of the **non**-climate-related challenges that you or your Department (or community) **foresee** in both the near and long-term, and how would you rank these in terms low, mid, or high-level prioritization?

8. What are some of the climate-related challenges that you or your Department (or community) **face now**, and how would you rank these in terms low, mid, or high-level prioritization?

9. What are some of the climate-related challenges that you or your Department (or community) **foresee** having to contend with in both the near and long-term, and how would you rank these in terms low, mid, or high-level prioritization?

10. In the development of adaptation strategies, it is important to consider the vulnerability of systems - be they social, environmental, or physical - and their ability to respond and recover to a changing climate.

a) In terms of social demographics, what is your sense of New Maryland's vulnerable populations and the climate-related challenges to be addressed in order to reduce harm to them?
b) With regard to environmental systems, like forests and wetlands which act as natural infrastructure, what steps or measures do you think should be in place to ensure their protection from a changing climate? Do you know of any sensitive natural areas in or around the Village that you think may be most vulnerable to climate change?
c) Do you know of any existing physical assets or infrastructure within or around the Village that may be vulnerable, and what would be your suggestions on how to reduce harm to them?
d) Of those three types of systems mentioned – social, environmental, physical - how would you rank these in terms of prioritizing harm reduction, or should each be kept on equal footing?

11. What are some the things that the Village could be doing to maintain adequate forecasting capabilities (in order to warn the public) and emergency preparedness and response?

12. Can you think of any events or activities that may be adversely affected by a changing climate? For example, are there any winter leisure activities that may be threatened by a warming climate, and therefore, negatively impact visitor experience and tourism? What do you think can be done to ensure that these activities can continue into the future?

13. What is the Village doing to educate the public on the potential effects and implications of a changing climate? Do you think that more needs to be done to educate the public on the potential effects and implications of a changing climate?

14. Do you foresee any potential *positive* opportunities for the Village of New Maryland as a result of a changing climate? For example, how might warmer winters, an increase in frost-free days, or longer warmer summers provide positive opportunities for the community?

15. What do you think are the most urgent issues facing the Village of New Maryland today with respect to climate change adaptation?

16. From your particular standpoint, what adjustments in terms of current decisions, activities, or planning could be made to limit harm and reduce costs due to climate related impacts?

17. Overall, a) what do you think would be the top 3 short-term priorities to deal with climate change impacts in the Village, and b) what do you think would be the top 3 long-term priorities to manage climate change related risks?

LIST OF INTERVIEWEES

Interviewee	Position/ Association
Michelle Sawler	Recreation Coordinator
Aaron McFadyen	Public Works Transportation Technician
Chris Nash	Public Works Utilities Supervisor
Cynthia Geldart	Chief Administrative Officer/Clerk
Kyle Arsenault	Assistant Building Inspector/ Development Officer
Rob Pero	Building Inspector/ Development Officer
Bill O'Donnell	Past Chair, Water and Waste Committee, member Age-Friendly Committee
Brad Marshall	Member/Chairperson Planning Advisory Committee
Gisèle McCaie-Burke	Councilor, past Chair Age-Friendly Committee, past Chair Emergency Response Plan Committee
David Wiezel	Past Mayor, past committee member
Alex Scholten	Deputy Mayor
Karen Taylor	Assistant Clerk
Frank Brown	Past Councilor
James McAnany	EOC Director /Emergency Response Plan Committee
John McKinney	Village Engineer
Mariet van Groenewoud	Past Mayor and past Councilor
Judy Wilson-Shee	Mayor
Mike Pope	Councilor, past Recreation Committee and past Planning Committee member, past Chair Solar Energy Research Committee
Paul LeBlanc	Councilor, member of various committees
Peter Wiggins	Past Councilor
Tim Scammell	Councilor, past Chair Water and Wastewater Committee

Appendix B Village of New Maryland Climate Profile

APPENDIX B – VILLAGE OF NEW MARYLAND CLIMATE PROFILE

When developing a profile of the historic climate of an area, the most valuable data is typically temperature, precipitation, and wind data collected from nearby weather stations. New Maryland itself does not have a weather station that can be used to provide historical climate data. There are three nearby weather stations with historical data covering various time periods, as pictured in Figure 1.

Figure 1: Site Location and Proximity to Closest Weather Stations

The stations have recorded nearly complete historical sets of data, and the distances from New Maryland to these stations (7, 8 and 12km) would normally suggest the historical data at these stations would be a reasonable representation of the historical data at New Maryland. However, there are two main reasons to question if this is an accurate representation: 1) all

three weather stations are very close to the St. John River, and a body of water of that size could influence weather patterns; 2) being near the St. John River also means these stations are set in the river's valley; New Maryland itself has an elevation roughly 80m higher than all three stations, which could also influence weather patterns.

Climate data for these weather stations were obtained through the Climate Change Hazards Information Portal (CCHIP) created by Risk Sciences International (RSI). In addition to assembled climate data from weather stations, CCHIP also publishes data sets for the entire country, on a 10km by 10km grid – known as the CANGRD data. This gridded data was developed in a collaboration between Natural Resources Canada and Environment and Climate Change Canada (ECCC). Although data from a real weather station is preferable, this CANGRD is well accepted and researched. The latitude and longitude of the Village of New Maryland (45.891°N, 66.685°W) was used to obtain data from the CANGRD data set.

In the scenario for New Maryland, the CANGRD data for Total Annual Precipitation and Mean Daily Temperature at the New Maryland location was compared to available data from the nearby weather stations with the most complete data. The results of these comparisons are summarized in the Figures 2 and 3 below and support the reasonable use of this CANGRD data for New Maryland.

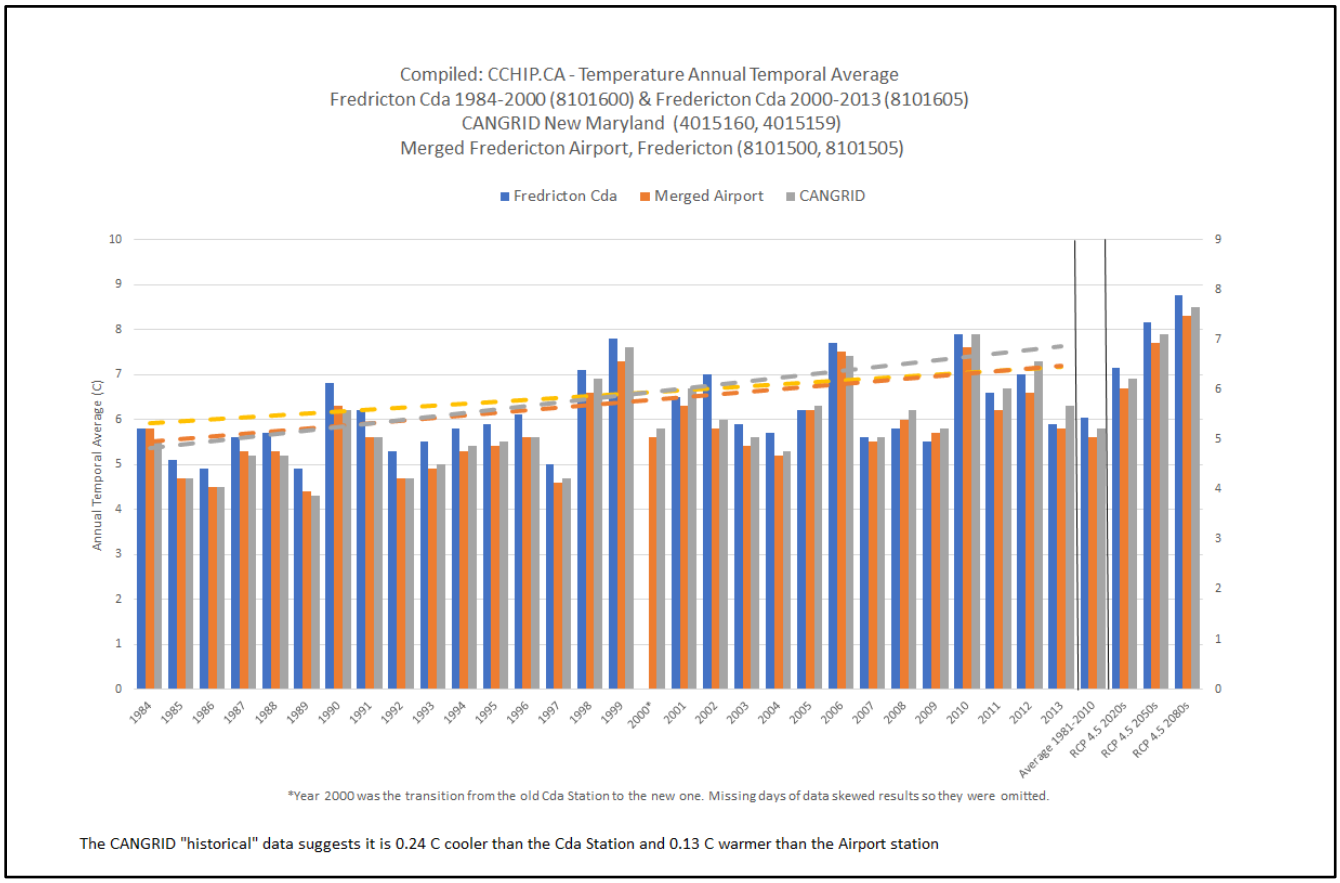


Figure 2: Annual Temperature Average for New Maryland under CANGRD model, and Historical Annual Average Temperature for two nearby weather stations with most complete data

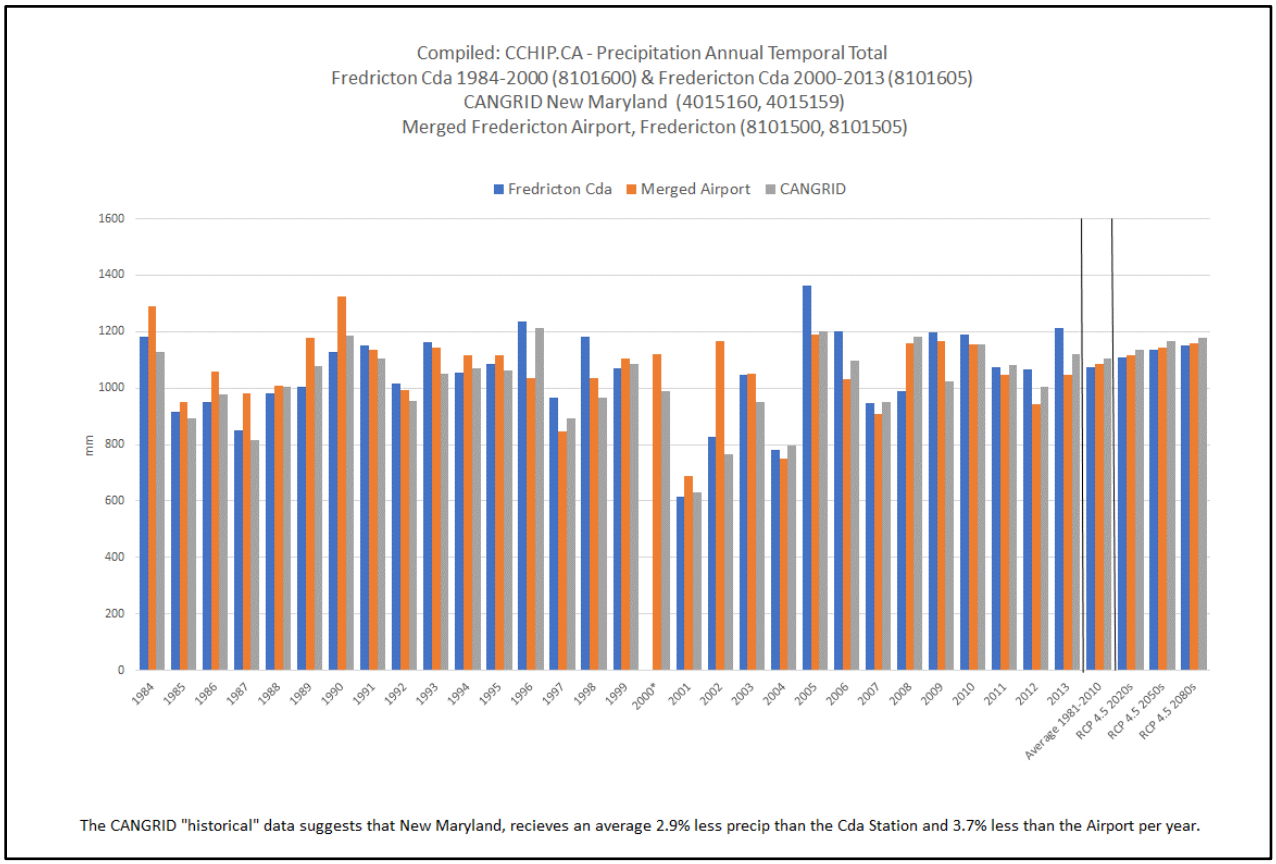


Figure 3:Total Annual Precipitation for New Maryland under CANGRD model, and Historical Total Annual Precipitation for two nearby weather stations with most complete data.

As discussed, beyond a profile of the "current climate", this document outlines the projected future climate for the Village of New Maryland. A large source of uncertainty in future climate projections is based on global progress towards meeting greenhouse gas (GHG) emissions targets. There are four Representative Concentration Pathways (RCP)[1] scenarios adopted by the Intergovernmental Panel on Climate Change (IPCC) that are based on various future greenhouse gas concentration scenarios. This climate profile will focus on two of these scenarios: 1) the "business as usual" greenhouse gas concentrations scenario, RCP 8.5 and 2) the RCP 4.5 scenario which is characterized by GHG emissions peaking in 2040 and then declining. Currently, global GHG concentrations are closer to following the RCP 8.5 pathway despite global agreements/targets for GHG emissions reductions.

The IPCC is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). The assessments are policy-relevant but not policy-prescriptive: they may present projections of future climate change based on different scenarios and the risks that climate change poses and discuss the implications of response options, but they do not tell policymakers what actions to take.

[1] RCP: Representative Concentration Pathways – a greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC) for its fifth Assessment Report (AR5) in 2014.

The time horizons for the study were selected as current conditions (establishing the baseline risks) and the future predicted climate of 2020s (2011 to 2040), 2050s (2041 to 2070) and, 2080s (2071 to 2100) for future conditions. Climate is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of meteorological variables such as temperature, precipitation and wind over a period of time, typically 30 years.[2] The “2050s” projected climate is therefore the projected average over the 30-year period from 2041 to 2070. The “baseline” current climate will be based on the 1981 to 2010 Climate Normals, as this information is widely available. This baseline represents the typical climate in an area to which infrastructure designers and operators are accustomed for their designs and operations.

TEMPERATURE: MEAN

Table 1: Average Change in Mean Temperature from Baseline

Season	Average Change in Mean Temperature from 1981-2010 Baseline (°C)					
	RCP 4.5			RCP 8.5		
	2020s	2050s	2080s	2020s	2050s	2080s
Annual	1.1	2.1	2.7	1.3	3.1	5.0
Winter	1.3	2.5	3.1	1.5	3.5	5.6
Spring	1.1	2.0	2.5	1.1	2.8	4.6
Summer	1.1	2.1	2.6	1.2	3.0	5.0
Autumn	1.1	2.1	2.5	1.3	3.0	4.9

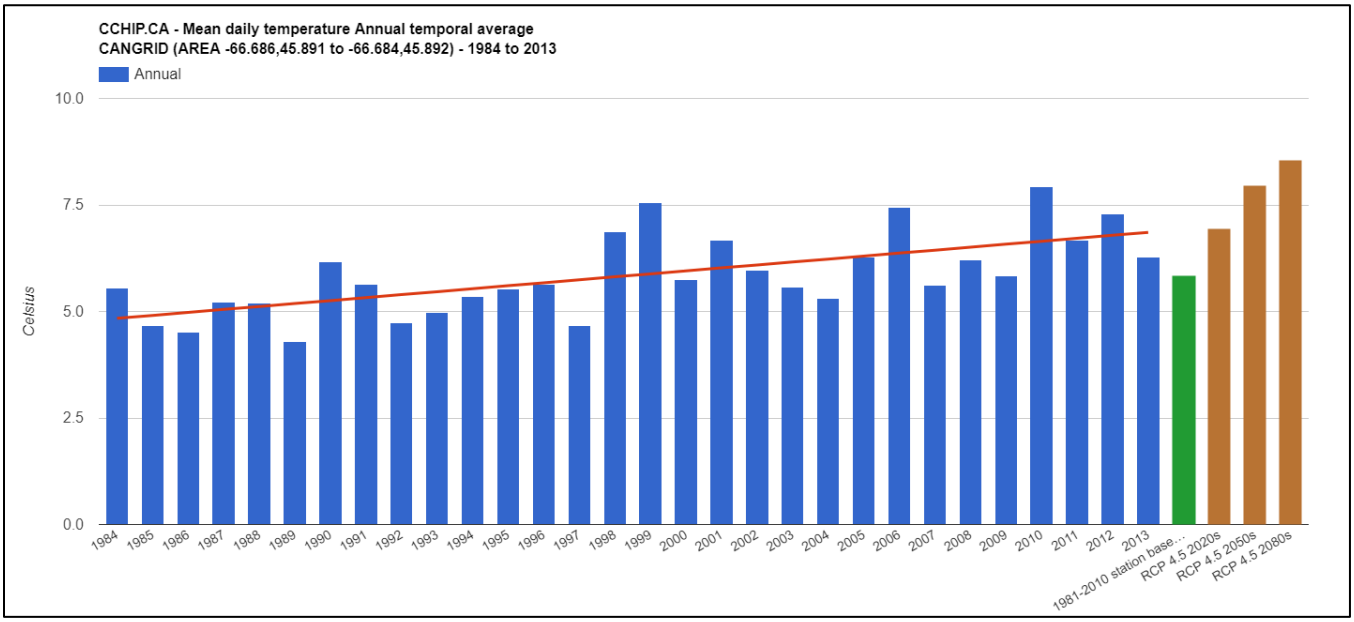


Figure 4: Annual Temporal Average – Mean Daily Temperature (RCP 4.5)

[2] World Meteorological Organization, 2017: Commission for Climatology: Frequently Asked Questions. http://www.wmo.int/pages/prog/wcp/ccl/faqs.php (accessed Sept.28,2018)

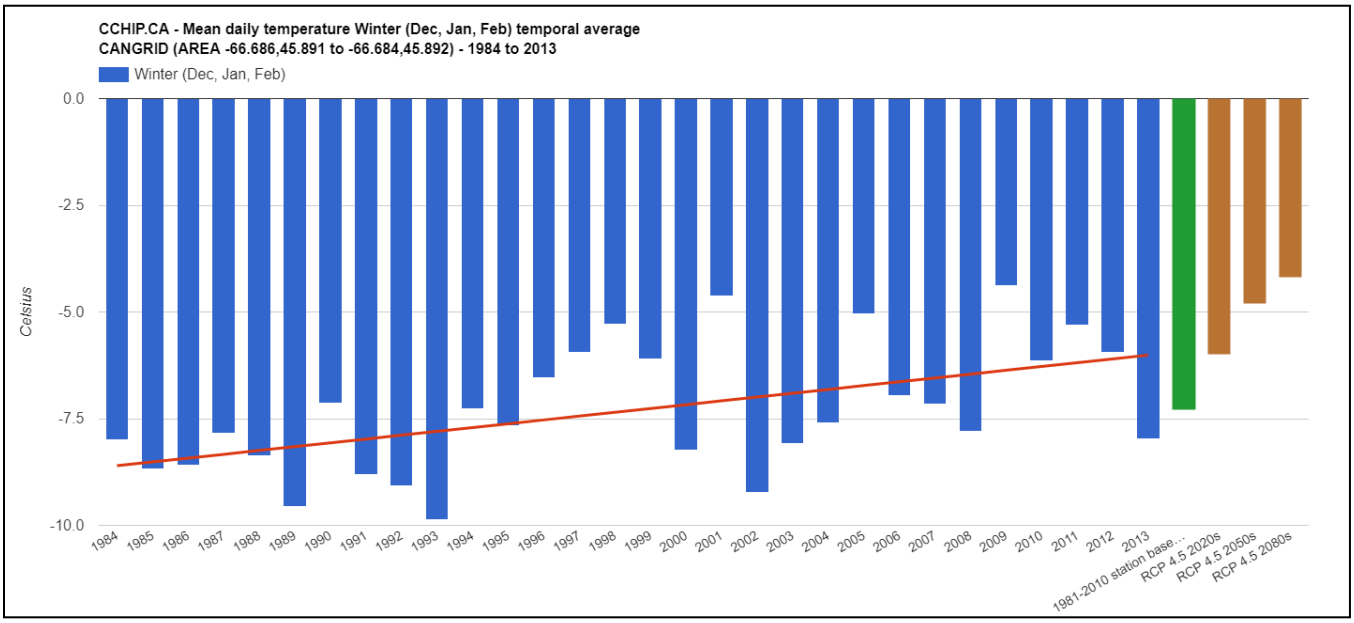


Figure 5: Winter Temporal Average – Mean Daily Temperature (RCP 4.5)

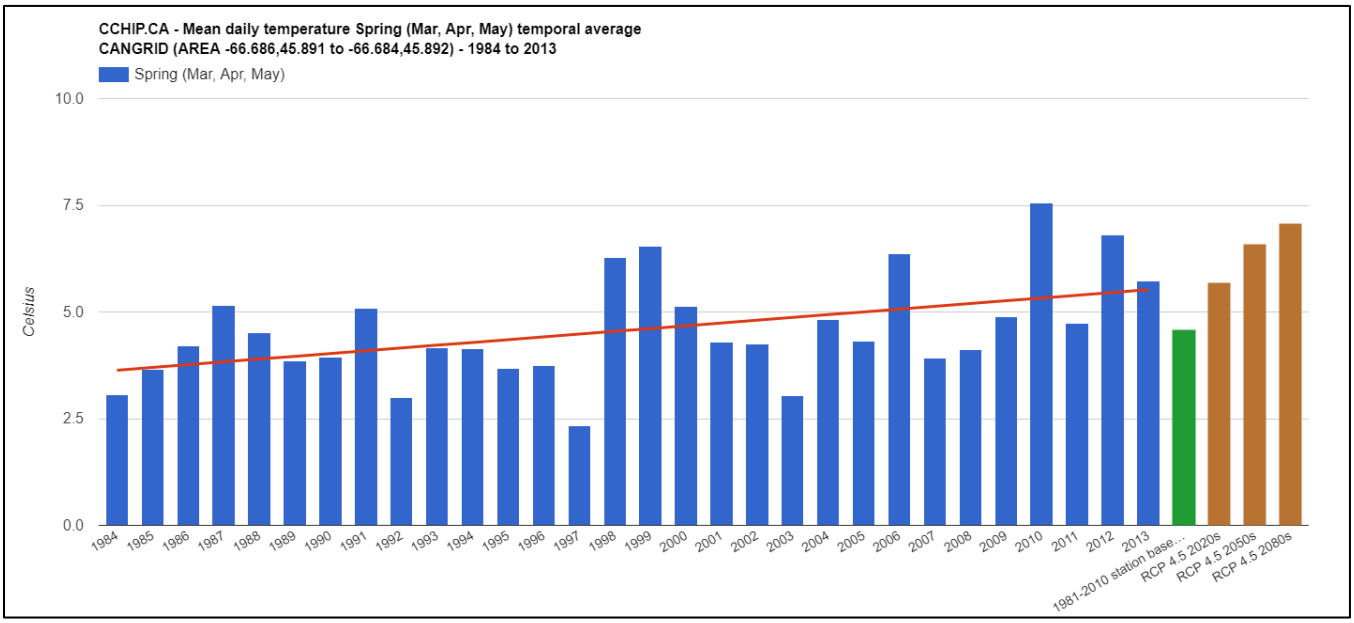


Figure 6: Spring Temporal Average – Mean Daily Temperature (RCP 4.5)

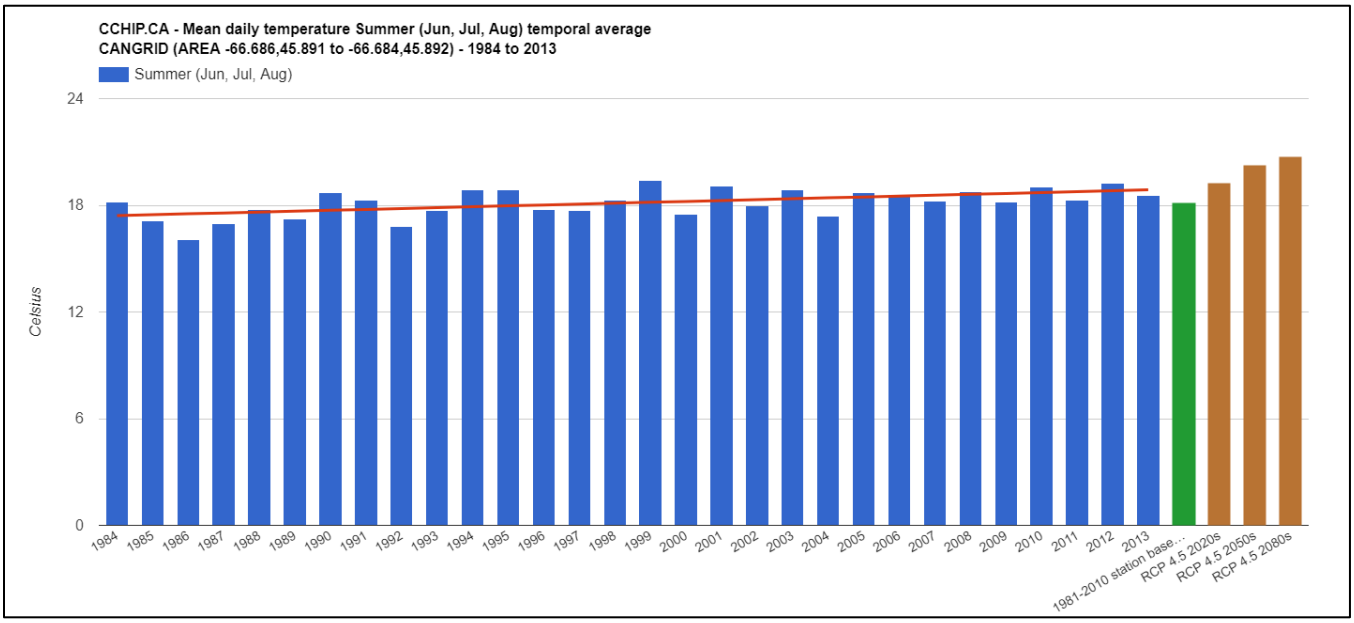


Figure 7: Summer Temporal Average – Mean Daily Temperature (RCP 4.5)

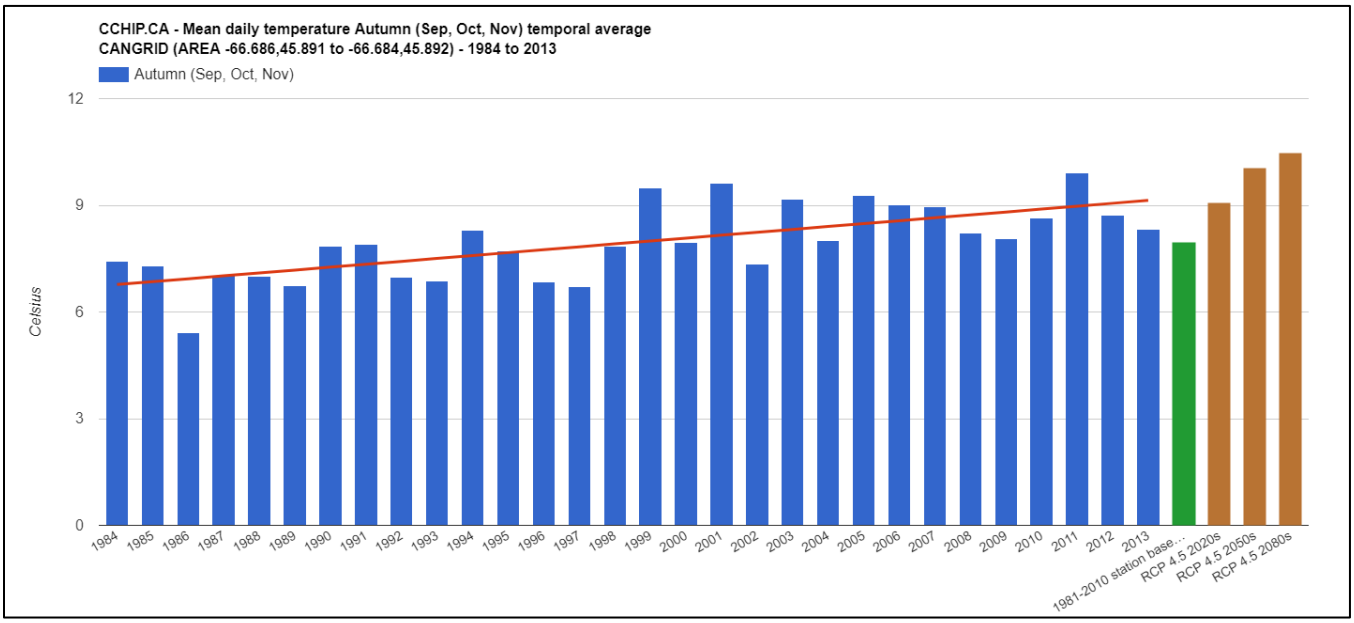


Figure 8: Autumn Temporal Average - Mean Daily Temperature (RCP 4.5)

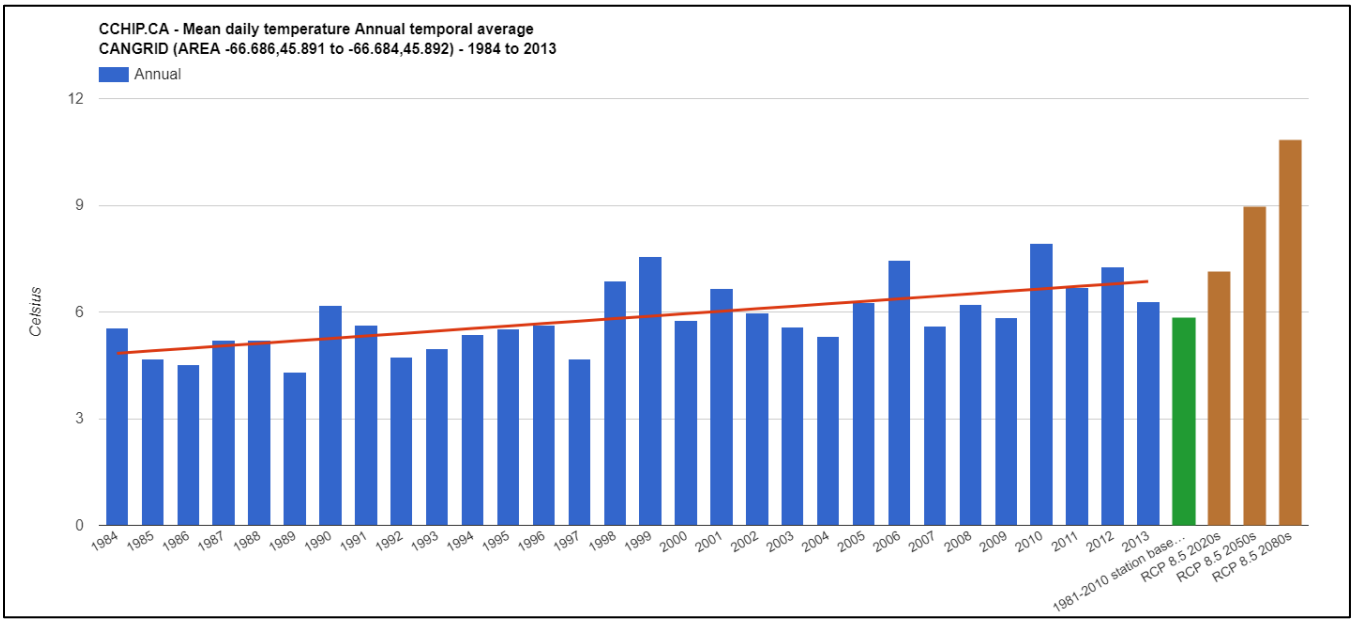


Figure 9: Annual Temporal Average - Mean Daily Temperature (RCP 8.5)

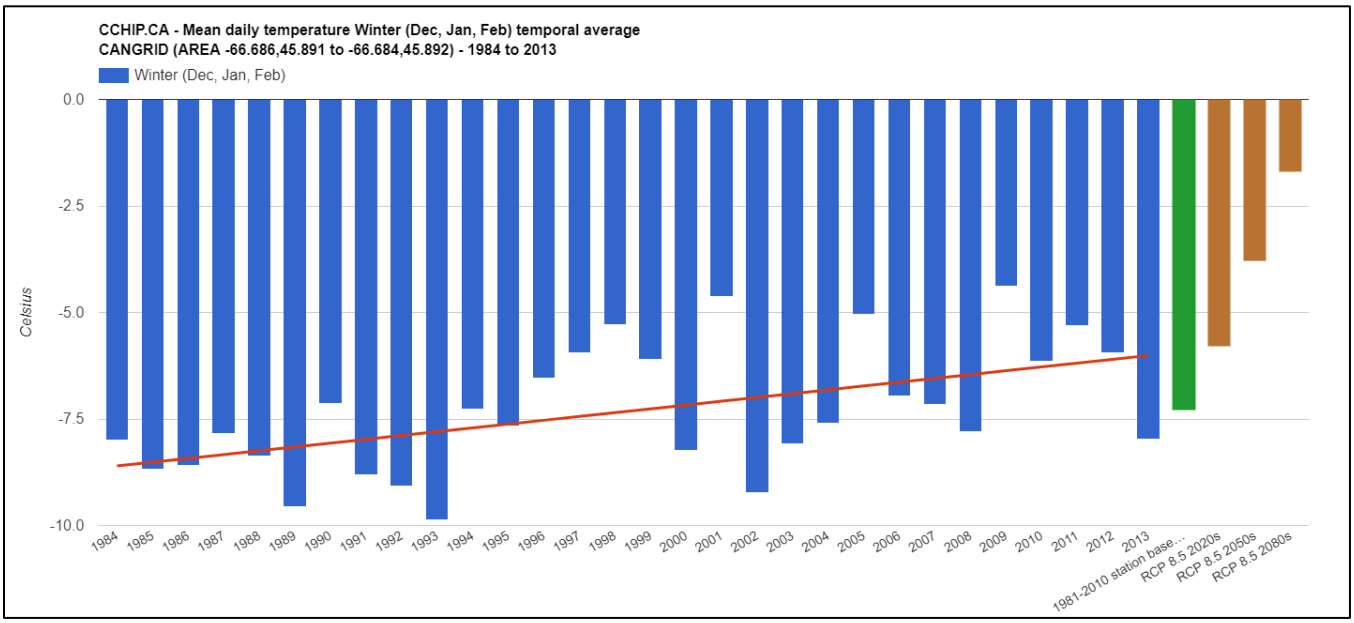


Figure 10: Winter Temporal Average – Mean Daily Temperature (RCP 8.5)

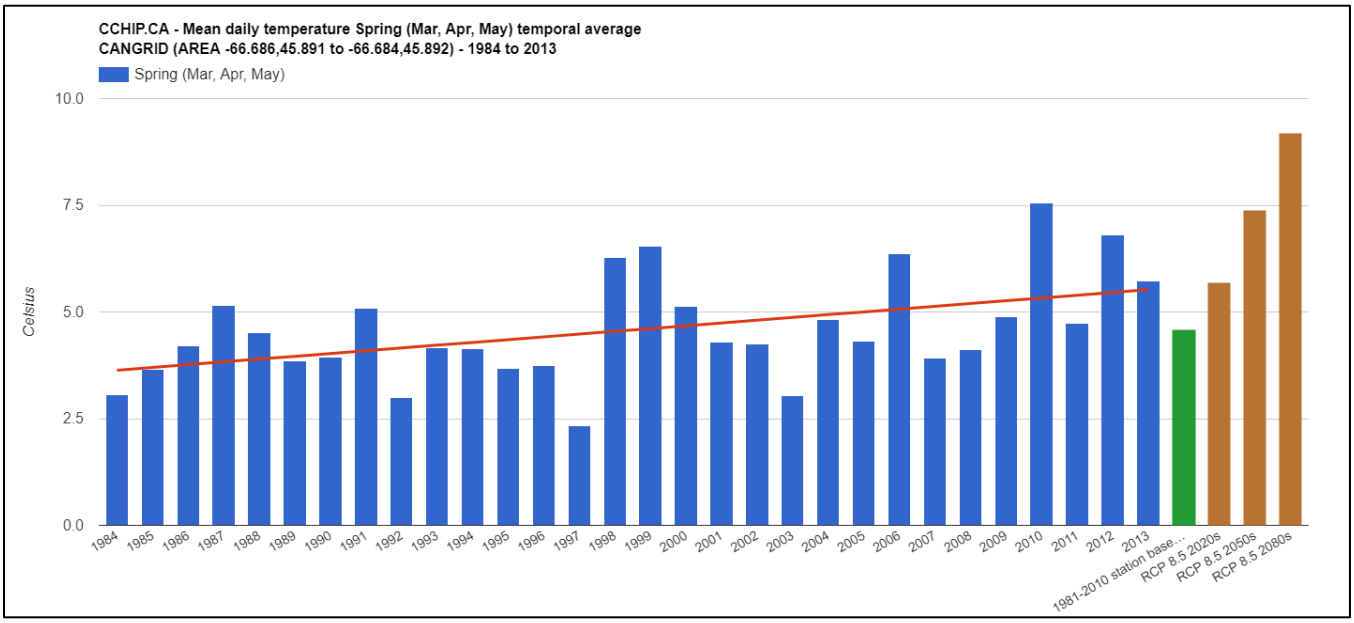


Figure 11: Spring Temporal Average – Mean Daily Temperature (RCP 8.5)

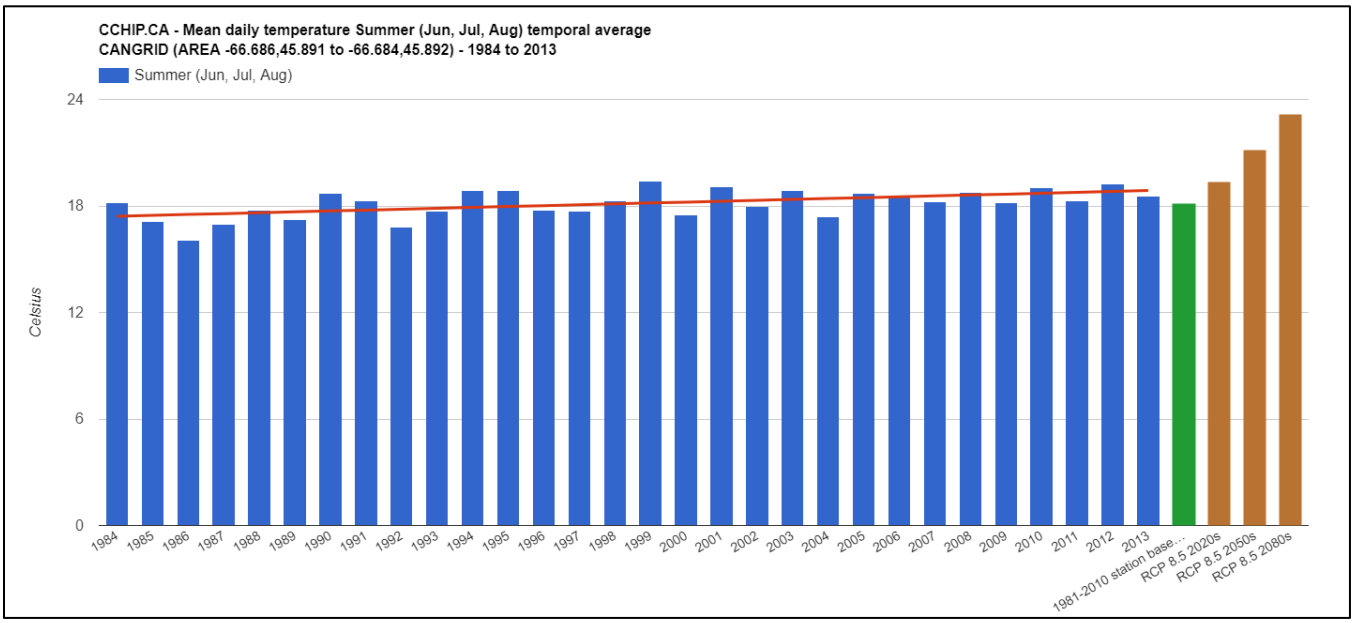


Figure 12: Summer Temporal Average – Mean Daily Temperature (RCP 8.5)

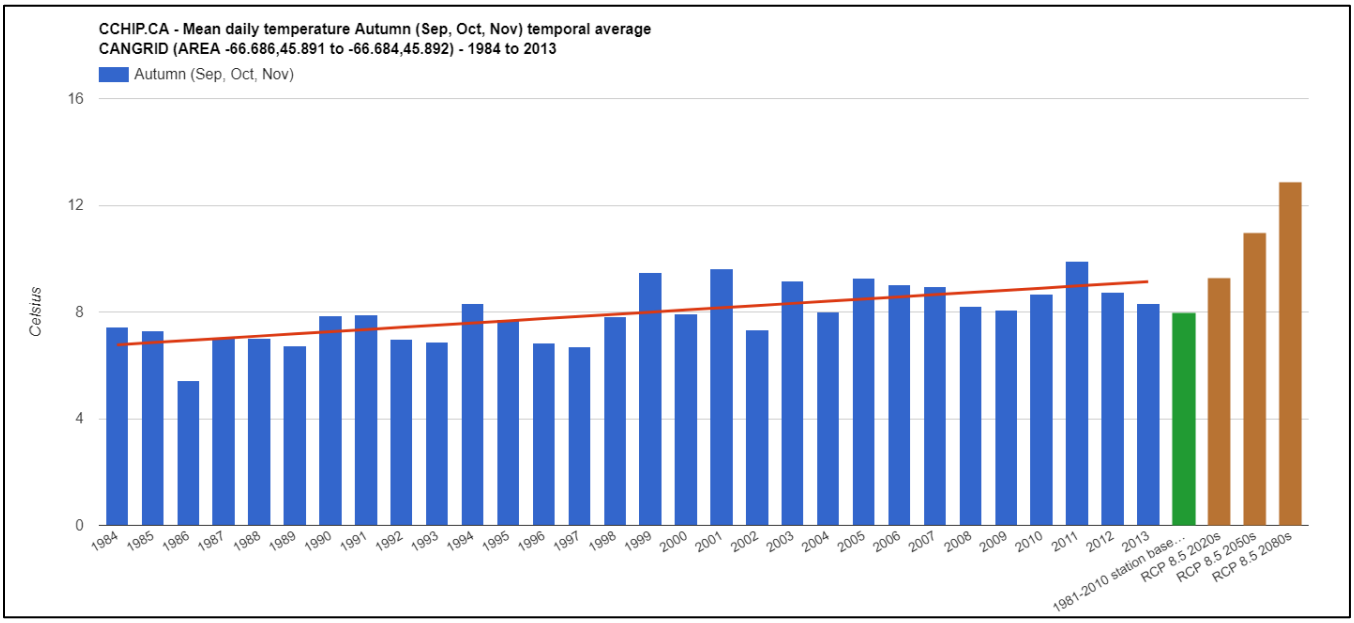


Figure 13: Autumn Temporal Average – Mean Daily Temperature (RCP 8.5)

TEMPERATURE: MAXIMUM

Table 2: Average Change in Maximum Temperature from Baseline

Season	Average Change in Maximum Temperature from 1981-2010 Baseline (°C)					
	RCP 4.5			RCP 8.5		
	2020s	2050s	2080s	2020s	2050s	2080s
Annual	1.1	2.1	2.6	1.2	3.0	4.9
Winter	1.2	2.2	2.8	1.3	3.1	4.9
Spring	1.1	2.0	2.5	1.1	2.8	4.6
Summer	1.1	2.1	2.6	1.2	3.0	5.2
Autumn	1.1	2.1	2.6	1.3	2.9	4.9

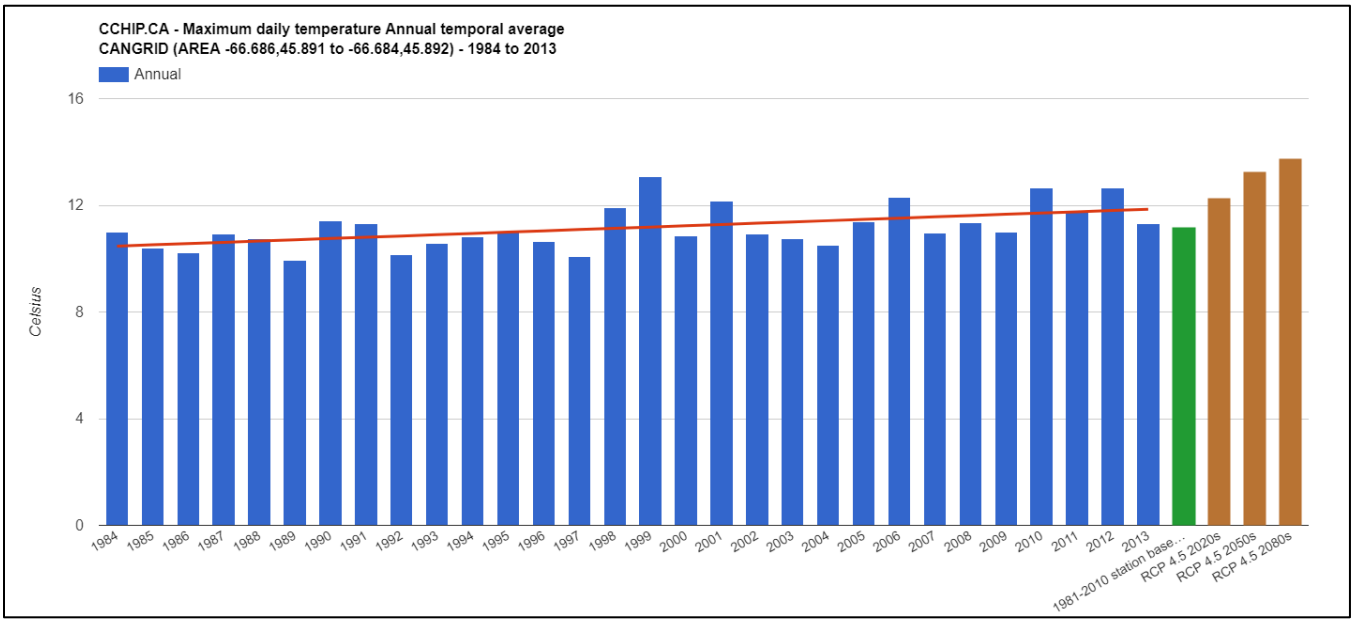


Figure 14: Annual Temporal Average – Maximum Daily Temperature (RCP 4.5)

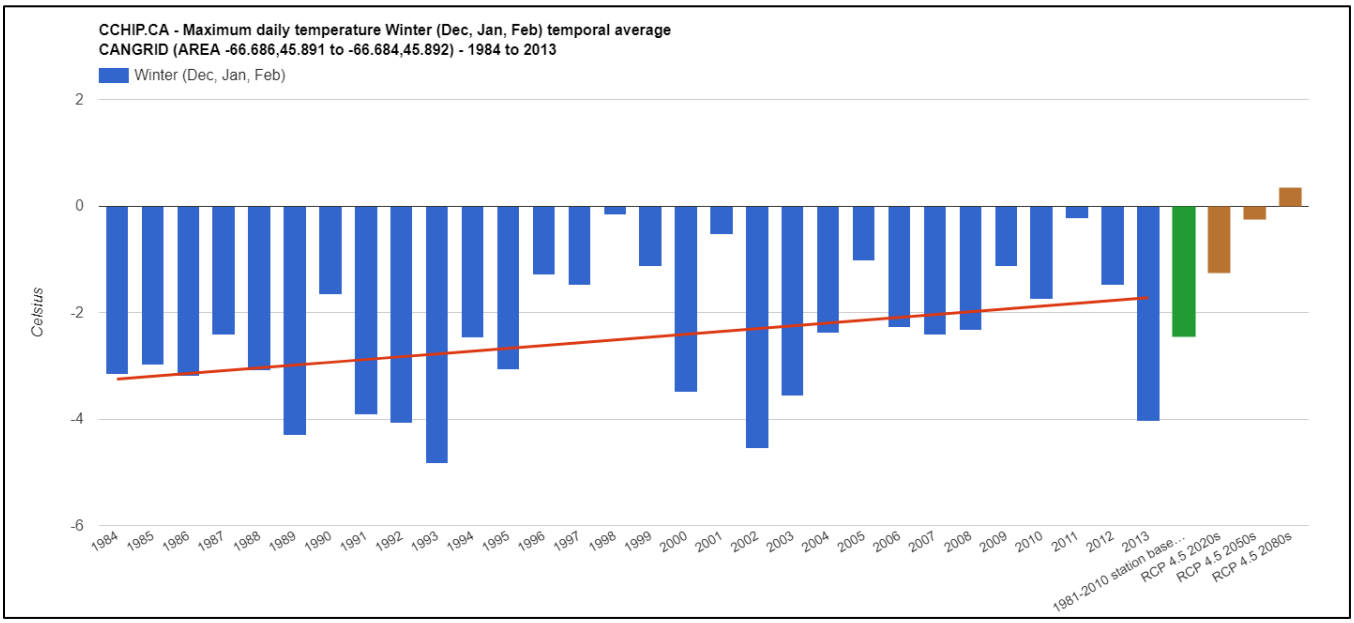


Figure 15: Winter Temporal Average – Maximum Daily Temperature (RCP 4.5)

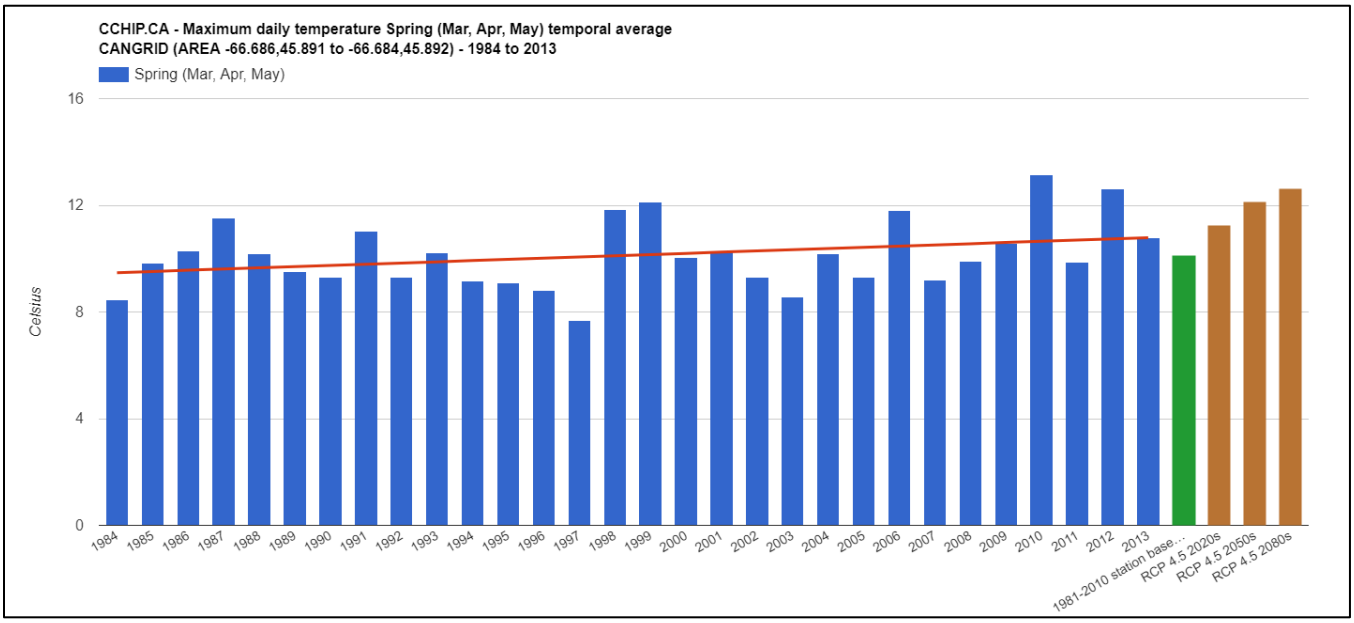


Figure 16: Spring Temporal Average – Maximum Daily Temperature (RCP 4.5)

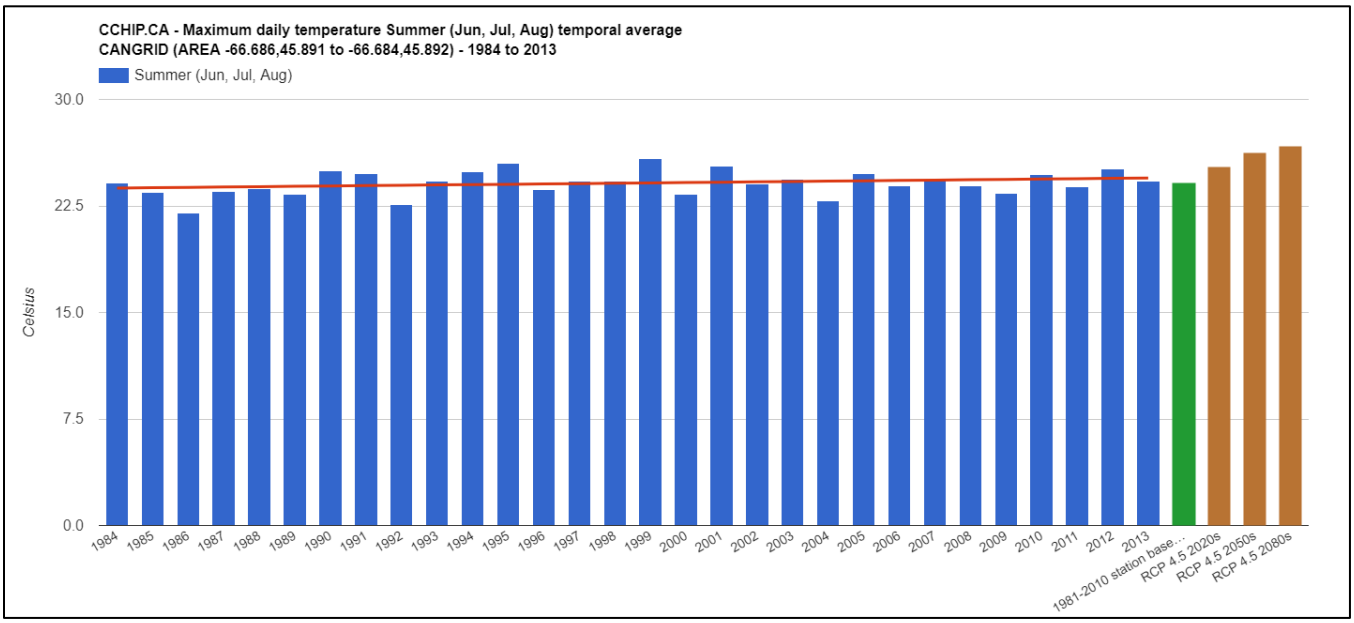


Figure 17: Summer Temporal Average – Maximum Daily Temperature (RCP 4.5)

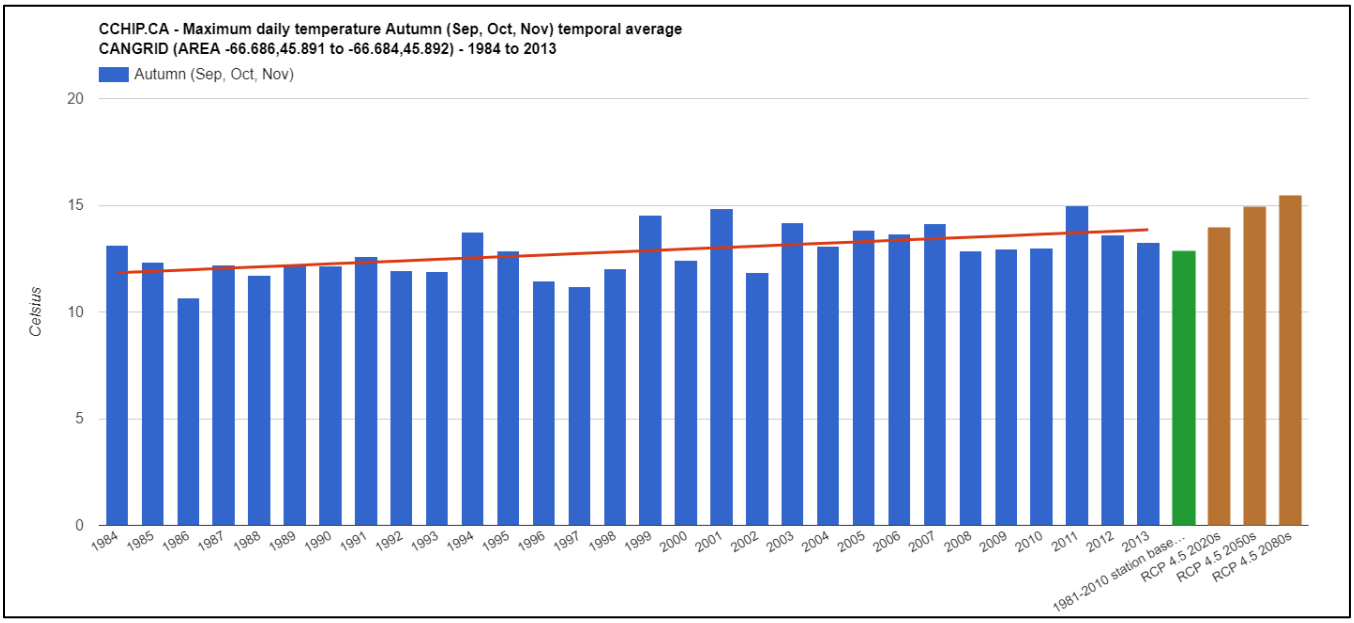


Figure 18: Autumn Temporal Average – Maximum Daily Temperature (RCP 4.5)

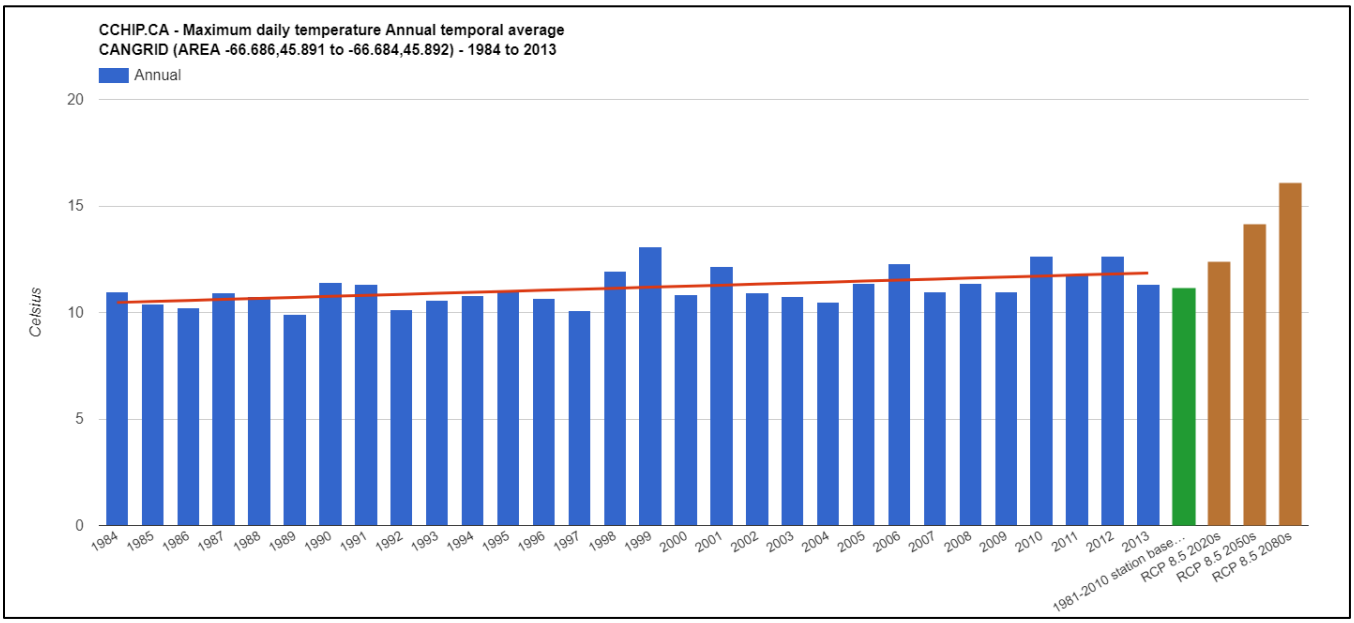


Figure 19: Annual Temporal Average – Maximum Daily Temperature (RCP 8.5)

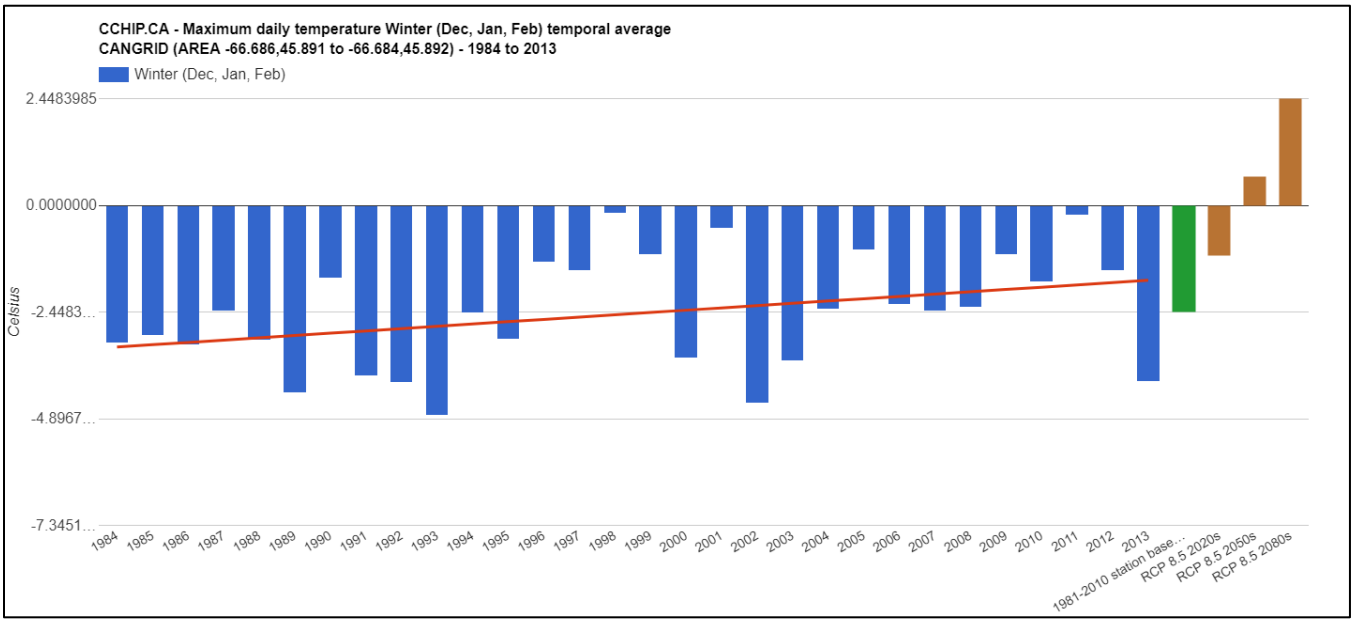


Figure 20: Winter Temporal Average – Maximum Daily Temperature (RCP 8.5)

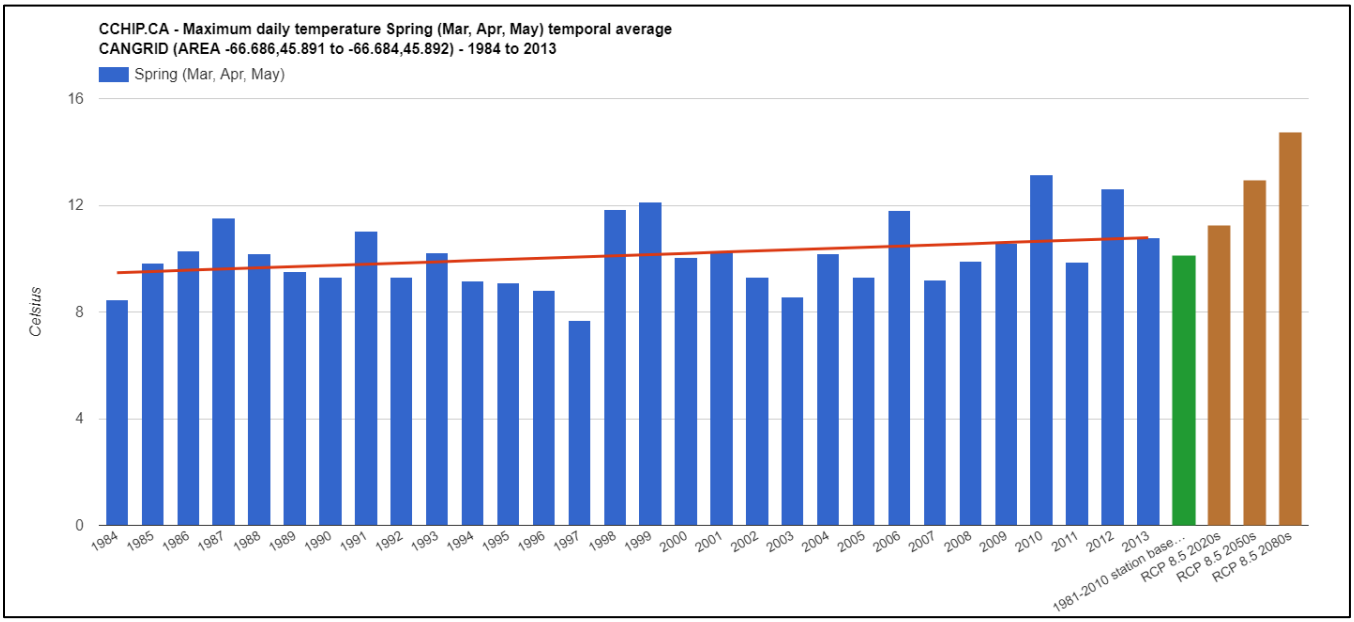


Figure 21: Spring Temporal Average – Maximum Daily Temperature (RCP 8.5)

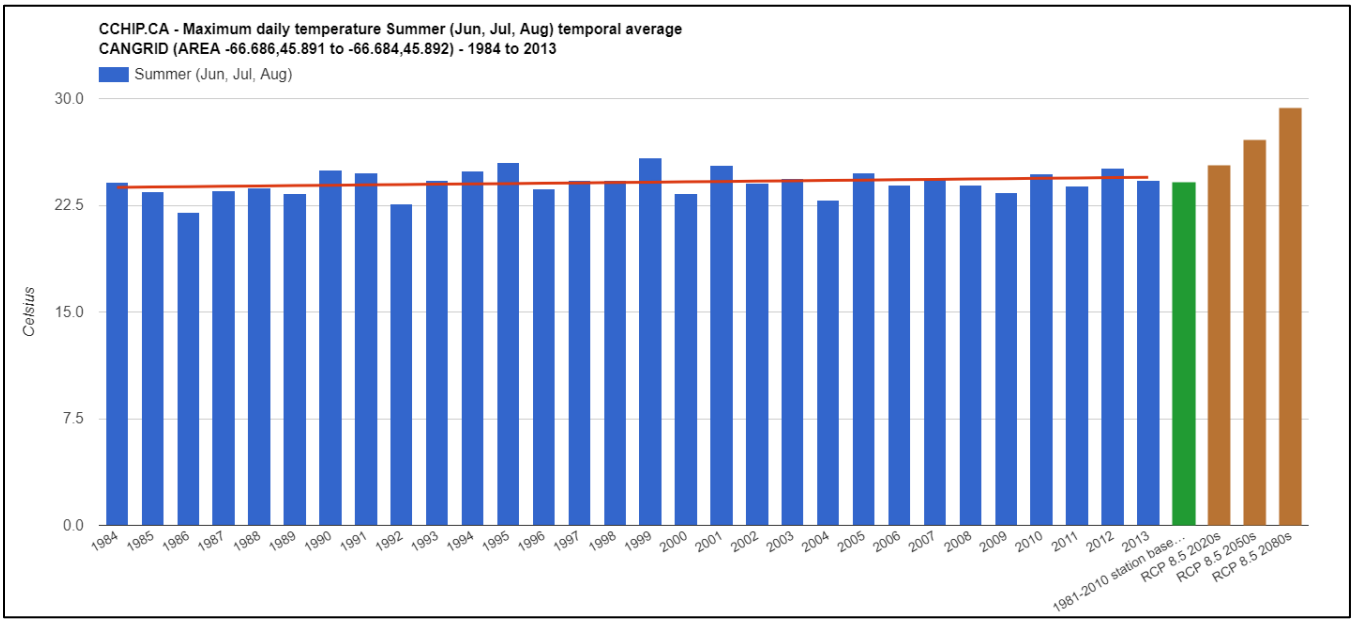


Figure 22: Summer Temporal Average – Maximum Daily Temperature (RCP 8.5)

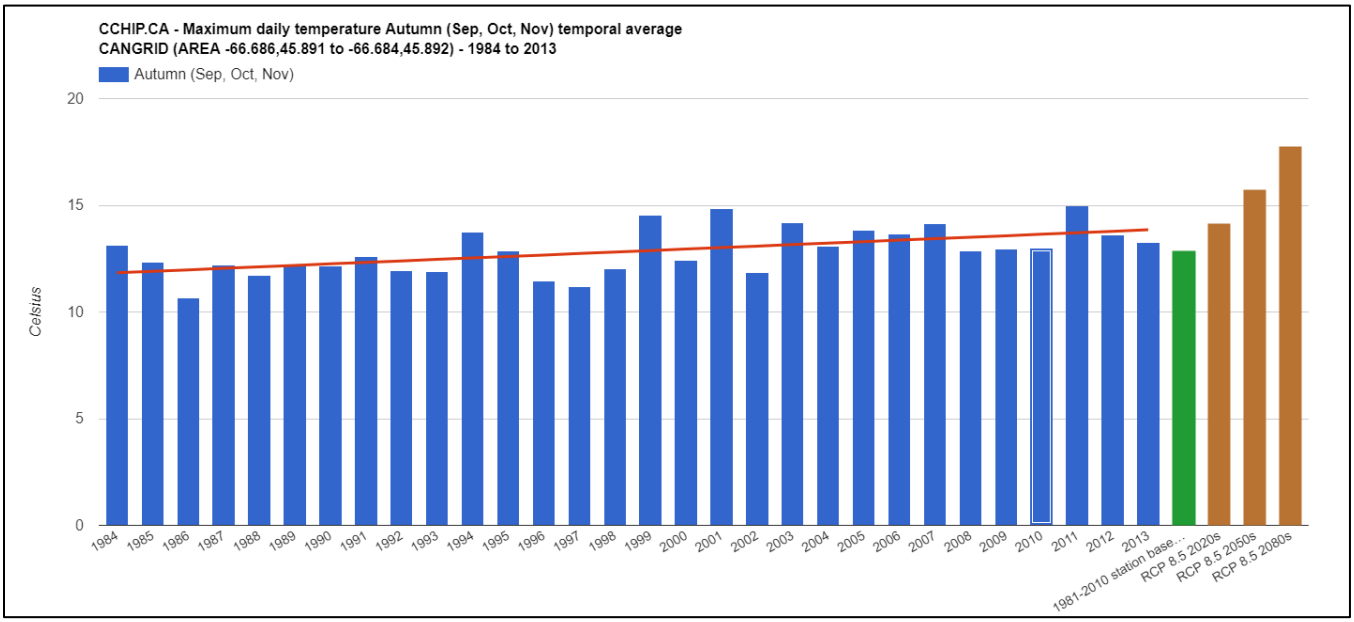


Figure 23: Autumn Temporal Average – Maximum Daily Temperature (RCP 8.5)

It can also be useful to view projected increases in temperatures as the change in the occurrence of days with a temperature higher than a certain threshold. Table 3 represents the climate projection for the occurrence of days with temperatures greater than 32°C.

Table 3: CCHIP Custom Report: CANGRD Data, New Maryland; Day with Max Temp >32°C (RCP 8.5)

	Annual Occurrence of Days with Max. Temp >32°C						
	Historical 1981-2010	RCP 4.5			RCP 8.5		
		2020s	2050s	2080s	2020s	2050s	2080s
Days/year	2.5	4.9	8.1	9.7	5.6	11.4	27.1

TEMPERATURE: MINIMUM

Table 4: Average Change in Minimum Temperature from Baseline

Season	Average Change in Minimum Temperature from 1981-2010 Baseline (°C)					
	RCP 4.5			RCP 8.5		
	2020s	2050s	2080s	2020s	2050s	2080s
Annual	1.2	2.2	2.8	1.3	3.2	5.3
Winter	1.2	2.8	3.6	1.7	4.0	6.4
Spring	1.1	2.0	2.6	1.1	2.9	4.7
Summer	1.1	2.1	2.5	1.2	2.9	4.9
Autumn	1.1	2.0	2.6	1.3	3.0	5.0

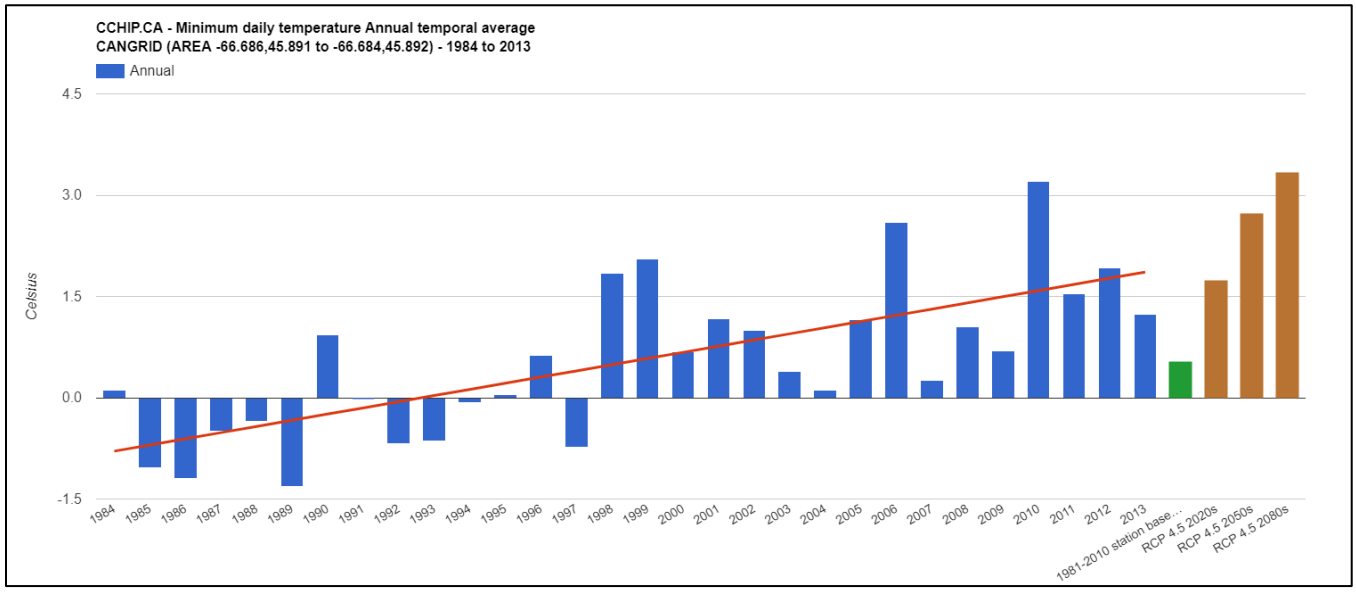


Figure 24: Annual Temporal Average – Minimum Daily Temperature (RCP 4.5)

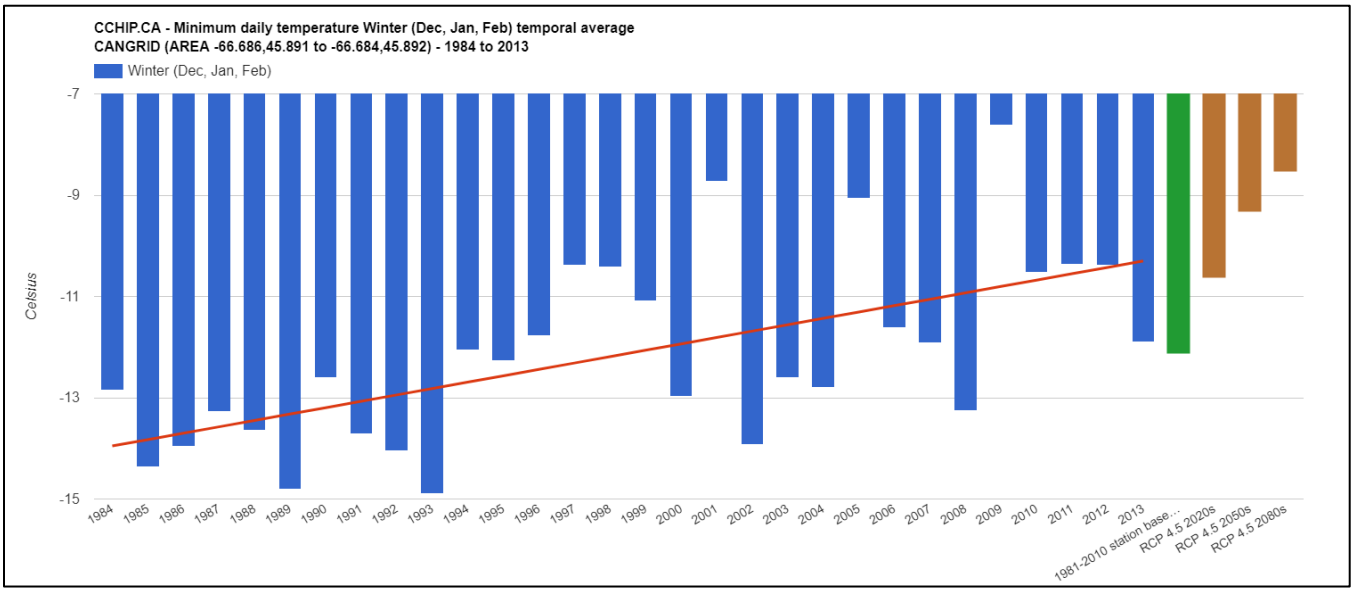


Figure 25: Winter Temporal Average – Minimum Daily Temperature (RCP 4.5)

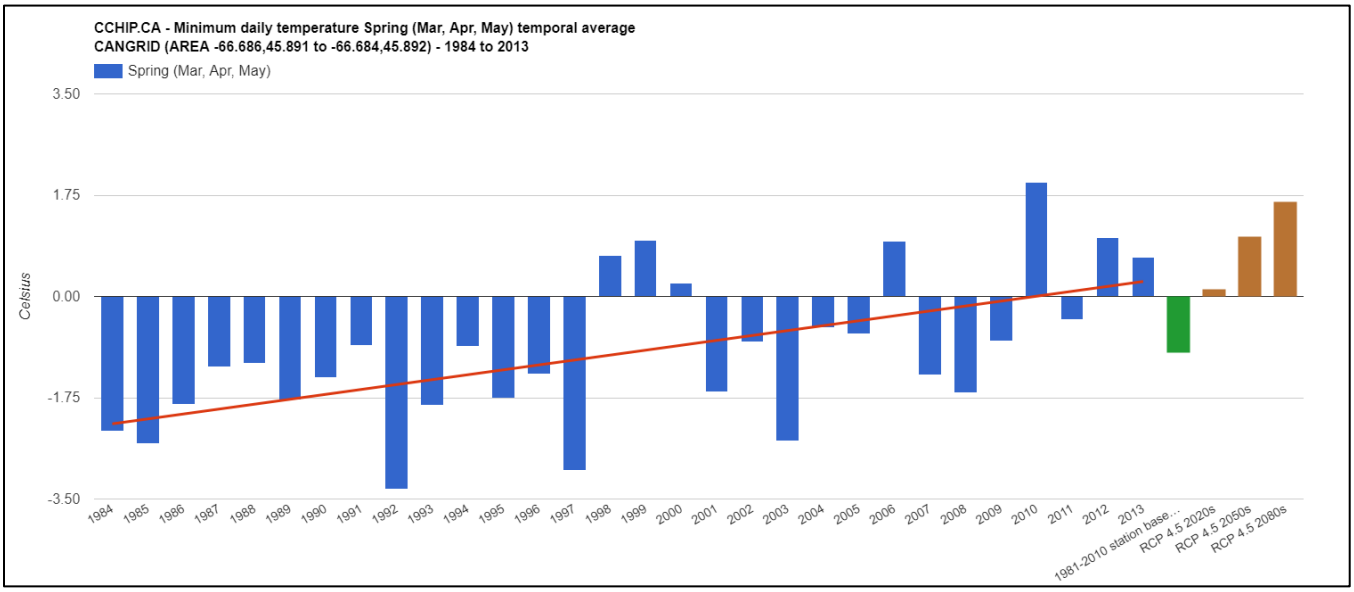


Figure 26: Spring Temporal Average – Minimum Daily Temperature (RCP 4.5)

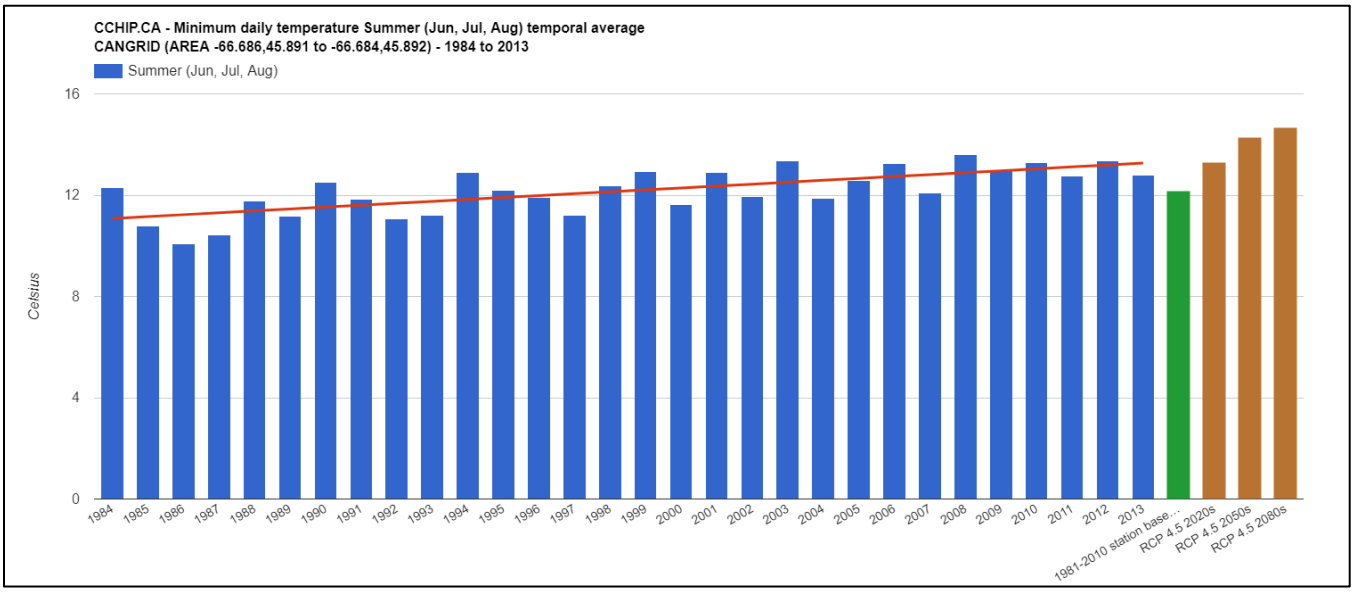


Figure 27: Summer Temporal Average – Minimum Daily Temperature (RCP 4.5)

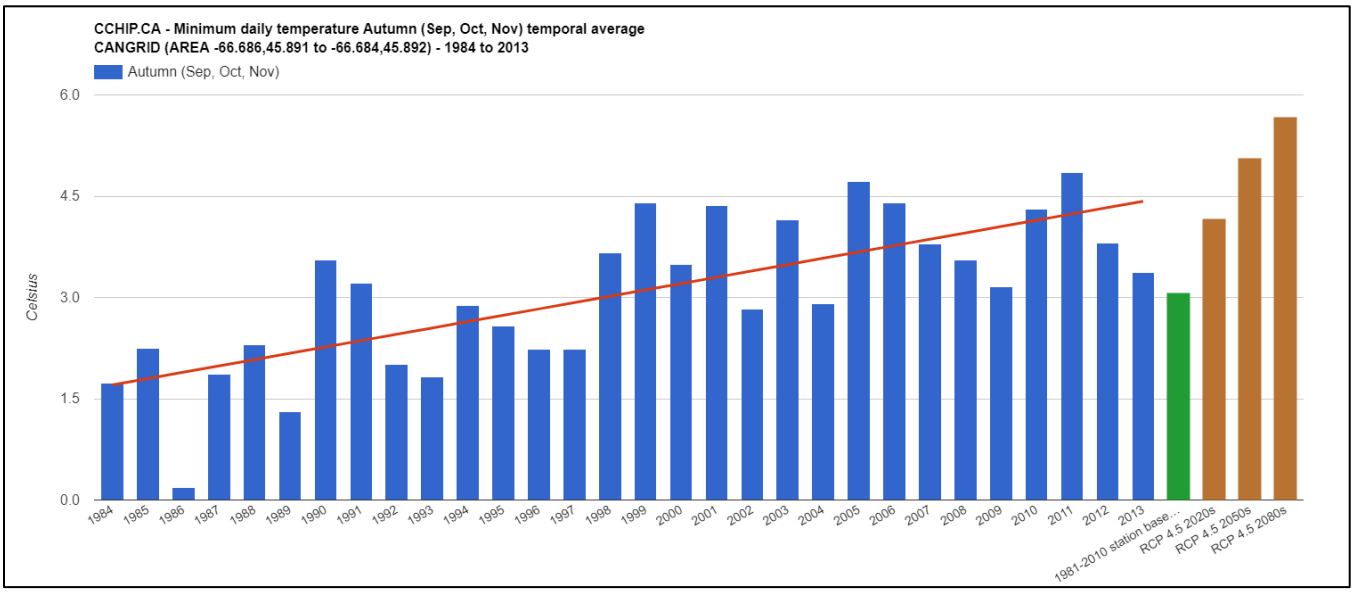


Figure 28: Autumn Temporal Average – Minimum Daily Temperature (RCP 4.5)

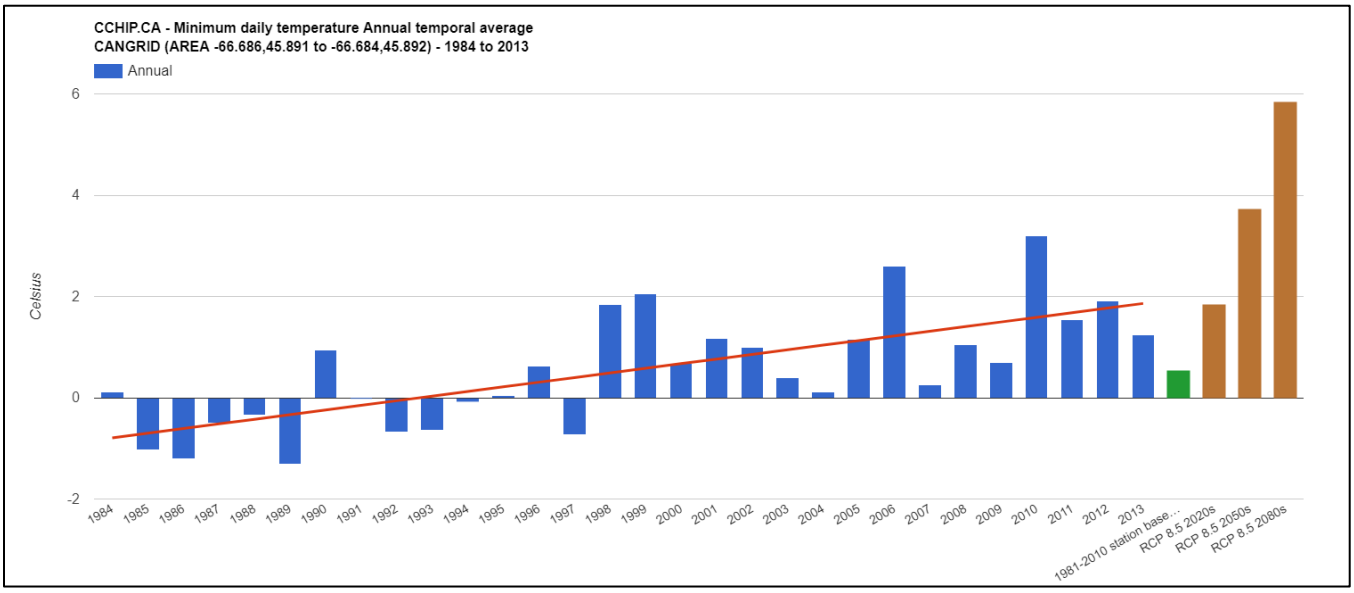


Figure 29: Annual Temporal Average – Minimum Daily Temperature (RCP 8.5)

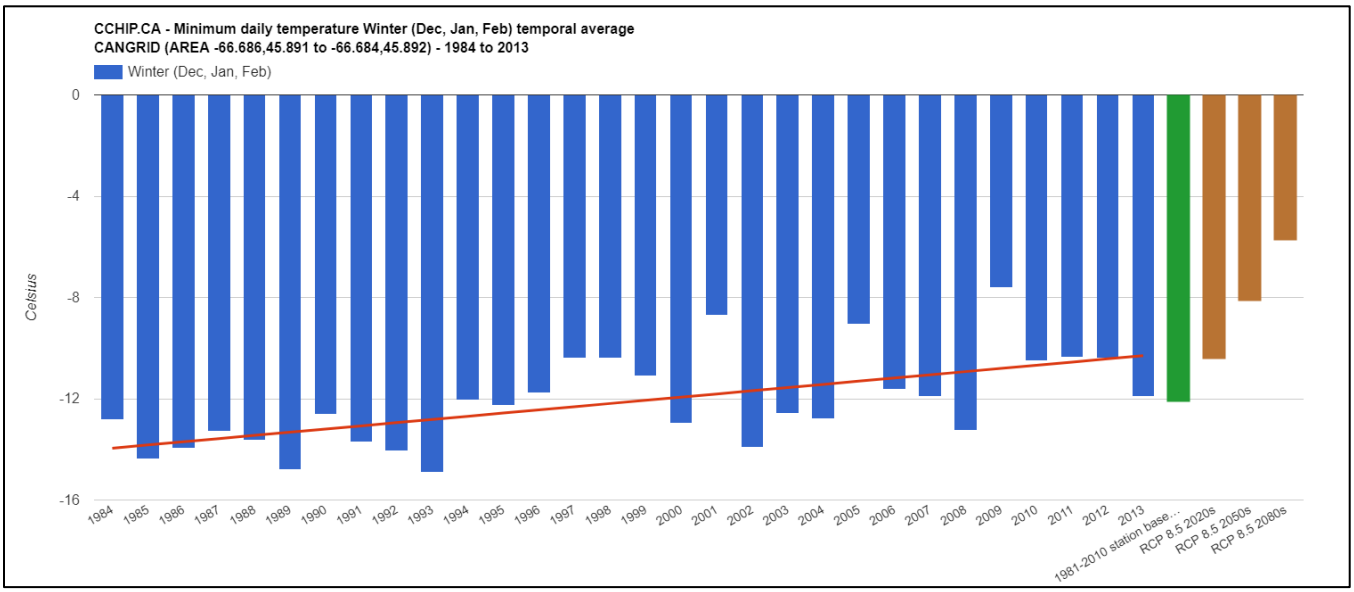


Figure 30: Winter Temporal Average – Minimum Daily Temperature (RCP 8.5)

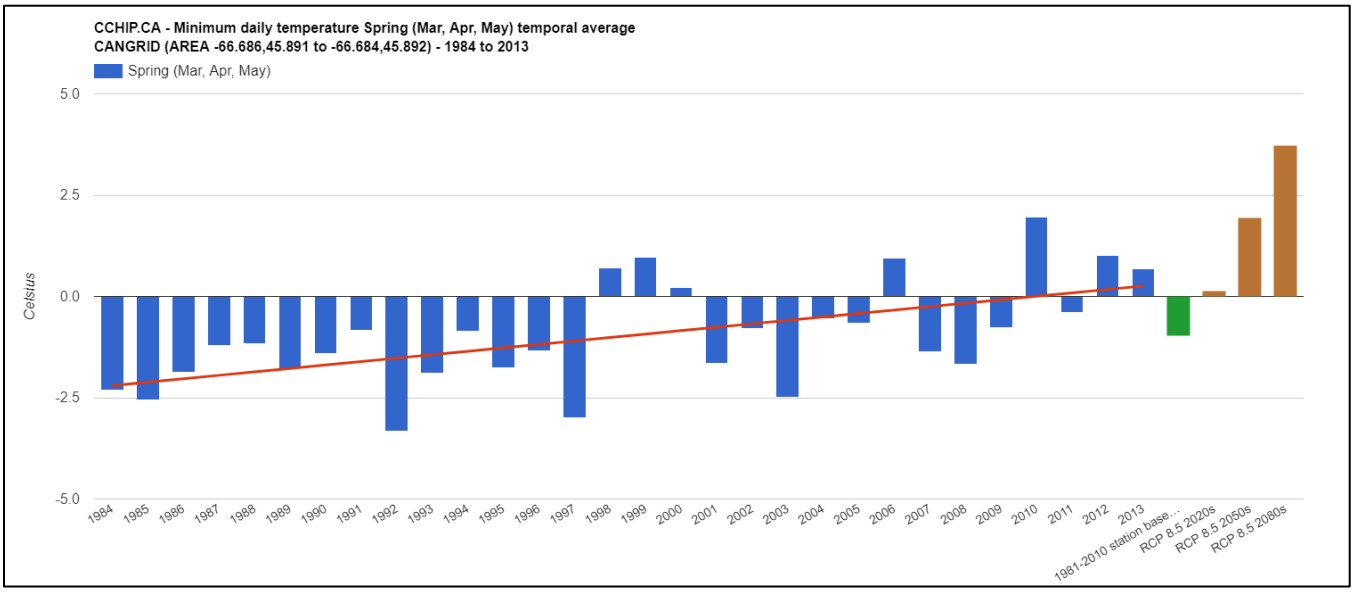


Figure 31: Spring Temporal Average – Minimum Daily Temperature (RCP 8.5)

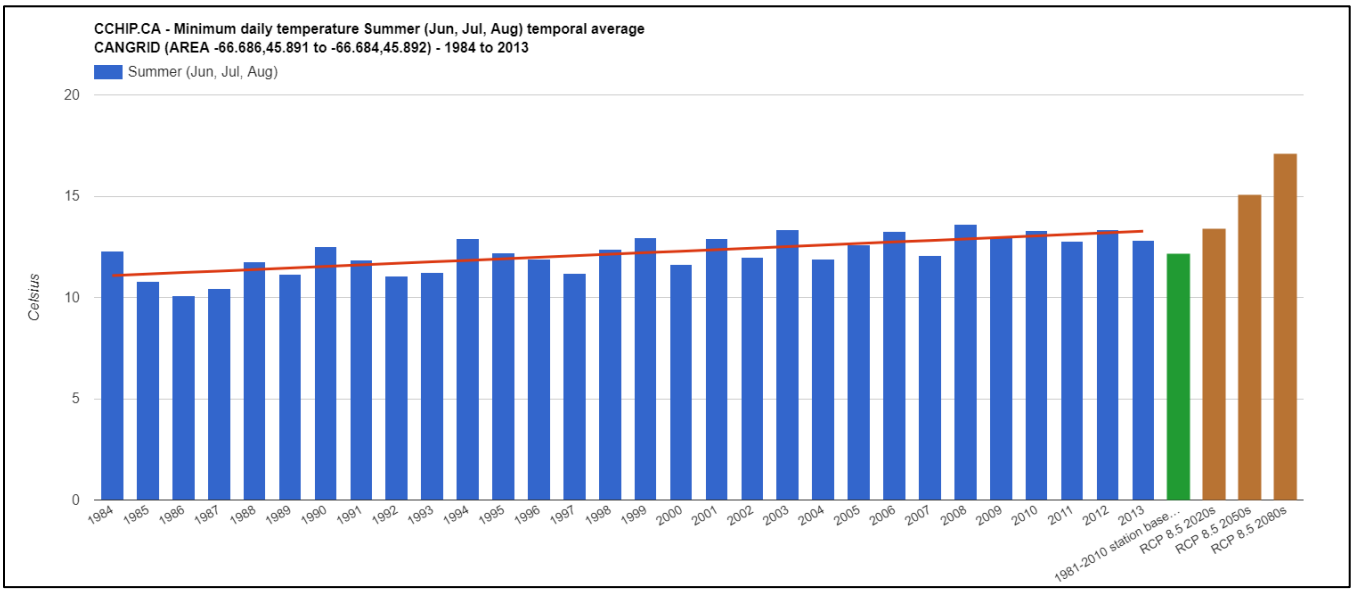


Figure 32: Summer Temporal Average – Minimum Daily Temperature (RCP 8.5)

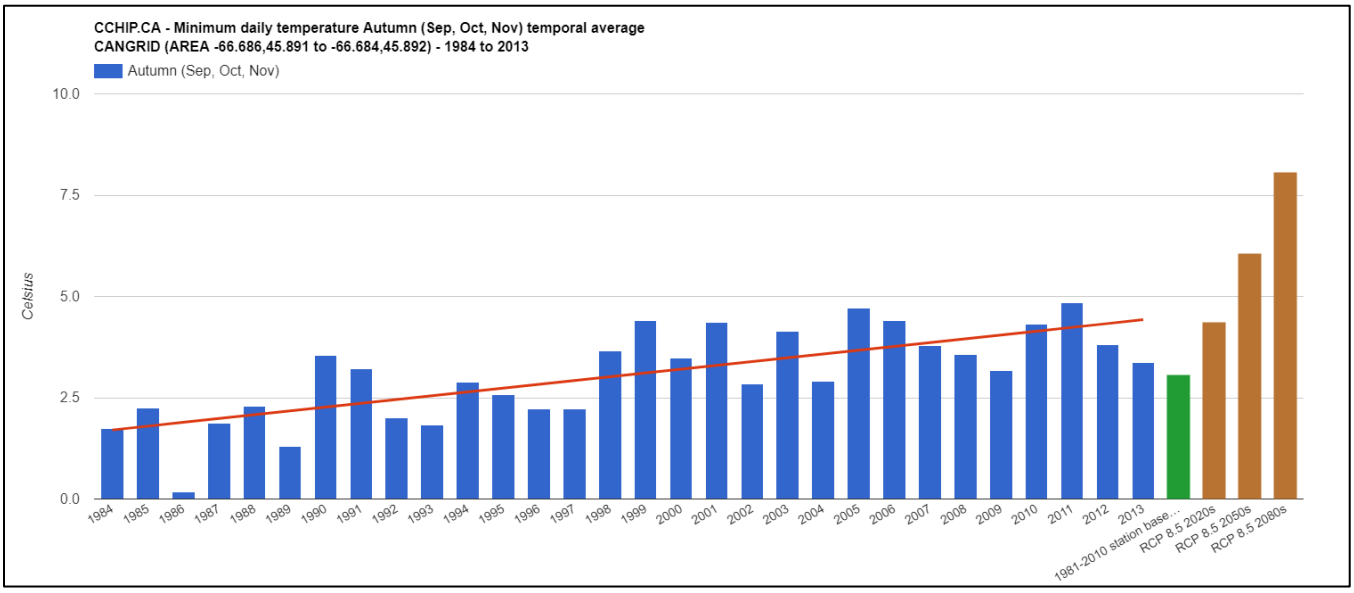


Figure 33: Autumn Temporal Average – Minimum Daily Temperature (RCP 8.5)

PRECIPITATION

Table 5: Average Percent Change in Total Precipitation from Baseline

Season	Average Percent Change in Total Precipitation from 1981-2010 Baseline (%)					
	RCP 4.5			RCP 8.5		
	2020s	2050s	2080s	2020s	2050s	2080s
Annual	3.0	5.6	6.9	3.2	7.2	10.7
Winter	4.4	7.3	10.3	4.9	10.6	17.7
Spring	3.0	6.8	7.9	3.9	9.8	14.9
Summer	2.1	3.8	5.5	3.1	4.4	5.6
Autumn	2.7	4.9	4.1	1.1	4.2	4.9

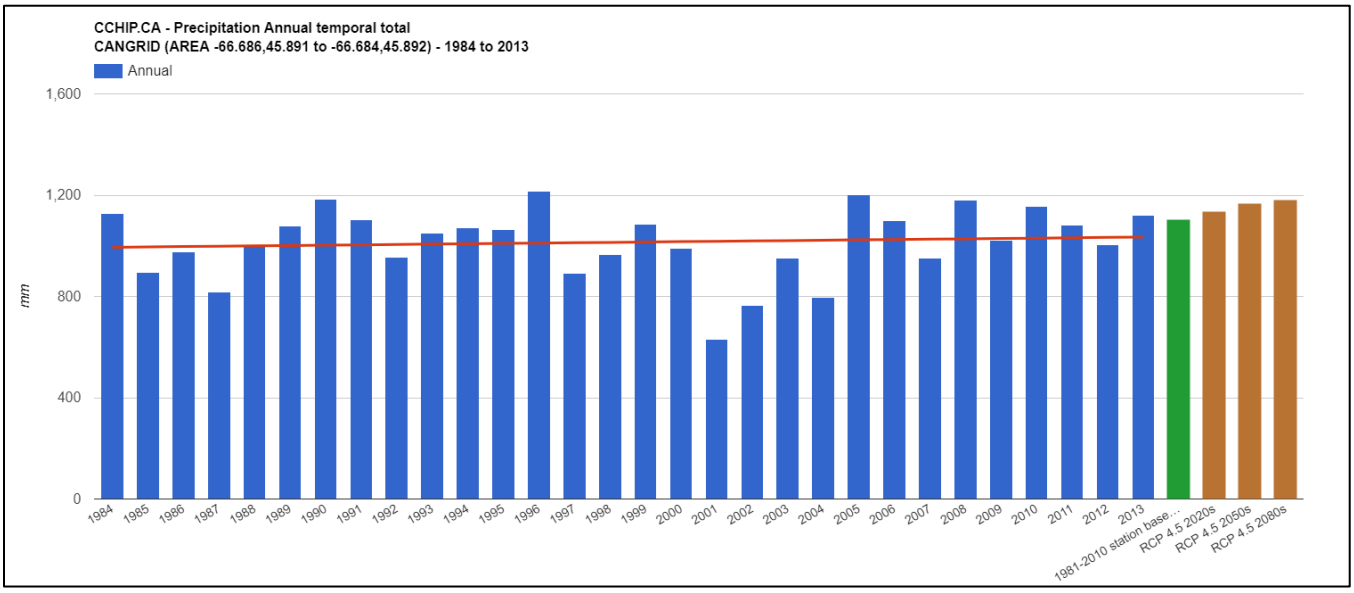


Figure 34: Annual Precipitation Temporal Total (RCP 4.5)

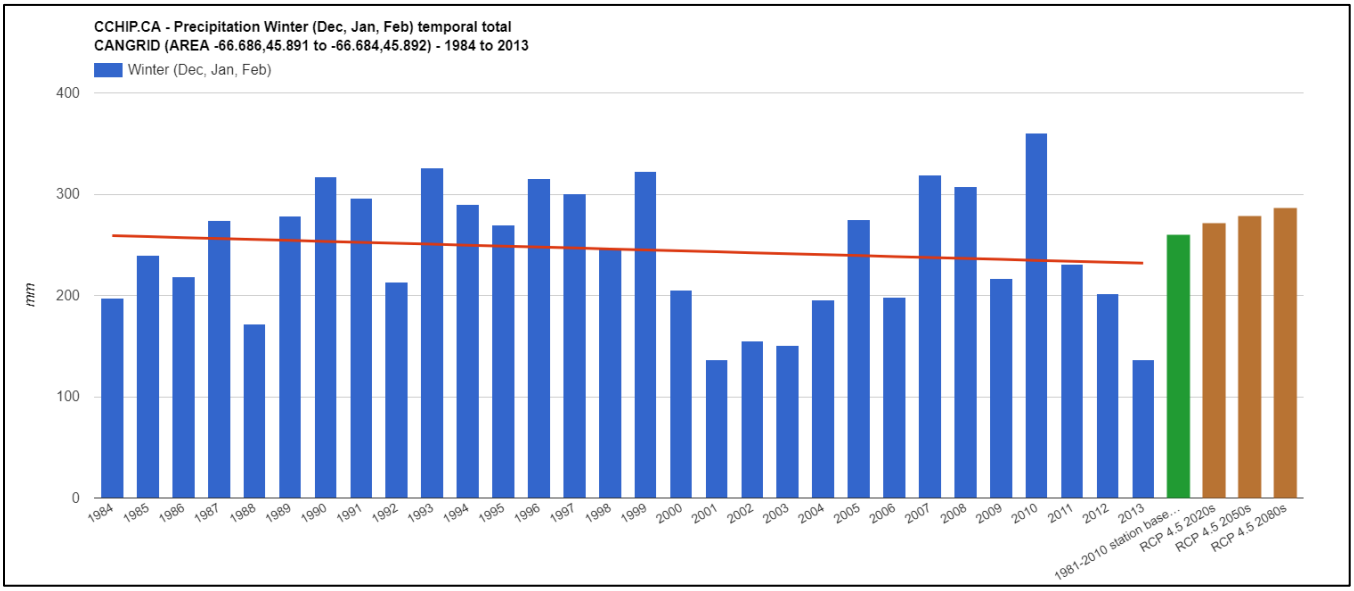


Figure 35: Winter Precipitation Temporal Total (RCP 4.5)

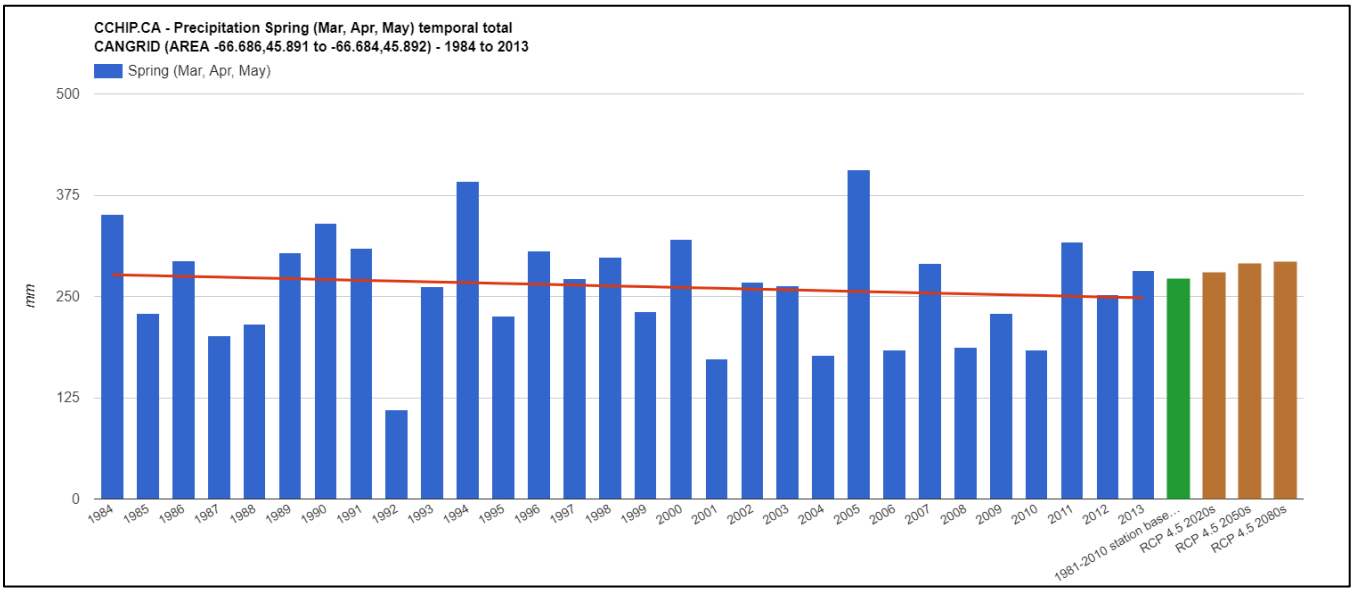


Figure 36: Spring Precipitation Temporal Total (RCP 4.5)

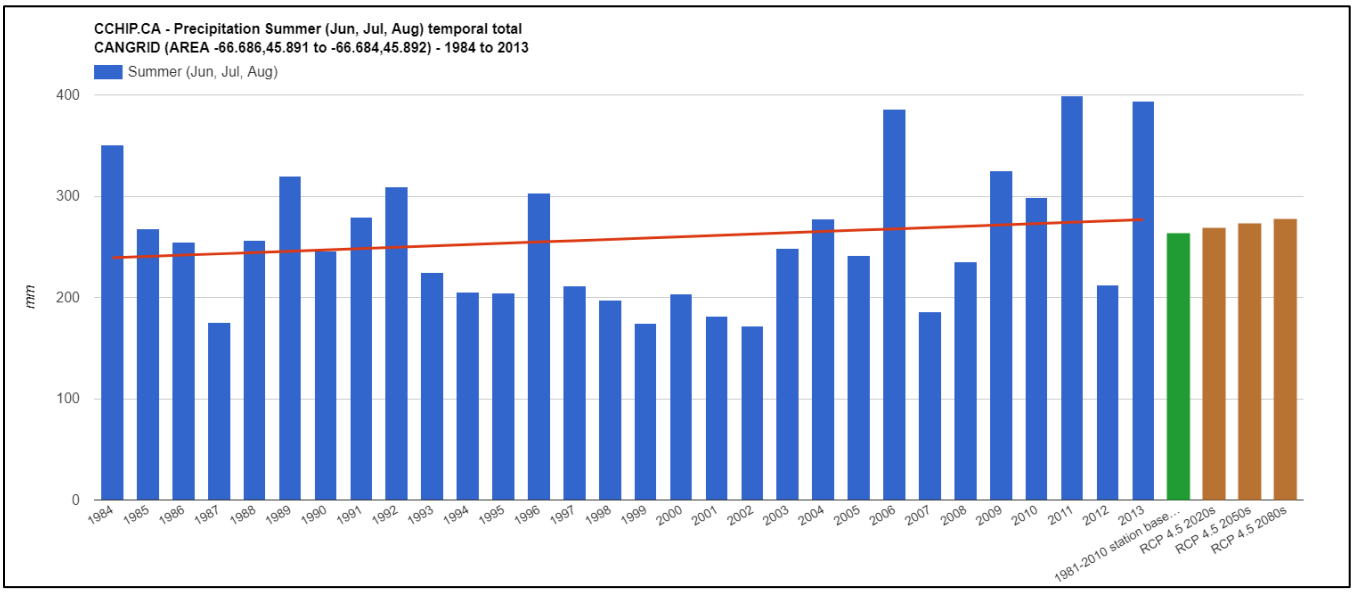


Figure 37: Summer Precipitation Temporal Total (RCP 4.5)

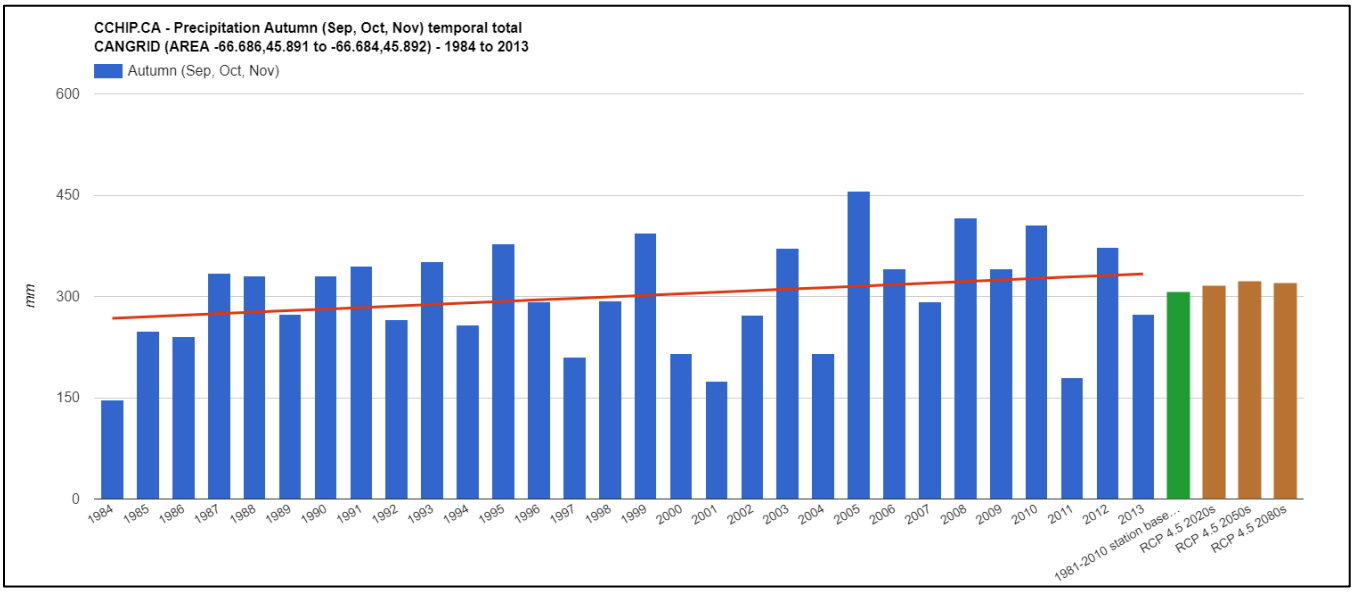


Figure 38: Autumn Precipitation Temporal Total (RCP 4.5)

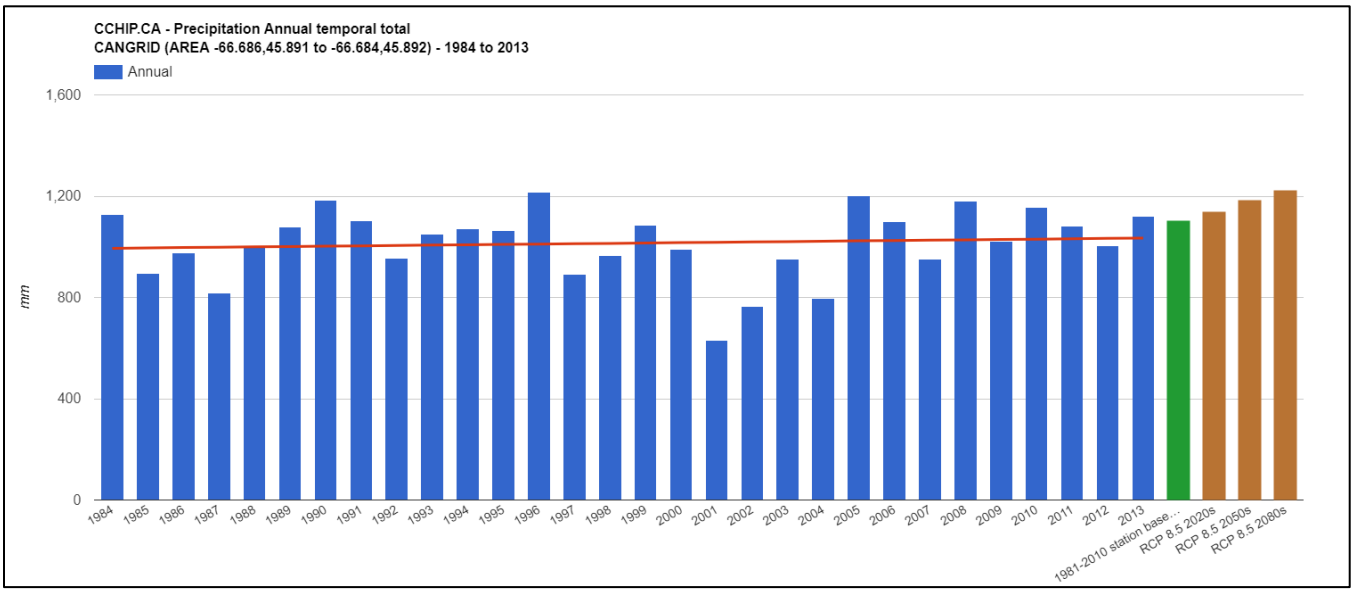


Figure 39: Annual Precipitation Temporal Total (RCP 8.5)

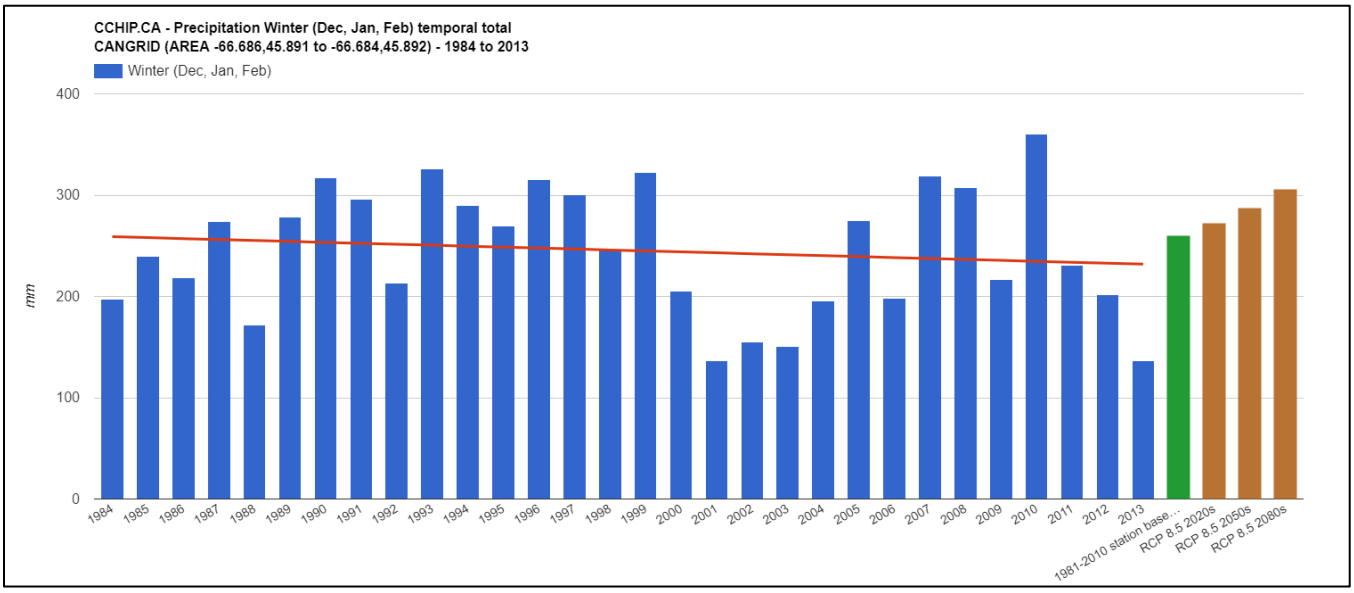


Figure 40: Winter Precipitation Temporal Total (RCP 8.5)

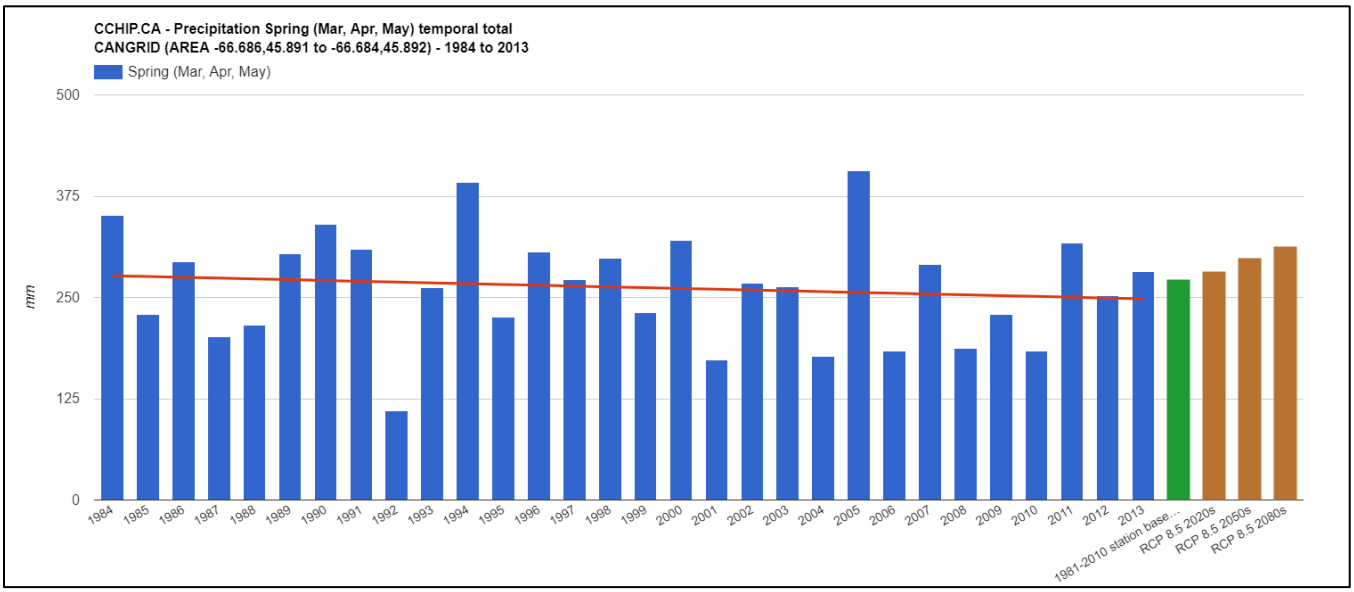


Figure 41: Spring Precipitation Temporal Total (RCP 8.5)

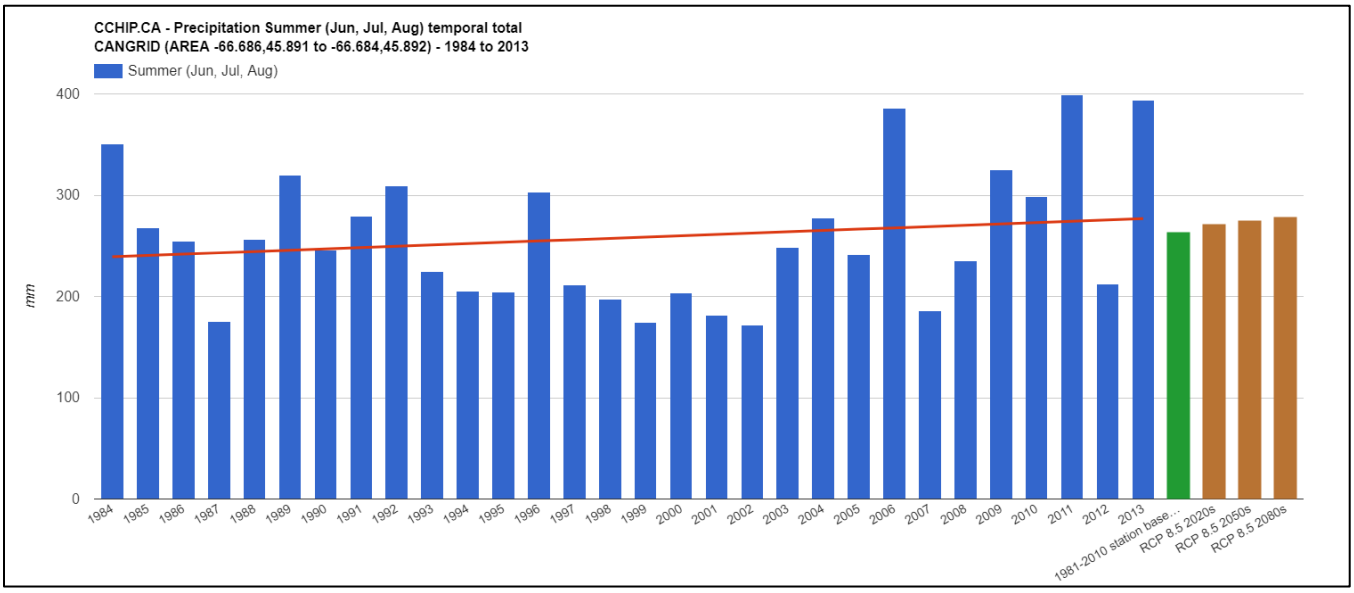


Figure 42: Summer Precipitation Temporal Total (RCP 8.5)

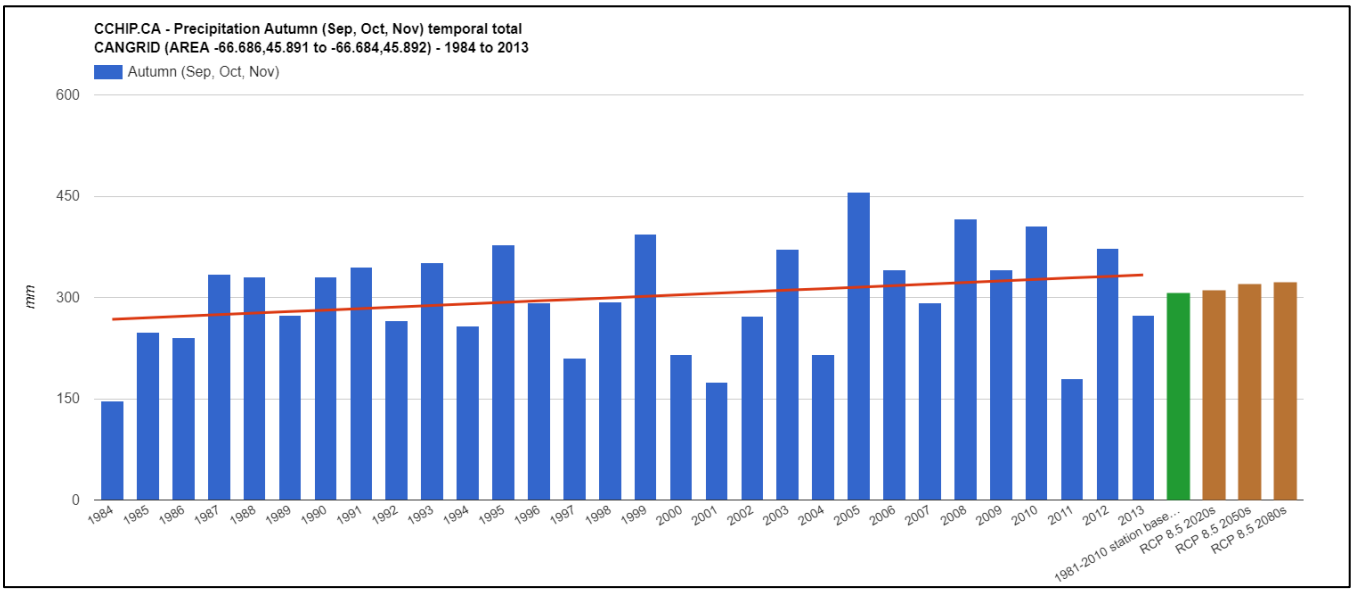


Figure 43: Autumn Precipitation Temporal Total (RCP 8.5)

It can also be useful to view projected increases in precipitation as the change in the occurrence of days with precipitation accumulation more than a certain threshold. Table 6 represents the climate projections for the occurrence of days with more than 50 mm of precipitation. The historical data and projections were obtained for the Fredericton Airport weather station location to ensure the historical occurrence was based on real measured instances of >50mm precipitation.

Table 6: CCHIP Custom Report: Fredericton A; Day with Precipitation >50 mm (RCP 4.5 & 8.5)

Annual occurrence of days with Max. Temp <-40°C
Historical 1981-2010
RCP 4.5
RCP 8.5
2020s
2050s
2080s
2020s
2050s
2080s
Days/year
1
1.2
1.3
1.4
1.2
1.4
1.5

DAILY FROST

Table 7: Average Frost Free Days, CANGRD data, New Maryland (CCHIP)

Period	RCP 4.5	RCP 8.5
Baseline (Historical 1987-2016)	200	200
2020s	218	220
2050s	232	244
2080s	239	268

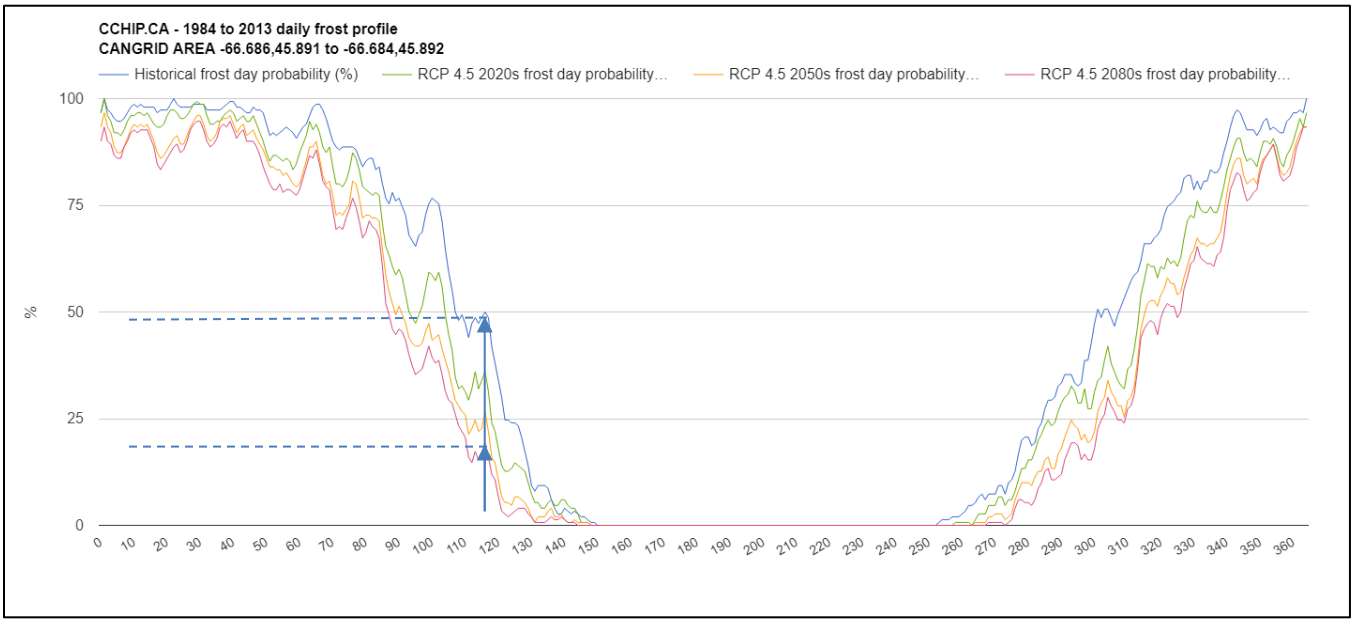


Figure 44: Daily Frost Profile (RCP 4.5)

The daily frost profiles shown in Figure 44 and Figure 45 present the historic and projected probability of frost on a given day of the year. Figure 44 has been marked up to show, for example, how on the 118th day of the year (April 28th in non-leap years), historically there has been about an 50% chance that there is frost on that day. Whereas under RCP 4.5 conditions, by the 2080s, April 28th will only have about an 17% chance of frost.

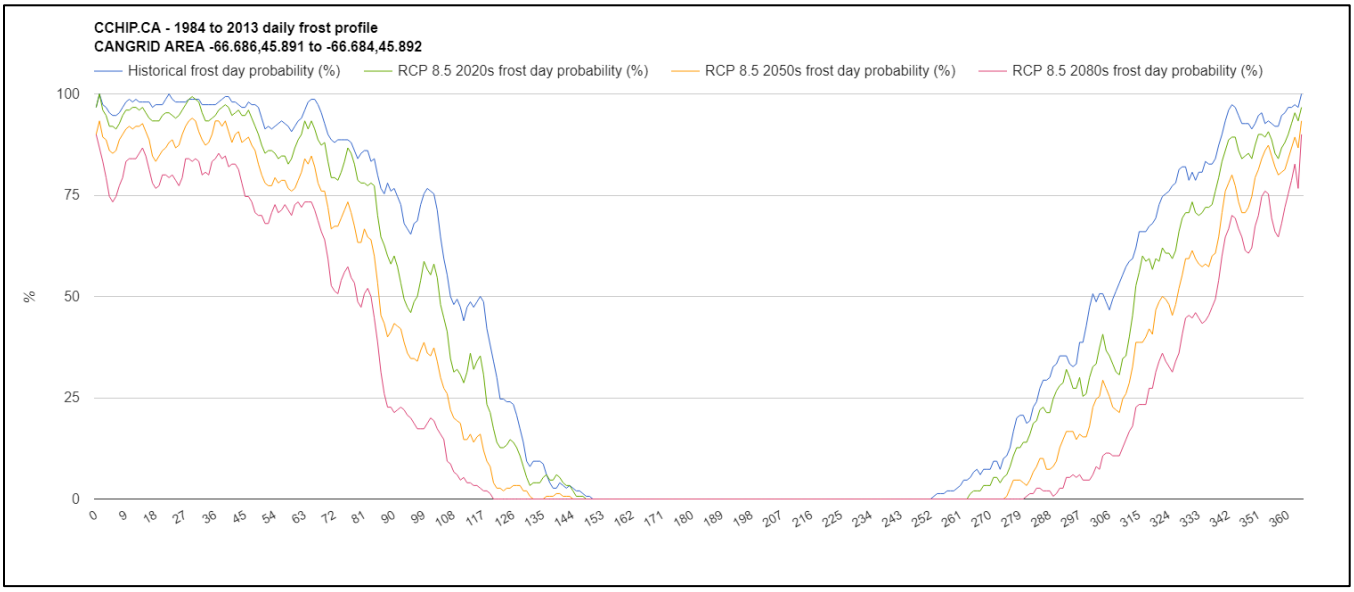


Figure 45: Daily Frost Profile (RCP 8.5)

PRECIPITATION: INTENSITY-DURATION-FREQUENCY (IDF)

Historic IDF curves for New Maryland were not available, so the historical data shown here is based on the nearby Fredericton Cda weather station. There was a high degree of consistency in precipitation data between the Fredericton Cda and the selected CANGRD area for New Maryland. The projections apply results from 24 Global Circulation Models that simulate future climate conditions and were obtained from information published by the Institute for Catastrophic Loss Reduction at Western University. The projected IDF information is based on bias corrected results from 9 climate models from the Pacific Climate Impacts Consortium.

TOTAL PRECIPITATION - Historical IDF for Fredericton Cda (ID: 8101605)

Total precipitation amount (mm) in specific time interval (5 minutes to 24 hours) for various return periods (2 years to 100 years)

Historical (1953-2013)

T (years)	2	5	10	25	50	100
5 min	6.69	8.74	10.00	11.48	12.51	13.47
10 min	9.58	12.68	14.72	17.29	19.19	21.06
15 min	11.32	14.86	17.21	20.19	22.40	24.60
30 min	14.02	18.30	21.27	25.19	28.22	31.34
1 h	18.25	23.21	26.74	31.50	35.25	39.19
2 h	24.19	31.25	36.27	43.03	48.36	53.95
6 h	39.03	51.06	58.81	68.37	75.30	82.04
12 h	48.80	63.28	72.71	84.46	93.06	101.49
24 h	60.23	76.07	85.73	97.05	104.87	112.16

2025 – 2075 (RCP 4.5)

T (years)	2	5	10	25	50	100
5 min	8.33	11.05	12.76	14.76	16.12	17.30
10 min	11.94	16.04	18.80	22.10	24.47	26.66
15 min	14.10	18.79	21.99	25.79	28.53	31.06
30 min	17.46	23.15	27.26	32.04	35.66	39.10
1 h	22.72	29.38	34.35	40.01	44.34	48.46
2 h	30.13	39.56	46.57	54.63	60.84	66.84
6 h	48.60	64.56	75.05	87.56	96.34	104.24
12 h	60.77	80.02	92.86	108.07	118.82	128.49
24 h	74.91	96.16	109.50	124.79	134.98	143.61

2025-2075 (RCP 8.5)

T (years)	2	5	10	25	50	100
5 min	8.25	11.19	13.12	15.41	17.10	18.56
10 min	11.82	16.22	19.30	23.10	26.06	28.18
15 min	13.96	19.01	22.57	26.96	30.40	32.81
30 min	17.30	23.40	27.88	33.52	37.86	40.91
1 h	22.52	29.69	35.09	41.84	47.02	50.61
2 h	29.86	39.96	47.56	57.14	64.44	69.65
6 h	48.14	65.33	77.14	91.50	102.49	110.80
12 h	60.20	80.97	95.39	112.94	126.49	136.40
24 h	74.26	97.39	112.52	130.25	143.25	154.58

The above results indicate an increase in precipitation accumulation that can be expected for all rainfall events. The projected percentage increase from the historical data for rainfall events under RCP 4.5 and 8.5 range from 23.3% to 37.8% as shown below in Table 8.

Table 8: Projected Percentage Precipitation Accumulation Increase for Fredericton Cda Weather Station Under RCP 4.5 and 8.5, 2025-2075. (ICLR, 2018)

T (years)	2		5		10		25		50		100	
RCP	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5
5 min	24.5%	23.3%	26.4%	28.0%	27.6%	31.2%	28.6%	34.2%	28.9%	36.7%	28.4%	37.8%
10 min	24.6%	23.4%	26.5%	27.9%	27.7%	31.1%	27.8%	33.6%	27.5%	35.8%	26.6%	33.8%
15 min	24.6%	23.3%	26.4%	27.9%	27.8%	31.1%	27.7%	33.5%	27.4%	35.7%	26.3%	33.4%
30 min	24.5%	23.4%	26.5%	27.9%	28.2%	31.1%	27.2%	33.1%	26.4%	34.2%	24.8%	30.5%
1 h	24.5%	23.4%	26.6%	27.9%	28.5%	31.2%	27.0%	32.8%	25.8%	33.4%	23.7%	29.1%
2 h	24.6%	23.4%	26.6%	27.9%	28.4%	31.1%	27.0%	32.8%	25.8%	33.3%	23.9%	29.1%
6 h	24.5%	23.3%	26.4%	27.9%	27.6%	31.2%	28.1%	33.8%	27.9%	36.1%	27.1%	35.1%
12 h	24.5%	23.4%	26.5%	28.0%	27.7%	31.2%	28.0%	33.7%	27.7%	35.9%	26.6%	34.4%
24 h	24.4%	23.3%	26.4%	28.0%	27.7%	31.2%	28.6%	34.2%	28.7%	36.6%	28.0%	37.8%

PRECIPITATION INTENSITY – Historical IDF for Fredericton Cda (ID: 8101605)

Precipitation intensity (mm/hr) in specific time interval (5 minutes to 24 hours) for various return periods (2 years to 100 years)

Historical

T (years)	2	5	10	25	50	100
5 min	80.28	104.90	119.98	137.75	150.06	161.60
10 min	57.49	76.08	88.32	103.73	115.12	126.38
15 min	45.27	59.44	68.84	80.75	89.60	98.40
30 min	28.03	36.59	42.54	50.37	56.44	62.67
1 h	18.25	23.21	26.74	31.50	35.25	39.19
2 h	12.10	15.62	18.13	21.51	24.18	26.98
6 h	6.50	8.51	9.80	11.40	12.55	13.67
12 h	4.07	5.27	6.06	7.04	7.75	8.46
24 h	2.51	3.17	3.57	4.04	4.37	4.67

2025 – 2075 (RCP 4.5)

T (years)	2	5	10	25	50	100
5 min	99.92	132.58	153.11	177.13	193.41	207.55
10 min	71.63	96.21	112.81	132.59	146.84	159.97
15 min	56.39	75.17	87.98	103.15	114.13	124.24
30 min	34.92	46.31	54.52	64.09	71.32	78.20
1 h	22.72	29.38	34.35	40.01	44.34	48.46
2 h	15.06	19.78	23.29	27.32	30.42	33.42
6 h	8.10	10.76	12.51	14.59	16.06	17.37
12 h	5.06	6.67	7.74	9.01	9.90	10.71
24 h	3.12	4.01	4.56	5.20	5.62	5.98

2025-2075 (RCP 8.5)

T (years)	2	5	10	25	50	100
5 min	98.98	134.26	157.40	184.95	205.19	222.74
10 min	70.93	97.31	115.80	138.62	156.37	169.09
15 min	55.85	76.03	90.27	107.84	121.59	131.22
30 min	34.60	46.80	55.77	67.03	75.72	81.83
1 h	22.52	29.69	35.09	41.84	47.02	50.61
2 h	14.93	19.98	23.78	28.57	32.22	34.82
6 h	8.02	10.89	12.86	15.25	17.08	18.47
12 h	5.02	6.75	7.95	9.41	10.54	11.37
24 h	3.09	4.06	4.69	5.43	5.97	6.44

Correlating with the projected increases in precipitation accumulation; the above results indicate an increase in the intensity of the rainfall events for each return period. The projected percentage increase from the historical data for rainfall events under RCP 4.5 and 8.5 range from 23.3% to 37.8% as shown in Table 9.

Table 9: Projected Percentage Precipitation Intensity Increase for Fredericton Cda Weather Station under RCP 4.5 and 8.5, 2025-2075. (ICLR, 2018)

T (years)	2		5		10		25		50		100	
RCP	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5	4.5	8.5
5 min	24.5%	23.3%	26.4%	28.0%	27.6%	31.2%	28.6%	34.2%	28.9%	36.7%	28.4%	37.8%
10 min	24.6%	23.4%	26.5%	27.9%	27.7%	31.1%	27.8%	33.6%	27.5%	35.8%	26.6%	33.8%
15 min	24.6%	23.3%	26.4%	27.9%	27.8%	31.1%	27.7%	33.5%	27.4%	35.7%	26.3%	33.4%
30 min	24.5%	23.4%	26.5%	27.9%	28.2%	31.1%	27.2%	33.1%	26.4%	34.2%	24.8%	30.5%
1 h	24.5%	23.4%	26.6%	27.9%	28.5%	31.2%	27.0%	32.8%	25.8%	33.4%	23.7%	29.1%
2 h	24.6%	23.4%	26.6%	27.9%	28.4%	31.1%	27.0%	32.8%	25.8%	33.3%	23.9%	29.1%
6 h	24.5%	23.3%	26.4%	27.9%	27.6%	31.2%	28.1%	33.8%	27.9%	36.1%	27.1%	35.1%
12 h	24.5%	23.4%	26.5%	28.0%	27.7%	31.2%	28.0%	33.7%	27.7%	35.9%	26.6%	34.4%
24 h	24.4%	23.3%	26.4%	28.0%	27.7%	31.2%	28.6%	34.2%	28.7%	36.6%	28.0%	37.8%

PRECIPITATION: ACCUMULATION

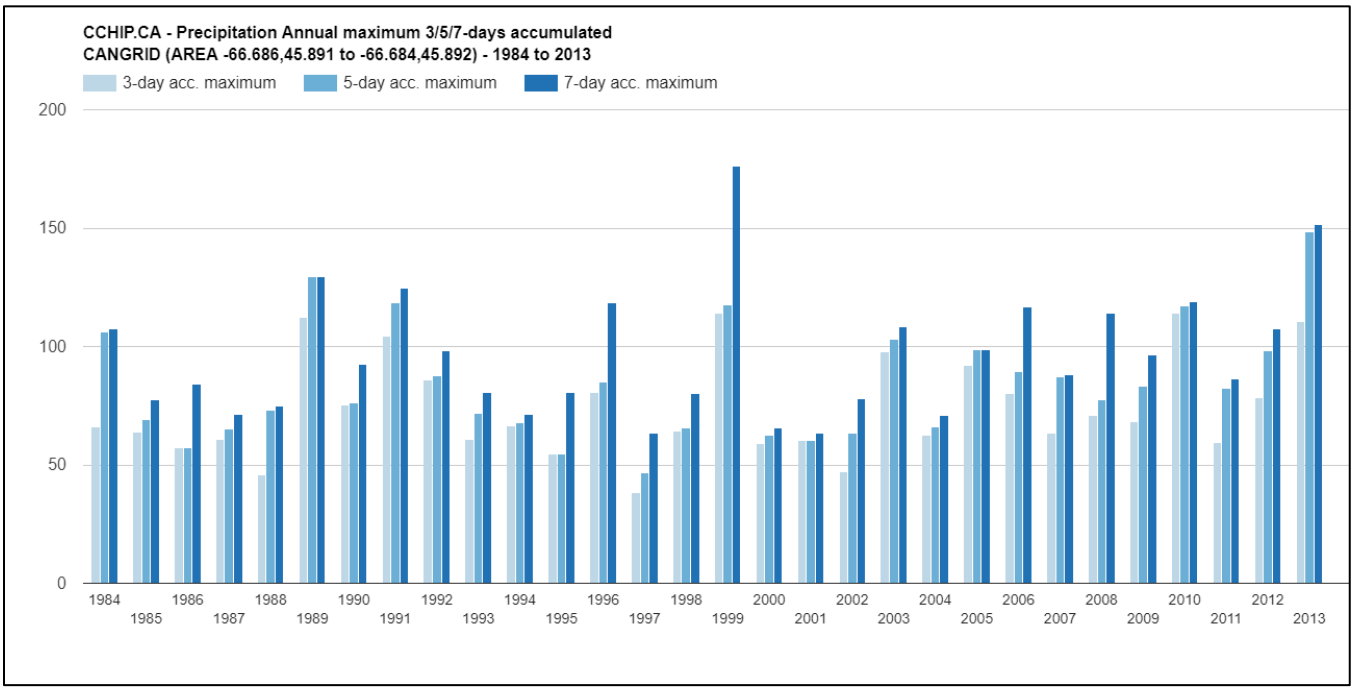


Figure 46: Annual Maximum 3/5/7 Days Precipitation Accumulation

Table 10: Record Maximum 3/5/7 days precipitation accumulation

	Record Maximum Precipitation Accumulation					
	Recent Climate (1984-2013)			Historic (1950-2013)		
	3 day	5 day	7 day	3 day	5 day	7 day
Precipitation (mm)	114.28	148.44	176.42	121.93	148.44	176.42
Ended	14-Dec-2010	27-Jul-2013	22-Sep-1999	29-May-1961	27-Jul-2013	22-Sep-1999

Data from projected climate models for 3, 5, and 7 day accumulation were not available, however, based on the projected increase in precipitation accumulation for all events less than 24 hours duration, it is highly probable this trend would extend to long term accumulation as well.

WIND

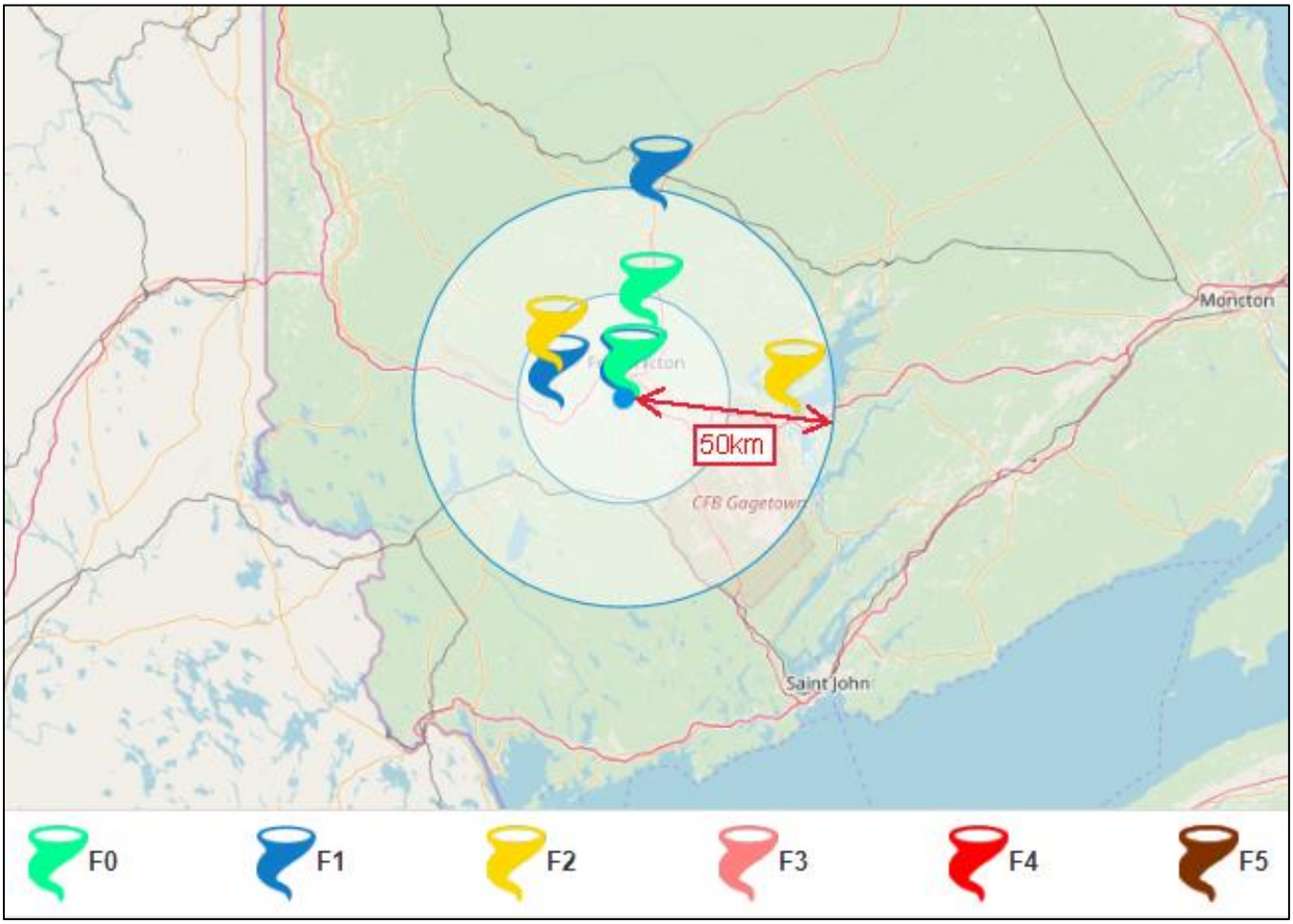
Historical wind data for New Maryland are not available, however the Fredericton Airport weather station has collected sufficient historical wind data to represent the general wind characteristics of this area's climate.

Table 11: 1981 to 2010 Canadian Climate Normals – Wind
Station: Fredericton Cda
Source: Government of Canada – Environment and Natural Resource

	Speed (km/h)	Most Frequent Direction	Max. Hourly Speed (km/h)	Date (yyyy/dd)	Direction of Max. Hourly Speed	Max. Gust Speed (km/h)	Date (yyyy/dd)	Direction of Max. Gust
January	12.2	W	64	1959/06	W	119	1962/27	W
February	12.7	NW	80	1970/03	S	121	1976/02	S
March	13.9	NW	64	1962/02	W	105	1959/23	W
April	14.2	NW	72	1970/30	S	100	1977/03	W
May	13.1	S	64	1953/24	NW	97	1961/28	W
June	11.5	S	64	1958/14	W	132	1971/30	N
July	10.3	S	48	1953/03	W	105	1974/03	NW
August	9.6	S	53	1956/15	W	93	1991/02	NW
September	10.5	SW	65	1985/27	S	105	1960/13	S
October	11.6	SW	64	1963/29	NE	117	1963/29	NE
November	12.1	W	67	2001/07	N	116	1963/30	S
December	12.4	W	60	1962/30	NE	103	1968/05	W
Year	12	W	80	1970/03	S	132	1971/30	N

The projected climate changes with respect to wind are not as well understood as other climate variables however research has been undertaken in this field in a report titled *Forecasting a Sea of Change: Lessons from Atlantic Canada*. The 2014 Canadian Climate Forum report explained "for the coasts of New Brunswick, Nova Scotia and Newfoundland there is no strong evidence that top annual wind speeds will increase significantly over the next century"[3]

TORNADOES

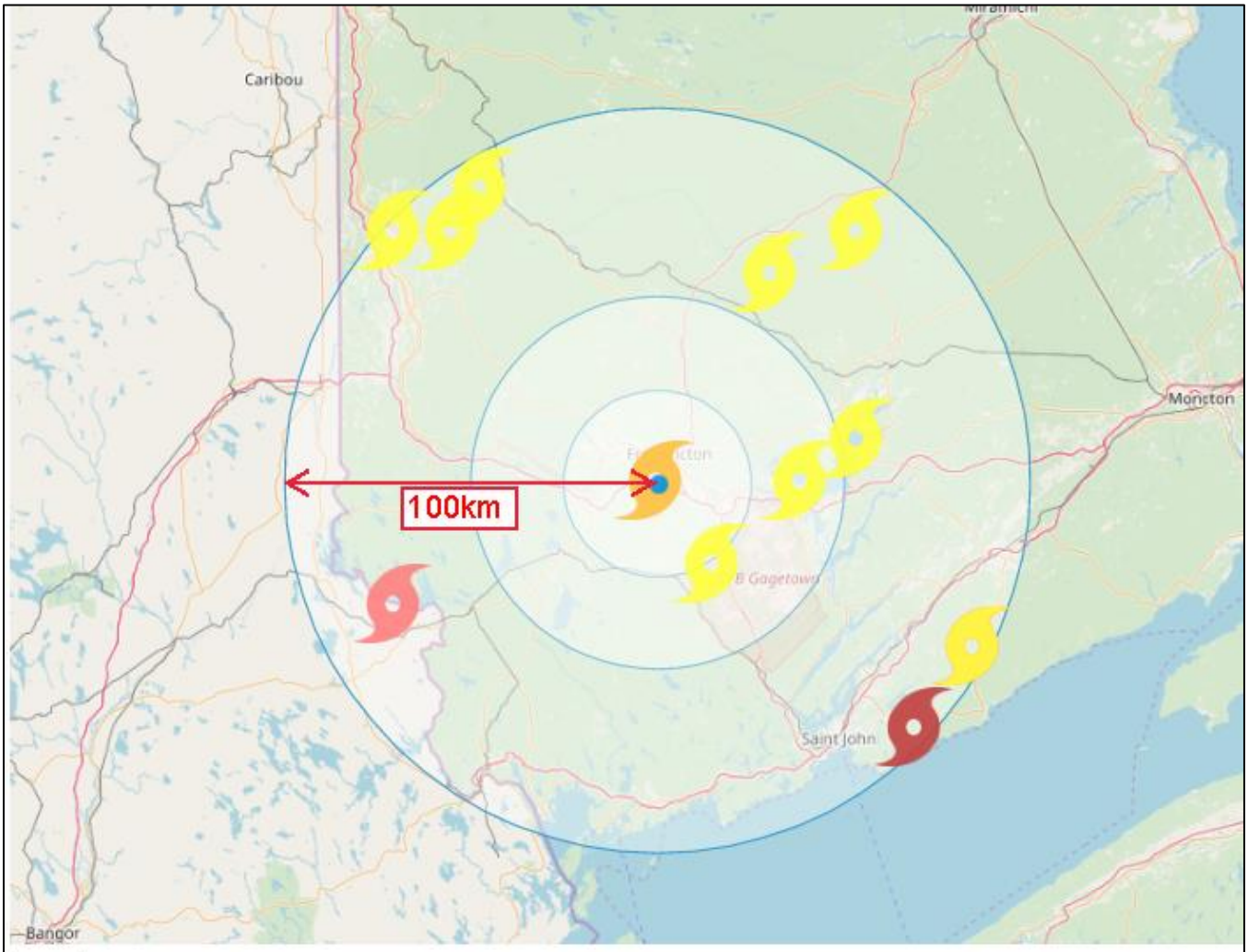


*Windspeeds (km/h) F0:64-116; F1:117-180; F2:181-253; F3:254-332; F4:333-418; F5:419-512

Figure 47: Recorded Tornadoes and Fujita Scale Rating. Canadian Tornado Database 1980-2009

[3] Canadian Climate Forum, 2014. Forecasting a Sea of Change: Lessons from Atlantic Canada. Vol. 2, No. 1 September 2014.

TROPICAL DISTURBANCES



Legend

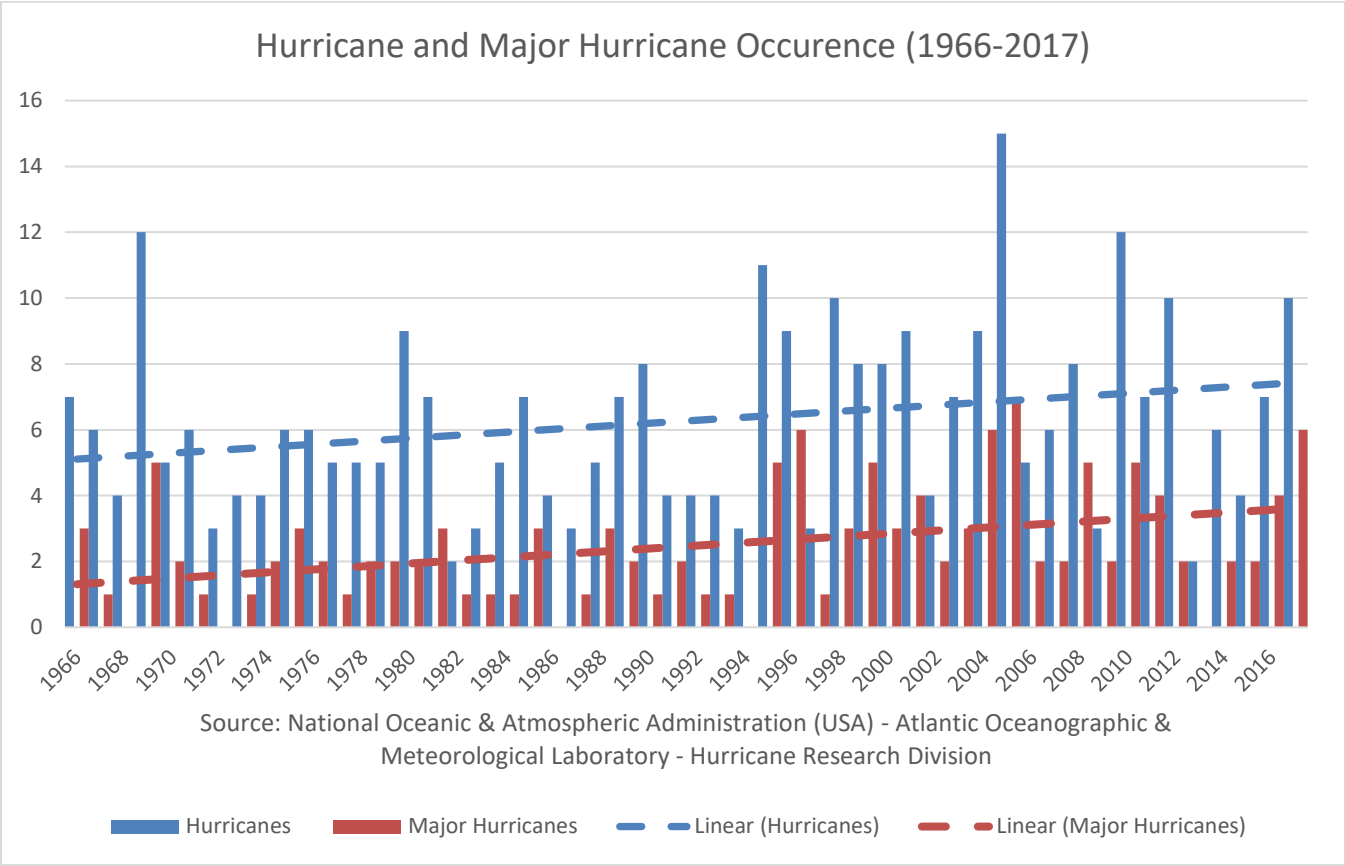
HU	Tropical cyclone of hurricane intensity (> 64 knots)
TS	Tropical cyclone of tropical storm intensity (34-63 knots)
TD	Tropical cyclone of tropical depression intensity (< 34 knots)
EX	Extratropical cyclone (of any intensity)

Figure 48: Recorded Historical Tropical Disturbances. Atlantic Hurricane Database 1851-2017

Date & Time	Name	System	Coordinates	Max. Surface Wind (kt)	Central Pressure (mbar)	Approx. Distance from Location (km)
1877-08-05 00:00:00	UNNAMED	TS	45.5, -65.6	50		95
1888-09-27 06:00:00	UNNAMED	EX	46.4, -66.3	40		64
1889-09-26 06:00:00	UNNAMED	EX	45.9, -66.2	35		38
1897-09-25 00:00:00	UNNAMED	TD	45.9, -66.7	30		1
9/14/1937 12:00:00 PM	UNNAMED	EX	45.5, -65.6	45		95
2/5/1952 6:00:00 AM	UNNAMED	EX	46.5, -67.4	45		87
9/7/1953 10:00:00 PM	CAROL	HU, L	45.3, -65.8	70		95
9/4/1972 6:00:00 PM	CARRIE	EX	45.7, -66.5	45		26
9/7/1979 6:00:00 AM	DAVID	EX	46.5, -66	50	988	86
8/20/1991 6:00:00 AM	BOB	TS	45.6, -67.6	50	987	78
7/14/1996 12:00:00 PM	BERTHA	EX	46, -66	50	995	54
9/10/2004 12:00:00 PM	FRANCES	EX	46.6, -67.3	20	1005	92
7/10/2005 12:00:00 PM	CINDY	EX	46.5, -67.6	25	1006	98

Source: Atlantic Hurricane Database 1851-2017 (1 kt = 1.85 km/h)

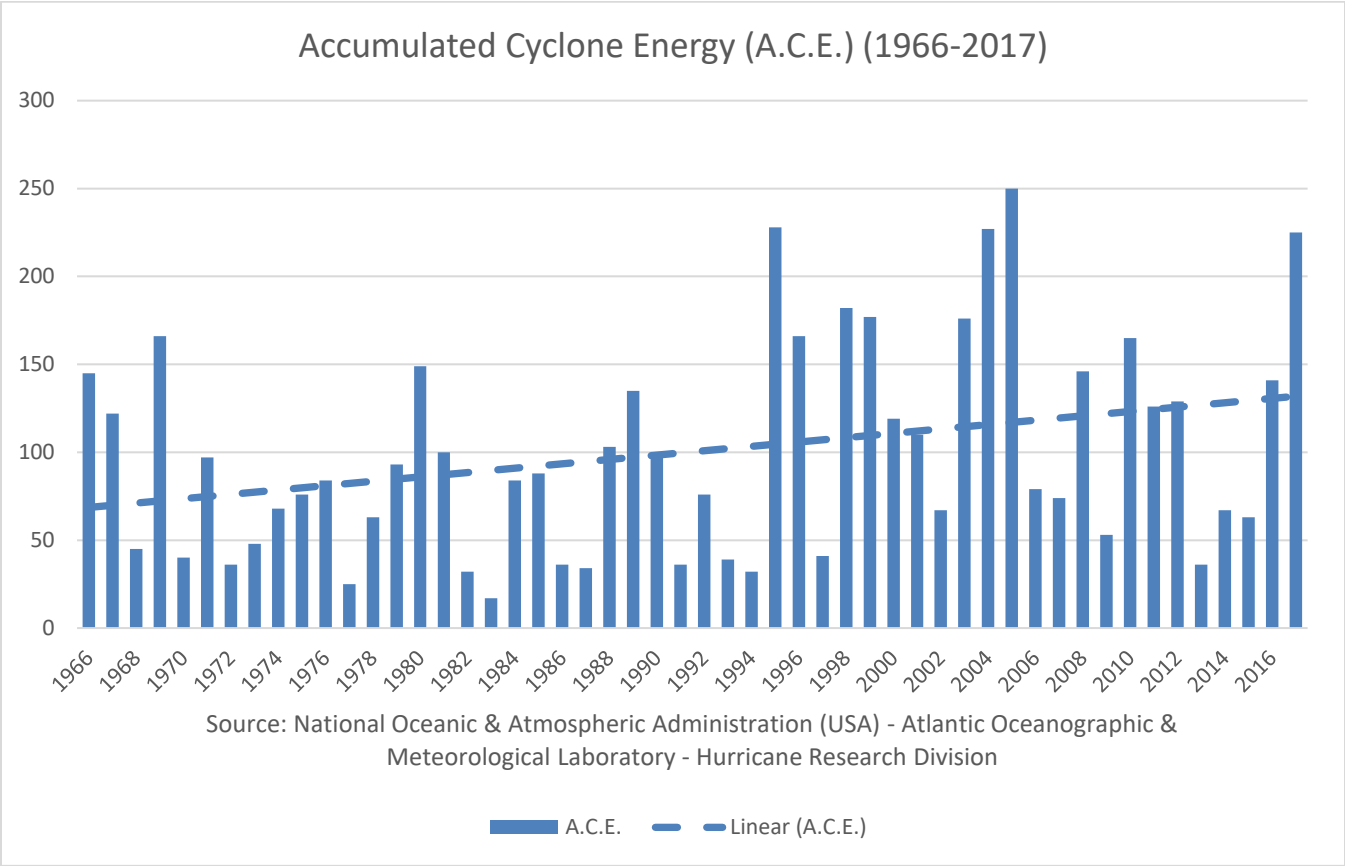
Figure 49: Recorded Historical Tropical Disturbances Statistics.



Hurricanes = Saffir-Simpson Hurricane Scale 1 to 5. Major Hurricanes = Saffir-Simpson Hurricane Scale 3, 4, or 5

Figure 50: Annual Recorded Atlantic hurricane occurences (1966-2017)

Note that Arthur, a tropical storm that came into the area in 2014 was not logged in the above databases however other data sources indicate the wind speeds were as high as 53 knots in Fredericton (98km/hr).



Accumulated Cyclone Energy = An index that combines the numbers of systems, how long they existed and how intense they became.

Figure 51: Annual Atlantic Hurricane Accumulated Cyclone Energy

Appendix C Climate Change Adaptation Risk Matrix

CURRENT CLIMATE

P: Probability Rating for Event Occuring
S: Severity of Impact Rating
R: Risk Rating (PxS)

Asset/Infrastructure Elements	Climate Event (A) Heat Waves						Climate Event (B) Intense Rains						Climate Event (C) Ice Storms						Climate Event (D) Droughts						Climate Event (E) Forest Fire						Climate Event (F) Hurricanes						Climate Event (G) Winter Storms					
	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R	P	Grp 1 - S	Grp 2- S	Grp 3- S	Net S	R
	4						3						3						2						1						1						3					
BUILT INFRASTRUCUTRE																																										
Storm Water Collection		1	0	0	**1**	4		4	3	3	**4**	12		3	3	1	**3**	9		3	0	0	**3**	6		1	0	1	**1**	1		4	3	3	**4**	4		2	2	2	**2**	6
Water		3	3	0	**3**	12		2	1	0	**2**	6		5	0	2	**5**	15		5	3	4	**5**	10		5	1	3	**5**	5		4	2	3	**4**	4		4	1	2	**4**	12
Roadways (incld. Sidewalks)		3	1	0	**3**	12		4	2	2	**4**	12		4	2	2	**4**	12		2	0	0	**2**	4		2	2	2	**2**	2		4	2	2	**4**	4		4	2	2	**4**	12
Wastewater		2	1	0	**2**	8		4	3	2	**4**	12		4	0	2	**4**	12		4	1	0	**4**	8		3	1	3	**3**	3		4	3	3	**4**	4		4	1	2	**4**	12
Power		4	0	0	**4**	16		5	2	1	**5**	15		5	4	3	**5**	15		4	0	0	**4**	8		5	3	4	**5**	5		5	4	4	**5**	5		5	3	2	**5**	15
BUILDINGS				0																																						
Fire Hall		2	1	0	**2**	8		2	0	0	**2**	6		3	1	1	**3**	9		2	1	0	**2**	4		4	1	3	**4**	4		5	2	3	**5**	5		3	2	2	**3**	9
Municipal Office		2	1	0	**2**	8		2	0	0	**2**	6		3	1	1	**3**	9		2	1	0	**2**	4		4	1	3	**4**	4		5	2	3	**5**	5		3	2	2	**3**	9
New Maryland Centre		2	1	0	**2**	8		3	1	0	**3**	9		3	2	1	**3**	9		2	1	0	**2**	4		4	2	3	**4**	4		5	2	3	**5**	5		3	2	2	**3**	9
Victoria Hall		2		0	**2**	8		2	0	0	**2**	6		3	0	1	**3**	9		2	0	0	**2**	4		2	0	3	**3**	3		5	0	3	**5**	5		3	0	2	**3**	9
Sts. John and Paul Church; Faith United Church		2	1		**2**	8		2	0		**2**	6		3	1		**3**	9		2	1		**2**	4		4	1		**4**	4		5	2	0	**5**	5		3	2	0	**3**	9
New Maryland Elementary School			1	0	**1**	4			0	0	**0**				1	1	**1**	3			0	0	**0**				2	3	**3**	3		0	1	3	**3**	3		0	2	2	**2**	6
NATURAL ENVIRONMENT																																										
Parks		2	1	0	**2**	8		2	1	1	**2**	6		2	0	1	**2**	6		2	1	1	**2**	4		3	2	2	**3**	3		4	3	2	**4**	4		2	1	0	**2**	6
Sports fields		2	1	0	**2**	8		2	1	2	**2**	6		2	1	0	**2**	6		2	2	2	**2**	4		3	2	2	**3**	3		4	2	1	**4**	4		2	2	1	**2**	6
Forests		2	1	0	**2**	8		2	0	0	**2**	6		2	2	3	**3**	9		2	3	2	**3**	6		3	4	3	**4**	4		4	3	3	**4**	4		2	2	1	**2**	6
Trails		2	0	0	**2**	8		2	2	2	**2**	6		2	2	2	**2**	6		2	1	1	**2**	4		3	3	3	**3**	3		4	4	2	**4**	4		2	1	1	**2**	6
PEOPLE																																										
Adult Residents		3	1	1	**3**	12		3	0	1	**3**	9		3	1	2	**3**	9		2	1	2	**2**	4		4	2	2	**4**	4		4	2	2	**4**	4		3	2	2	**3**	9
Senior Residents		4	3	2	**4**	16		3	1	1	**3**	9		3	2	2	**3**	9		2	2	2	**2**	4		4	3	2	**4**	4		4	3	2	**4**	4		3	3	2	**3**	9
Youth		4	2	1	**4**	16		3	0	1	**3**	9		3	1	1	**3**	9		2	1	1	**2**	4		4	2	2	**4**	4		4	2	2	**4**	4		3	1	1	**3**	9
Extra needs Residents (e.g. the Aged)		4	3	2	**4**	16		3	1	1	**3**	9		4	2	2	**4**	12		2	2	2	**2**	4		4	4	2	**4**	4		4	4	2	**4**	4		4	3	2	**4**	12
Chief/ Volunteer Firefighters		3	1	2	**3**	12		3	0	1	**3**	9		3	2	2	**3**	9		2	2	3	**3**	6		4	4	3	**4**	4		4	3	3	**4**	4		3	2	2	**3**	9
RCMP Staff		3	1	1	**3**	12		3	1	1	**3**	9		3	2	2	**3**	9		2	1	2	**2**	4		4	2	2	**4**	4		4	3	3	**4**	4		3	2	2	**3**	9
Operations Staff		3	3	1	**3**	12		3	2	2	**3**	9		3	3	2	**3**	9		2	2	2	**2**	4		4	2	3	**4**	4		4	3	3	**4**	4		3	2	2	**3**	9
Village Office Staff		3	1	0	**3**	12		3	0	1	**3**	9		3	1	1	**3**	9		2	1	2	**2**	4		4	2	2	**4**	4		2	2	2	**2**	2		3	1	1	**3**	9
Mayor & Council Members		3			**3**	12		3			**3**	9		3			**3**	9		2			**2**	4		4			**4**	4		2	0	0	**2**	2		3	0	0	**3**	9
SOCIAL/ CULTURAL																																										
Service Clubs		3	1	1	**3**	12		3	1	1	**3**	9		3	2	1	**3**	9		2	1	1	**2**	4		4	3	2	**4**	4		4	3	2	**4**	4		3	1	1	**3**	9
Churches		3	1	1	**3**	12		3	1	1	**3**	9		3	2	1	**3**	9		2	1	1	**2**	4		4	3	2	**4**	4		4	3	2	**4**	4		3	1	1	**3**	9

1-5	Low Risk Rating	6-14	Moderate Risk Rating	15-25	High Risk Rating

Appendix D Climate Change Adaptation and Mitigation Strategy Annual Report Card and Action Plan

APPENDIX D – VILLAGE OF NEW MARYLAND CLIMATE CHANGE ADAPTATION AND MITIGATION ANNUAL REPORT CARD: YEAR _____

This Report Card identifies the following objectives to be considered on an annual basis:

- identify and monitor local impacts associated with climate change; review and revise risk assessment for various aspects of the community's assets including buildings, infrastructure, parks, etc. based on most recent climate change data;
- implement and revise strategies/actions to mitigate or adapt to climate change;
- carry out a cost/benefit analysis for various measures and actions as needed;
- identify priorities to be undertaken; and
- identify responsibility for implementing aspects of the action plans and to set reasonable timelines for action items.

Identify any local climate change/extreme weather-related events that occurred in this year within the Village:
Does the climate change strategy require revision or prioritization of certain components based on the event and outcomes to Village infrastructure or community members?

Strategic Actions	Estimated Cost/ Potential Funding Sources	Timeline	Responsible Department	Status Update	Rating
Rating Suggestions: A-strategy completely implemented or of key focus during year B-strategy partially implemented, will require more work and/or focus in future years to fully implement C-limited progress made on strategy item D-no progress made on strategy item					
Heat Waves					
1. Continue to promote the Sentinel Emergency Alerts Assistance registry to provide increased support to vulnerable community members during extreme events					
2. Incorporate heat wave response and heat advisories into the Emergency Response Plan					
3. Implement cooling stations during heat waves - access to air-conditioned spaces and drinking water for community members					
4. Continue education in the community around the risks of heat exposure and available methods to take care during heat waves					
5. Recreation Planning to consider opportunities to incorporate additional shade, water stations, consider heat and drought resistant plants and trees in recreational planning.					
6. Promote the Fire Smart Program					

Strategic Actions	Estimated Cost/ Potential Funding Sources	Timeline	Responsible Department	Status Update	Rating
Rating Suggestions: A-strategy completely implemented or of key focus during year B-strategy partially implemented, will require more work and/or focus in future years to fully implement C-limited progress made on strategy item D-no progress made on strategy item					
Intense Rains/Hurricanes					
1. Continue diligent preventative maintenance on storm water drainage system and implement a procedure to track frequency of maintenance and occurrences of any flood issues to better inform planning					
2. Continue to promote basement flood prevention					
3. Consider revised storm water management master plan to incorporate potential worst case storm intensities based on current climate change predictions;					
4. Encourage and educate the public and developers on low impact development;					
5. Protect wetlands and the natural function of existing watercourses;					
6. Prioritize additional roadways to improve access in and out of the Village for residents (in the event Route 101 is unavailable due to rain or tree fall or other event)					
7. Enhance enforcement of Municipal Plan and Storm Water Management Plan in future developments.					
8. Coordinate with the New Brunswick Department of Transportation and Infrastructure to ensure resiliency of Route 101 storm water infrastructure.					

Strategic Actions	Estimated Cost/ Potential Funding Sources	Timeline	Responsible Department	Status Update	Rating
Rating Suggestions: A-strategy completely implemented or of key focus during year B-strategy partially implemented, will require more work and/or focus in future years to fully implement C-limited progress made on strategy item D-no progress made on strategy item					
Ice/Winter Storms					
1. Include consideration of increased snow loads from mixed snow/rain events in planning maintenance activities on buildings (consider clearing snow)					
2. Develop maintenance policy and procedure.					
3. Keep informed on pending updates to building codes that are expected to increase roof load design requirements and plan a risk assessment of Village buildings once codes are revised					
4. Review the adequacy of emergency power systems in the Village to support essential services and provide comfort and safety to residents in the event of prolonged power outages. Consider options such as renewable systems which do not require fuel storage and would lower GHG emissions, or propane or diesel systems which allow for more onsite fuel storage as compared to gasoline generators.					
5. Coordinate with NB Power to promote resiliency on local electrical distribution infrastructure.					

Strategic Actions	Estimated Cost/ Potential Funding Sources	Timeline	Responsible Department	Status Update	Rating
Rating Suggestions: A-strategy completely implemented or of key focus during year B-strategy partially implemented, will require more work and/or focus in future years to fully implement C-limited progress made on strategy item D-no progress made on strategy item					
GHG Mitigation					
1. Establish baseline energy and fuel use to allow for completion of a Village GHG inventory to establish magnitude of GHG emissions from various sources.					
2. Track energy and fuel use accurately, disaggregated to specific sources to allow for potential GHG reductions to be identified and quantified.					
3. Set a GHG reduction target for the Village following the baseline inventory.					
4. Evaluate reduction opportunities to meet the targets.					
5. Promote GHG reductions with community members.					
6. Consider carbon sequestration strategies such as a street tree planting initiative.					

Strategic Actions	Estimated Cost/ Potential Funding Sources	Timeline	Responsible Department	Status Update	Rating
Rating Suggestions: A-strategy completely implemented or of key focus during year B-strategy partially implemented, will require more work and/or focus in future years to fully implement C-limited progress made on strategy item D-no progress made on strategy item					
Monitoring and Follow-up					
1. Identify a champion within Village staff who will be responsible for climate change adaption and mitigation action monitoring.					
2. Use a report card for the CCAS to track progress and review priorities on a regularly scheduled frequency.					
3. Plan for ongoing public and stakeholder engagement to communicate progress and provide opportunities for education and sharing of ideas.					