# Climate Change Projections, Hazards, and Impact Report

## City of Saskatoon


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SLR Project No.: 201.089318.00001

January 29, 2025

Revision: 0

## Revision Record

| Revision | Date | Prepared By | Checked By | Authorized By |
|---|---|---|---|---|
| 0 | January 29, 2025 | A. Templeman | S. Lynch | S. Lynch |
| | | | | |

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# Land Acknowledgement

*We acknowledge that the City of Saskatoon is located on Treaty 6 Territory and the Traditional Homeland of the Métis. Indigenous people including Cree, Dakota and Saulteaux have called the area now referred to as Saskatoon home for thousands of years. Today, Saskatoon is home to Indigenous people from a diversity of cultures and language groups. The City of Saskatoon recognizes the distinct order of government of First Nations and Métis and is committed to maintaining strong relationships through meaningful dialogue with Indigenous communities and organizations. Strengthening cooperation and mutual support by working in partnership with Indigenous communities toward respective community goals and objectives is vital to fostering more inclusive communities.*

Source: City of Saskatoon, 2023.

# Executive Summary

SLR has prepared a Climate Change Projections, Hazards, and Impacts Report (the Report) for the City of Saskatoon. The report includes projections on near-term (2050) and long-term (2080) time horizons. Climate change data was collected from a variety of reliable and accepted sources including the **CLIMsystems Climate Insights** tool. Climate Insight's latest (CMIP6) climate data has been used to evaluate three “Shared Socioeconomic Pathways" (SSPs), corresponding to moderate (SSP2-4.5) and high (SSP5-8.5) emissions scenarios resulting in distinct future climates.

Data was used to identify relevant climate hazards in Saskatoon for future time horizons. An initial screening process determined relevant climate parameters, with climate data collected for the outlined time periods and emission scenarios.

SLR has assessed the likelihood of occurrence and magnitude for potential climate hazards. Likelihood scoring follows a 1-5 scale from low to high chance of occurrence. For climate hazards where a numerical likelihood score cannot be quantified for a particular hazard, SLR has provided qualitative context as to how these hazards should be considered for risk assessment and planning.

Based on the review of the available data, future projected climate change parameters for Saskatoon include:

- Average annual temperatures are expected to increase in the future.
- The number of very hot days (>30°C) is expected to increase in the future.
- The number of very cold days (<-30°C) is expected to decrease in the future.
- Total annual precipitation is expected to increase in the future.
- Extreme precipitation events (24hr and 72hr) are expected to increase in the future.
- Frost-free season length is expected to increase in the future.
- Provincial wildfire events are predicted to increase in the future.
- Pluvial flooding and washout events are predicted to increase in the future.

Results of the Report are presented in **Appendix A1** and **Appendix A2**, providing a summary of the climate change hazards, their projections under SSP2-4.5 and SSP5-8.5.



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# Acronyms and Abbreviations

| | |
|---|---|
| AR | Assessment Report |
| °C | Degrees Celsius |
| CF | Change factors |
| CMIP | Coupled Model Intercomparison Project |
| CMIP5 | Coupled Model Intercomparison Project Phase 5 |
| CMIP6 | Coupled Model Intercomparison Project Phase 6 |
| COS | City of Saskatoon |
| ENV | BC Ministry of Environment and Climate Change Canada |
| GHG | greenhouse gas |
| IAAC | Impact Assessment Agency of Canada |
| IDF | Intensity duration frequency |
| IPCC | Intergovernmental Panel on Climate Change |
| km/h | Kilometres per hour |
| kPa | Kilopascal |
| mm | millimetre |
| NOAA | National Oceanic and Atmospheric Administration |
| RCP | Representative concentration pathway |
| SLR | SLR Consulting (Canada) Ltd. |
| SSP | Shared Socioeconomic Pathway |
| The City | City of Saskatoon |
| US | United States |



# Climate Hazard Definitions

**Mean Temperature (Annual) (˚C):** Mean temperature describes the average temperature for the 24-hour day. Annual Mean Temperature is the average yearly temperature for the 24-hour day (ClimSystems 2024).

**Mean Temperature (Spring) (˚C):** Mean temperature describes the average temperature for the 24-hour day. Spring Mean Temperature is the average seasonal temperature for the 24-hour day. Spring is represented as the averages of the months of March, April, and May (ClimSystems 2024).

**Mean Temperature (Summer) (˚C):** Mean temperature describes the average temperature for the 24-hour day. Summer Mean Temperature is the average seasonal temperature for the 24-hour day. Summer is represented as the averages of the months of June, July, and August (ClimSystems 2024).

**Mean Temperature (Fall) (˚C):** Mean temperature describes the average temperature for the 24-hour day. Fall Mean Temperature is the average seasonal temperature for the 24-hour day. Fall is represented as the averages of the months of September, October, and November (ClimSystems 2024).

**Mean Temperature (Winter) (˚C):** Mean temperature describes the average temperature for the 24-hour day. Winter Mean Temperature is the average seasonal temperature for the 24-hour day. Winter is represented as the averages of the months of December, January, and February (ClimSystems 2024).

**Mean Max Temperature (˚C):** Mean Max Temperature describes the average maximum temperature for the 24-hour day. Mean Max Temperature; temperature is the average maximum yearly temperature for the 24-hour day (ClimSystems 2024).

**Mean Min Temperature (˚C):** Mean Min Temperature describes the average minimum temperature for the 24-hour day. Mean Min Temperature; temperature is the average minimum yearly temperature for the 24-hour day (ClimSystems 2024).

**Hottest Day (˚C):** The Hottest Day describes the warmest daytime temperature in the selected time period. In general, the hottest day of the year occurs during the summer months (ClimateData.ca 2024).

**Coldest Day (˚C):** The *Coldest Day* describes the lowest nighttime temperature in the selected time period. In general, the coldest day of the year occurs during the winter months (ClimateData.ca 2024).

**Summer Days (>25 ˚C) (Annual) (˚C):** Summer Days (> 25°C) describes the number of days where the daytime high temperature is warmer than 25°C. This index gives an indication of number of summer days in the selected time period (ClimSystems 2024).

**Winter Days (<-5˚C) (Annual) (˚C):** Winter Days (<-5°C) describes the number of days where the daytime low temperature is lower than -5°C. This index gives an indication of number of winter days in the selected time period (ClimSystems 2024).

**Very Hot Days (≥ 30 ˚C) (Annual) (˚C):** Very Hot Days (> 30°C) describes the number of days where the daytime high temperature is warmer than 30°C. This index gives an indication of number of very hot days in the selected time period (ClimSystems 2024).

**Very Cold Days (≤ -30 ˚C) (Annual) (˚C):** Very Cold Days (<-30°C) describes the number of days where the lowest temperature of the day is colder than -30°C. This index gives an indication of the number of very cold days in the selected time period (Climate Atlas 2024).

**Date of Last Spring Frost (Annual):** The Last Spring Frost marks the approximate beginning of the growing season for frost-sensitive crops and plants. When the lowest temperature of the day remains above 0°C for one consecutive day (before July 15th) the date of the last spring frost is established (ClimateData.ca 2024).

**Date of First Fall Frost (Annual):** The First Fall Frost marks the approximate end of the growing season for frost-sensitive crops and plants. When the lowest temperature of the day is colder than 0°C for one consecutive day (after July 15th) the date of the first fall frost is established (ClimateData.ca 2024).

**Frost-Free Season (Days) (Annual):** The Frost Free Season is the approximate length of the growing season during which there are no freezing temperatures to kill or damage frost-sensitive plants. This index describes the number of days between the Last Spring Frost and the First Fall Frost (ClimateData.ca 2024).

**Growing Degree Days (15 ˚C) (Annual):** Growing degree days (GDD) are a measure of whether climate conditions are warm enough to support plant and insect growth. When the daily average temperature is warmer than the threshold temperature (15 ˚C), growing degree days are accumulated (Climate Atlas 2024).

**Freeze-Thaw Cycles (Annual):** This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and re-freezing of water can, over time, cause significant damage to roads, sidewalks, and other outdoor structures (ClimateData.ca 2024).

**Freeze-Thaw Cycles (Spring):** This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Spring is represented as the months of March, April, and May (ClimateData.ca 2024).

**Freeze-Thaw Cycles (Summer):** This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Summer is represented as the months of June, July, and August (ClimateData.ca 2024).

**Freeze-Thaw Cycles (Fall):** This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Fall is represented the months of September, October, and November (ClimSystems 2024).

**Freeze-Thaw Cycles (Winter):** This is a simple count of the days when the air temperature fluctuates between freezing and non-freezing temperatures on the same day. Winter is represented as the months of December, January, and February (ClimSystems 2024).

**Air Heatwave Days (Annual):** Heatwave days (HWD, days/year) are the total number of days or length of a heatwave occurring within a year. Daily maximum temperature and daily minimum temperature must simultaneously exceed the calendar-day 90th percentile for at least three consecutive days for a heatwave to be declared (ClimSystems 2024).

**Heat Wave Total Duration (Days):** The total number of days in heat wave events, where an event is when daily minimum temperature is >18 degrees C and daily maximum temperature is >30 degrees C for a minimum of 3 consecutive days.

**Tropical Nights (>20˚C):** Tropical Nights (Days with Tmin >20°C) describes the number of days where the nighttime low temperature is warmer than 20°C (ClimateData.ca 2024).

**HDD:** Heating degree days (HDDs) give an indication of the amount of space heating (e.g., from a gas boiler/furnace, baseboard electric heating or fireplace) that may be required to maintain comfortable conditions inside a building during cooler months.



When the daily average temperature is colder than the threshold temperature, HDDs are accumulated. Threshold values may vary, but 18°C is commonly used in Canada and what was used for this assessment. Larger HDD values indicate a greater need for space heating (ClimateData.ca 2024).

**CDD:** Cooling degree days (CDDs) give an indication of the amount of space cooling, i.e., air conditioning, that may be required to maintain comfortable conditions in a building during warmer months. When the daily average temperature is hotter than the threshold temperature, CDDs are accumulated. Threshold values may vary, but 18°C is commonly used in Canada and what was used for this assessment. Larger CDD values indicate a greater need for air conditioning (ClimateData.ca 2024).

**Building Zone:** Climate Zones for buildings are determined based on the unique climatic conditions of a particular region. The National Energy Code of Canada for Buildings (NECB) uses Heating Degree Days to define Climate Zones. In this case, Heating Degree Days (HDDs) are calculated using a threshold of 18°C. This metric indicates the potential heating required to maintain comfortable conditions inside a building. (ClimateData.ca 2024). Zones represent the following number of HDD:

- Zone 4 - <3000 HDD
- Zone 5 – 3000-4000 HDD
- Zone 6 – 4000-4999 HDD
- Zone 7A – 5000-5999 HDD
- Zone 7B – 6000-6999 HDD
- Zone 8 - ≥7000 HDD

**Mean Precipitation (Annual) (mm):** Mean Precipitation (Annual) describes the total average amount of precipitation (rain and snow combined) that falls annually (ClimateData.ca 2024).

**Mean Precipitation (Spring) (mm):** Mean Precipitation (Spring) describes the total average amount of precipitation (rain and snow combined) that falls seasonally. Spring is represented as the months of March, April, and May (ClimateData.ca 2024).

**Mean Precipitation (Summer) (mm**): Mean Precipitation (Summer) describes the total average amount of precipitation (rain and snow combined) that falls seasonally. Summer Mean Temperature is the average seasonal temperature for the 24-hour day. Summer is represented as the months of June, July, and August (ClimateData.ca 2024).

**Mean Precipitation (Fall) (mm):** Mean Precipitation (Fall) describes the total average amount of precipitation (rain and snow combined) that falls seasonally. Fall Mean Temperature is the average seasonal temperature for the 24-hour day. Fall is represented the months of September, October, and November (ClimSystems 2024).

**Mean Precipitation (Winter) (mm):** Mean Precipitation (Winter) describes the total average amount of precipitation (rain and snow combined) that falls seasonally. Winter is represented as the months of December, January, and February (ClimSystems 2024).

**Mean Rain (Annual) (mm):** Mean Rain (Annual) describes the total average amount of precipitation as rain that falls annually (ClimSystems 2024).

**Mean Snow (Annual) (mm):** Mean Snow (Annual) describes the total average amount of precipitation as snow that falls annually (ClimSystems 2024).



**Heavy Precipitation Days (>10mm) (Annual):** Heavy Precipitation Days (>10mm) describes the number of days where at least 10 mm of precipitation (rain and snow combined) falls annually (ClimateData.ca 2024).

**Heavy Precipitation Days (>20mm) (Annual):** Heavy Precipitation Days (>20mm) describes the number of days where at least 20 mm of precipitation (rain and snow combined) falls annually (ClimateData.ca 2024).

**Extreme Precipitation (24hrs) (100YR) (mm):** Extreme precipitation qualifies the heavy precipitation amount over various durations (24hr) and average recurrence interval (100 yr) for engineering design (ClimSystems 2024).

**Extreme Precipitation (72hrs) (100YR) (mm):** Extreme precipitation qualifies the heavy precipitation amount over various durations (72hr) and average recurrence interval (100 yr) for engineering design (ClimSystems 2024).

**RL50 Annual Max Rain on Snow, 1/50 (kPa):** Used by the National Building Code of Canada and the Canadian Highway Bridge Design Code, RL50 Annual Max Rain on Snow, 1/50 describes the Annual Maximum rain on snow load for a 50 year return period (PCIC 2024).

**Maximum Number of Consecutive Dry Days:** The Maximum Number of Consecutive Dry Days describes the longest spell of days where less than 1mm of precipitation falls daily (ClimateData.ca 2024).

**Extreme Land Wind Speed (100yr) (km/h):** Extreme Wind Speed qualifies as strong wind speed over various average recurrence intervals (100 yr) for engineering design (ClimSystems 2024).

**Relative Humidity (Annual) (%):** Relative humidity is the amount of moisture in the air as a percentage of the amount the air can actually hold. Warmer air can hold more moisture than cooler air, which means that for a given amount of atmospheric moisture, RH will be lower if the air is warm than it would be if the air is cool (ClimSystems 2024).

**Relative Humidity (Spring) (%):** Relative humidity is the amount of moisture in the air as a percentage of the amount the air can actually hold. Warmer air can hold more moisture than cooler air, which means that for a given amount of atmospheric moisture, RH will be lower if the air is warm than it would be if the air is cool. Spring is represented as the months of March, April, and May (ClimSystems 2024).

**Relative Humidity (Summer) (%):** Relative humidity is the amount of moisture in the air as a percentage of the amount the air can actually hold. Warmer air can hold more moisture than cooler air, which means that for a given amount of atmospheric moisture, RH will be lower if the air is warm than it would be if the air is cool. Summer is represented as the months of June, July, and August (ClimSystems 2024).

**Relative Humidity (Fall) (%):** Relative humidity is the amount of moisture in the air as a percentage of the amount the air can actually hold. Warmer air can hold more moisture than cooler air, which means that for a given amount of atmospheric moisture, RH will be lower if the air is warm than it would be if the air is cool. Fall is represented the months of September, October, and November (ClimSystems 2024).

**Relative Humidity (Winter) (%):** Relative humidity is the amount of moisture in the air as a percentage of the amount the air can actually hold. Warmer air can hold more moisture than cooler air, which means that for a given amount of atmospheric moisture, RH will be lower if the air is warm than it would be if the air is cool. Winter is represented as the months of December, January, and February (ClimSystems 2024).



**Forest Fire Danger Index (Very High) (%):** The Forest Fire Danger Index (FFDI) (developed by CSIRO scientist A. G. McArthur) combines a measure of vegetation dryness with air temperature, wind speed, and humidity to measure the potential danger of a bushfire on a given day and location. The Fire Danger Ratings (FDR) (Very High) are derived from the FFDI scores. They use the plain-language terms low-moderate, high, very high, severe, extreme, and catastrophic to give the general public an indication of the fire danger and the consequences and risk to life should a fire start (ClimSystems 2024).

**Forest Fire Danger Index (Severe) (%):** The Forest Fire Danger Index (FFDI) (developed by CSIRO scientist A. G. McArthur) combines a measure of vegetation dryness with air temperature, wind speed, and humidity to measure the potential danger of a bushfire on a given day and location. The Fire Danger Ratings (FDR) (Severe) are derived from the FFDI scores. They use the plain-language terms low-moderate, high, very high, severe, extreme, and catastrophic to give the general public an indication of the fire danger and the consequences and risk to life should a fire start (ClimSystems 2024).



# 1.0 Introduction

## 1.1 Project Context

The City of Saskatoon (the City) has taken steps to identify and adapt to the near-term and long-term effects of climate change on its corporate operations and its citizens. The City acknowledges that increasingly, people in cities and rural locations are being impacted by progressively frequent and severe heat waves, sudden and unexpected flooding, and unseasonable weather patterns causing social, economic and environmental impacts and at times possibly devastation (City of Saskatoon (COS) 2019a). In light of these identified effects, the City has focused on improving its resilience through adaptation planning. Adaptation involves activities that increase the ability to prepare for, withstand, and recover from the impacts of changing climate conditions (COS 2019b).

The City launched its Climate Action Plan as part of the 2018-2021 Corporate Strategic Plan through the Strategic Goal of Environmental Leadership (COS 2019a). As part of the Climate Action Plan, the City of Saskatoon completed its first Climate Change Projections and Possible Impacts report, and Corporate Climate Adaptation Strategy (COS 2019a, 2019b). The strategy refers to projected climate events and potential impacts on the City's services, infrastructure, and programs and recommends adaptation actions to mitigate impacts.

***The City of Saskatoon, Corporate Climate Adaptation Strategy***

**Vision:** The City of Saskatoon is a climate ready and resilient organization

**Mission:** We implement climate change adaptation actions as planned and on purpose in order to limit disruptions and negative impacts on our staff, services, and assets, allowing us to continue to deliver high quality services to the residents of Saskatoon.

Source: COS 2019b

In 2024, the City requested an update to its climate change projections, hazards and impacts to support future planning and strategy development for city-wide resilience. The update includes the most recent and relevant climate change projection data to ensure the City's climate change adaptation initiatives align with the most current model of future climate conditions.

As part of the update, the City is committed to considering how equity-deserving groups can be disproportionately impacted by climate change and may be more vulnerable to climate hazards than other sections of the population. The City will identify opportunities for an integrated consideration of equity-deserving groups, as well as ongoing reconciliation with First Nations and Métis communities within its climate action planning approach.

## 1.2 Project Overview

The City requested SLR Consulting (Canada) Ltd. prepare a Climate Change Projections, Hazards, and Impacts Report (the Report) for the Saskatoon region for both medium and high greenhouse gas (GHG) emission scenarios. The Report includes projections on near-term (2050) and long-term (2080) time horizons.

The Report draws on the best available climate science and existing reports to identify potential municipal impacts based on the type of hazards that are projected. Climate change projection data for individual climate hazards were collected from reliable, and recognized sources, including:

- ClimSystems, Climate Insights tool.
- Environment and Climate Change Canada, climatedata.ca
- Prairie Climate Centre, Climate Atlas of Canada
- Pacific Climate Impacts Consortium, Design Value Explorer

The determination of likelihood of occurrence for individual climate hazards follows the Public Infrastructure Engineering Vulnerability Committee (PIEVC) middle-baseline approach. Likelihood scoring uses a 1 to 5 scale from low to high potential of occurrence. Where likelihood scoring could not be determined numerically for a particular climate hazard, SLR has provided qualitative context for the potential occurrence of these hazards.

# 2.0 City of Saskatoon Environmental Setting & Climate

The City is situated in a relatively flat area in the central region of Saskatchewan and is bisected by the South Saskatchewan River. The City is located within the Prairie ecozone, and the moist mixed grassland ecoregion of Canada (Environment Canada 2008; Warren 2021). The mixed grassland ecoregion includes the northern extension of open grasslands in the Interior Plains of Canada and is associated with semi-arid moisture conditions, and dark brown Chernozemic soils (Environment Canada 2008). Prehistorically, the region has experienced multiple glaciation events with the effects of the most recent glacial period, the Wisconsin Glaciation (approximately 75,000 to 11,500 years before present), leaving its mark on the geomorphology of the region (Christensen and Sauer 1998; Burdeyney 2019). The surficial geology of Saskatoon is generally comprised of glaciolacustrine silt and clay deposits left by Glacial Lake Saskatchewan (Christensen and Sauer 1998; Burdeyney 2019).

Native vegetation in the moist mixed grassland ecoregion typically consists of nonarable pasturelands, dominated by spear grass and wheat grass, and a variety of deciduous shrubs including buckbrush, chokecherry, wolf willow, and saskatoon (Environment Canada 2008). Patches of scrubby aspen, willow, cottonwood, and box-elder occur to a limited extent on shaded slopes of valleys, on river terraces, and ringing non-saline depressional sites covered with meadow grasses and sedges (Environment Canada 2008). Local saline soil areas support alkali grass, wild barley, red sampire, and sea blite (Environment Canada 2008).

Saskatoon experiences four distinct seasons with hot summers and cold winters (ClimSystems 2024). The baseline (1991-2020) mean annual temperature for the city is 2.5 ˚C, and the baseline annual precipitation is approximately 351 mm. The Summer season has the greatest amount of rainfall (approximately 169 mm) with winter being the driest season (approximately 68 mm). Saskatoon has a baseline frost-free season of approximately 130 days with the first fall frost in mid to late September. The city experiences approximately 7.4 very hot days (>30 ˚C) and 12.5 very cold days (<-30 ˚C) per year at baseline (ClimSystems 2024).

Saskatchewan has already experienced climate-related impacts including flooding, drought, and wildfire events, impacting residents and infrastructure, and costing the Province billions of dollars (City of Saskatoon 2019). These hazards are expected to become more variable and significant due to the effects of climate change (City of Saskatoon 2019). Details of these projected changes for the City of Saskatoon are outlined below in Section 3.

# 3.0 Climate Change Projections

## 3.1 Time Horizons and Climate Scenarios

Time horizons selected include the baseline period[1], 2050, and 2080 time horizons.

**Baseline Period:** recent historical climate data that establishes a baseline.(1991-2020)

- **2050:** near-term projections for climate conditions.(2041-2070)
- **2080:** long-term projections for climate conditions. (2071-2100)

The 30 year averages used for each time horizons help to identify the trend (i.e., increases or decreases) of future climate hazards, and isolate outlier events that can occur within a narrower window of time.

The future climate is dependent on several complex interactions including the gravitational interactions in our solar system, as well as the cumulative volumes of global greenhouse gases (GHG) in the earth's atmosphere. Notably, the GHG emission choices made by humans today will affect the global and regional climate of tomorrow. In response to the intensification of GHG emissions from the combustion of fossil fuels, many national and regional governments and non-governmental organizations are united to limit their contribution to climate change as well as its effects.

The Intergovernmental Panel on Climate Change (IPCC) was commissioned in 1988 by the World Meteorological Organization and the United Nations Environment Program to provide policymakers with regular assessments of the scientific basis of climate change, including its impacts and future risks, as well as options for climate change adaptation and mitigation (Bush and Lemmen 2019). The IPCC issues regular updates as assessment reports (AR) that present the results of climate change models developed by the Coupled Model Intercomparison Project (CMIP). CMIP6 was presented in the IPCC's AR6 (i.e., sixth report) and presented the use of SSP (i.e., shared socioeconomic pathways) GHG scenarios to project the future climate. The updated CMIP6 model using SSPs define how societal choices can lead to changes in climate change related outcomes by the end of the century (Environment and Climate Change Canada (ECCC), 2023).

There are five SSPs developed to model future climate events based on low to high GHG emission scenarios: SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. Generally, climate scenarios SSP2-4.5 and SSP5-8.5 are considered in this Report for the City. Where data for an individual climate hazard was unavailable under CMIP6, CMIP5 and representative concentration pathway scenario (RCP) RCP4.5 and RCP8.5 were used. Climate projections under RCP4.5 and RCP8.5 are in agreement with the results of SSP2-4.5 and SSP5-8.5 respectively.

Climate scenario SSP5-8.5 was selected as a conservative approach to account for limited to no mitigation of global GHG emissions (i.e., "business as usual") which is understood to result in the warmest climate feature. A conservative scenario is important to understand the highest level of risk currently understood as possible.

[1] For the purposes of the Report based on the climate hazards considered the baseline period can reflect the years spanning: 1981-2010 or 1986-2016, or 2005. Table 3-1 describes the specific time horizons considered for each climate event.

Preparing for higher risk scenarios will help achieve higher levels of resilience. Under climate scenario SSP5-8.5 the global average temperatures are projected to increase above 1.5 degrees Celsius (°C) to 4°C by the end of the century (Arias et al. 2021). Historically, and under SSP5-8.5, Canada and the Arctic are expected to warm at 2 to 3 times greater than the global average rate (Bush and Lemmen 2019). Scenario SSP2-4.5 is considered a "middle-of-the-road" scenario where, the world follows a path in which social, economic, and technological trends do not shift markedly from historical patterns (ECCC 2023). Under this scenario, gradual reductions of GHG emissions are made, however, global temperatures continue to rise beyond current baseline averages.

## 3.2 Climate Hazards Likelihood of Occurrence

In general, the likelihood of a climate event occurring in the future is based on quantified measures of uncertainty expressed probabilistically based on statistical analysis of observations, model results, and or expert judgment (Bush and Lemmen 2019). Table 3-1 provides the likelihood scale used for this Report for quantified climate events on a 1 to 5 scale.

The likelihood scores used in this Report follow the Public Infrastructure Engineers Vulnerability Committee (PIEVC) middle baseline approach (PIEVC 2022). The "middle-baseline" method assigns likelihood to hazard indicators by establishing the baseline conditions in the historical period (e.g., 2005), with the mean conditions over this period being represented as a "likelihood of 3" in the scoring system (PIEVC 2022). For the Report, likelihood values are based calculated percentage change between the baseline and the "medium" (i.e., 50$^{th}$ percentile) projected valued for any individual climate hazard.

As described by Mastrandrea et al. (2010), Likelihood may be based on statistical or modeling analyses, elicitation of expert views, or other quantitative analyses. Where likelihood has been assigned using expert judgement the likelihood definitions adapted from Mastrandrea et al. (2010; 2011) are used (see Table 3-1) and identified in Tables 4-2 and 4-3 with an Asterix.

Levels of confidence are not assigned for individual climate events. Levels of confidence provide a qualitative explanation of the validity of findings (level of agreement) (Mastrandrea et al. 2011). While levels of confidence are not assigned in the Report for individual climate events, the "Tier" system as described by Cannon et al. (2020) can be used for the relative consideration of confidence for the climate data presented in this Report:

**Table 3-1: Confidence Teir Descriptions**

| Confidence Teir | Description | Example(s) |
|---|---|---|
| **Tier 1** | Variables are those for which there is generally high or very high confidence in the future projections for a given level of global warming | • Maximum and minimum mean daily air temperatures<br>• Heating degree days |
| **Tier 2** | Variables are those for which there is generally medium confidence in the future projections for a given level of global warming | • Annual total precipitation and annual total rainfall<br>• Annual maximum 1-day rain<br>• Annual maximum 15-min rainfall<br>• Intensity duration frequency (IDF) change factors (CF) |

| Confidence Teir | Description | Example(s) |
|---|---|---|
| **Tier 3** | Variables are those for which there is low or very low confidence in the future projections for a given level of global warming | • Annual mean relative humidity<br>• Annual maximum hourly wind pressures (10- and 50-yr return periods)<br>• Annual maximum driving rain wind pressures (5-yr return period)<br>• Annual maximum snow load & rain-on-snow load (50-yr return period)<br>• Moisture index |
| Source: Cannon et al. 2020. | | |

Using the ratings described above Table 3-2 and 3-3 presents the likelihood of occurrence associated with each climate hazard for the moderate and high emissions scenarios (i.e., SSP/RCP).

**Table 3-2: Likelihood Rating Scale**

| Likelihood Score | Very Low (1) | Low (2) | Moderate (3) | High (4) | Very High (5) |
|---|---|---|---|---|---|
| PIEVC Middle-Baseline | Likely to occur less frequently than current climate | Likely to occur slightly less frequently than current climate | Likely to occur as frequently as the current climate | Likely to occur slightly more frequently than current climate | Likely to occur more frequently than current climate |
| | >50%-100% decrease from baseline conditions | >10%-50% decrease from baseline conditions | Baseline conditions or a change ≤±10% from baseline conditions | >10%-50% increase from baseline conditions | >50%-100% increase from baseline conditions |
| Expert Judgement | Not likely to occur in period | About as likely as not to occur in period | Likely to occur in period | Very likely to occur in period | Virtually certain to occur in period |

### 3.2.1 Magnitude

Magnitude refers to the amount of change in a measurable parameter relative to the baseline conditions (Impact Assessment Agency of Canada-IAAC 2024). This means that the projected change in an individual climate hazard's intensity, frequency, or duration, relative to baseline conditions are used to determine magnitude. In the context of cumulative events (e.g., rain on snow, drought occurring during a heat wave, or extreme precipitation occurring during a drought) the magnitude for any individual event may be amplified if occurring at the same time as other events (IAAC 2024). Below are the definitions used to describe magnitude in this Report. These definitions are used to describe the relative scale of change for the City's consideration.

**Table 3-3: Magnitude Level Descriptions**

| Level of Magnitude | Definition |
|---|---|
| **Negligible** | No detectable (i.e., noticeable) change from baseline conditions (≤5% change) |
| **Low** | The change slightly differs from the baseline (≥6% to 14% change) |
| **Moderate** | The change is detectable but is not anticipated to significantly affect natural or human system, level of service, or function (15% to 24% change) |
| **High** | The change is anticipated to significantly alter natural or human system, level of service, or function (≥25% change) |

## 3.3 Climate Parameters

The climate parameters (i.e., temperature and precipitation) and their associated events (i.e., climate hazards) identified for the assessment were selected based on their likelihood to occur in the City and the region. Relevant climate hazards and their projected frequency, intensity, or duration during the baseline period, near-term 2050, and long-term 2080 time horizons are reported below using the $5^{th}$ /$10^{th}$ (low), $50^{th}$ (mean), and $90^{th}$/$95^{th}$ (high) percentile results of ensembled CMIP6 /CMIP5 climate change model outputs for SSP2-4.5 and SSP5-8.5 / RCP4.5 and RCP8.5. The presentation of the percentile results are used to show where the bulk of results fall for an individual climate hazard within a given time horizon and climate scenario (i.e., SSP/RCP).

Table 3-18 summarizes the climate hazards, and future trends under both SSP2-4.5 and SSP5-8.5, as well as the sources of data and data attributes used in the Report.

Climate change projections are also presented in **Appendix A1** and **Appendix A2**.

### 3.3.1 Temperature

Average annual and seasonal temperatures are projected to increase in the future. Extreme heat events are expected to increase in frequency and extreme cold events are expected to decrease. Trends, data projections, and likelihood and magnitude scoring can be seen below in **Tables 3-4 to 3-11.**

**Table 3-4: Climate Hazards, Future Trends, and Sources - Temperature**

| Climate Hazard | Future Trend | Source | Notes |
|---|---|---|---|
| **Temperature** | | | |
| Mean Temperature (Annual, ˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Temperature (Spring, ˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Temperature (Summer, ˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Temperature (Fall, ˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Temperature (Winter, ˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Max Temperature (˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Min Temperature (˚C) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Hottest Day (Annual, ˚C) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Coldest Day (Annual, ˚C) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Summer Days (>25 ˚C, Annual) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Winter Days (<-5˚C, Annual) | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Very Hot Days (≥ 30 ˚C, Annual) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Very Cold Days (≤ -30 ˚C, Annual) | Decreasing | Climate Atlas | CMIP5, Baseline: 1981-2010, 10,50,90 |
| Date of Last Spring Frost (Annual) | Increasing Earlier | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Date of First Fall Frost (Annual) | Increasing Later | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Frost-Free Season (Days, Annual) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Growing Degree Days (15 ˚C, Annual) | Increasing | Climate Atlas | CMIP5, Baseline: 1981-2010, 10,50,90 |
| Freeze-Thaw Cycles (Annual) | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Freeze-Thaw Cycles (Spring) | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Freeze-Thaw Cycles (Summer) | Stable | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Freeze-Thaw Cycles (Fall) | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Freeze-Thaw Cycles (Winter) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |



| Climate Hazard | Future Trend | Source | Notes |
|---|---|---|---|
| Air Heatwave Days (Annual) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Heatwave Total Duration (Days) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Tropical Nights (>20˚C) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Heating Degree Days (HDD) | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Cooling Degree Days (CDD) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Building Zone | Decreasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |

**Table 3-5: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under High Emission Scenario (SSP5-8.5) - Temperature**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Temperature** | | | | | | | |
| Mean Temperature (Annual, ˚C) | 2.5 | 4.1 | 5.4 | 7.0 | 5.6 | 8.0 | 10.9 |
| Mean Temperature (Spring, ˚C) | 3.4 | 4.7 | 6.0 | 7.4 | 5.8 | 8.2 | 10.8 |
| Mean Temperature (Summer, ˚C) | 17.2 | 18.9 | 20.3 | 21.9 | 20.4 | 23.0 | 25.9 |
| Mean Temperature (Fall, ˚C) | 3.3 | 5.2 | 6.2 | 7.5 | 6.8 | 8.7 | 11.2 |
| Mean Temperature (Winter, ˚C) | -14.0 | -12.2 | -10.8 | -8.7 | -10.7 | -8.0 | -4.2 |
| Mean Max Temperature (˚C) | 8.6 | 10.2 | 11.4 | 13.6 | 11.6 | 13.9 | 17.9 |
| Mean Min Temperature (˚C) | -3.6 | -1.9 | -0.5 | 1.0 | -0.5 | 2.2 | 5.0 |
| Hottest Day (Annual, ˚C) | 34.4 | 37.4 | 39.1 | 41.8 | 40.1 | 42.3 | 46.2 |
| Coldest Day (Annual, ˚C) | -37.1 | -32.7 | -31.6 | -28.9 | -28.4 | -26.5 | -21.8 |
| Summer Days (>25 ˚C, Annual) | 38 | 56 | 69 | 83 | 76 | 96 | 116 |
| Winter Days (<-5˚C, Annual) | 141 | 88 | 113 | 133 | 54 | 92 | 119 |
| Very Hot Days (≥ 30 ˚C, Annual) | 7 | 14 | 21 | 33 | 25 | 45 | 72 |
| Very Cold Days (≤ -30 ˚C, Annual) | 13 | 0 | 3 | 10 | 0 | 0 | 3 |

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| Date of Last Spring Frost (Annual) ◊ | May 13 (133) | May 12 (112) | May 2 (122) | May 5 (125) | April 5 (95) | April 20 (110) | May 2 (122) |
| Date of First Fall Frost (Annual) ◊ | September 22 (265) | October 3 (276) | October 10 (282) | October 16 (289) | October 11 (284) | October 18 (291) | November 4 (208) |
| Frost-Free Season (Days, Annual) | 130 | 152 | 157 | 174 | 166 | 182 | 212 |
| Growing Degree Days (15 ˚C, Annual) | 362 | 474 | 716 | 958 | 681 | 1007 | 1321 |
| Freeze-Thaw Cycles (Annual) | 72 | 55 | 62 | 72 | 40 | 55 | 65 |
| Freeze-Thaw Cycles (Spring) | 30 | 13 | 21 | 31 | 7 | 16 | 26 |
| Freeze-Thaw Cycles (Summer) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freeze-Thaw Cycles (Fall) | 27 | 11 | 19 | 28 | 5 | 14 | 23 |
| Freeze-Thaw Cycles (Winter) | 14 | 10 | 20 | 34 | 11 | 23 | 38 |
| Air Heatwave Days (Annual) | 4 | 12 | 21 | 43 | 13 | 69 | 149 |
| Heatwave Total Duration (Days) | 0 | 2 | 12 | 34 | 12 | 41 | 71 |
| Tropical Nights (>20˚C) | 0 | 4 | 9 | 19 | 12 | 30 | 57 |
| HDD | 5673 | 4097 | 4664 | 4817 | 3387 | 3967 | 4282 |
| CDD | 153 | 348 | 441 | 710 | 551 | 757 | 1143 |
| Building Zone | 7A | 6 | 6 | 6 | 5 | 5 | 6 |

Notes:
"-" not determined
*CMIP5/RCP data used
◊ Non-leap year dates used

**Table 3-6: Likelihood Ratings for Climate Hazards (SSP5-8.5) - Temperature**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| **Temperature** | | | |
| Mean Temperature (Annual, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Spring, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Summer, ˚C) | 3 | 4 | 4 |
| Mean Temperature (Fall, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Winter, ˚C) | 3 | 4 | 4 |
| Mean Max Temperature (˚C) | 3 | 4 | 4 |
| Mean Min Temperature (˚C) | 3 | 5 | 5 |
| Hottest Day (Annual, ˚C) | 3 | 4 | 4 |
| Coldest Day (Annual, ˚C) | 3 | 4 | 4 |
| Summer Days (>25 ˚C, Annual) | 3 | 5 | 5 |
| Winter Days (<-5˚C) (Annual) | 3 | 2 | 2 |
| Very Hot Days (≥ 30 ˚C, Annual) | 3 | 5 | 5 |
| Very Cold Days (≤ -30 ˚C, Annual) | 3 | 1 | 1 |
| Date of Last Spring Frost (Annual) | 3 | 2 | 2 |
| Date of First Fall Frost (Annual) | 3 | 3 | 3 |
| Frost-Free Season (Days, Annual) | 3 | 4 | 4 |
| Growing Degree Days (15 ˚C, Annual) | 3 | 5* | 5* |
| Freeze-Thaw Cycles (Annual) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Spring) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Summer) | 3 | 3 | 3 |
| Freeze-Thaw Cycles (Fall) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Winter) | 3 | 4 | 5 |



| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| Air Heatwave Days (Annual) | 3 | 5 | 5 |
| Heatwave Total Duration (Days) | 3 | 5* | 5* |
| Tropical Nights (>20˚C) | 3 | 4* | 5* |
| HDD | 3 | 2 | 2 |
| CDD | 3 | 5 | 5 |
| Building Zone | 3 | 4* | 5* |

Notes:
* Deviation from Middle Baseline
[1] CMIP5/RCP Data used

**Table 3-7: Magnitude Ratings for Climate Hazards (SSP5-8.5) - Temperature**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Temperature** | | |
| Mean Temperature (Annual, ˚C) | High | High |
| Mean Temperature (Spring, ˚C) | High | High |
| Mean Temperature (Summer, ˚C) | Moderate | Moderate |
| Mean Temperature (Fall, ˚C) | High | High |
| Mean Temperature (Winter, ˚C) | Moderate | High |
| Mean Max Temperature (˚C) | High | High |
| Mean Min Temperature (˚C) | High | High |
| Hottest Day (Annual, ˚C) | Low | Moderate |
| Coldest Day (Annual, ˚C) | Moderate | High |
| Summer Days (>25 ˚C, Annual) | High | High |
| Winter Days (<-5˚C, Annual) | Moderate | High |
| Very Hot Days (≥ 30 ˚C, Annual) | High | High |

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| Very Cold Days (≤ -30 ˚C, Annual) | High | High |
| Date of Last Spring Frost (Annual) | Low | Moderate |
| Date of First Fall Frost (Annual) | Low | Low |
| Frost-Free Season (Days, Annual) | Moderate | High |
| Growing Degree Days (15 ˚C, Annual) | High* | High* |
| Freeze-Thaw Cycles (Annual) | Low | Moderate |
| Freeze-Thaw Cycles (Spring) | High | High |
| Freeze-Thaw Cycles (Summer) | Negligible | Negligible |
| Freeze-Thaw Cycles (Fall) | High | High |
| Freeze-Thaw Cycles (Winter) | High | High |
| Air Heatwave Days (Annual) | High | High |
| Heatwave Total Duration (Days) | High* | High* |
| Tropical Nights (>20˚C) | High* | High* |
| HDD | Moderate | High |
| CDD | High | High |
| Building Zone | Moderate* | Moderate* |
| Notes:<br>* Deviation from Middle Baseline<br>[1] CMIP5/RCP Data used | | |



**Table 3-8: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under Moderate Emission Scenario (SSP2-4.5) - Temperature**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Temperature** | | | | | | | |
| Mean Temperature (Annual, ˚C) | 2.5 | 3.7 | 4.6 | 5.7 | 4.1 | 5.4 | 6.9 |
| Mean Temperature (Spring, ˚C) | 3.4 | 4.4 | 5.3 | 6.3 | 4.7 | 5.9 | 7.3 |
| Mean Temperature (Summer, ˚C) | 17.2 | 18.4 | 19.4 | 20.6 | 18.9 | 20.2 | 21.8 |
| Mean Temperature (Fall, ˚C) | 3.3 | 4.7 | 5.4 | 6.3 | 5.1 | 6.2 | 7.4 |
| Mean Temperature (Winter, ˚C) | -14.0 | -12.7 | -11.7 | -10.2 | -12.3 | -10.8 | -8.8 |
| Mean Max Temperature (˚C) | 8.6 | 9.7 | 10.6 | 12.2 | 10.1 | 11.4 | 13.5 |
| Mean Min Temperature (˚C) | -3.6 | -4.5 | -1.4 | -0.3 | -2.0 | -0.6 | 0.9 |
| Hottest Day (Annual, ˚C) | 34.4 | 39.1 | 35.4 | 37.6 | 40.0 | 37.0 | 38.8 |
| Coldest Day (Annual, ˚C) | -37.1 | -34.5 | -32.8 | -30.7 | -33.2 | -30.7 | -28.1 |
| Summer Days (>25 ˚C, Annual) | 38 | 51 | 62 | 74 | 58 | 74 | 89 |
| Winter Days (<-5˚C, Annual) | 141 | 99 | 121 | 137 | 87 | 113 | 133 |
| Very Hot Days (≥ 30 ˚C, Annual) | 7 | 12 | 16 | 24 | 15 | 23 | 38 |
| Very Cold Days (≤ -30 ˚C, Annual) | 13 | 0 | 4 | 12 | 0 | 3 | 11 |
| Date of Last Spring Frost (Annual Day of the Year) ◊ | May 13 (133) | April 28(118) | May 3(123) | May 8(128) | April 22(120) | May 2(122) | May 5(125) |
| Date of First Fall Frost (Annual) ◊ | September 22 (265) | September 28 (271) | October 6 (279) | October 12 (285) | October 2 (275) | October 7 (280) | October 18 (291) |
| Frost-Free Season (Days, Annual) | 130 | 143 | 156 | 164 | 151 | 157 | 178 |
| Growing Degree Days (15 ˚C, Annual) | 363 | 397 | 598 | 819 | 443 | 678 | 925 |
| Freeze-Thaw Cycles (Annual) | 72 | 58 | 64 | 72 | 53 | 63 | 72 |



| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| Freeze-Thaw Cycles (Spring) | 30 | 14 | 23 | 32 | 11 | 21 | 31 |
| Freeze-Thaw Cycles (Summer) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Freeze-Thaw Cycles (Fall) | 27 | 13 | 21 | 30 | 12 | 20 | 28 |
| Freeze-Thaw Cycles (Winter) | 14 | 8 | 19 | 31 | 10 | 21 | 34 |
| Air Heatwave Days (Annual) | 4 | 9 | 15 | 27 | 13 | 25 | 53 |
| Heatwave Total Duration (Days) | 0 | 0 | 5 | 19 | 1 | 12 | 0 |
| Tropical Nights (>20˚C) | 0 | 2 | 3 | 10 | 3 | 7 | 17 |
| HDD | 5673 | 4505 | 4896 | 5114 | 4039 | 4610 | 4887 |
| CDD | 153 | 266 | 333 | 552 | 340 | 427 | 695 |
| Building Zone | 7A | 6 | 6.0 | 7A | 6 | 6 | 6 |

Notes:
"-" not determined
*CMIP5/RCP data used
◊ Non-leap year dates used

**Table 3-9: Likelihood Ratings for Climate Hazards (SSP2-4.5) - Temperature**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| **Temperature** | | | |
| Mean Temperature (Annual, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Spring, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Summer, ˚C) | 3 | 4 | 4 |
| Mean Temperature (Fall, ˚C) | 3 | 5 | 5 |
| Mean Temperature (Winter, ˚C) | 3 | 4 | 4 |
| Mean Max Temperature (˚C) | 3 | 4 | 4 |
| Mean Min Temperature (˚C) | 3 | 5 | 5 |

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| Hottest Day (Annual, ˚C) | 3 | 3 | 3 |
| Coldest Day (Annual, ˚C) | 3 | 4 | 4 |
| Summer Days (>25 ˚C, Annual) | 3 | 5 | 5 |
| Winter Days (<-5˚C, Annual) | 3 | 2 | 2 |
| Very Hot Days (≥ 30 ˚C, Annual) | 3 | 5 | 5 |
| Very Cold Days (≤ -30 ˚C, Annual) | 3 | 1 | 1 |
| Date of Last Spring Frost (Annual) | 3 | 3 | 3 |
| Date of First Fall Frost (Annual) | 3 | 3 | 3 |
| Frost-Free Season (Days, Annual) | 3 | 4 | 4 |
| Growing Degree Days (15 ˚C, Annual) | 3 | 5 | 5 |
| Freeze-Thaw Cycles (Annual) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Spring) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Summer) | 3 | 3 | 3 |
| Freeze-Thaw Cycles (Fall) | 3 | 2 | 2 |
| Freeze-Thaw Cycles (Winter) | 3 | 4 | 5 |
| Air Heatwave Days (Annual) | 3 | 5 | 5 |
| Heatwave Total Duration (Days) | 3 | 4* | 5* |
| Tropical Nights (>20˚C) | 3 | 4* | 5* |
| HDD | 3 | 2 | 2 |
| CDD | 3 | 5 | 5 |
| Building Zone | 3 | 4* | 4* |

Notes:
* Deviation from Middle Baseline
[1] CMIP5/RCP Data used

**Table 3-10: Magnitude Ratings for Climate Hazards (SSP2-4.5) - Temperature**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Temperature** | | |
| Mean Temperature (Annual, ˚C) | High | High |
| Mean Temperature (Spring, ˚C) | High | High |
| Mean Temperature (Summer, ˚C) | Low | Moderate |
| Mean Temperature (Fall, ˚C) | High | High |
| Mean Temperature (Winter, ˚C) | Moderate | Moderate |
| Mean Max Temperature (˚C) | Moderate | High |
| Mean Min Temperature (˚C) | High | High |
| Hottest Day (Annual, ˚C) | Low | Low |
| Coldest Day (Annual, ˚C) | Low | Moderate |
| Summer Days (>25 ˚C, Annual) | High | High |
| Winter Days (<-5˚C, Annual) | Moderate | Moderate |
| Very Hot Days (≥ 30 ˚C, Annual) | High | High |
| Very Cold Days (≤ -30 ˚C, Annual) | High | High |
| Date of Last Spring Frost (Annual) | Low | Low |
| Date of First Fall Frost (Annual) | Negligible | Low |
| Frost-Free Season (Days, Annual) | Moderate | Moderate |
| Growing Degree Days (15 ˚C) (Annual) | High | High |
| Freeze-Thaw Cycles (Annual) | Low | Low |
| Freeze-Thaw Cycles (Spring) | Moderate | High |
| Freeze-Thaw Cycles (Summer) | Negligible | Negligible |
| Freeze-Thaw Cycles (Fall) | Moderate | High |
| Freeze-Thaw Cycles (Winter) | High | High |



| Climate Hazards | 2050 | 2080 |
|---|---|---|
| Air Heatwave Days (Annual) | High | High |
| Heatwave Total Duration (Days) | High* | High* |
| Tropical Nights (>20˚C) | High* | High* |
| HDD | Low | Moderate |
| CDD | High | High |
| Building Zone | Moderate* | Moderate* |
| Notes:<br>* Deviation from Middle Baseline<br>[1] CMIP5/RCP Data used | | |



### 3.3.2 Precipitation

Average annual precipitation is projected to increase in the future, with increases seen in all seasons except for summer. Extreme precipitation events are expected to increase. Trends, data projections, and likelihood and magnitude scoring can be seen below in **Tables 3-12 to 3-18**.

**Table 3-11: Climate Hazards, Future Trends, and Sources – Precipitation**

| Climate Hazard | Future Trend | Source | Notes |
|---|---|---|---|
| **Precipitation** | | | |
| Mean Precipitation (Annual, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Precipitation (Spring, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Precipitation (Summer, mm) | Decreasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Precipitation (Fall, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Precipitation (Winter, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Rain (Annual, mm) | Decreasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Mean Snow (Annual, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Heavy Precipitation Days (>10mm, Annual) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Heavy Precipitation Days (>20mm, Annual) | Increasing | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |
| Extreme Precipitation (24hrs, 100YR, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Extreme Precipitation (72hrs, 100YR, mm) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | Stable | PCIC | CMIP5, Baseline: 1986-2016, 50 |
| Maximum Number of Consecutive Dry Days | Stable | ClimateData.ca | CMIP6, Baseline: 1981-2010, 10,50,90 |



**Table 3-12: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under High Emission Scenario (SSP5-8.5) – Precipitation**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Precipitation** | | | | | | | |
| Mean Precipitation (Annual, mm) | 351.7 | 259.7 | 357.5 | 467.3 | 179.5 | 362.7 | 568.2 |
| Mean Precipitation (Spring, mm) | 77.5 | 66.0 | 86.6 | 107.1 | 55.5 | 94.8 | 133.6 |
| Mean Precipitation (Summer, mm) | 168.7 | 108.6 | 159.4 | 214.7 | 56.5 | 151.3 | 254.4 |
| Mean Precipitation (Fall, mm) | 68.2 | 51.3 | 70.7 | 95.8 | 36.5 | 72.9 | 119.8 |
| Mean Precipitation (Winter, mm) | 37.3 | 33.9 | 40.8 | 49.8 | 31.0 | 43.7 | 60.5 |
| Mean Rain (Annual, mm) | 274.1 | 192.8 | 273.3 | 357.5 | 120.7 | 272.6 | 431.4 |
| Mean Snow (Annual, mm) | 90.9 | 81.7 | 99.3 | 125.4 | 73.3 | 106.7 | 156.4 |
| Heavy Precipitation Days (>10mm, Annual) | 7 | 7 | 7 | 9 | 6 | 8 | 11 |
| Heavy Precipitation Days (>20mm, Annual) | 2 | 2 | 2 | 3 | 2 | 2 | 3 |
| Extreme Precipitation (24hrs, 100YR, mm) | 84.5 | 71.7 | 97.4 | 122.7 | 59.0 | 110.2 | 160.5 |
| Extreme Precipitation (72hrs, 100YR, mm) | 138.2 | 127.4 | 159.9 | 196.0 | 116.7 | 181.4 | 253.2 |
| RL50 Annual Max Rain on Snow, 1/50 (kPa)* | 0.1 | - | 0.1 | - | - | 0.1 | - |
| Maximum Number of Consecutive Dry Days | 31 | 27 | 31 | 34 | 27 | 30 | 34 |

Notes:
"-" not determined
*CMIP5/RCP data used

**Table 3-13: Likelihood Ratings for Climate Hazards (SSP5-8.5) – Precipitation**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| **Precipitation** | | | |
| Mean Precipitation (Annual, mm) | 3 | 3 | 3 |
| Mean Precipitation (Spring, mm) | 3 | 4 | 4 |
| Mean Precipitation (Summer, mm) | 3 | 3 | 3 |
| Mean Precipitation (Fall, mm) | 3 | 3 | 3 |
| Mean Precipitation (Winter, mm) | 3 | 3 | 4 |
| Mean Rain (Annual, mm) | 3 | 3 | 3 |
| Mean Snow (Annual, mm) | 3 | 3 | 4 |
| Heavy Precipitation Days (>10mm, Annual) | 3 | 3 | 4 |
| Heavy Precipitation Days (>20mm, Annual) | 3 | 3 | 3 |
| Extreme Precipitation (24hrs, 100YR, mm) | 3 | 4 | 4 |
| Extreme Precipitation (72hrs, 100YR, mm) | 3 | 4 | 4 |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | 3 | 3 | 3 |
| Maximum Number of Consecutive Dry Days | 3 | 3 | 3 |

Notes:
* Deviation from the Middle Baseline
[1] CMIP5/RCP Data used

**Table 3-14: Magnitude Ratings for Climate Hazards (SSP5-8.5) – Precipitation**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Precipitation** | | |
| Mean Precipitation (Annual, mm) | Negligible | Negligible |
| Mean Precipitation (Spring, mm) | Low | Moderate |
| Mean Precipitation (Summer, mm) | Low | Low |
| Mean Precipitation (Fall, mm) | Negligible | Low |
| Mean Precipitation (Winter, mm) | Low | Moderate |
| Mean Rain (Annual, mm) | Negligible | Negligible |
| Mean Snow (Annual, mm) | Low | Moderate |
| Heavy Precipitation Days (>10mm, Annual) | Negligible | Low |
| Heavy Precipitation Days (>20mm, Annual) | Negligible | Negligible |
| Extreme Precipitation (24hrs, 100YR, mm) | Moderate | High |
| Extreme Precipitation (72hrs, 100YR, mm) | Moderate | High |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | Low | Low |
| Maximum Number of Consecutive Dry Days | Negligible | Negligible |

Notes:
* Deviation from the Middle Baseline
[1] CMIP5/RCP Data used

**Table 3-15: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under Moderate Emission Scenario (SSP2-4.5) – Precipitation**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Precipitation** | | | | | | | |
| Mean Precipitation (Annual, mm) | 351.7 | 285.3 | 355.9 | 435.2 | 260.9 | 357.6 | 466.0 |
| Mean Precipitation (Spring, mm) | 77.5 | 69.0 | 84.1 | 99.1 | 65.6 | 86.8 | 107.6 |
| Mean Precipitation (Summer, mm) | 168.7 | 125.4 | 162.0 | 201.8 | 109.8 | 159.5 | 213.6 |
| Mean Precipitation (Fall, mm) | 68.2 | 56.0 | 70.0 | 88.1 | 51.5 | 70.7 | 95.4 |
| Mean Precipitation (Winter, mm) | 37.3 | 34.8 | 39.8 | 46.2 | 34.0 | 40.6 | 49.4 |
| Mean Rain (Annual, mm) | 274.1 | 214.9 | 273.5 | 334.8 | 192.2 | 273.2 | 357.9 |
| Mean Snow (Annual, mm) | 90.9 | 84.2 | 97.0 | 116.2 | 81.4 | 99.4 | 126.3 |
| Heavy Precipitation Days (>10mm, Annual) | 7 | 7 | 8 | 10 | 7 | 8 | 10 |
| Heavy Precipitation Days (>20mm, Annual) | 2 | 2 | 2 | 3 | 2 | 2 | 3 |
| Extreme Precipitation (24hrs, 100YR, mm) | 84.5 | 74.7 | 94.4 | 113.7 | 69.9 | 99.2 | 127.9 |
| Extreme Precipitation (72hrs, 100YR, mm) | 138.2 | 129.9 | 154.8 | 182.4 | 125.9 | 162.8 | 203.9 |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | 0.1 | - | 0.12 | - | - | 0.12 | - |
| Maximum Number of Consecutive Dry Days | 31 | 27 | 30 | 34 | 27 | 31 | 33 |

Notes:
"-" not determined
*CMIP5/RCP data used
Non-leap year dates used

**Table 3-16: Likelihood Ratings for Climate Hazards (SSP2-4.5) – Precipitation**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| **Precipitation** | | | |
| Mean Precipitation (Annual, mm) | 3 | 3 | 3 |
| Mean Precipitation (Spring, mm) | 3 | 3 | 4 |
| Mean Precipitation (Summer, mm) | 3 | 3 | 3 |
| Mean Precipitation (Fall, mm) | 3 | 3 | 3 |
| Mean Precipitation (Winter, mm) | 3 | 3 | 3 |
| Mean Rain (Annual, mm) | 3 | 3 | 3 |
| Mean Snow (Annual, mm) | 3 | 3 | 3 |
| Heavy Precipitation Days (>10mm, Annual) | 3 | 4 | 4 |
| Heavy Precipitation Days (>20mm, Annual) | 3 | 3 | 3 |
| Extreme Precipitation (24hrs, 100YR, mm) | 3 | 4 | 4 |
| Extreme Precipitation (72hrs, 100YR, mm) | 3 | 4 | 4 |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | 3 | 3* | 3* |
| Maximum Number of Consecutive Dry Days | 3 | 3 | 3 |

Notes:
* Deviation from the Middle Baseline
[1] CMIP5/RCP Data used



**Table 3-17: Magnitude Ratings for Climate Hazards (SSP2-4.5) – Precipitation**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Precipitation** | | |
| Mean Precipitation (Annual, mm) | Negligible | Negligible |
| Mean Precipitation (Spring, mm) | Low | Low |
| Mean Precipitation (Summer, mm) | Negligible | Negligible |
| Mean Precipitation (Fall, mm) | Negligible | Negligible |
| Mean Precipitation (Winter, mm) | Low | Low |
| Mean Rain (Annual, mm) | Negligible | Negligible |
| Mean Snow (Annual, mm) | Low | Low |
| Heavy Precipitation Days (>10mm, Annual) | Low | Low |
| Heavy Precipitation Days (>20mm, Annual) | Negligible | Negligible |
| Extreme Precipitation (24hrs, 100YR, mm) | Low | Moderate |
| Extreme Precipitation (72hrs, 100YR, mm) | Low | Moderate |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | Moderate* | Moderate* |
| Maximum Number of Consecutive Dry Days | Negligible | Negligible |

Notes:
* Deviation from the Middle Baseline
[1] CMIP5/RCP Data used

### 3.3.3 Other Climate Hazards

Other Climate Hazards such as wildfire events are expected to increase in the future. Extreme wind events are expected to decrease. Trends, data projections, and likelihood and magnitude scoring can be seen below in **Tables 3-19 to 3-25**.

**Table 3-18: Climate Hazards, Future Trends, and Sources – Other Hazards**

| Climate Hazard | Future Trend | Source | Notes |
|---|---|---|---|
| **Other** | | | |
| Extreme Land Wind Speed (100yr, km/h) | Decreasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Relative Humidity (Annual, %) | Stable | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Relative Humidity (Spring, %) | Stable | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Relative Humidity (Summer, %) | Stable | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Relative Humidity (Fall, %) | Stable | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Relative Humidity (Winter, %) | Stable | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Forest Fire Danger Index (Very High, %) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |
| Forest Fire Danger Index (Severe, %) | Increasing | ClimSystems - Climate Insights | CMIP6, Baseline: 2005, 5,50,95 |

**Table 3-19: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under Moderate Emission Scenario (SSP2-4.5) – Other Hazards**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Other** | | | | | | | |
| Extreme Land Wind Speed (100yr, km/h) | 102.5 | 91.5 | 99.9 | 109 | 91.8 | 101 | 107.7 |
| Relative Humidity (Annual, %) | 77 | 72.9 | 75.7 | 78.5 | 70.1 | 75 | 79.3 |
| Relative Humidity (Spring, %) | 70.7 | 65.8 | 69.7 | 72.4 | 63.4 | 69.2 | 73.2 |
| Relative Humidity (Summer, %) | 63.9 | 57.6 | 61.0 | 66.3 | 54.5 | 59.6 | 67.4 |
| Relative Humidity (Fall, %) | 78.2 | 74.9 | 77.5 | 79.3 | 73.3 | 77.1 | 79.9 |
| Relative Humidity (Winter, %) | 95.0 | 93.3 | 94.5 | 96.2 | 92.5 | 94.3 | 96.7 |
| Forest Fire Danger Index (Very High, %) | 0.2 | 0.3 | 0.5 | 1.3 | 0.3 | 0.8 | 2.9 |
| Forest Fire Danger Index (Severe, %) | 0 | 0 | 0 | 0.02 | 0 | 0 | 0.05 |

Notes:
"-" not determined
*CMIP5/RCP data used

**Table 3-20: Climate Hazard Data for Baseline Period and Projected Climate Parameters Under High Emission Scenario (SSP5-8.5) – Other Hazards**

| Climate Hazards | Baseline | 2050 | | | 2080 | | |
|---|---|---|---|---|---|---|---|
| | | Low | Mean | High | Low | Mean | High |
| **Other** | | | | | | | |
| Extreme Land Wind Speed (100yr, km/h) | 102.5 | 88 | 100.1 | 106.9 | 90 | 98.2 | 108 |
| Relative Humidity (Annual, %) | 77 | 71.7 | 75.3 | 79 | 66.4 | 73.6 | 81.1 |
| Relative Humidity (Spring, %) | 70.7 | 64.3 | 69.4 | 72.9 | 57.9 | 68.0 | 75.1 |
| Relative Humidity (Summer, %) | 63.9 | 55.7 | 60.1 | 67.0 | 47.5 | 56.3 | 70.0 |
| Relative Humidity (Fall, %) | 78.2 | 73.9 | 77.3 | 79.7 | 69.6 | 76.3 | 81.1 |
| Relative Humidity (Winter, %) | 95.0 | 92.8 | 94.4 | 96.5 | 90.6 | 93.8 | 98.1 |
| Forest Fire Danger Index (Very High, %) | 0.2 | 0.3 | 0.7 | 2.1 | 0.4 | 1.8 | 12.9 |
| Forest Fire Danger Index (Severe, %) | 0 | 0 | 0 | 0.03 | 0 | 0.02 | 0.6 |

Notes:
"-" not determined
*CMIP5/RCP data used

**Table 3-21: Likelihood Ratings for Climate Hazards (SSP2-4.5) – Other Hazards**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| **Other** | | | |
| Extreme Land Wind Speed (100yr, km/h) | 3 | 3 | 3 |
| Relative Humidity (Annual, %) | 3 | 3 | 3 |
| Relative Humidity (Spring, %) | 3 | 3 | 3 |
| Relative Humidity (Summer, %) | 3 | 3 | 3 |
| Relative Humidity (Fall, %) | 3 | 3 | 3 |
| Relative Humidity (Winter, %) | 3 | 3 | 3 |
| Forest Fire Danger Index (Very High, %) | 3 | 3* | 3* |
| Forest Fire Danger Index (Severe, %) | 3 | 3* | 3* |

Notes:
* Deviation from the Middle Baseline
[1] CMIP5/RCP Data used

**Table 3-22: Likelihood Ratings for Climate Hazards (SSP5-8.5) – Other Hazards**

| Climate Hazards | Baseline | 2050 | 2080 |
|---|---|---|---|
| Other | | | |
| Extreme Land Wind Speed (100yr, km/h) | 3 | 3 | 3 |
| Relative Humidity (Annual, %) | 3 | 3 | 3 |
| Relative Humidity (Spring, %) | 3 | 3 | 3 |
| Relative Humidity (Summer, %) | 3 | 3 | 3 |
| Relative Humidity (Fall, %) | 3 | 3 | 3 |
| Relative Humidity (Winter, %) | 3 | 3 | 3 |
| Forest Fire Danger Index (Very High, %) | 3 | 3* | 3* |
| Forest Fire Danger Index (Severe, %) | 3 | 3* | 4* |
| Notes:<br>* Deviation from the Middle Baseline<br>[1] CMIP5/RCP Data used | | | |

**Table 3-23: Magnitude Ratings for Climate Hazards (SSP2-4.5) – Other Hazards**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Other** | | |
| Extreme Land Wind Speed (100yr, km/h) | Negligible | Negligible |
| Relative Humidity (Annual, %) | Negligible | Negligible |
| Relative Humidity (Spring, %) | Negligible | Negligible |
| Relative Humidity (Summer, %) | Negligible | Low |
| Relative Humidity (Fall, %) | Negligible | Negligible |
| Relative Humidity (Winter, %) | Negligible | Negligible |
| Forest Fire Danger Index (Very High, %) | High* | High* |
| Forest Fire Danger Index (Severe, %) | Negligible* | Negligible* |
| Notes:<br>* Deviation from the Middle Baseline<br>[1] CMIP5/RCP Data used | | |

**Table 3-24: Magnitude Ratings for Climate Hazards (SSP5-8.5) – Other Hazards**

| Climate Hazards | 2050 | 2080 |
|---|---|---|
| **Other** | | |
| Extreme Land Wind Speed (100yr, km/h) | Negligible | Negligible |
| Relative Humidity (Annual, %) | Negligible | Negligible |
| Relative Humidity (Spring, %) | Negligible | Negligible |
| Relative Humidity (Summer, %) | Low | Low |
| Relative Humidity (Fall, %) | Negligible | Negligible |
| Relative Humidity (Winter, %) | Negligible | Negligible |
| Forest Fire Danger Index (Very High, %) | High* | High* |
| Forest Fire Danger Index (Severe, %) | Negligible* | Low* |
| Notes:<br>* Deviation from the Middle Baseline<br>[1] CMIP5/RCP Data used | | |

# 4.0 Other Identified Climate Hazards

Where possible, a relative likelihood rating and a determination of magnitude for climate hazards not defined in Table 3-1. These climate events were assigned a numerical value for their projected intensity, frequency, or duration due to their complex nature and the reasonable limits of available and reliable modeled data. The determination of likelihood and magnitude for hazards identified in Section 5.0 are based on the review of available data, including publications and reports, and expert judgment.

## 4.1 Flooding: Fluvial & Pluvial:

Flooding from fluvial (i.e., riverine) and pluvial (i.e., precipitation) is considered to be a climate hazard with the potential to be experienced by the city in the future. Increases in precipitation events have the potential to lead to washouts as well as Pluvial and Fluvial flooding events.

Western University's Flood Map Viewer Tool (Simonovic 2023) shows heightened flood risk for areas directly adjacent to the South Saskatchewan River for both baseline and future conditions. This area of risk increases under future climate conditions (Simonovic 2023). However, these areas are constrained to the current floodplain of the South Saskatchewan River.

While the overall amount of summer rainfall is projected to decrease, the frequency and intensity of individual rainfall events are likely to increase with climate change (ClimateWest 2022). These events often cause flash flooding with potentially severe impacts on natural and built infrastructure (ClimateWest 2022). Stormwater infrastructure may not be designed to handle the increased volume of water and may lead to flooding and washout events (ClimateWest 2022). More precipitation during winter and spring also increases the risk of flooding from snow melt (ClimateWest 2022). Key factors contributing to flooding and washout events include:

**Increased Annual Precipitation:** Increases in Precipitation can overload storm management systems that lack additional capacity.

**Increased intensity, duration, and frequency of precipitation events:** Precipitation events are predicted to increase in intensity, duration, and frequency, which may lead to flash flooding and wash out events.

**Increased Snow Melt:** Rising temperatures and earlier time in the year have the potential to lead to flooding and washout events.

**Pluvial Flooding:** Increased Precipitation and snowmelt may increase the flow and water level of neighbouring rivers and water systems causing flooding in the surrounding areas.

### 4.1.1 Fluvial Flooding

**Likelihood: Low***

**Magnitude: Low***

Overall, the City is considered to have a low likelihood of flooding from fluvial events based on the review of historical and future projected data. Although, increases in precipitation are projected for Saskatoon and Saskatchewan, the flow of the South Saskatchewan is managed by the Saskatchewan Water Security Agency through Lake Diefenbaker and the Gardiner Dam. As a result, future flows of the South Saskatchewan River through Saskatoon are expected to be managed to limit the potential risk of flooding in the City.

### 4.1.2 Pluvial Flooding

**Likelihood: High***

**Magnitude: Moderate***

On August 24, 2024, the City experienced pluvial flooding resulting in the closure of Idylwyld Drive and Circle Drive due to 24.2 mm of rain falling through the night (CTV News 2024). Similar events have also occurred in the recent past such as in June, 2022 when heavy rainfall events caused road closures and flooded resident's homes (CBC 2022). While mean annual and seasonal precipitation is expected to vary in the future, with wetter springs and earlier snow melt runoff have the potential to exceed the capacity of stormwater systems and lead to flooding and washout events.

## 4.2 Wildfire & Air Quality Hazards

**Likelihood: High***

**Magnitude: Moderate***

Wildfires are one of the main disturbances affecting Canadians (Climate West 2022). Wildfires are natural events that help maintain the long-term health of a forest ecosystem through factors such as: initiating regeneration, limiting invasive species, and revitalizing soils and vegetation (Climate West 2022). Forest fires also have the potential to be extremely dangerous. Fires have the ability to threaten human health, livelihood, and infrastructure. The impacts of climate change are predicted to increase forest fire frequency, intensity, and duration in the province (Climate West 2022).

Saskatchewan has a history of wildfire events including the wildfires of 2015 which destroyed over 1.7 million acres, caused over 10,000 people to evacuate, and cost over $100 million (City of Saskatoon 2019).



Broadly, the effects of climate change through increasing annual regional temperatures and the duration and seasonality of precipitation as rainfall instead of snowfall increases risks of wildfire, as well as changes to ground-level ozone, particulate matter from wildfires and droughts, and extend pollen season. Wildfires degrade air quality through harmful fire plumes. Key factors contributing to wildfire and reduced air quality include:

- **Hot dry weather:** The return of hot, dry conditions increases wildfire risk. Saskatchewan is currently experiencing minimal rainfall, drying out vegetation and making it more prone to ignition.
- **Extended fire season:** Warmer temperatures and changing precipitation patterns are lengthening the fire season, allowing wildfires to start earlier and continue later into the fall.
- **Increased lightning strikes:** Evidence suggests climate change may lead to more frequent lightning strikes, igniting wildfires in remote northern areas.
- **Prolonged droughts:** More common due to climate change, droughts dry out forests and grasslands, providing ample fuel for wildfires.

For ground-level ozone, rising temperatures can lead to higher levels of ground-level ozone, a harmful air pollutant. Hot, sunny days accelerate the chemical reactions that produce ozone, worsening air quality.

Wildfires and droughts can release large amounts of particulate matter into the air. Droughts, another consequence of climate change, can also increase dust and particulate matter.

Higher temperatures and increased carbon dioxide levels can extend the pollen season and increase pollen production, leading to more allergens in the air.

Overall, the effects of climate change have a demonstrably negative impact on air quality. Trends in regional and global climate change may be a contributing factor to the current state and trend of air quality in the City, and the region.

Live regional air quality for Saskatoon can be viewed using United States (US) National Oceanic and Atmospheric Administration (NOAA), Hazard Mapping System Fire and Smoke Product: Current Analysis (NOAA 2024).

## 4.3 Freeze-Thaw

**Likelihood: High***

**Magnitude: Moderate***

Freeze-thaw cycles have the potential to increase maintenance costs to city infrastructure (e.g., Roads, sidewalks, roofing) through increased temperature-induced expansion and contraction. Freeze-thaw cycles also have the potential to increase slip and fall risks to residents and workers.

Annual freeze-thaw cycles in the city are projected to decrease in the future. This decrease will be seen across all seasons with the exception of winter. Winter freeze-thaw cycles are expected to increase in future time periods. This has the potential to reduce overall risk from freeze-thaw cycles annually but will also see a potential increase in freeze-thaw cycles during winter months.



# 5.0 Saskatoon Climate Hazard Profile

This section summarizes the results of the climate change projections and provides a high-level interpretation of the relative corporate and community level hazards the City has potential to face in the future.

Based on the review of the available data projected climate change parameters for Saskatoon include:

- Average annual temperatures are expected to increase in the future.
- The number of very hot days (>30°C) is expected to increase in the future.
- The number of very cold days (<-30°C) is expected to decrease in the future.
- Total annual precipitation is expected to increase in the future.
- Extreme precipitation events (24hr and 72hr) are expected to increase in the future.
- Frost-free season length is expected to increase in the future.
- Provincial wildfire events are predicted to increase in the future.
- Pluvial flooding and washout events are predicted to increase in the future.

## 5.1 Corporate Level Climate Hazards and Impacts

The City has developed eight major asset categories as part of its Corporate Asset Management Plan (City of Saskatoon 2024a). The City's Corporate Asset Management Plan is a long-term plan developed to manage infrastructure and ensure that the City's assets are capable of meeting the levels of service required to support the City of Saskatoon's goals (City of Saskatoon 2024a). The asset categories developed by the City include:

- **Resilient Buildings and Infrastructure**
  - Homes
  - City buildings & facilities
  - City utilities (treatment plants, water & power distribution networks, storm and wastewater)
  - Transportation infrastructure: roads & sidewalks, bridges & overpasses
- **Health and Wellbeing**
  - Public health impacts (direct – heat, air quality, storms/flood)
  - Public health (indirectly) - disease
  - Affordability
  - Quality of life
- **Green Infrastructure**
  - Tree canopy
  - Parks, greenspaces
  - Wetlands & river



- **The Economy, Businesses, and Workers**
  - Damage to businesses: private buildings and other assets
  - Disruptions and lost productivity
  - Worker safety

The climate hazards identified here in the Report will have varying degrees of affect on each asset category and respective subcategories based on an individual asset's relative vulnerability. Vulnerability considers the exposure, sensitivity, and adaptive capacity of individual assets. Table 5.1 provides a summary of some of the anticipated impacts of climate change under scenarios SSP5-8.5 and SSP2-4.5

### 5.1.1 Saskatoon as Shelter City

While the City is unlikely to experience many of direct effects of forest fires or bushfires (i.e., excluding impacts to air quality) given its surrounding environment, the City faces indirect impacts as a shelter city for northern Saskatchewan communities. With potential increases in climate hazard events such as wildfire and flooding, these shelters can provide refuge to individuals experiencing homelessness from these types of climate related events..

**Table 5-1: Impacts and Climate-Related Hazards - Corporate**

| Climate Hazard Category | Resiliency Categories | | | |
|---|---|---|---|---|
| | **Resilient Buildings and Infrastructure** | **Health and Wellbeing** | **Green Infrastructure** | **The Economy, Businesses, and Workers** |
| Warmer Annual Temperatures  | Increased water demand<br>Increased electricity demand for cooling<br>Rapid spring melt and drainage<br>Longer road construction and maintenance season<br>Increased need for indoor recreation activities | Increase in ozone-related health effects for workers<br>Increase in demand for cooling services | Increased demand for outdoor green spaces<br>Longer growing season<br>Greater maintenance for natural assets<br>Potential increase in invasive species and pests (e.g., plants and animals) | Increased costs from increasing water demand<br>Increased costs from increasing electricity demand for cooling<br>Increased costs from longer construction and maintenance season<br>Seasonal program turnover and deployment challenges in shoulder seasons.<br>Increased costs Increase in demand of emergency services |
| Extreme Heat Events  | Increased water demand<br>Increased electricity demand for cooling | Increase in heat-related health risks to outdoor workers/residents and vulnerable populations (e.g., heat stroke, heat exhaustion)<br>Increase in demand for emergency services | Greater maintenance of natural assets (e.g., watering and replanting) | Increased costs from increasing water demand<br>Increased costs from increasing electricity demand for cooling<br>Increased costs from increase in demand of emergency services<br>Increased costs from need for indoor recreation activities<br>Increased costs from lower worker productivity and absenteeism (e.g., sick days) |
| Increased Annual Precipitation  | Increased demand on storm water systems<br>Increased loading on roofs from rain-on-snow events | Increased flood risk for residents/workers | Greater maintenance of natural assets (e.g., replanting, erosion control) | Increased costs from increase in storm water system demand |
| Extreme Precipitation Events (Pluvial Flooding)  | Increased flood risk for public Infrastructure<br>Increased frequency of roof maintenance | Increased flood risk for residents/workers<br>Increase in demand for emergency services (e.g., flooded roadways) | Greater maintenance of natural assets (e.g., replanting, erosion control) | Increased costs Increase in demand of emergency services<br>Increased costs for municipal services (e.g., stormwater and sewer clearing) |
| Other (e.g., Wildfire/Grassfire, Snowstorm)  | Increased risk of fire damage to infrastructure<br>Increased risk of roof damage from snowstorm and high wind events | Increase risk of fire damage to residents/workers<br>Increased risks of trips, slips, and falls for residents/workers with freeze-thaw cycles | Increased risk of fire damage to natural assets<br>Increased risk of tree death from snow and ice loading | Increased costs from increased fire risk<br>Increased maintenance costs from snow/ice and freeze-thaw events<br>Increased capital expenditures for infrastructure replacement |

## 5.2 Community Level Climate Hazards and Impacts

Climate hazards have the potential to impact not just corporate infrastructure but the community of Saskatoon as well. Individuals and organizations will have varying degrees of relative vulnerability based on their individual levels of exposure, adaptive capacity, and proximity. Anticipated community level climate hazards may include:

- Population Shifts (Human/Animal/Plant)
  - Temporary or permanent displacement of residents from northern Saskatchewan communities
  - Increases in Invasive species (Animal and Plant)
  - Increases in Pests (Animal and Plant)
  - Increases in the spread of disease through water, vector, and airborne
- Large Scale Events
  - Increases in wildfire events (including impacts on air quality)
  - Increases in storm events (e.g., tornadoes, freezing rain)
  - Increases in flood events
  - Increases in heatwave events
  - Compound events (i.e. heatwave and wildfire, storm, and flood events)

### 5.2.1 Equity-Deserving Communities & Vulnerable Populations

The effects of climate change are expected to impact natural and built infrastructure as well as organizations and individuals. However, the impacts of climate change will not be felt equally; certain vulnerable, and equity-deserving groups and individuals will be more impacted than others. For example, climate hazards such as extreme temperature events, flooding, and impacts on air quality may negatively impact unhoused individuals in greater numbers than individuals with access to shelter (UBC 2023).However, as seen in British Columbia in 2021 during the summer heat-dome event, premature deaths from heat related affects can also occur in-doors to vulnerable populations (BC Coroners Service 2022).

When discussing solutions to climate change impacts and the transition to a green, low-carbon community, it is important to consider equity-deserving groups and whether these actions will impact them differently than other groups and individuals. Improper planning around climate action has the potential to increase inequality and negatively impact vulnerable populations (UBC 2023). Properly planned climate action should positively impact all groups and share the benefits and opportunities amongst all communities or at the very least not negatively impact already vulnerable populations.

### 5.2.2 Community Level Impacts

While the results of this Report focus on the climate change projections and hazards anticipated for Saskatoon, it is valuable to consider the recorded events that have occurred across Saskatchewan (see Public Safety Canada 2024). Since 1900, Saskatchewan has experienced several natural disasters that impact the lives of its residents. Based on the anticipated effects of climate change identified in this Report, the City can work with local organizations, stakeholders and rightsholders to support overall community resilience. Table 5.2 provides a summary of some of the anticipated impacts of climate change under scenarios SSP5-8.5 and SSP2-4.5.

**Table 5-2: Impacts and Climate-Related Hazards – Community**

| Climate Hazard Category | Resiliency Categories | | | |
|---|---|---|---|---|
| | Resilient Buildings and Infrastructure | Health and Wellbeing | Green Infrastructure | The Economy, Businesses, and Workers |
| Warmer Annual Temperatures  | Increased water demand<br>Increased electricity demand for cooling<br>Rapid spring melt and drainage (e.g., basement flooding)<br>Increased home maintenance (e.g., roof maintenance) | Increase in ozone-related health effects for residents<br>Increase in demand for cooling services/cooling centres | Longer growing season<br>Greater maintenance for private green infrastructure<br>Potential increase in invasive species and pests (e.g., plants and animals) | Increased costs from increasing water demand<br>Increased costs from increasing electricity demand for cooling. |
| Extreme Heat Events  | Increased water demand<br>Increased electricity demand for cooling<br>Increased home maintenance (e.g., roof maintenance) | Increase in heat-related health risks to residents including vulnerable populations (e.g., heat stroke, heat exhaustion)<br>Increase in demand for emergency services | Greater maintenance of natural assets (e.g., watering and replanting) | Increased costs from increasing water demand<br>Increased costs from increasing electricity demand for cooling<br>Decreased income from absenteeism (e.g., sick days) |
| Increased Annual Precipitation  | Increased loading on roofs from rain-on-snow events | Increased flood risk for residents | Greater maintenance of natural assets (e.g., replanting, erosion control) | Increased costs from flood damage and insurance |
| Extreme Precipitation Events (Pluvial Flooding)  | Increased flood risk for private Infrastructure (e.g., basement flooding)<br>Increased frequency of roof maintenance | Increased flood risk for residents | Greater maintenance of natural assets (e.g., replanting, erosion control) | Increased costs from flood damage and insurance<br>Decreased income from property damage and property loss |
| Other (e.g., Wildfire/Grassfire, Snowstorm)  | Increased risk of fire damage to homes and structures<br>Increased risk of roof damage from snowstorm and high wind events | Decreased air quality from wildfire/grassfire<br>Increased risks of trips, slips, and falls for residents with freeze-thaw cycles | Increased risk of fire damage to natural assets<br>Increased risk of tree death from snow and ice loading | Increased costs for insurance<br>Increased maintenance costs from snow/ice and freeze-thaw events<br>Increased expenditures for property replacement |

# 6.0 Conclusions

The results of the Report are meant to inform future consideration of the effects of climate change on the City. Climate change data were collected from defensible and reliable sources of information, using the latest climate models from CMIP6, where possible. The consideration of multiple climate scenarios (i.e., SSP2-4.5 and SSP5-8.5) allow the City to prepare for potential worst case and moderate climate change scenarios. Climate change hazards, likelihood, and magnitude are summarized in **Appendix A1** and **Appendix A2**.

Likelihood values were assigned for individual climate hazards to communicate their potential occurrence in the future relative to the historical baseline. The PIEVC middle baseline approach was used to assign likelihood values. Determinations of the magnitude of change were also provided for individual climate hazards. Magnitude is meant to communicate the relative scale of noticeable change that can affect human or natural systems.

Future climate change risk or vulnerability assessments can use this Report to support determinations of risk or vulnerability using the likelihood values presented here for individual climate events.



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# Appendix A1 Climate Change Hazards Likelihood and Magnitude SSP2-4.5

## Climate Change Projections, Hazards, and Impact Report

City of Saskatoon

**City of Saskatoon**

SLR Project No.: 201.089318.00001

January 29, 2025

SLR

**Appendix A Climate Change Hazards, likelihood and Magnitude SSP2-4.5**

| Climate Hazards | Baseline | 2050 | | | 2080 | | | Source | Notes (Model, Baseline, Percentiles) | % Change 2050 | % Change 2080 | Likelihood | | | Magnitude | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High | Low | Med | High | | | Med | Med | Baseline | 2050 | 2080 | 2050 | 2080 |
| **Temperature** | | | | | | | | | | | | | | | | |
| Mean Temperature (Annual) (˚C) | 2.5 | 3.7 | 4.6 | 5.7 | 4.1 | 5.4 | 6.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 84% | 116% | 3 | 5 | 5 | High | High |
| Mean Temperature (Spring) (˚C) | 3.4 | 4.4 | 5.3 | 6.3 | 4.7 | 5.9 | 7.3 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 56% | 74% | 3 | 5 | 5 | High | High |
| Mean Temperature (Summer) (˚C) | 17.2 | 18.4 | 19.4 | 20.6 | 18.9 | 20.2 | 21.8 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 13% | 17% | 3 | 4 | 4 | Low | Moderate |
| Mean Temperature (Fall) (˚C) | 3.3 | 4.7 | 5.4 | 6.3 | 5.1 | 6.2 | 7.4 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 64% | 88% | 3 | 5 | 5 | High | High |
| Mean Temperature (Winter) (˚C) | -14.0 | -12.7 | -11.7 | -10.2 | -12.3 | -10.8 | -8.8 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 16% | 23% | 3 | 4 | 4 | Moderate | Moderate |
| Mean Max Temperature (˚C) | 8.6 | 9.7 | 10.6 | 12.2 | 10.1 | 11.4 | 13.5 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 23% | 33% | 3 | 4 | 4 | Moderate | High |
| Mean Min Temperature (˚C) | -3.6 | -4.5 | -1.4 | -0.3 | -2.0 | -0.6 | 0.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 61% | 83% | 3 | 5 | 5 | High | High |
| Summer Days (>25 ˚C) (Annual) (˚C) | 38.2 | 51.2 | 62.1 | 74.0 | 58.4 | 73.8 | 88.6 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 63% | 93% | 3 | 5 | 5 | High | High |
| Very Hot Days (≥ 30 ˚C) (Annual) (˚C) | 7.4 | 12.2 | 16.4 | 23.8 | 15.2 | 23.4 | 37.9 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 122% | 216% | 3 | 5 | 5 | High | High |
| Very Cold Days (≤ -30 ˚C) (Annual) (˚C) | 12.5 | 0.1 | 4.3 | 12.4 | 0.0 | 3.2 | 11.4 | Climate Atlas | CMIP5, Baseline:1981-2010, 10,50,90 | -66% | -74% | 3 | 1 | 1 | High | High |
| Date of Last Spring Frost (Annual) | 133.0 | 118.0 | 123.0 | 128.0 | 112.0 | 122.0 | 125.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -8% | -8% | 3 | 3 | 3 | Low | Low |
| Date of First Fall Frost (Annual) | 265.0 | 271.0 | 279.0 | 285.0 | 275.0 | 280.0 | 291.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 5% | 6% | 3 | 3 | 3 | Negligible | Low |
| Frost-Free Season (Days) (Annual) | 130.0 | 143.0 | 156.0 | 164.0 | 151.0 | 157.0 | 178.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 20% | 21% | 3 | 4 | 4 | Moderate | Moderate |
| Growing Degree Days (15 ˚C) (Annual) | 363.0 | 397.0 | 598.0 | 819.0 | 443.0 | 678.0 | 925.0 | Climate Atlas | CMIP5, Baseline:1981-2010, 10,50,90 | 65% | 87% | 3 | 5 | 5 | High | High |
| Freeze Thaw Cycles (Annual) | 72.0 | 58.0 | 64.0 | 72.0 | 53.0 | 63.0 | 72.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -11% | -13% | 3 | 2 | 2 | Low | Low |
| Air Heatwave Days (Annual) | 3.6 | 9.0 | 15.2 | 27.0 | 13.4 | 25.0 | 53.3 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 322% | 594% | 3 | 5 | 5 | High | High |
| Tropical Nights (>20˚C) | 0.0 | 2.0 | 3.0 | 10.0 | 3.0 | 7.0 | 17.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 300% | 700& | 3* | 4* | 5* | High | High |
| Heating Degree Days | 5673.0 | 4505.0 | 4896.0 | 5114.0 | 4039.0 | 4610.0 | 4887.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -14% | -19% | 3 | 2 | 2 | Low | Moderate |
| Cooling Degree Days | 153.0 | 266.0 | 333.0 | 552.0 | 340.0 | 427.0 | 695.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 118% | 179% | 3 | 5 | 5 | High | High |
| Building Zone | 7A | 6.0 | 6.0 | 7A | 6.0 | 6.0 | 6.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -14% | -14% | 3* | 4* | 4* | Moderate | Moderate |
| Precipitation | | | | | | | | | | | | | | | | |
| Mean Precipitation (Annual) (mm) | 351.7 | 285.3 | 355.9 | 435.2 | 260.9 | 357.6 | 466.0 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 1% | 2% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Precipitation (Spring) (mm) | 77.5 | 69.0 | 84.1 | 99.1 | 65.6 | 86.8 | 107.6 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 9% | 12% | 3 | 3 | 4 | Low | Low |
| Mean Precipitation (Summer) (mm) | 168.7 | 125.4 | 162.0 | 201.8 | 109.8 | 159.5 | 213.6 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | -4% | -5% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Precipitation (Fall) (mm) | 68.2 | 56.0 | 70.0 | 88.1 | 51.5 | 70.7 | 95.4 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 3% | 4% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Precipitation (Winter) (mm) | 37.3 | 34.8 | 39.8 | 46.2 | 34.0 | 40.6 | 49.4 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 7% | 9% | 3 | 3 | 3 | Low | Low |

**Appendix A Climate Change Hazards, likelihood and Magnitude SSP2-4.5**

| Climate Hazards | Baseline | 2050 | | | 2080 | | | Source | Notes (Model, Baseline, Percentiles) | % Change 2050 | % Change 2080 | Likelihood | | | Magnitude | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High | Low | Med | High | | | Med | Med | Baseline | 2050 | 2080 | 2050 | 2080 |
| Mean Rain (Annual) (mm) | 274.1 | 214.9 | 273.5 | 334.8 | 192.2 | 273.2 | 357.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 0% | 0% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Snow (Annual) (mm) | 90.9 | 84.2 | 97.0 | 116.2 | 81.4 | 99.4 | 126.3 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 7% | 9% | 3 | 3 | 3 | Low | Low |
| Heavy Precipitation Days (>10mm) (Annual) | 7.0 | 7.0 | 8.0 | 10.0 | 7.0 | 8.0 | 10.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 14% | 14% | 3 | 4 | 4 | Low | Low |
| Heavy Precipitation Days (>20mm) (Annual) | 2.0 | 2.0 | 2.0 | 3.0 | 2.0 | 2.0 | 3.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 0% | 0% | 3 | 3 | 3 | Negligible | Negligible |
| Extreme Precipitation (24hrs) (100YR) (mm) | 84.5 | 74.7 | 94.4 | 113.7 | 69.9 | 99.2 | 127.9 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 12% | 17% | 3 | 4 | 4 | Low | Moderate |
| Extreme Precipitation (72hrs) (100YR) (mm) | 138.2 | 129.9 | 154.8 | 182.4 | 125.9 | 162.8 | 203.9 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 12% | 18% | 3 | 4 | 4 | Low | Moderate |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | 0.1 | NA | 0.12 | NA | NA | 0.12 | NA | PCIC | CMIP5, Baseline:1986-2016, 50 | 20% | 20% | 3* | 3* | 3* | Moderate | Moderate |
| Maximum Number of Consecutive Dry Days | 31 | 27 | 30 | 34 | 27 | 31 | 33.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -3% | 0% | 3 | 3 | 3 | Negligible | Negligible |
| **Other** | | | | | | | | | | | | | | | | |
| Extreme Land Wind Speed (100yr) (km/h) | 102.5 | 91.5 | 99.9 | 109 | 91.8 | 101 | 107.7 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | -3% | -1% | 3 | 3 | 3 | Negligible | Negligible |
| Relative Humidity (Annual) (%) | 77 | 72.9 | 75.7 | 78.5 | 70.1 | 75 | 79.3 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | -2% | -3% | 3 | 3 | 3 | Negligible | Negligible |
| Forest Fire Danger Index (Very High) (%) | 0.2 | 0.3 | 0.5 | 1.3 | 0.3 | 0.8 | 2.9 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 150% | 300% | 3* | 3* | 3* | High | High |
| Forest Fire Danger Index (Severe) (%) | 0 | 0 | 0 | 0.02 | 0 | 0 | 0.05 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 0% | 0% | 3* | 3* | 3* | Negligible | Negligible |
| Note:* Denotes Deviation from PIEVC Middle Baseline Approach | | | | | | | | | | | | | | | | |

# Appendix A2 Climate Change Hazards Likelihood and Magnitude SSP5-8.5

## Climate Change Projections, Hazards, and Impact Report

City of Saskatoon

**City of Saskatoon**

SLR Project No.: 201.089318.00001

January 29, 2025

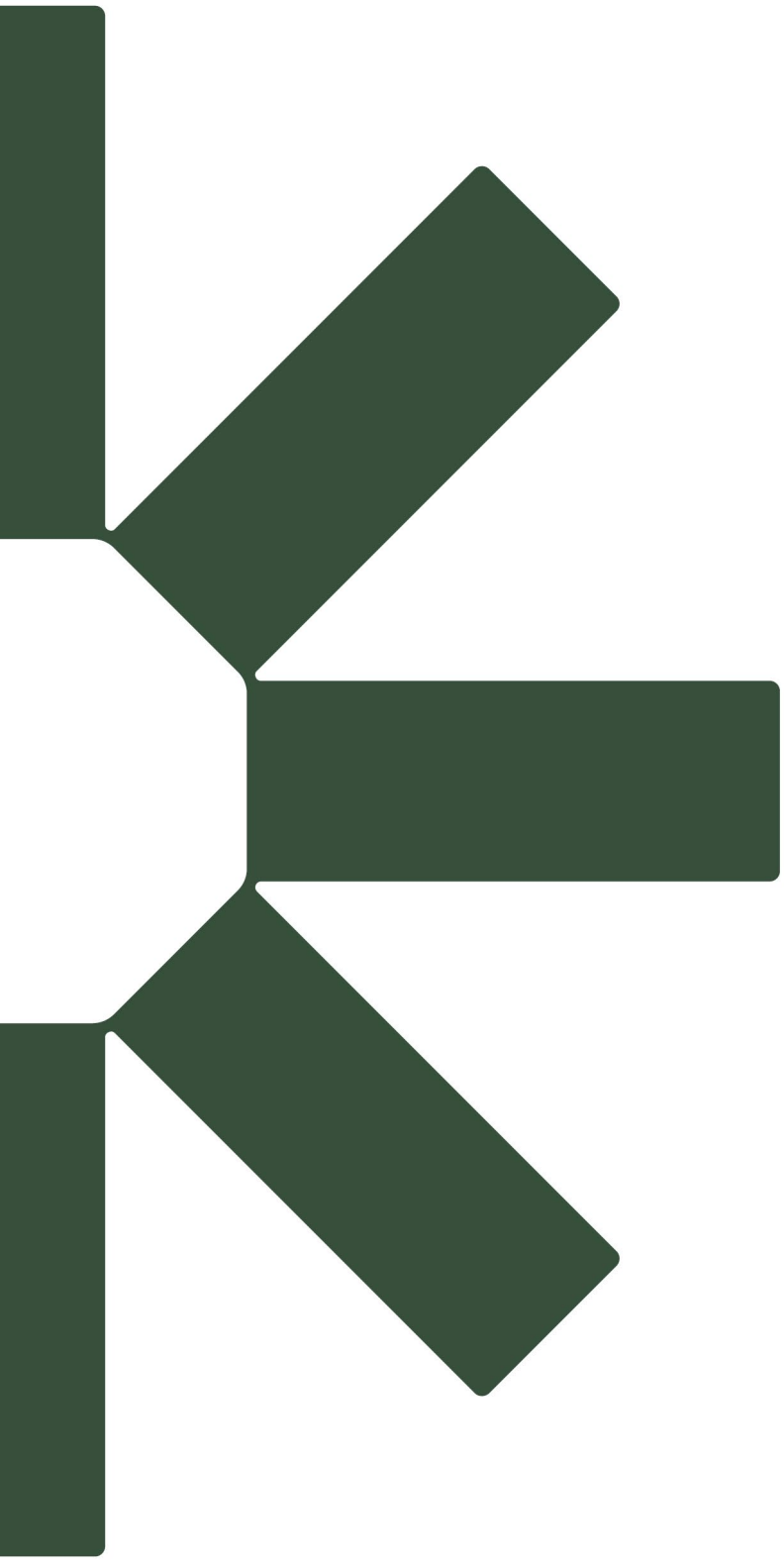
SLR

**Appendix A Climate Change Hazards, likelihood and Magnitude SSP2-8.5**

| Climate Hazards | Baseline | 2050 | | | 2080 | | | Source | Notes (Model, Baseline, Percentiles) | % Change 2050 | % Change 2080 | Likelihood | | | Magnitude | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High | Low | Med | High | | | Med | Med | Baseline | 2050 | 2080 | 2050 | 2080 |
| **Temperature** | | | | | | | | | | | | | | | | |
| Mean Temperature (Annual) (˚C) | 2.5 | 4.1 | 5.4 | 7.0 | 5.6 | 8.0 | 10.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 116% | 220% | 3 | 5 | 5 | High | High |
| Mean Temperature (Spring) (˚C) | 3.4 | 4.7 | 6.0 | 7.4 | 5.8 | 8.2 | 10.8 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 76% | 141% | 3 | 5 | 5 | High | High |
| Mean Temperature (Summer) (˚C) | 17.2 | 18.9 | 20.3 | 21.9 | 20.4 | 23.0 | 25.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 18% | 34% | 3 | 4 | 4 | Moderate | Moderate |
| Mean Temperature (Fall) (˚C) | 3.3 | 5.2 | 6.2 | 7.5 | 6.8 | 8.7 | 11.2 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 88% | 164% | 3 | 5 | 5 | High | High |
| Mean Temperature (Winter) (˚C) | -14.0 | -12.2 | -10.8 | -8.7 | -10.7 | -8.0 | -4.2 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 23% | 43% | 3 | 4 | 4 | Moderate | High |
| Mean Max Temperature (˚C) | 8.6 | 10.2 | 11.4 | 13.6 | 11.6 | 13.9 | 17.9 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 33% | 62% | 3 | 4 | 4 | High | High |
| Mean Min Temperature (˚C) | -3.6 | -1.9 | -0.5 | 1.0 | -0.5 | 2.2 | 5.0 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 86% | 161% | 3 | 5 | 5 | High | High |
| Summer Days (>25 ˚C) (Annual) (˚C) | 38.2 | 56.1 | 69.3 | 83.1 | 75.9 | 96.3 | 115.9 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 81% | 152% | 3 | 5 | 5 | High | High |
| Very Hot Days (≥ 30 ˚C) (Annual) (˚C) | 7.4 | 14.3 | 20.5 | 32.5 | 24.6 | 44.6 | 72.1 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 177% | 503% | 3 | 5 | 5 | High | High |
| Very Cold Days (≤ -30 ˚C) (Annual) (˚C) | 12.6 | 0.0 | 2.8 | 9.7 | 0.0 | 0.2 | 3.2 | Climate Atlas | CMIP5, Baseline:1981-2010, 10,50,90 | -78% | -98% | 3 | 1 | 1 | High | High |
| Date of Last Spring Frost (Annual) | 133.0 | 112.0 | 122.0 | 125.0 | 95.0 | 110.0 | 122.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -8% | -17% | 3 | 2 | 2 | Low | Moderate |
| Date of First Fall Frost (Annual) | 265.0 | 276.0 | 282.0 | 289.0 | 284.0 | 291.0 | 308.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 6% | 10% | 3 | 3 | 3 | Low | Low |
| Frost-Free Season (Days) (Annual) | 130.0 | 152.0 | 157.0 | 174.0 | 166.0 | 182.0 | 212.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 21% | 40% | 3 | 4 | 4 | Moderate | High |
| Growing Degree Days (15 ˚C) (Annual) | 362.0 | 474.0 | 716.0 | 958.0 | 681.0 | 1007.0 | 1321.0 | Climate Atlas | CMIP5, Baseline:1981-2010, 10,50,90 | 98% | 178% | 3* | 5* | 5* | High | High |
| Freeze Thaw Cycles (Annual) | 72.0 | 55.0 | 62.0 | 72.0 | 40.0 | 55.0 | 65.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -14% | -24% | 3 | 2 | 2 | Low | Moderate |
| Air Heatwave Days (Annual) | 3.6 | 11.8 | 21.4 | 43.0 | 13.4 | 69.3 | 149.1 | ClimSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 494% | 1825% | 3 | 5 | 5 | High | High |
| Tropical Nights (>20˚C) | 0.0 | 4.0 | 9.0 | 19.0 | 12.0 | 30.0 | 57.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 900% | 3000% | 3* | 4* | 5* | High | High |
| Heating Degree Days (HDD) | 5673.0 | 4097.0 | 4664.0 | 4817.0 | 3387.0 | 3967.0 | 4282.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -18% | -30% | 3 | 2 | 2 | Moderate | High |
| Cooling Degree Days (CDD) | 153.0 | 348.0 | 441.0 | 710.0 | 551.0 | 757.0 | 1143.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 188% | 395% | 3 | 5 | 5 | High | High |
| Building Zone | 7.0 | 6.0 | 6.0 | 6.0 | 5.0 | 5.0 | 6.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | -14% | -29% | 3* | 4* | 5* | Moderate | Moderate |
| **Precipitation** | | | | | | | | | | | | | | | | |
| Mean Precipitation (Annual) (mm) | 351.7 | 259.7 | 357.5 | 467.3 | 179.5 | 362.7 | 568.2 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 2% | 3% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Precipitation (Spring) (mm) | 77.5 | 66.0 | 86.6 | 107.1 | 55.5 | 94.8 | 133.6 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 12% | 22% | 3 | 4 | 4 | Low | Moderate |
| Mean Precipitation (Summer) (mm) | 168.7 | 108.6 | 159.4 | 214.7 | 56.5 | 151.3 | 254.4 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | -6% | -10% | 3 | 3 | 3 | Low | Low |
| Mean Precipitation (Fall) (mm) | 68.2 | 51.3 | 70.7 | 95.8 | 36.5 | 72.9 | 119.8 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 4% | 7% | 3 | 3 | 3 | Negligible | Low |
| Mean Precipitation (Winter) (mm) | 37.3 | 33.9 | 40.8 | 49.8 | 31.0 | 43.7 | 60.5 | ClimSystems | CMIP6, Baseline:2005, 5,50,95 | 9% | 17% | 3 | 3 | 4 | Low | Moderate |

**Appendix A Climate Change Hazards, likelihood and Magnitude SSP2-8.5**

| Climate Hazards | Baseline | 2050 | | | 2080 | | | Source | Notes (Model, Baseline, Percentiles) | % Change 2050 | % Change 2080 | Likelihood | | | Magnitude | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Low | Med | High | Low | Med | High | | | Med | Med | Baseline | 2050 | 2080 | 2050 | 2080 |
| Mean Rain (Annual) (mm) | 274.1 | 192.8 | 273.3 | 357.5 | 120.7 | 272.6 | 431.4 | CLIMSystems | CMIP6, Baseline:2005, 5,50,95 | 0% | -1% | 3 | 3 | 3 | Negligible | Negligible |
| Mean Snow (Annual) (mm) | 90.9 | 81.7 | 99.3 | 125.4 | 73.3 | 106.7 | 156.4 | CLIMSystems | CMIP6, Baseline:2005, 5,50,95 | 9% | 17% | 3 | 3 | 4 | Low | Moderate |
| Heavy Precipitation Days (>10mm) (Annual) | 7.0 | 7.0 | 7.0 | 9.0 | 6.0 | 8.0 | 11.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 0% | 14% | 3 | 3 | 4 | Negligible | Low |
| Heavy Precipitation Days (>20mm) (Annual) | 2.0 | 2.0 | 2.0 | 3.0 | 2.0 | 2.0 | 3.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 0% | 0% | 3 | 3 | 3 | Negligible | Negligible |
| Extreme Precipitation (24hrs) (100YR) (mm) | 84.5 | 71.7 | 97.4 | 122.7 | 59.0 | 110.2 | 160.5 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 15% | 30% | 3 | 4 | 4 | Moderate | High |
| Extreme Precipitation (72hrs) (100YR) (mm) | 138.2 | 127.4 | 159.9 | 196.0 | 116.7 | 181.4 | 253.2 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 16% | 31% | 3 | 4 | 4 | Moderate | High |
| RL50 Annual Max Rain on Snow, 1/50 (kPa) | 0.1 | NA | 0.1 | NA | NA | 0.1 | NA | PCIC | CMIP5, Baseline:1986-2016, 50 | 10% | 10% | 3 | 3 | 3 | Low | Low |
| Maximum Number of Consecutive Dry Days | 31.0 | 27.0 | 31.0 | 34.0 | 27.0 | 30.0 | 34.0 | ClimateData.ca | CMIP6, Baseline:1981-2010, 10,50,90 | 0% | -3% | 3 | 3 | 3 | Negligible | Negligible |
| **Other** | | | | | | | | | | | | | | | | |
| Extreme Land Wind Speed (100yr) (km/h) | 102.5 | 88 | 100.1 | 106.9 | 90 | 98.2 | 108 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | -2% | -4% | 3 | 3 | 3 | Negligible | Negligible |
| Relative Humidity (Annual) (%) | 77 | 71.7 | 75.3 | 79 | 66.4 | 73.6 | 81.1 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | -2% | -4% | 3 | 3 | 3 | Negligible | Negligible |
| Forest Fire Danger Index (Very High) (%) | 0.2 | 0.3 | 0.7 | 2.1 | 0.4 | 1.8 | 12.9 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 250% | 800% | 3* | 3* | 3* | High | High |
| Forest Fire Danger Index (Severe) (%) | 0 | 0 | 0 | 0.03 | 0 | 0.02 | 0.6 | ClIMSystems - Climate insights | CMIP6, Baseline:2005, 5,50,95 | 0 | 0 | 3* | 3* | 4* | Negligible | Low |
| Note:* Denotes Deviation from PIEVC Middle Baseline Approach | | | | | | | | | | | | | | | | |



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