




Municipality of Grand Lake Climate Change Adaptation Plan

Final Report Rev1



261201.00 • March 2026

Image: Tourism NB, Province of New Brunswick

| 02 | Final Report Rev 1 | L. Bolton | 14-Apr-2026 | S. Sundarraj |
|---|--------------------|---|-------------|--------------|
| 01 | Final Report | L. Bolton | 31-Mar-2026 | S. Sundarraj |
| 00 | Draft Report | L. Bolton | 25-Mar-2026 | S. Sundarraj |
| Rev. | Issue | Reviewed By: | Date | Issued By: |
|  | | <p>This document was prepared for the party indicated herein. The material and information in the document reflects CBCL Limited's opinion and best judgment based on the information available at the time of preparation. Any use of this document or reliance on its content by third parties is the responsibility of the third party. CBCL Limited accepts no responsibility for any damages suffered as a result of third party use of this document.</p> | | |



April 14, 2026

Tiffany (English) Ward, CPA
Municipality of Grand Lake
420 Pleasant Drive, Minto, NB E4B 2T3
tiffany.english@municipalityofgrandlake.ca

Dear Tiffany Ward:

RE: Grand Lake Climate Change Adaptation Plan – Final Report

CBCL is pleased to provide a Climate Change Adaptation Plan (CCAP) for the Municipality of Grand Lake. The attached report includes an evaluation of climate change and extreme weather impacts to the Municipality's infrastructure, assets, community, and environment. Adaptation actions are presented for the highest ranked climate change and extreme weather-related vulnerabilities identified, including flooding, heatwaves, water quality and quantity, wildfire and air quality concerns, as well as extreme rainfall, among others. Adaptation actions were developed with input from the steering committee.

This project was completed as a partnership between NB DELG, Grand Lake, and CBCL.

Yours very truly,

CBCL Limited

Prepared by:
Stephen Sundarraj
Climate Resilience Specialist
E-Mail: ssundarraj@cbcl.ca

Reviewed by:
Lindsay Bolton, P.Eng.
Manager, Water Resources & Climate Change

CC: Prativa Pradhan

Project No.: 261201.00

This document was prepared for the party indicated herein. The material and information in the document reflects CBCL Limited's opinion and best judgment based on the information available at the time of preparation. Any use of this document or reliance on its content by third parties is the responsibility of the third party. CBCL Limited accepts no responsibility for any damages suffered as a result of third-party use of this document.



Department of Environment and Local Government

Acknowledgement

CBCL would like to acknowledge the collaborative efforts of the Municipality of Grand Lake, the Government of New Brunswick, and the Steering Committee in the development of this Climate Change Adaptation Plan. The Steering Committee consists of the following members:

- ▶ Tiffany Ward, Treasurer
- ▶ Danny Hargrove, EMO Coordinator
- ▶ Jason Leblanc, Sewer Technician
- ▶ Shawn Patterson, Councillor
- ▶ Randy Hickey, Fire Department
- ▶ Olga Gudkova, Economic Development Officer
- ▶ Katelyn Belknap, Horizon Health Network Community Developer
- ▶ Prativa Pradhan, NBDELG Adaptation Analyst

This project was made possible by funding provided through the Government of New Brunswick.

Executive Summary

The Municipality of Grand Lake is facing growing climate-related pressures on public safety, local infrastructure, and overall community well-being. In response, and with support from the Government of New Brunswick, Grand Lake has initiated the development of a Climate Change Adaptation Plan (CCAP). This plan is intended to improve understanding of current and future climate risks and to identify practical, locally tailored actions that will strengthen resilience across the region. The CCAP is designed to guide long-term decision-making, support infrastructure and land-use planning, and enhance community preparedness as climate conditions continue to change.

The primary objective of this project is to provide Grand Lake with a coordinated, evidence-based approach to climate adaptation. The CCAP focuses on identifying vulnerabilities, prioritizing key risks, and outlining strategic recommendations that reflect community values, anticipated development, and environmental stewardship goals. The resulting plan offers clear, actionable steps that the municipality and local partners can undertake to strengthen resilience.

Built infrastructure, natural assets, and community services were assessed to identify which assets were most vulnerable to extreme weather and long-term climatic shifts. Risks were evaluated using publicly available information on existing community assets and resources, historical and projected climate data, documented climate impacts, and local insights gathered through community engagement.

Key climate hazards considered included:

- ▶ Riverine flooding
- ▶ Extreme rainfall
- ▶ Extreme hot and cold temperatures
- ▶ Snow and ice
- ▶ Extreme winds
- ▶ Hurricanes and winter storms
- ▶ Drought
- ▶ Wildfires

Community assets evaluated in the assessment included emergency response capabilities, high risk facilities and public health more broadly, culturally or recreationally significant locations, roads and bridges, residential and commercial buildings, stormwater management systems, sewer collection system (including wastewater treatment plant), potable water supply, and tourism.

The risk assessment prioritized vulnerabilities based on the likelihood of occurrence and potential impacts on the community. Based on these results, this CCAP outlines a series of

recommendations aimed at reducing risk, protecting infrastructure and natural systems, and strengthening community preparedness.

Recommended actions items fall within the following categories:

- ▶ Riverine Flood Preparedness and Mitigation
- ▶ Emergency Preparedness
- ▶ Heat-related Risks and Preparedness
- ▶ Extreme Rainfall Resilience
- ▶ Wildfire Resilience Planning
- ▶ Drought Management Planning

Each category includes a suite of recommended actions intended to strengthen community resilience, along with suggested timelines, potential partners and resources, and estimated levels of effort.

Ongoing monitoring and evaluation will be crucial for the long-term success of the plan. As climate conditions, development patterns, and community needs evolve, the adaptation strategy must remain flexible and responsive. Regular progress reviews, updates to risk information, and assessments of the effectiveness of implemented actions will help ensure the plan remains current and effective.

The adaptation actions outlined in this plan provide a clear and practical pathway for Grand Lake to reduce vulnerabilities, enhance emergency preparedness, and build long-term climate resilience. It is expected that next steps will involve soliciting input from the community on the recommendations presented in this report, to tailor the execution strategy to the community's needs.

Contents

- Acknowledgement..... ii
- Executive Summary..... iii
- 1 Introduction..... 1
 - 1.1 Climate Change Adaptation Objectives 1
 - 1.2 Background and Historical Extreme Weather Events 2
 - 1.2.1 2018 and 2019 Floods 4
 - 1.2.2 Historical Extreme Weather Events 6
 - 1.3 Key Infrastructure and Community Assets 6
 - 1.4 Scope and Methodology 13
- 2 Climate Change and Extreme Weather 14
 - 2.1 Climate Parameters 14
 - 2.2 Emission Scenarios 17
 - 2.3 Projection Horizons 17
 - 2.4 Climate Projections..... 17
 - 2.4.1 Precipitation and Flooding..... 18
 - 2.4.2 Temperature 22
 - 2.4.3 Extreme Weather 25
 - 2.4.4 Other Hazards 32
 - 2.5 Projection Scores 37
- 3 Risk and Vulnerability Assessment 39
 - 3.1 Impact Assessment..... 40
 - 3.2 Community Consultation..... 43
 - 3.3 Risk Matrix 45
 - 3.4 Prioritization of Risks..... 46
- 4 Adaptation Plan..... 48
 - 4.1 Priority Based Adaptation Actions..... 49
 - 4.1.1 Riverine Flood Preparedness and Mitigation..... 49
 - 4.1.2 Emergency Response Planning 64

| | | |
|-------|-------------------------------------|----|
| 4.1.3 | Preparing for Heatwaves | 70 |
| 4.1.4 | Extreme Rainfall Resilience..... | 71 |
| 4.1.5 | Wildfire Resilience Plan | 74 |
| 4.1.6 | Drought Management Plan | 76 |
| 4.2 | Monitoring and Implementation | 79 |
| 5 | Conclusions | 81 |

Appendices

- A Flood Risk Maps
- B Risk Assessment Matrix
- C Summary of Recommended Action Items

1 Introduction

New Brunswick has seen notable changes in its climate over the past few decades including warmer seasons, frequent rain events, high intensity storms, rising sea levels, and extreme flooding, among others. These climate hazards pose a threat to people, infrastructure, essential services, natural assets, and municipal operations. On the other hand, climatic variability can also provide opportunities such as a longer growing season for agriculture, warmer weather for recreation and tourism, and reduced snow clearing.

The Municipality of Grand Lake faces challenges under changing climate conditions, like many other municipalities in the province. Some of the observed changes in the region's climate include:

- ▶ Higher temperatures
- ▶ Increasing rainfall intensity
- ▶ Overland flooding
- ▶ Erosion
- ▶ High Winds
- ▶ Wildfire smoke

To respond proactively to these changes, Grand Lake has developed a Climate Change Adaptation Plan (CCAP). The plan is intended to provide guidance on integrating adaptation into existing municipal operations, infrastructure management, emergency planning, and development plans.

1.1 Climate Change Adaptation Objectives

A changing climate poses varying degrees of risks to the natural environment, built infrastructure, well-being, and economy. The primary objective of a CCAP is to provide a roadmap to not only proactively address the threats induced by extreme weather events to the local population and essential services, but also to add resilience to critical infrastructure that are susceptible to the adverse effects of a changing climate.

A holistic knowledge of the local climate, community, and assets can be achieved through engagement with stakeholders such as local governments, businesses, residents, and environmental organisations. Engaging stakeholders supports a deeper understanding of the vulnerabilities and opportunities present within the community. Additionally, it ensures

a comprehensive and inclusive strategy that reflects the diverse interests and concerns of the community.

The health and safety of residents and visitors is a priority, particularly during extreme weather events. Along with protecting critical infrastructure assets, other key objectives of the Grand Lake CCAP include prioritizing educating residents on potential climate impacts, strategies for mitigating risks, and identifying opportunities that will further advance adaptation actions through community-driven efforts. In essence, the purpose of the CCAP is to create a resilient and sustainable future by addressing the challenges posed by climate change through a prioritized actionable plan.

This project is being supported by a Steering Committee, made of up individuals with experience in municipal operations, emergency response, public health, and municipal governance, among others. This report was made possible through valuable contributions from:

- ▶ Tiffany Ward, Treasurer
- ▶ Danny Hargrove, EMO Coordinator
- ▶ Jason Leblanc, Sewer Technician
- ▶ Shawn Patterson, Councillor
- ▶ Randy Hickey, Fire Department
- ▶ Olga Gudkova, Economic Development Officer
- ▶ Katelyn Belknap, Horizon Health Network Community Developer
- ▶ Prativa Pradhan, NBDELG Adaptation Analyst

1.2 Background and Historical Extreme Weather Events

The Municipality of Grand Lake was incorporated on Jan 1, 2023, through the amalgamation of the then Village of Minto and Village of Chipman, along with additional annexations of certain unincorporated areas contiguous to the Municipality (Local Governments Establishment Regulation – Local Governance Act, 2022). **Figure 1-1** shows the municipal boundary for Grand Lake.

Besides coal mining, which was a major industry from the 1630s until 2010, Forestry and Tourism are the two major industries of the region (About Us - Municipality of Grand Lake, 2023).

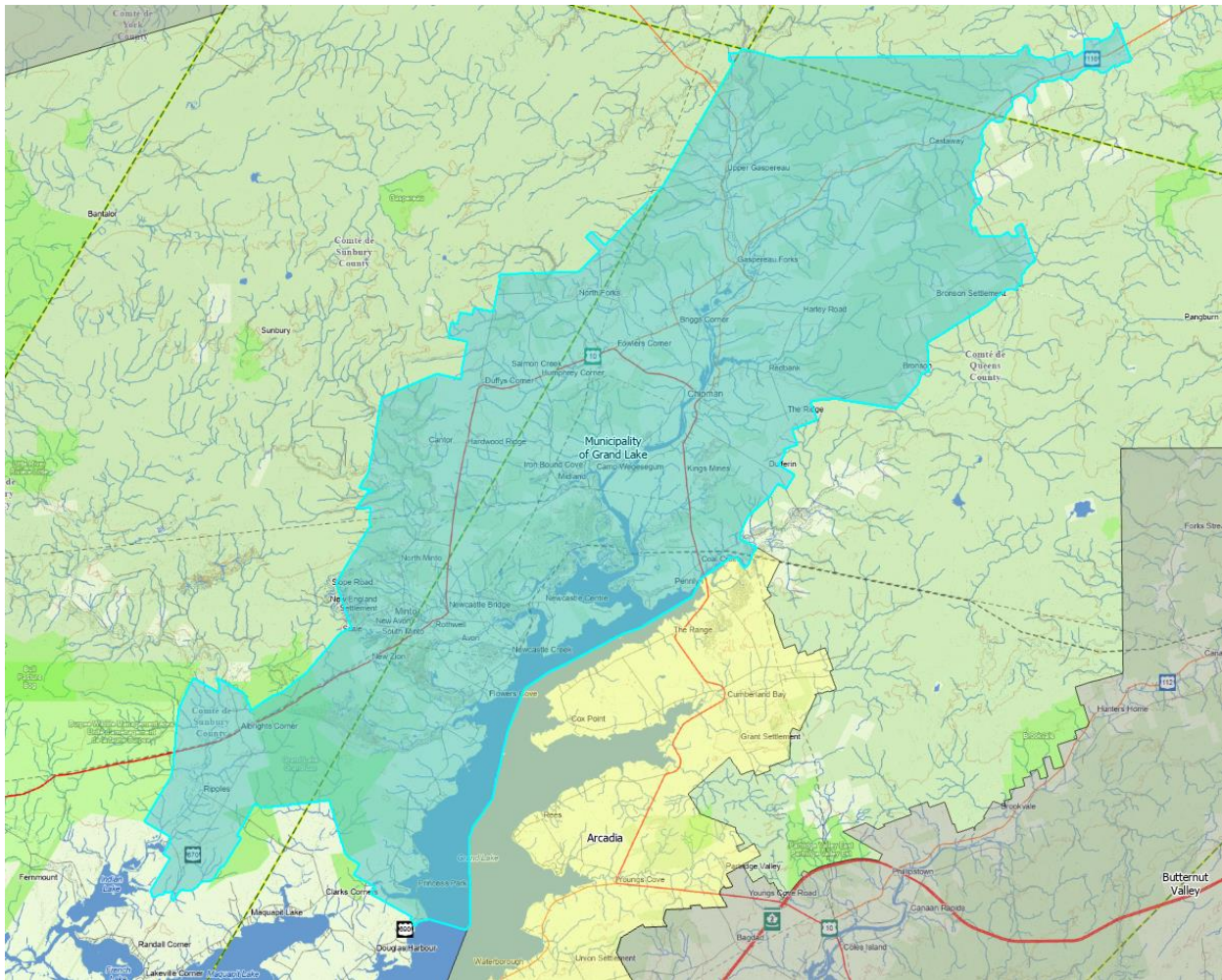


Figure 1-1 Municipal Boundary for the Municipality of Grand Lake (GeoNB, 2026)

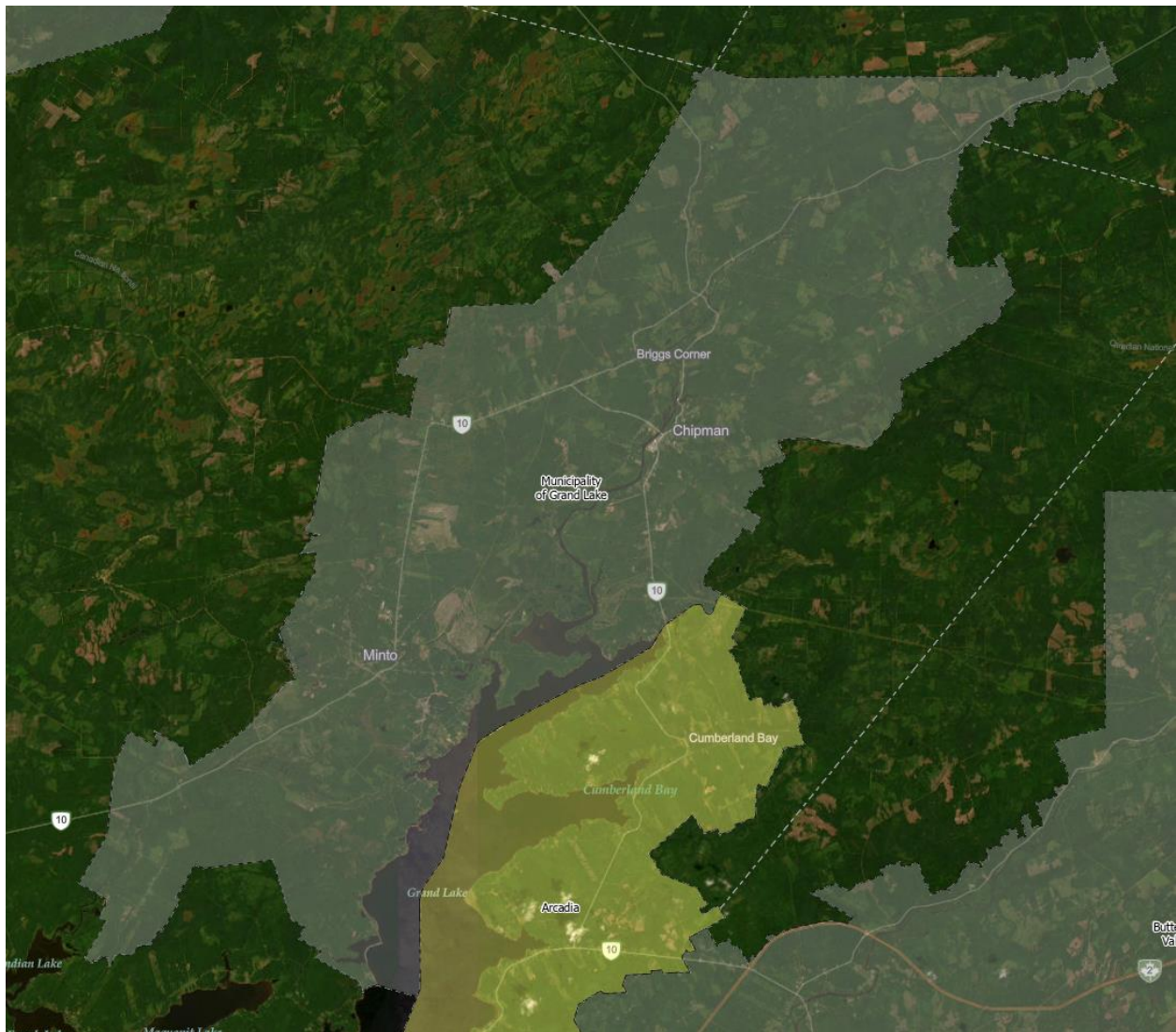


Figure 1-2 Municipal Boundary for the Municipality of Grand Lake (GeoNB, 2026)

The municipality is home to Atlantic Canada’s largest freshwater lake, Grand Lake (171 km²), that hosts recreational activities such as boating, swimming, and fishing. Other popular outdoor recreational activities in the area include mountain biking, hiking, camping, snowmobiling, and ice fishing. The current rural population of 5,800 is expected to increase by 40% in the coming years and reach a population of over 8,000 (About Us - Municipality of Grand Lake, 2023).

1.2.1 2018 and 2019 Floods

Historically, the region has been subject to multiple extreme weather events. In more recent years, riverine floods, intense rains, strong wind gusts, and ice jams have been the most common natural threats in the area.

In 2018 and 2019, Grand Lake experienced extreme flooding as a result of back-to back 1 in 100-year floods on the Saint John River due to rainfall and snowmelt in the tributary

watershed. In the 2019 spring flood, the municipality saw water levels reaching 6.63 m (CGVD 28), which is 1.63 m above flood stage (Environment and Local Government, 2019). The high-water levels, in combination with gusts around 60 km/h, gave rise to waves ranging from three to four feet high, resulting in smashed windows and flooded basements (Bosse & Morin, 2019).

The following impacts and responses were noted following these events:

- ▶ **Road Closures and Flooded Roads:** On May 5, 2018, all roads to the Village of Chipman (Route 10, Route 123, and Route 116) were closed due to flooding. Transportation was set up to move people, groceries and other supplies in and out of Chipman via the railway bridge in town. Mail and newspaper services were suspended, leaving the community of just over 1,000 feeling cut off from the rest of the province (Perry, 2019). In 2018, Route 690, a main access road was completely submerged in Princess Park area (RetroNB, 2018). Bronson Settlement Rd was brought to a better condition when Route 10 was closed during the 2018 floods (Yoursaintjohn.ca, 2018)
- ▶ **Infrastructure Damage:** Docks, stairs, and other parts of homes and cottages were broken loose from the floods and high winds and were carried away. Three-to-four-foot waves crashed homes, ripped off sidings, and detached a deck (Campbell, 2019). As noted during community consultation, there were many private properties (primarily cottages and homes) destroyed when waves knocked homes off their foundations or collapsed walls and basements.
- ▶ **Power Outages:** Chunks of ice knocked down a series of power poles in 2019 (CBC, 2019). Power poles were knocked, snapped, or pushed away (RetroNB, 2019).
- ▶ **Tree Fall and Erosion:** Debris cleanup took place on the Nature Conservancy's Keyhole property on the west side of Grand Lake near Princess Park. The land is also home to rare bur oak trees and marshland, with only eight known populations of bur oak remaining in New Brunswick. Aaron Dowding, the New Brunswick stewardship manager of the Nature Conservancy of Canada, said that this area is only one of two protected bur oak groves in the forest. "*We've lost much of what we used to have and what we do have. Some of the trees are 400 years old and are a unique floodplain forest,*" she told Shift New Brunswick. Also note that the debris clean-up was still active in Aug 2022, years after the 2018-2019 floods that displaced nearly 1,100 residents along the St. John River and nearby lakes (Prapti Bamaniya, 2022). Erosion barriers were damaged or moved further downstream. Trees were uprooted and road signs were found scattered (RetroNB, 2019)
- ▶ **Flood Event Communications:** Review of 2018 flood response found gaps in communication (New Brunswick Preparedness and Response Spring Freshet 2018 Flood after Action Review -Advice to Minister, n.d.). The Municipality of Grand Lake has partnered with 'Voyent Alert!' to provide routine and emergency notifications for events such as wildfires and floods (Voyent Alert - Municipality of Grand Lake, 2025).
- ▶ **Community Engagement:** Jemseg Grand Lake Watershed Association held a workshop to share flood resilience strategies. About 30 people attended a meeting in Minto on a

Saturday morning to hear presentations from people who have taken measures to protect their property (The Weather Network, 2020)

1.2.2 Historical Extreme Weather Events

In addition to flooding, Grand Lake has experienced a number of extreme weather events, including:

- ▶ **EF-1 Tornado Hits Grand Lake Area, 2013.** An EF-1 tornado landed just outside the municipality in Jemseg and moved easterly. Numerous trees uprooted and at least three barns destroyed in Whites Cove. Power and communication outages reported (CBC, 2013).
- ▶ **Wind and Hail Storm, 2017.** Localised squalls uprooted trees, broke off branches, and flung porch items; hailstones seen by a local (CBC, 2017).
- ▶ **Ice Storm and Power Outage, 2017.** Chipman Fire Station was used as a warming center during the 2017 ice storm event (Previl, 2017).
- ▶ **Princess Park Tree Loss Due to Soil Erosion, 2018.** Floods erode soil leaving trees with exposed roots, causing environmental damages, and forcing a potential cut down of trees (Ibrahim, 2018).
- ▶ **Wind Damage to Residential Buildings, 2018.** Wind-driven waves moved a fully intact two-storey cottage across Grand Lake up to a distance of 6kms (Fowler, 2018).
- ▶ **Wildfire, 2020.** Three fires about 30 km NW of Chipman were reported in 2020 but they were significantly smaller compared to the ones in 2025 (Harding, 2020).
- ▶ **Heat Wave, 2021.** Heat warning issued to Grand Lake as temperatures were expected to reach 31°C in 2021 (CBC, 2021).
- ▶ **Grand Lake Cyanobacteria Bloom, 2025.** Cyanobacteria (blue-green algae) bloom confirmed most recently in Grand Lake, NB on August 7, 2025 (Government of New Brunswick, 2026).
- ▶ **Heat Wave, 2025.** Heat warning issued to Grand Lake as multi-day heatwave hits NB, 2025 (Waugh, 2025).
- ▶ **Wildfires, 2025.** An out-of-control wildfire (Fire 366) east of Grand Lake, 2025 (Telegraph-Journal, 2025).
- ▶ **Blizzards and Winter Storms, various years.** Blizzards have forced school closures in Minto and Chipman on at least two occasions (Blanch & Fraser, 2017) (Waugh, 2026).

1.3 Key Infrastructure and Community Assets

Grand Lake is in the process of developing an Asset Management Plan which will detail the location, condition, and performance of the communities' key assets. At the time of writing this report, the draft Asset Management Plan is not available. The following summary outlines municipal and community assets of potential importance for the CCAP.

Grand Lake is expected to grow significantly in the next 2 – 3 years, including an expected population growth of 40% by 2027 (relative to baseline population in 2021) (Building Grand Lake, n.d.). As of spring 2025, there were 40 new homes under construction in the Forest Ave development area, among others. As the municipality continues to attract new residents and business, supporting infrastructure such as transportation improvements, sewer system expansion, and housing development planning will be required to support this growth. A proactive approach to climate change adaptation will improve long term performance of assets, reduce risk, and potentially unlock access to additional funding mechanisms for which the community relies.

The following assets have been considered in the development of the Grand Lake CCAP:

- ▶ **Transportation and Roads:** Both the municipality and province own portions of the road network through the municipality, and as a result maintenance responsibilities are shared. Grand Lake works closely with the province to develop a paving plan, prioritizing roads in the worst condition and highest usage for paving. The Chipman Airport is a private airport operated by J. D. Irving Woodlands servicing the Grand Lake Timber Sawmill that employs approximately 400 people (Haggett, 2025).
- ▶ **Bridges and Culverts:** All bridges are owned and maintained by the province. Culverts are owned and maintained by the municipality. The largest bridge in the community is the Burpee Bridge (Covered Bridges - Municipality of Grand Lake, 2023), a covered bridge built in 1913 spanning 50 m across the North Gaspereau River. Additional bridges include:
 - New construction - Salmon River Bridge on NB-10 in Chipman– expected to complete in Fall of 2026. Bridge addresses flood issues and has a design lifespan of 75 yrs. Note that there is a temporary modular bridge right next to it (Government of New Brunswick, 2026)
 - Coal Creek Bridge #1 on NB-10
 - Newcastle Centre Rd Bridge connecting Newcastle Centre and Newcastle Creek – closed in 2025 due to structural safety (Brown, 2025)
 - Park Street Bridge in Minto
 - Bridge Street Bridge in Minto
 - NB – 123 SW of Gaspereau Forks
 - NB – 116 on Gaspereau Forks
 - Northside Dr Bridge to the northeast of North Minto
- ▶ **Environmental Assets:** The community is surrounded by lakes, rivers, and streams as outlined in **Figure 1-1**, as well as dense vegetation as seen in **Figure 1-2**. Jemseg Watershed Association actively monitors water quality in the area and has partnered with Hammond River Angling Association to deploy CyanoTracker in Grand Lake (Water Quality Monitoring, 2024).
- ▶ **Municipal Operations Buildings:** Through amalgamation, Grand Lake now maintains municipal buildings in both Minto and Chipman. Those include the Minto Office (420 Pleasant Drive) and Chipman Office (10 Civic Court, Unit 1, Chipman). All development and construction projects in Grand Lake are overseen by the Capital Region Service

Commission/ Planning and Development (Municipal Planning - Municipality of Grand Lake, 2023). The Service New Brunswick is located within the Chipman Municipal Building.

- ▶ **Water Distribution and Treatment:** The community of Grand Lake relies on wells for drinking water, with the exception of a private water treatment plant and distribution system operated by Province of New Brunswick for the Industrial Park.
- ▶ **Wastewater Collection and Treatment:** There is a wastewater collection, pumping and treatment system in the former downtown area of the Village of Minto and Village of Chipman. See **Figure 1-2** for the location of Pumping Stations (PS) and Wastewater Treatment Plants (WWTPs). In 2023, the Chipman WWTP received funding for replacement and upgrade of the WWTP to improve service delivery (Government of New Brunswick, 2023). Work has not yet been started on the new WWTP.
- ▶ **Stormwater Management:** Primarily ditches and culverts throughout the municipality. There does not appear to be any additional stormwater management infrastructure such as swales, stormwater detention/ retention systems, or storm sewer.
- ▶ **Emergency Services and Health Centres:** There are two Fire Halls in the community, the Minto Fire Department (187A Main St) and Chipman Fire Hall (10 Civic Court). The Chipman Fire Station was used as a warming center during the 2017 ice storm (Previl, 2017). Additionally, the community is serviced by the RCMP. The Queens North Community Health Center and Chipman Health Centre are the community health centers servicing the region. There is a Provincial Corrections Facility in the community, that is planned to be operational in 2027 (Cunningham, 2026).
- ▶ **Community Centers and Heritage Buildings:** The community has a community resources center in Minto, as well as the New Brunswick Internment Camp Museum, Chipman Museum, Chipman Community Heritage Center, and Chipman Public Library. In addition to community centers, there are several schools in the area.
- ▶ **Recreation:** The community has two arenas, the Chipman Centennial Arena and Minto Centennial Arena, which also serve as community centers. Additionally, there are multiple parks including: Gilbert Park, North Minto Park, Hamilton Baird Park, and Princess Park. Chipman Marina Wharf is a community wharf (Boating - Municipality of Grand Lake, 2023) and the Newcastle Creek Wharf is operated by Grand Lake Boater's club. Additionally, there are large ATV and snowmobile trails. **Figure 1-3** shows the location of key community buildings.
- ▶ **Energy:** The community is serviced by NB Power and natural gas is supplied by Enbridge Gas. There is a potential Natural Gas plant discussed for the area.

In addition to physical assets, the community also has development plans, emergency response plan (New Brunswick Emergency Measures Organization - NBEMO), a municipal plan, and zoning by-laws.

A summary of the assets included in the CCAP are presented in **Table 1.1** below.

Table 1.1: Key Infrastructure and Community Assets Included in the CCAP

| Asset Category | Description / Components |
|--|---|
| Emergency Response and Management | <ul style="list-style-type: none"> • Emergency Measures Organization (EMO) Plan – NBEMO only (Municipality of Grand Lake NB, 2026) (NBEMO, n.d.) • Emergency shelters • Minto and Chipman Fire Hall • Queens North Community Health Center and Chipman Community Care centres • Backup power supply at multiple locations (Chipman Community Heritage Centre, Chipman Fire Hall, Minto municipal office, an additional portable generator, and some senior care facilities that already possess or are in the process of installing backup power in 2026) • Communication systems and critical response coordination from Municipal Office in Minto |
| Transportation | <ul style="list-style-type: none"> • Roads maintained by Municipality/ NBDTI • Bridges |
| Natural Assets | <ul style="list-style-type: none"> • Salmon River • Rare bur oak trees • Other vegetation |
| Water and Sewer | <ul style="list-style-type: none"> • Private potable water wells • Wastewater Treatment plants (Chipman to receive a new WWTP) • Sewer collection system and pumping |
| Stormwater Management | <ul style="list-style-type: none"> • Drainage systems including roadside ditches and culverts |
| Recreation Assets | <ul style="list-style-type: none"> • Chipman Marina Wharf (Boating - Municipality of Grand Lake, 2023) • Docks along Princess Park • Beaches • Community parks and green spaces • Trails (walking and biking, ATV) • Recreational facilities - buildings (hockey arenas which also double up as community spaces) • Recreational facilities – outdoors (campgrounds, boating areas, fishing, swimming) • Museums and historic sites (Internment camp, mines, Burpee Bridge) |
| Tourism and Economic Development | <ul style="list-style-type: none"> • Forestry (Timber mill) • Tourism • Chipman Industrial Park • Minto Industrial Park |

| Asset Category | Description / Components |
|---|---|
| Commercial and Residential Buildings | <ul style="list-style-type: none"> • Residential homes • Private businesses |
| Land Use Policies | <ul style="list-style-type: none"> • Rural Plan - Rural plan by-law and Grand Lake's draft zoning map (proposed amendments Jan 21, 2026) • Development standards and policies |

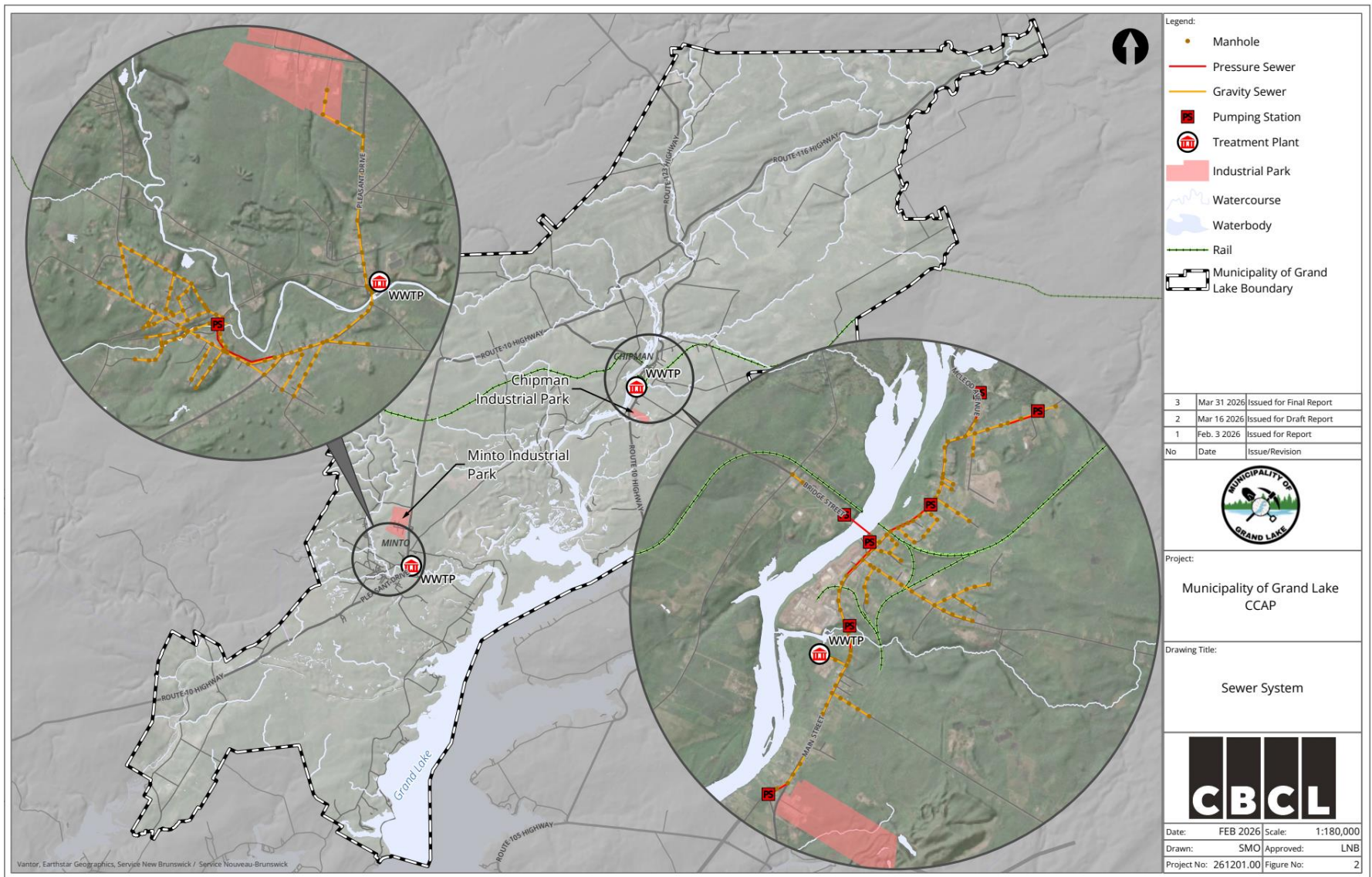


Figure 1-3 Locations of Pumping Stations (PS) and Wastewater Treatment Plants (WWTPs) in Municipality of Grand Lake.

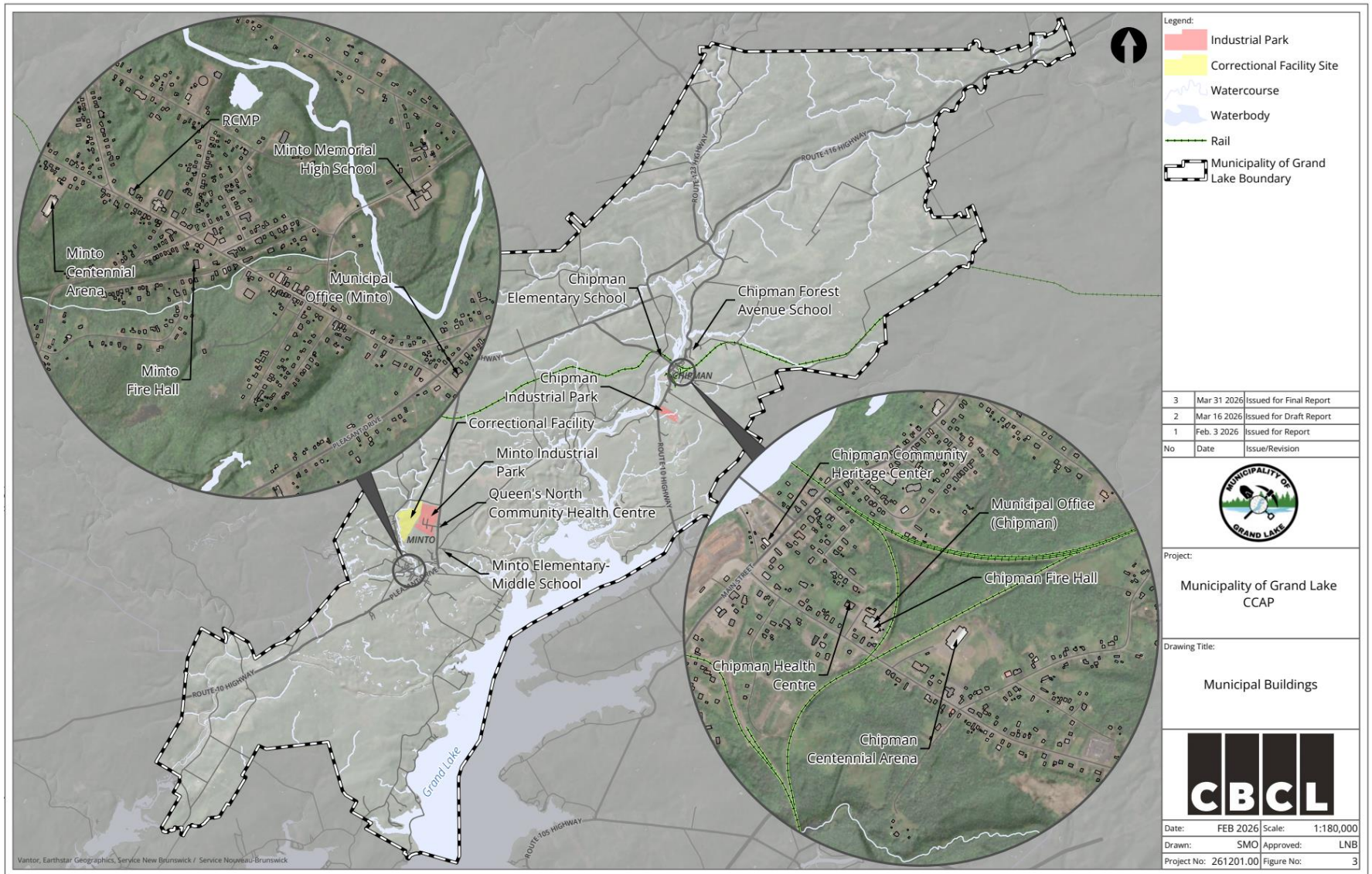


Figure 1-4 Locations of key community buildings in the Municipality of Grand Lake.

1.4 Scope and Methodology

This CCAP is developed in accordance with the NB Department of Environment and Local Government (NBDELG) guidance document for climate change adaptation planning developed in 2023, along with overarching objectives of the province's 2022-2027 Climate Change Action Plan (Our Pathway towards Decarbonization and Climate Resilience, n.d.).

The Public Infrastructure Engineering Vulnerability Committee (PIEVC), led and developed by Engineers Canada, is a protocol to assess infrastructure vulnerabilities to extreme weather. The Protocol is scalable and is used to assess various types of infrastructure across Canada and other parts of the world. It applies a bottom-up approach, starting with a preliminary assessment to recognize climate-based hazards relevant to the region and the list of assets that lie within the scope. Following this, threshold values for every relevant hazard is determined based on standards, codes, design data, operational experiences, observations, or professional judgement. The best available historical climate data and future projections are used to evaluate how the relevant climate parameters are likely to change in the future, and how these changes could impact the community.

A high-level risk and vulnerability assessment is then conducted to understand how each climate hazard interacts with each of the municipal assets to identify the key areas that need to be addressed. The assessment is made across three time horizons, 2030s, 2050s, and 2080s, to evaluate the risks and adaptation needs across short-, medium-, and long-term planning time horizons respectively. Additionally, the levels of effort required to respond to the risks are estimated to be low, moderate, or high. High and extreme risks are prioritized for adaptation plans that are designed to minimize the severity of their respective impacts.

The outcomes of this process form the foundation for the following chapters of the report, which present the climate risk assessment results and recommended adaptation actions for the Municipality of Grand Lake.

2 Climate Change and Extreme Weather

Canada's annual average temperature has increased at roughly twice that of global average (Bush and Lemmen, 2019). New Brunswick, likewise, has observed increasing average temperatures, precipitation intensities, rise in sea levels, flooding events, and coastal erosion. Climate scientists predict that Atlantic Canada will become progressively warmer, wetter, and stormier, with longer and more frequent heat waves. Therefore, the impacts to people, infrastructure, and the environment may present new challenges as well as opportunities.

The following sections outline various climate indicators applicable to the Municipality of Grand Lake region and the projected changes that are expected from now to the end of the century (2100). Preliminary discussions on impacts are also presented. The climate projections developed were used to assign likelihood scores for the PIEVC risk assessment to evaluate overall risk and prioritize items for adaptation action, which are summarized at the end of the Chapter.

2.1 Climate Parameters

The list of climate parameters considered for this project was developed by CBCL's risk assessment team and internal subject matter experts. Selection of these parameters was based primarily on climate and extreme weather phenomena that are known to impact community assets or could potentially impact these assets in the future.

Table 2.1 below lists the climate parameters considered in the development of the CCAP including a brief description of the reasoning for inclusion. It should be noted that the potential impacts of each climate-asset interaction described may not be fully encompassing and the Risk Matrix in the Appendix B should be referred to for all identified climate-asset interactions and resulting impacts.

Table 2.1 Climate Parameters included in Scope of the Project.

| Climate Parameter | Index | Reason for Inclusion in the Project |
|---------------------------|---|--|
| Warm Temperatures | Cooling Degree Days Greater than 18°C | Impacts to vulnerable populations due to lack of proper AC units, stress on building HVAC systems, warm water temperatures impacting various environmental conditions. |
| Heat Extremes | Number of Days with Maximum Temperature Greater than 30°C | Impacts to vulnerable populations due to heat stress, wear and tear to transportation infrastructure, warm water temperatures impacting various environmental conditions. |
| Freeze-Thaw Cycles | Number of Days with Max. Temp Greater than 0°C and Min. Temp Less than 0°C in the Winter Season (Dec - Feb) | Impacts to road network, hard standing surfaces such as parking lots and walkways, underground infrastructure not located below the frost line (e.g., wells, septic). |
| Extreme Rainfall | 1 in 10-year sub-daily rainfall event | Localized runoff and pooling of water. Potential environmental concerns from contaminant transport. |
| | 1 in 100-year sub-daily rainfall event | Overland flow entering the downstream environment and potentially impacting water quality. Flooding of infrastructure including basements or roadways. Disruption of municipal services. |
| Riverine Flooding | 1 in 100-year Riverine Flood Extent | Wide ranging flooding and damage to buildings, transportation routes, drainage features such as ditches and culverts, and recreational or culturally significant areas. Potential contamination of potable water sources, environmental degradation. |
| Snowfall | Days with Snowfall > 10 cm | Impacts to roads/ transportation and maintenance operations. |
| Ice Accretion | Ice Accretion Thickness (1 in 20 year) | Potential impacts to electrical transmission and power distribution. Potential ice damming on roofs, and hazards due to falling ice. |
| Wind Load | Hourly Wind Pressures (1 in 50 year) | Impacts to structures and natural elements (e.g., trees, parks, vegetation) |
| Storms | Frequency and Intensity of Tropical Storms/ | Impacts to structures, roads/ transportation, natural elements (e.g., trees, parks, vegetation), electrical transmission |

| Climate Parameter | Index | Reason for Inclusion in the Project |
|-------------------|--|---|
| | Hurricanes & Winter Storms | and power distribution, source water quality, exterior electrical/ mechanical equipment. |
| Lightning | Average number of days with lightning (within 25 km) | Impacts to buildings or exterior electrical/ mechanical equipment that is not grounded. |
| Wildfire | Intensity and Frequency of Wildfires | Potential impacts to the community as a whole (including all municipal assets), emergency response procedures and operations of emergency centers, and water quality. |
| Drought | Intensity and Frequency of Drought | Impacts to source (groundwater wells) water quantity, and natural elements (trees, vegetation, parks, etc.). |

2.2 Emission Scenarios

Climate models are driven by different emissions scenarios. The Climate Model Intercomparison Project 5 (CMIP5) project uses “Representative Concentration Pathways” (RCPs) to represent different emissions scenarios, whereas the CMIP6 project uses “Shared Socioeconomic Pathways” (SSP). For this analysis, the higher emissions scenario (RCP 8.5 & SSP5-8.5) was applied for projections. The higher emissions scenarios represent when the level of radiative forcing reaches 8.5 W/m² by 2100. RCP 8.5 accounts for radiative forcing only through anthropogenic sources, while SSP5-8.5 integrates socioeconomic factors in the emission scenario.

2.3 Projection Horizons

Climate parameters were characterized for “baseline”, “near-term” (2030s), “mid-term” (2050s), and “long-term” (2080s). The baseline represents the historical period, when measured data are available (e.g., 1981-2010 if available). Project horizons encompass the following periods:

- ▶ Baseline: 1981-2010
- ▶ Near-term (2030s): 2021-2050
- ▶ Mid-term (2050s): 2041-2070
- ▶ Long-term (2080s): 2071-2100

2.4 Climate Projections

The following sections present the general future projected trend for each climate parameter, along with preliminary discussions on respective impacts, considered in the

project scope. For more detailed information, the Risk Matrix in the Appendix B should be referred to for all identified climate-asset interactions and resulting impacts.

2.4.1 Precipitation and Flooding

In the Grand Lake region, the patterns of extreme rainfall events are expected to change in the future. Rainfall behaviors are related to temperature, as a warmer atmosphere can hold more water. Therefore, increased temperature trends can translate into an increase in rainfall duration and intensity. Additionally, rainfall dynamics are related to large-scale circulation and storm tracks, such as hurricanes and winter storms that can bring heavy precipitation. Winter precipitation is predicted to shift from snowfall to rainfall due to warmer winter temperatures.

2.4.1.1 Extreme Rainfall

Starting in the near-term, the IPCC expects “more intense and frequent extreme rainfall and associated flooding in many regions including coastal and other low-lying cities” (IPCC, 2023). It is projected that the intensity of extreme rainfall will likely increase by approximately 30% and 50% in the mid- and long-term, respectively.

Rainfall frequency and intensity are used by designers to size storm sewer and drainage infrastructure. Intensity-Duration-Frequency (IDF) curves can represent the probability of a certain sized rainfall event occurring in the future of a given data collection site. IDF curves are typically based on historically measured precipitation data collected at local weather stations. Due to the lack of long-term observation stations in Grand Lake, the data was obtained from the Fredericton CDA CS station (ID 8101605). Future projections are based on a “temperature scaling” approach that each degree of warming is taken to result in an approximately 7% increase in precipitation intensity (Westra et al., 2014). **Figure 2-1** shows the comparison of the 1 in 100-year IDF curve between the historical and the end of the century (i.e., 2100). Projections depict an increase in extreme rainfall intensity, meaning a potential decrease in the return period of extreme rainfall events. For example, the current 1 in 100-year rainfall event is expected to occur more frequently over time, potentially becoming a 1 in 10-year event in the long-term.

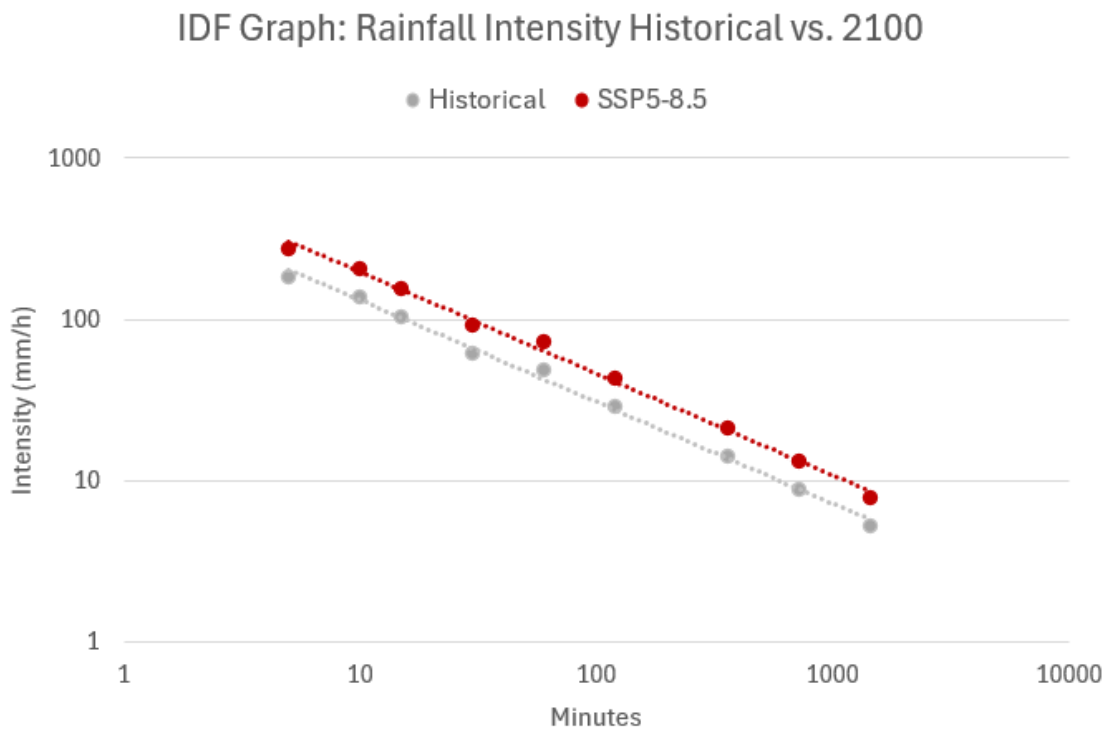


Figure 2-1: Historical and Projected 1 in 100-year IDF curves for Grand Lake, predicted using the “temperature scaling” approach.

2.4.1.2 Snow

Bush and Lemmen (2019) stated that it is “very likely” that snow cover duration will decline across Canada due to increases in surface air temperature, and it is likely that the seasonal snow accumulation will decrease. The main processes driving potential change in snow are 1) increases in precipitation and 2) increased temperatures (more snowmelt; also more precipitation falling as rain). In Eastern Canada, snow accumulation is mostly influenced by temperatures rather than precipitation (this is not the case everywhere). Therefore, a net decrease in snow is expected, with greater inter-annual variability.

Historically, the Grand Lake region experienced approximately 7 days with snowfall greater than 10 cm and typically occurred from October to April. Projections depict a decreasing trend in heavy snowfall days. By the end of the century, a historically typical snow season will likely see approximately four days with snowfall greater than 10 cm (**Figure 2-2**).

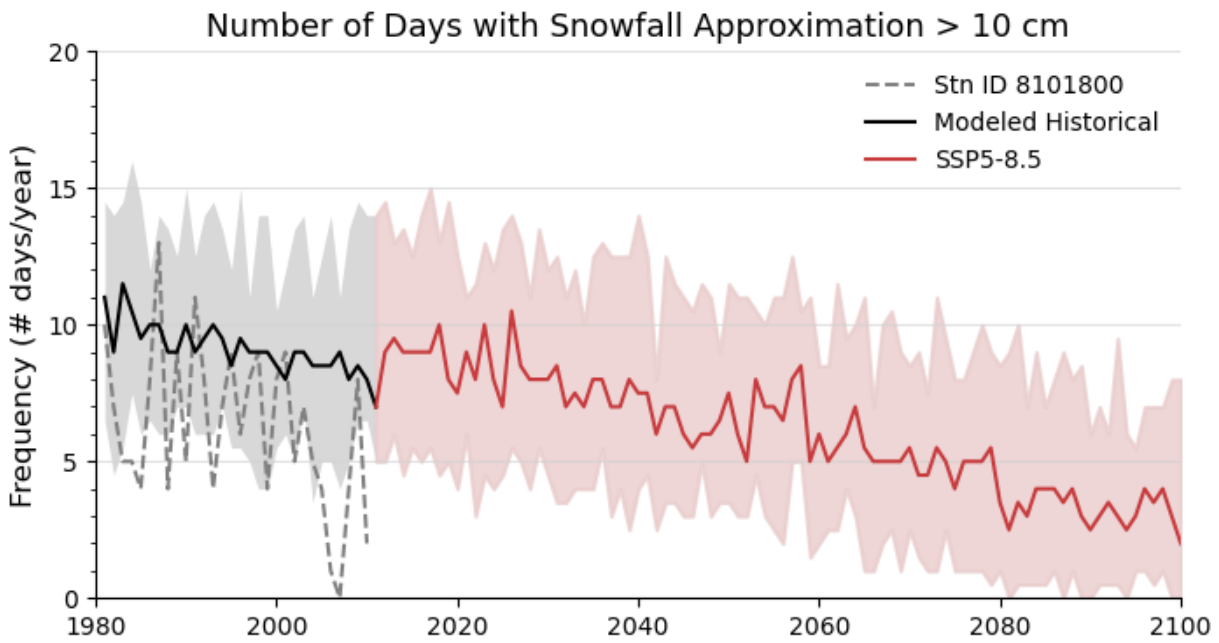


Figure 2-2: Projected snowfall > 10 cm during a typical snowfall season (October-April) in Grand Lake compared to both observed and modelled historical values. Historical snow days were obtained from Environmental and Climate Change Canada (ECCC) Climate Normals for Gagetown 2 Station (ID 8101800). Future values were projected using the SSP5-8.5 scenario from the CMIP6 climate models.

2.4.1.3 Freezing Rain

The formation of freezing rain, sleet, and ice pellets depends primarily on the vertical profile of atmospheric temperature. Freezing rain forms when snowflakes fall through a warm layer, then a layer of cold air that is too thin for the drops to have time to freeze. Water freezes on contact with the surface, forming glaze ice. In Atlantic Canada, such inversion in the vertical temperature profile is associated with a warm front that rapidly moves across the province with very high precipitation rates while subfreezing temperatures remain near the surface (Chartrand et al., 2022).

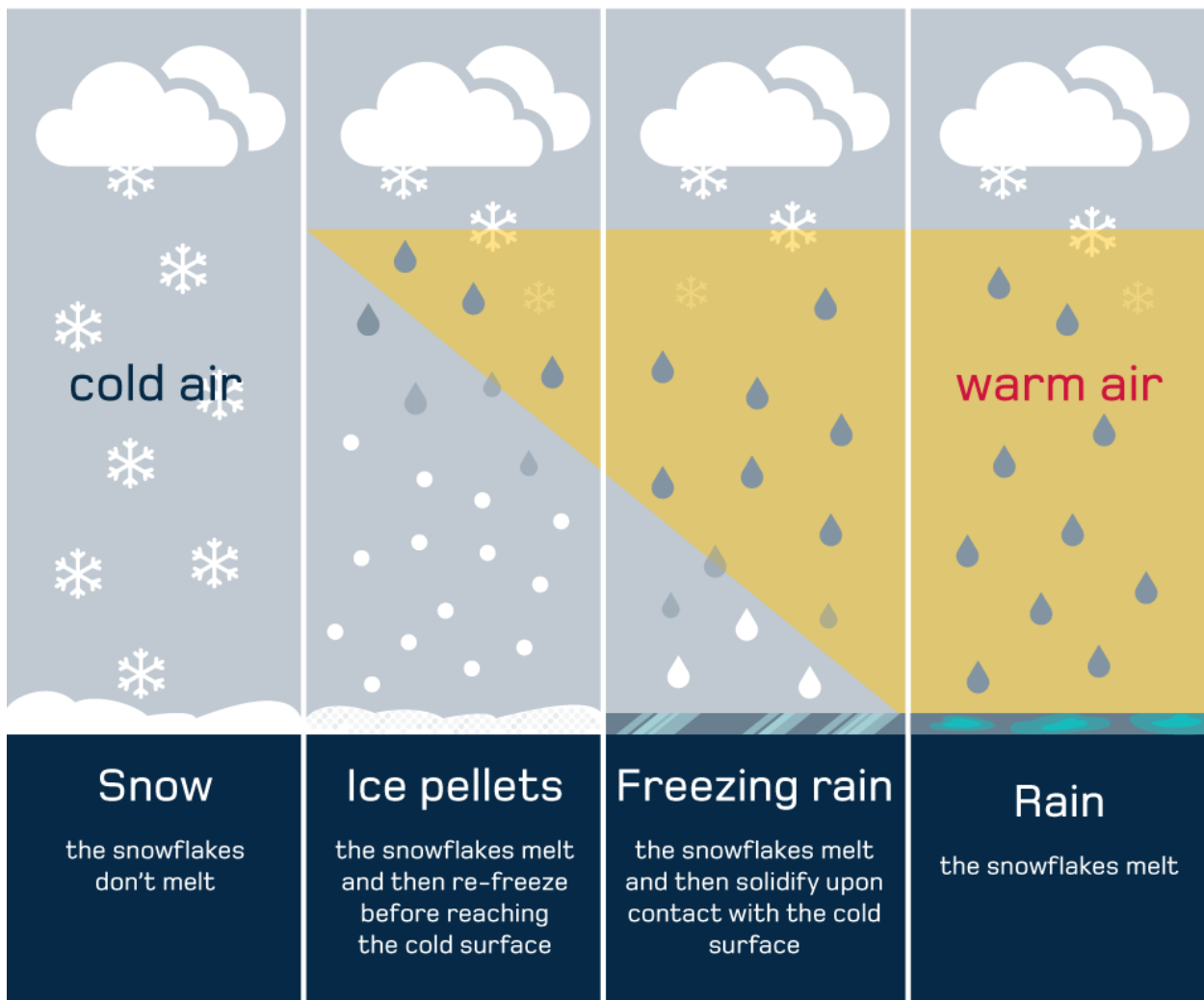


Figure 2-3: Atmospheric temperatures during the formation of various types of precipitation: snow, ice pellets, freezing rain and rain. Figure from Ouranos.



Note: The nominal ice thickness and corresponding range (mm) is indicated for each zone

Figure 2-4: The nominal ice thickness zones and corresponding range (mm) (CSA S6, 2019).

Grand Lake sits in a historically characterized heavy ice zone, with an average of 31 mm ice thickness (CSA S6, 2019). This part of New Brunswick typically saw 20-30 hours of freezing rain per year, with an average of about 2-4 extreme ice storm/ freezing rain exceeding 18 hours (Freezing Rain, 2023). However, decreasing changes in days per year with freezing precipitation events was observed in the last decade (2005-2014), compared to the previous three decades (1975-2004) (Groisman et al., 2016).

Future projections in freezing rain indicate potential decreases in the region due to temperature increases at both upper levels and the surface. Decreases are projected to be approximately 15% and 25% in the mid- and long-term, respectively (Cannon et al., 2020). However, extreme ice storms can still be expected due to a poleward shift of storm tracks (Klima and Morgan, 2015).

2.4.2 Temperature

The IPCC (2023) states that human activities have caused global warming, with global surface temperature reaching 1.1°C in the past decade relative to the 1850-1900 level.

However, Canada’s annual average temperature has increased at roughly twice that of global average (Bush and Lemmen, 2019). In New Brunswick, increases in the average temperatures for all seasons have been observed across the province, with a greater change in winter than summer. An upward shift of average temperatures is expected to correlate to changes in temperature extremes and freeze thaw cycles that can pose challenges on infrastructure.

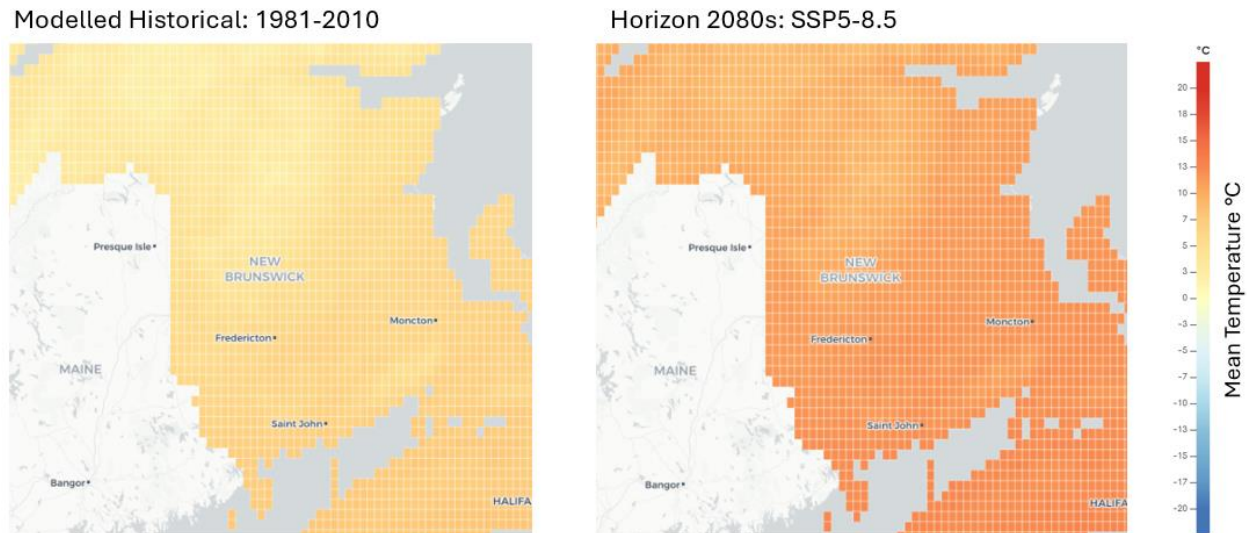


Figure 2-5: Projected mean temperature across NB for the 2080s under the CMIP6 SSP5-8.5 scenario, as compared with modelled 1981-2010 baseline value. (ClimateData.ca, 2026)

2.4.2.1 Warm Temperatures

Cooling degree days (CDD) represent how much, and for how long, outside air temperatures exceed a specified base temperature. For this study, a base temperature of 18°C was used. CDD are calculated by subtracting the base temperature from the mean daily temperature. For example, a day with a mean temperature of 25°C results in 7 cooling degree days. These values are commonly used to inform the design and sizing of mechanical systems that regulate indoor cooling.

Cooling degree days in New Brunswick are projected to increase as average temperatures rise throughout the province. In the Grand Lake region, CDD are expected to approximately double in the near term to about 310 CDD, compared with the historical baseline of roughly 150 CDD (obtained from ECCC Climate Normals for Gagetown 2 Station [ID 8101800]). This upward trend is projected to continue throughout the century, reaching as high as 740 CDD in the long term.

Increasing CDD will translate to greater demand for cooling energy during the summer months. This may place additional strain on building mechanical systems and present challenges for structures without adequate cooling capacity. Existing cooling systems may

not have been originally designed to accommodate such increased loads, potentially reducing their operating efficiency under future climate conditions.

These projected increases in cooling demand highlight the importance of ensuring that future HVAC upgrades, retrofits, and new building designs account for rising CDD values. Integrating climate-informed cooling requirements into building codes, mechanical system sizing, and long-term asset planning will support more effective adaptation to warmer summer conditions in the region.

2.4.2.2 Extreme Heat

Extreme heat was rarely experienced in the area, with only about 5 days per year with maximum temperature exceeding 30°C in the baseline period 1981-2010 (Gagetown 2 Station [ID 8101800]). Although mostly occurring in the summer season, Grand Lake has occasionally seen hot days in the shoulder months (i.e., May and September).

Extreme heat is projected to become more frequent and intense. This trend is expected to increase from 5 days per year to approximately 20 days in the near-term, 33 days in the mid-term, and 62 days in the long-term. In addition, the shoulder seasons will likely see more extreme heat occurrences.

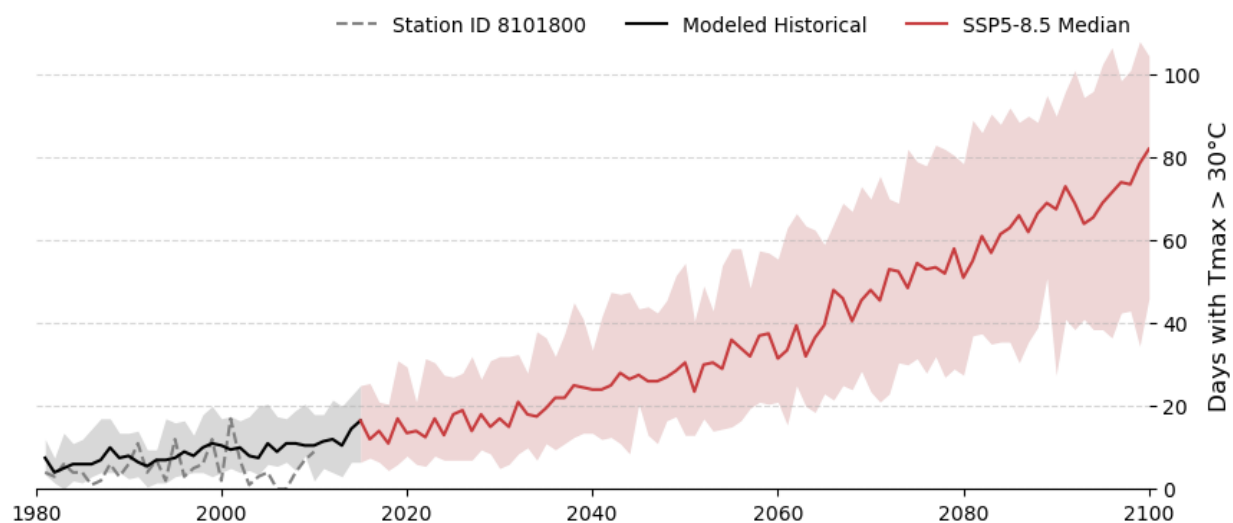
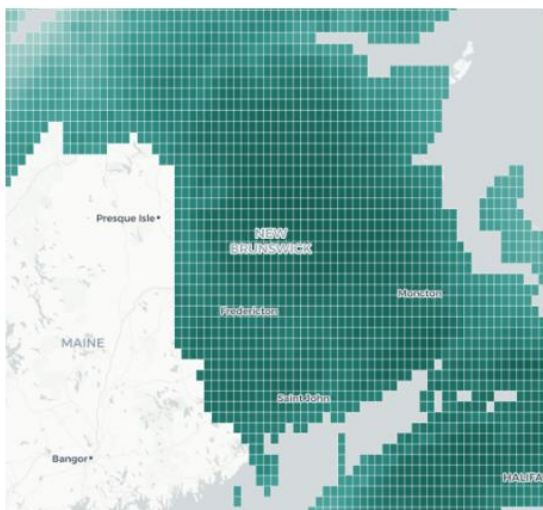


Figure 2-6: Projected number of days with maximum temperature > 30°C during historically warmer months (May-September) for the Grand Lake region under the CMIP6 SSP5-8.5 scenario.

2.4.2.3 Freeze-Thaw Cycles

Freeze-thaw cycles occur when temperatures fluctuate above and below 0°C, a common feature of temperate climates. Historically, these cycles have occurred most frequently during the transitional seasons, particularly in early spring, when the frozen ground begins to thaw and temperatures hover near the freezing point.

Modelled Historical: 1981-2010



Horizon 2080s: SSP5-8.5

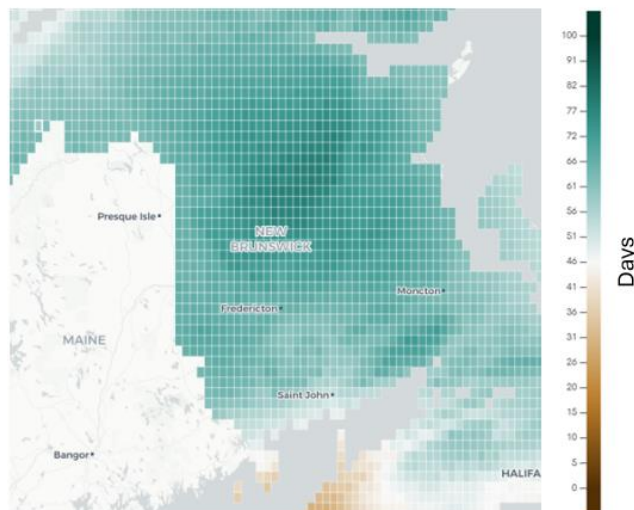


Figure 2-7: Projected number of annual freeze-thaw days (days where the maximum temperature is $\geq 0^{\circ}\text{C}$ and the minimum temperature is $< 0^{\circ}\text{C}$) across NB for the 2080s under the CMIP6 SSP5-8.5 scenario, as compared with modelled 1981-2010 baseline value. Source: ClimateData.ca, 2026.

With rising temperatures, the number of freeze-thaw days in the shoulder seasons (fall and spring) is projected to decrease, as temperatures will spend less time crossing the freezing threshold. However, winter temperatures are expected to warm enough that daily maximum temperatures may rise above 0°C while nighttime lows remain below freezing. As a result, more freeze-thaw cycles are anticipated to shift into the winter months.

Overall, the region is projected to experience an upward trend in winter freeze-thaw days, increasing from the historical value of approximately 30 days to about 50 days in the long term. Historical values are based on data from the Gagetown 2 Station (ID 8101800), due to limited long-term observations within the Grand Lake area.

2.4.3 Extreme Weather

Extreme weather events pose great challenges for infrastructure in the province and are usually caused by low and high pressure systems that travel through the region. Examples include winter storms and hurricanes that are typically accompanied by high winds and heavy precipitation. The following table characterizes each type of extreme weather event that would occur in different seasons.

Table 2.2: Extreme Weather Events by Season.

| Season | Weather and Event Description |
|--------|--|
| Winter | Frequent nor'easter-type systems bringing heavy snow, blowing snow, and strong winds; major storm impacts recently documented across NB. |

| Season | Weather and Event Description |
|---------------|--|
| Summer | Warm, humid conditions supporting thunderstorms, short-duration intense rainfall, and local gusty winds. |
| Fall | <p>Highest likelihood of tropical depressions, tropical storms, and post-tropical cyclones; systems can produce heavy rainfall and strong winds, due to warmer ocean temperatures after summer, resulting in hurricanes and tropical storms/depressions. In the Atlantic Ocean,</p> <ul style="list-style-type: none"> ▶ Tropical depressions are storms with 20-33 knot (37-62 km/h) sustained winds; ▶ Tropical storms are characterized by 34-63 knot (63-117 km/h); and ▶ Hurricanes are any storm event with winds above 64 knots (>117 km/h). <p>On average, Eastern Canada experiences 4-5 tropical cyclones each year.</p> |

As global temperatures climb, warmer temperatures provide more energy to fuel storms, making them more powerful and less predictable. As a result, storm-related hazards such as hail, damaging winds, and flash floods can be expected to become more frequent and severe in regions that have historically been subject to such events.

2.4.3.1 Hurricanes

Within the monitored historical period (1981-2025) available from NOAA, the area within a radius of 60 nautical miles of Grand Lake has been impacted by a total of 12 storms. One example of the destructive damage hurricanes can bring is Hurricane Arthur, which hit NB in 2014 (NB Power, 2019). The storm made landfall as a post-tropical storm and caused power outages to 195,000 homes and businesses, representing approximately 60% of the NB Power customer base. Power outages were caused by both high winds and fallen trees on power lines. Intense rainfall (100mm in Fredericton) caused flooding of roads and washouts. Storm surges were measured across the Acadian coastline.

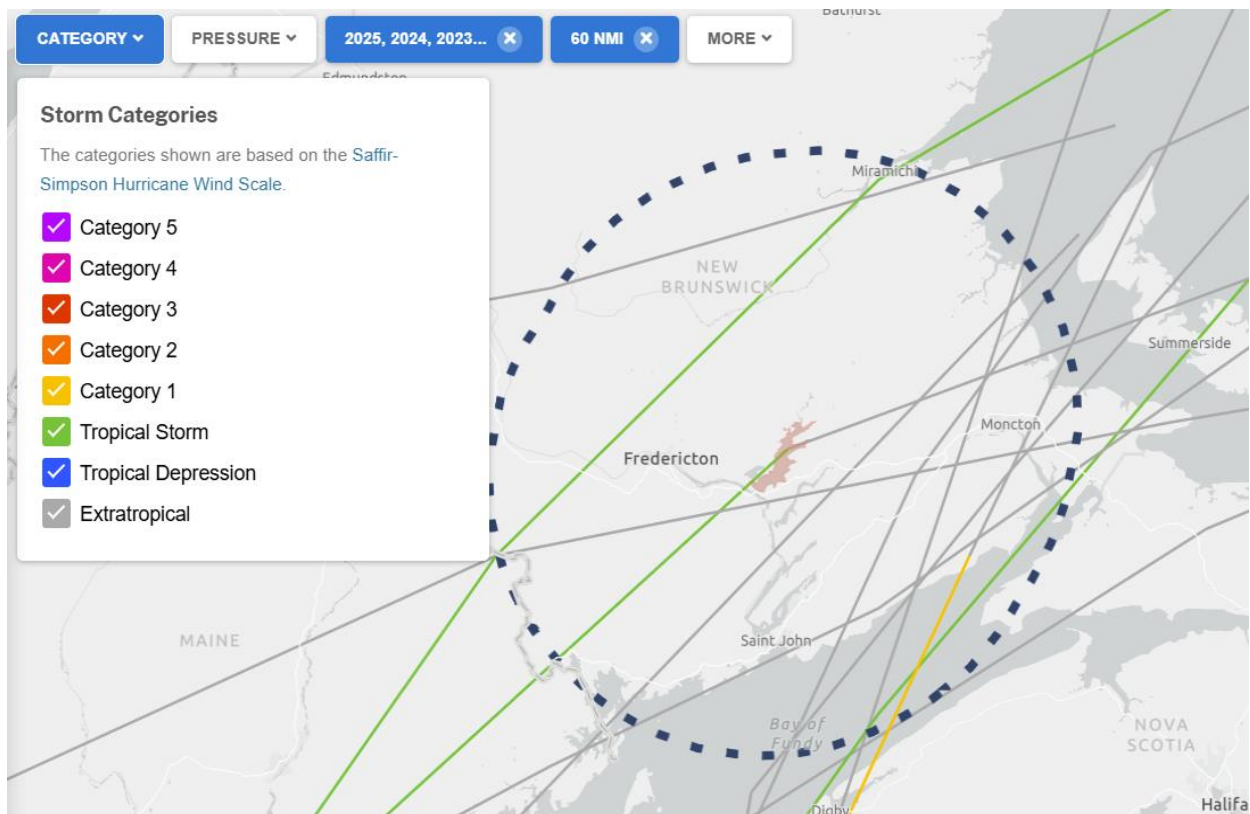


Figure 2-8: NOAA historical hurricane tracks from 1981-2025 within a radius of 60 nautical miles of the Municipality of Grand Lake.

Intensity of future hurricanes could be enhanced by the climate change induced rising sea surface temperature, which provides more energy needed for a hurricane to form. Warmer water not only increases the intensity of hurricanes but also strengthens their ability to hold moisture, leading to heavier rainfall during these events (Knutson et al., 2020). Therefore, it is expected that hurricanes and tropical storms will likely increase in intensity with climate change. In particular, there is a projected increase in the frequency of Category 4 and 5 hurricanes in the Atlantic, and the latitude of maximum intensity may move northward (Knutson et al., 2020; ClimateData.ca, 2024b).

2.4.3.2 Thunderstorms and Tornadoes

Thunderstorms and their associated hazards, including hail, high winds, heavy rain, tornadoes, and lightning are not unusual in the region. For example, an intense thunderstorm in 2015 brought heavy lightning, hail, and localized flash flooding to the Fredericton area, causing power outages and downed trees (CBC News, 2015). Although severe thunderstorms and tornadoes occur less often here than in the Prairie provinces or Ontario, they do still happen. In 2013, an EF1 tornado touched down near Jemseg, resulting in extreme winds up to 175 km/h and 15-km long destruction, power and communication outages (CBC News, 2013). Historical analyses from 1980–2009 classify much of New Brunswick as having some exposure to stronger F2–F5 tornado events, even though these remain rare (**Figure 2-9**).

These hazards typically form when the atmosphere has enough moisture, warm air near the surface, and instability, conditions that allow air to rise rapidly and form powerful storm clouds. As temperatures increase with climate change, the atmosphere can hold more moisture and accumulate more energy. This combination can create more favourable conditions for severe thunderstorms by enhancing the upward movement of warm, moist air, which is a key ingredient in storm development (ClimateData.ca, 2024a). Also see the discussion in the *Lightning and Wildfires* section.

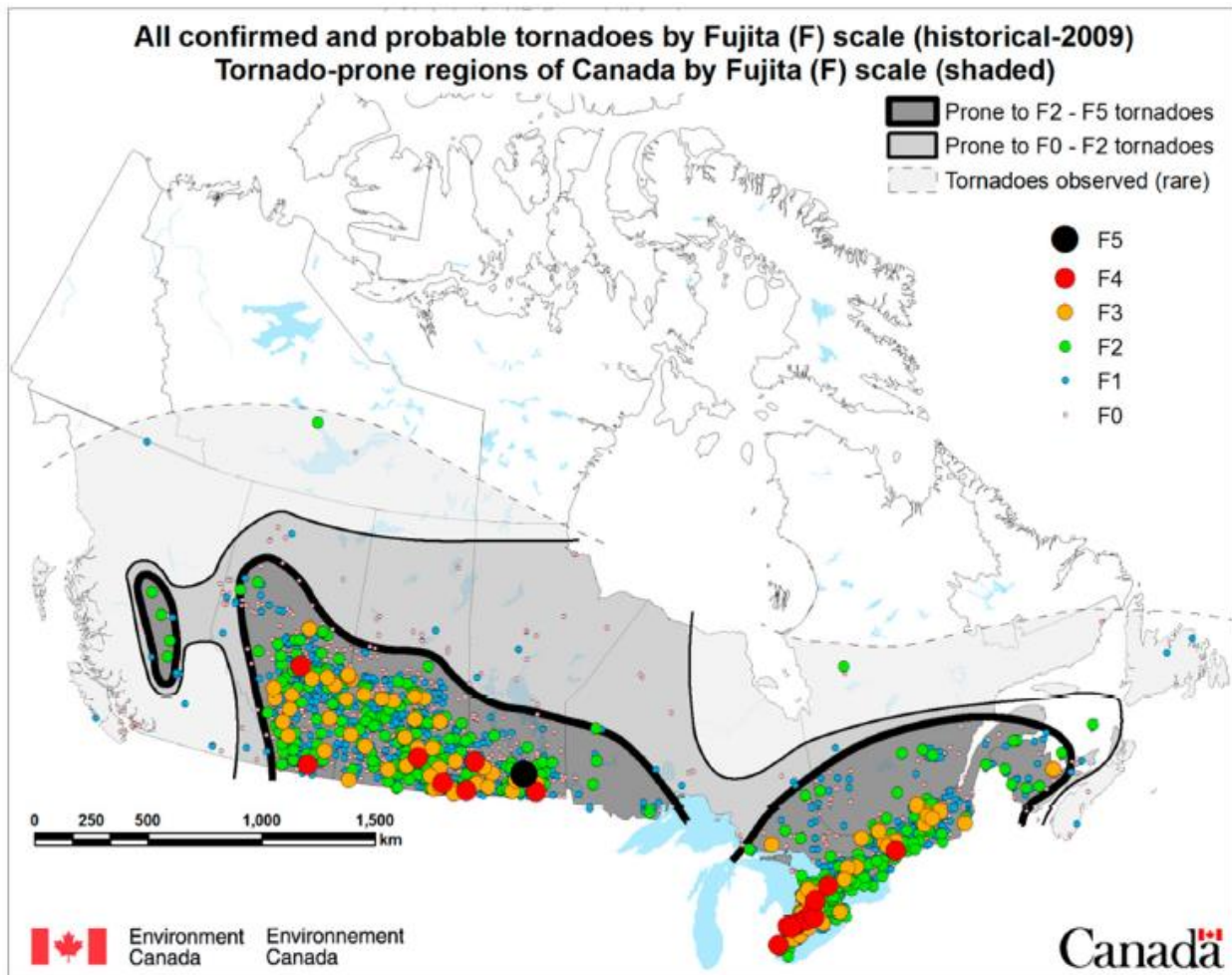


Figure 2-9: Confirmed and probable tornadoes from 1980 to 2009 highlighting prone regions to Tornadoes across Canada (Sills, 2013)

2.4.3.3 Winter Storms

Historically, the region has experienced high year-to-year variability in the frequency and intensity of winter storms. The 2009 “Snow bomb” storm dumped about 48 cm snow in Fredericton. Historical trends show insignificant increasing changes in the days with heavy snowfall and the highest 1-day snowfall during the 1948-2012 period, indicating more heavy snowfall days and more intense events.



Figure 2-10: “Snow Bomb” in 2009 in Fredericton. Source: (CBC News, 2009).

Although warming winter temperatures may result in a shift in winter precipitation from snow to rain, projections depict that winter storm occurrences will experience a slight decrease, however, intense high-impact snowfall events can be expected to continue to occur (McCray et al., 2023). This is because of a slight northward shift of storm tracks that has been observed and is projected to continue through this century (Bush and Lemmen, 2019). However, projections for winter storms have high uncertainty due to high year-to-year variability.

2.4.3.4 Riverine Flooding

The municipality lies within the New Brunswick Lowlands and is located adjacent to the Grand Lake (hereafter “the Lake”) system, with the Salmon River flowing past Chipman into Grand Lake. The short Jemseg River connects the Saint John River to the Grand Lake system, which functions as a natural floodwater storage area (Newton and Burrell, 2016). However, during high-flow periods, driven by seasonal runoff, snowmelt, and intense rainfall, water can flow in reverse through the Jemseg River into the Lake, resulting in elevated water levels and flooding in surrounding areas.

Recent riverine flood mapping completed through the GeoNB Flood Hazard Mapping Study provides the most up-to-date publicly available projections of extreme water levels for New Brunswick’s river systems. The study outlines the predicted location, frequency, and depth of both coastal and inland flooding and incorporates future climate change impacts.

For the Grand Lake region, the GeoNB mapping indicates that extreme water levels are expected to increase progressively throughout the century, driven primarily by heavy rainfall or a combination of rainfall of snowmelt. As a result, areas currently affected by flooding may experience more frequent and more severe flooding events across the future time horizons. These projections highlight the growing vulnerability of low-lying riverine infrastructure, homes, recreational assets, and natural habitats, emphasizing the importance of integrating forward-looking flood levels into land-use planning, emergency management, and community adaptation decisions.

Extreme flood water levels for two return period events in the Lake, as per the GeoNB Flood Mapping Study, are outlined in **Table 2.3**. Projections indicate that extreme flood levels may increase by approximately 0.6 m by 2100 compared to the present-day values for both the 1 in 20-year and 1 in 100-year events. Detailed flood hazard mapping for the region is available through the GeoNB Flood Hazard Mapping Database.

Table 2.3: Flood Levels Comparisons Between Present-Day and 2100 in Grand Lake.

| Extreme Flood Levels (m CGVD28) | | |
|---|-------------|------|
| Return Period (Annual Exceedance Probability) | Present-day | 2100 |
| 1 in 100-year (1%) | 7.12 | 7.7 |
| 1 in 20-year (5%) | 6.31 | 6.92 |

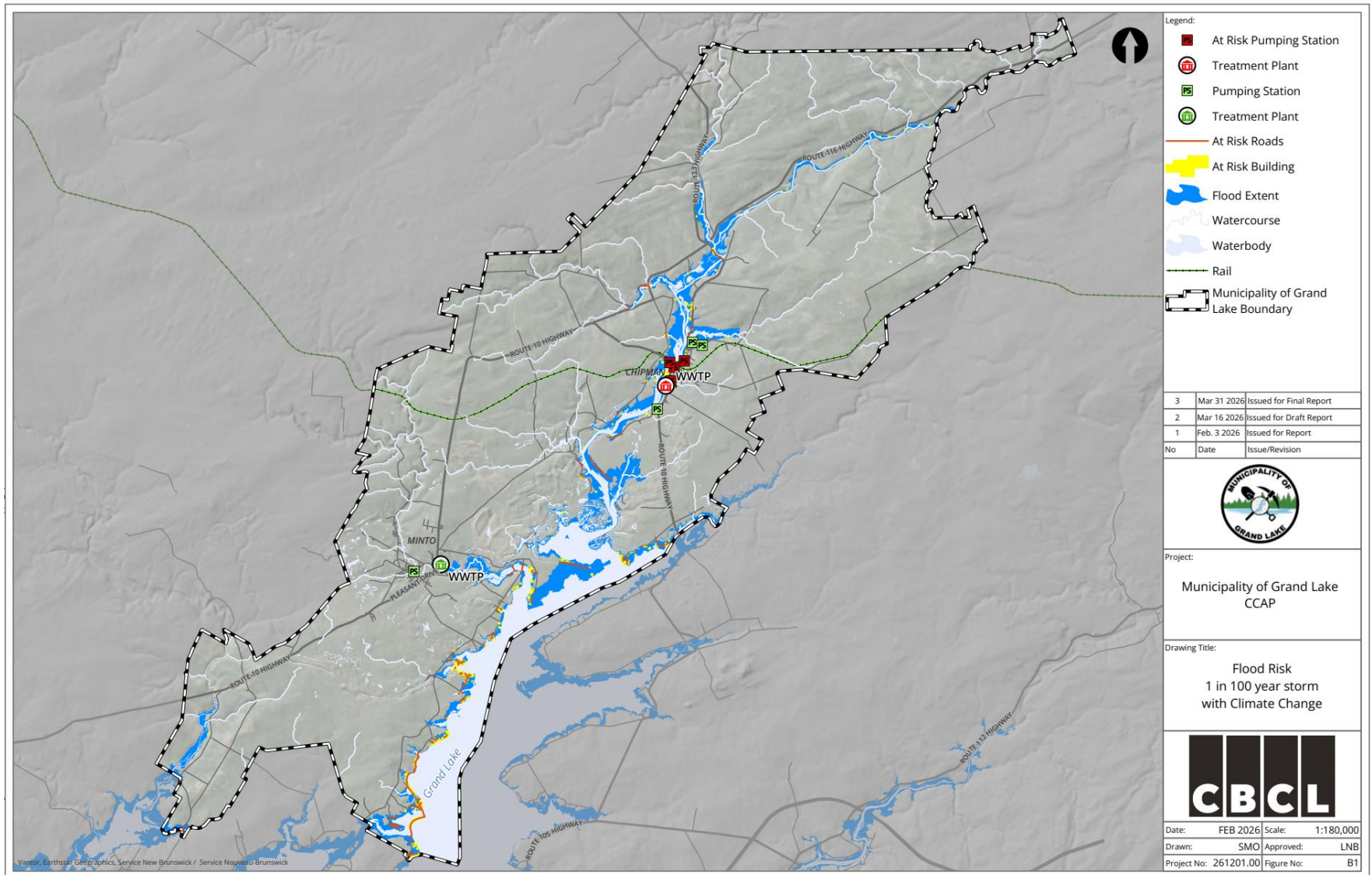


Figure 2-11: Flood mapping for the community

2.4.3.5 Extreme Wind

As one of the weather products of extreme weather conditions, extreme wind events are not uncommon in the region, which are generally associated with hurricanes and storms.

In the abovementioned future projections, the potential increase in intensity of hurricanes and winter storm events could result in great wind load on infrastructure. Projections depict small (about 10%) changes in the 1 in 50-year wind load over time in the region (**Figure 2-12**). However, wind projections from both global and regional climate models are limited by coarse spatial resolution, simplified boundary-layer physics, and large uncertainties in how models represent regional terrain and small-scale wind processes. Therefore, high uncertainty and low confidence in modelling should be taken into account when assessing wind-related projections.

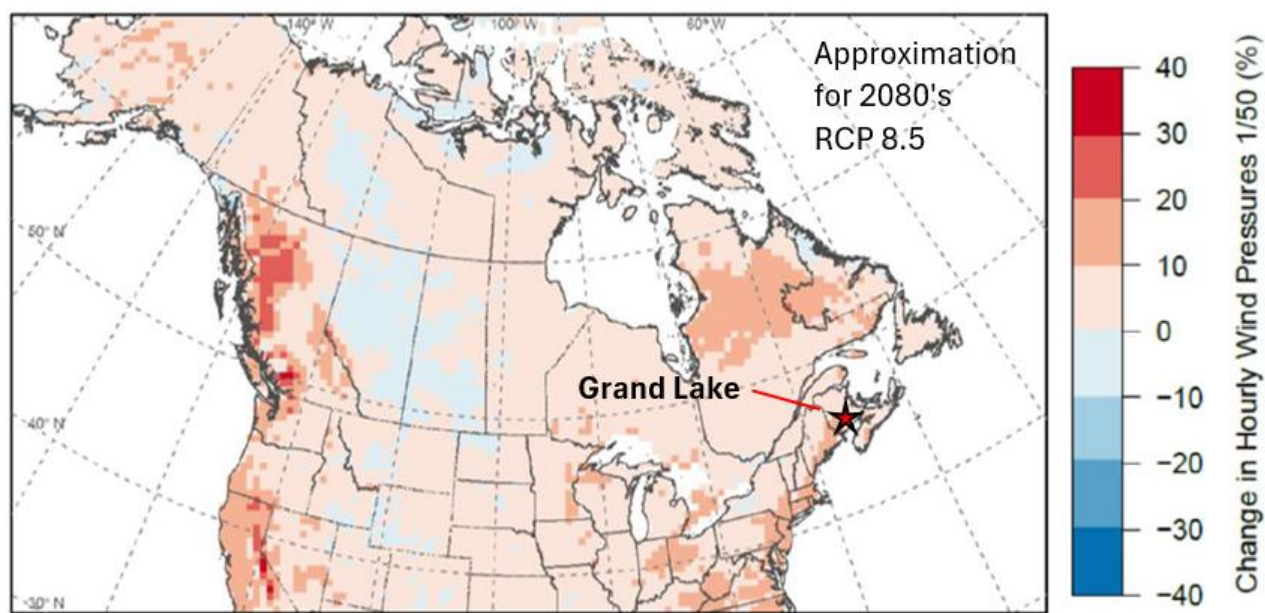


Figure 2-12: Projected changes (in percent) for 50-year return period design wind pressure for +3°C global warming levels with respect to the 1986-2016 baseline period (Cannon et al., 2020)

2.4.4 Other Hazards

Other climate-related hazards, including drought, lightning, and wildfires, also pose risks to the region. While these events have historically been less common than storms or flooding, projected warming and shifting precipitation patterns may increase their likelihood and impact.

2.4.4.1 Drought

Changes in the frequency of temperature and precipitation extremes are expected to alter the likelihood of droughts and wildfires in the region. Warmer air can hold more moisture,

and under a warming climate the hydrological cycle is projected to intensify. This leads to a pattern of more precipitation falling during extreme rainfall events (as noted in the *Extreme Rainfall* section), followed by longer dry intervals between storms (Bush and Lemmen, 2019). Rising winter temperatures may also reduce snowpack and cause earlier snowmelt, resulting in less meltwater available during the dry season for regions that depend on it for water supply. In addition, increasing summer heat extremes can accelerate evaporation and plant transpiration, further intensifying drought conditions.

Historically, although periodic droughts have occurred across much of Canada, prolonged or severe long-term droughts have been relatively uncommon (Bush and Lemmen, 2019). Droughts are even less frequent in the Atlantic Provinces (Bonsal et al., 2011). New Brunswick experiences high inter-annual and intra-annual variability in water availability, with rainfall, snowmelt, and groundwater all contributing to streamflow and fluctuating considerably throughout the year. Low river flows typically occur in late summer, when precipitation is minimal and evaporation is high, and again in winter, when precipitation is largely stored in the form of snow and ice until the spring melt (El-Jabi et al., 2016).

Recent conditions have demonstrated the region's growing vulnerability to seasonal water shortages. For example, in fall 2025, the Province of New Brunswick reported that both groundwater and surface water levels were well below normal across much of the province and issued broad public appeals for water conservation.

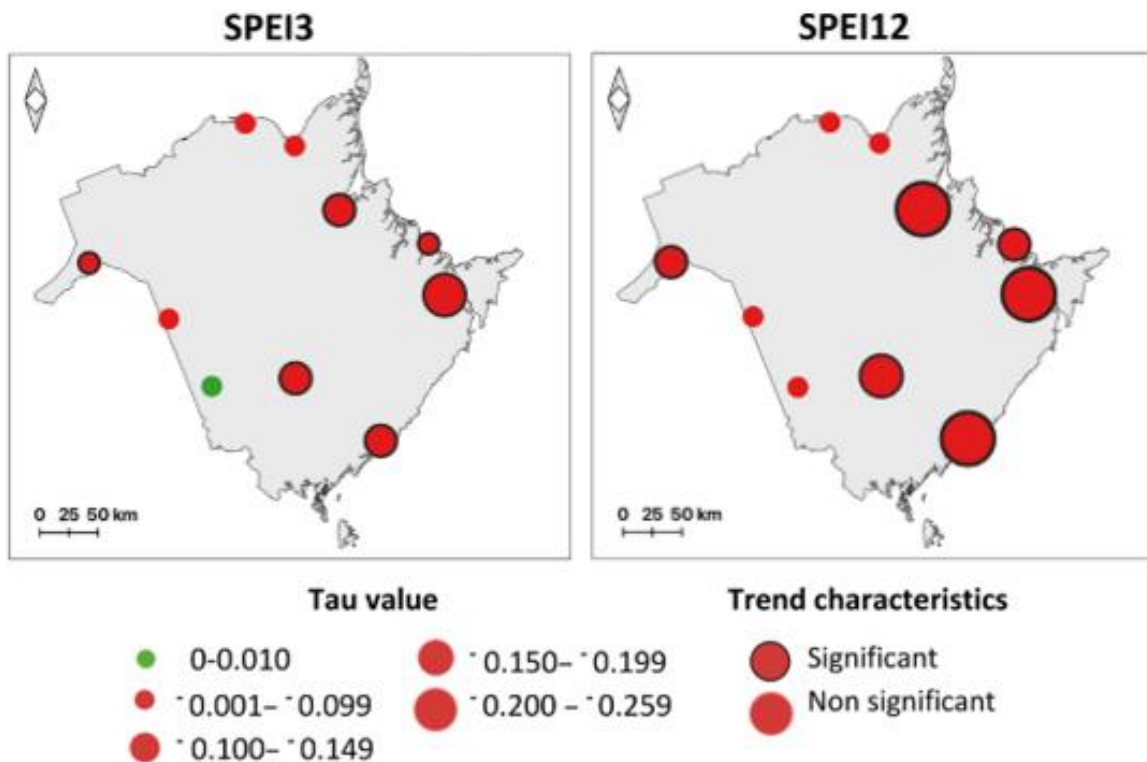


Figure 2-13: Spatial distribution for the trend analysis for SPEI at 3 and 12 months for 10 stations in New Brunswick (1971-2020), excerpted from Poirier et al. (2023).

In the future, higher variability due to climate change could result in more extreme low flow conditions. Atlantic Canada may be less susceptible to decreases in water availability, but a potential shift to more drought conditions is projected in both summer and autumn seasons (Tam et al., 2018). Extreme droughts are likely to have a lower return period, meaning a higher probability of occurring in a given year (Gu et al., 2023).

2.4.4.2 Lightning and Wildfires

Wildfires may start due to natural factors (i.e., lightning) and human influence, with the latter accounting for a significant portion. For example, in 2023, out of 209 wildfires that occurred in the province, only 10 were caused by lightning strikes. Conditions such as dry fuels, high temperatures, and extended low precipitation periods are favourable for wildfires. The most recent occurrence was the wildfire occurred between Chipman and Canaan Forks in September 2025 that burned over 650 hectares.

Lightning is the product of positive and negative charges in clouds, making contact with the



Figure 2-14: Fires burning out of control (red) in New Brunswick, as of September 22nd, 2025. Source: (Rewind 95.9, 2026)

positive charges on the ground to create what we perceive as a lightning strike. Lightning can be dangerous due to the unpredictability of where and how the strike will connect with the ground. Lightning strikes have the potential to damage buildings, electrical systems, wind turbines, and infrastructure that is not equipped with grounding devices. Control measures, such as lightning rods and grounds, can attract lightning strikes to a localized point, which will then dissipate the charge.

Grand Lake, similar to other areas on Canada’s east coast, does not experience as frequent and as many lightning strikes as other cities in central Canada (e.g., Ontario). From 1999-2018, Fredericton experienced an average of 19.7 days with lightning strikes per year. Presently, there is little scientific consensus on how the frequency and intensity of lightning storms (and/or extreme thunderstorms that can result in lightning strikes) will be impacted by climate change. Rising temperatures, however, are considered to be related to increases in convective available potential energy (CAPE) that can result in enhanced instability of the atmosphere and therefore initiate and strengthen severe convective storms (Climatedata.ca, 2024a). This, in turn, may create more favorable conditions for more frequent and intense lightning strikes.

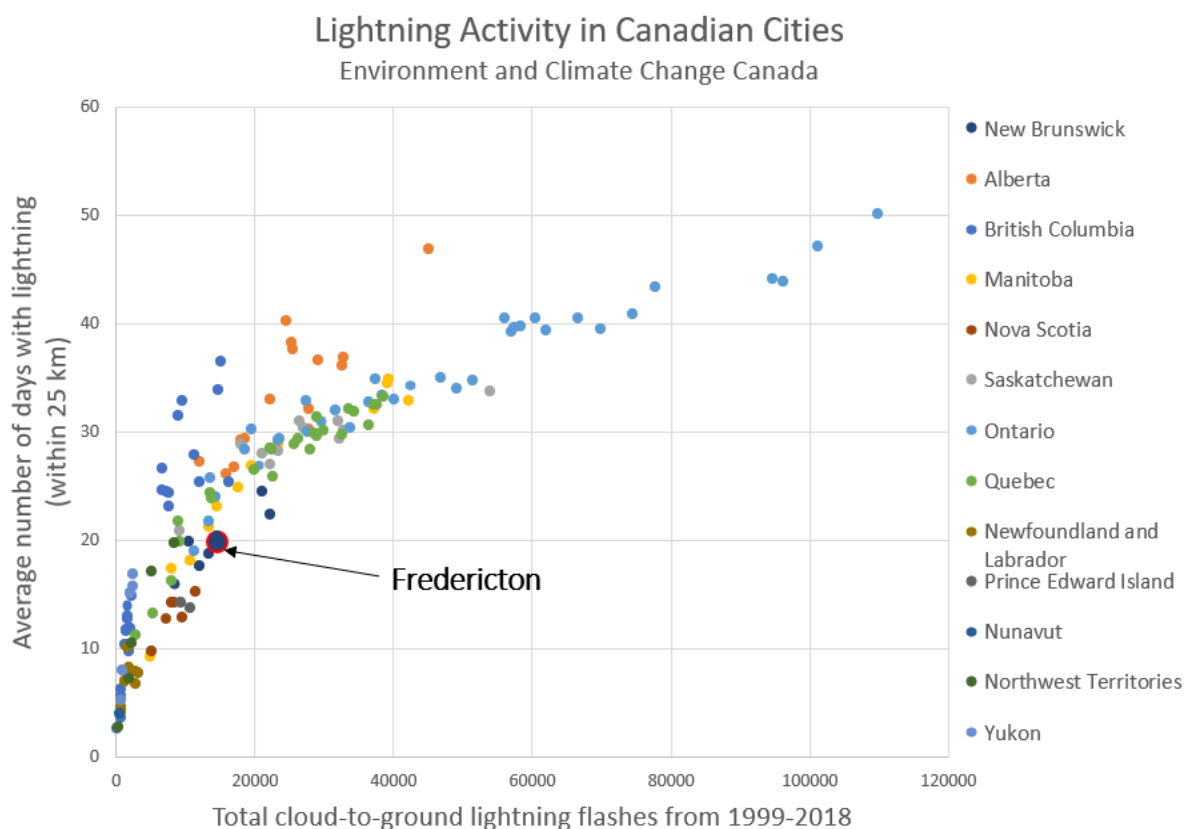


Figure 2-15: Baseline reference for Lightning (ECCC Lightning activities in Canadian Cities). In comparison to other major Canadian cities. Lighting for the region is interpolated from historical value for Fredericton.

Although the link between climate change and lightning isn’t straightforward, there is clear evidence of the impacts of climate change on forest fires, or rather on temperature and

precipitation. It is projected that the risk of wildfire will increase due to drier fuel, lengthened fire season, and increased number and extent of wildfires due to warmer temperatures (Flannigan et al., 2013). Moreover, an increase in the proportion of days in fire season with the potential for unmanageable fire is expected in the eastern boreal forest (Wotton et al., 2017).

With the increasing potential for wildfires both within New Brunswick and in neighbouring regions, such as Quebec and the Prairie Provinces, it is likely that wildfire smoke will travel into the region more often. This can lead to reduced air quality and associated health impacts, even when fires occur far from Grand Lake.

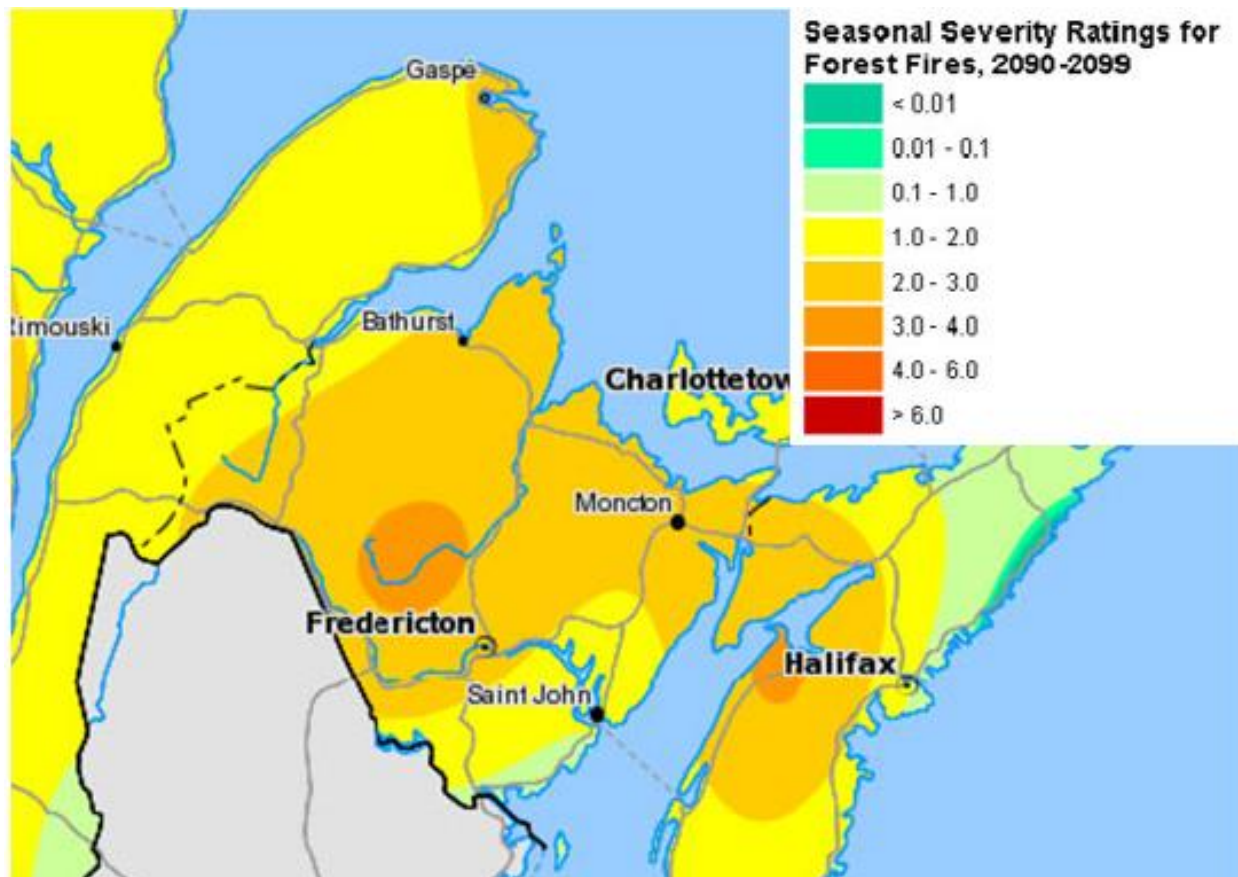


Figure 2-16: Projected seasonal severity ratings of forest fire between 2090 and 2099 with a tripling of atmosphere carbon dioxide (Natural Resources Canada, 2009).

The land surrounding Grand Lake is heavily forested with seasonal fire restrictions and limited fire breaks in place to prevent the spread of a wildfire. Although relatively rare, a wildfire in the Grand Lake area could have significant impacts, including public safety concerns, loss of potentially large areas of forest, danger to wildlife, health concerns due to smoke produced from wildfire, and infrastructure damage.

2.5 Projection Scores

Climate projections have been converted into likelihood scoring for the purposes of quantifying and prioritizing risk to the community. The PIEVC scoring system is designed to emphasize relative risk among different possible climate-infrastructure interactions. Different approaches (or scales) were used for different types of climate parameters (**Table 2.4**). The PIEVC scores assigned that are used in the quantification of risk are summarized in **Table 2.5**.

Table 2.4: Scoring Scales (#1-#3) for Likelihood Scores, Based on PIEVC Template.

| Score | Scale #1 | Scale #2 | Scale #3 |
|-------|--|--------------------------------|---------------------|
| | Return Period | % of Days in the Year | Qualitative |
| 0 | Significant Single Event (100+ years) | N/A | Negligible |
| 1 | Likely to occur once in 51 and 100 years | Not expected to occur annually | Highly unlikely |
| 2 | Likely to occur once in 31 and 50 years | 0 – 3% of the days | Remotely possible |
| 3 | Likely to occur once in 11 and 30 years | 4 – 35% of the days | Possible occasional |
| 4 | Likely to occur once per decade | 35 – 75% of the days | Somewhat likely |
| 5 | Likely to occur once or more annually | >75% of the days | Likely |

Table 2.5: Summary of PIEVC Scoring used in Risk Assessment.

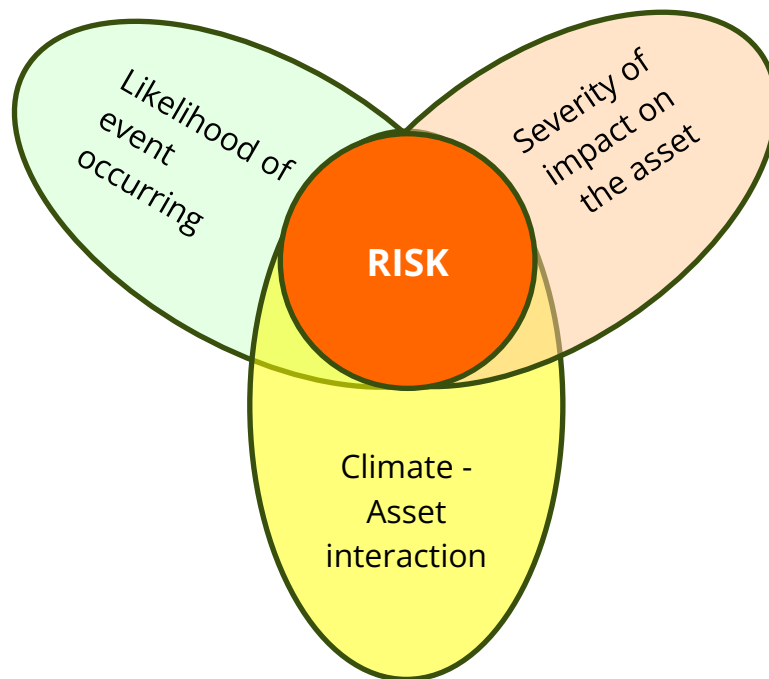
| Climate Category | Climate Parameter | Description | PIEVC Scoring Scale | Likelihood Scores | | | |
|-----------------------|--|---|---------------------|-------------------|-------|-------|-------|
| | | | | Baseline | 2030s | 2050s | 2080s |
| Temperature | Warm Temperatures | Cooling Degree Days > 18 °C | #2 (Percent Days) | 3 | 5 | 5 | 5 |
| | Extreme Heat | Days $T_{max} > 30$ °C in the Summer Season | #2 (Percent Days) | 2 | 3 | 3 | 4 |
| | Freeze-Thaw Cycles | Days with $T_{max} > 0$ °C and $T_{min} < 0$ °C | #2 (Percent Days) | 3 | 4 | 4 | 4 |
| Precipitation | Extreme Rainfall | 1 in 10-year 24 hour | #1 (Return Period) | 4 | 4 | 5 | 5 |
| | | 1 in 100-year 24 hour | | 1 | 2 | 3 | 4 |
| | Riverine Flooding | 1 in 100-year Water Level | #1 (Return Period) | 1 | 2 | 3 | 4 |
| | Snow Days | Days with Snowfall > 10cm | #2 (Percent Days) | 3 | 3 | 3 | 2 |
| | Ice Accretion | 1 in 20-year Ice Thickness | #1 (Return Period) | 3 | 3 | 2 | 2 |
| Wind & Extreme Events | Wind Load | 1 in 50-year Wind Load | #1 (Return Period) | 2 | 2 | 2 | 3 |
| | Winter Storms | Frequency / Intensity | #3 (Qualitative) | 3 | 3 | 3 | 3 |
| | Hurricanes and Tropical Storms (incl. Tornadoes) | Frequency / Intensity | #3 (Qualitative) | 1 | 1 | 2 | 2 |
| Other Hazards | Lightning | Average number of days with lightning strikes within 25km | #3 (Qualitative) | 3 | 3 | 3 | 3 |
| | Wildfire | Frequency and Intensity of Wildfire (incl. Air Quality) | #3 (Qualitative) | 1 | 2 | 3 | 3 |
| | Drought | Frequency and Intensity of Drought | #3 (Qualitative) | 1 | 2 | 3 | 3 |

3 Risk and Vulnerability Assessment

The PIEVC protocol provides the tools and guidelines necessary to quantify risks by conducting climate change risk assessments. This CCAP follows the guidelines outlined by the province’s Department of Environment and Local Government (A Guide for Climate Change Adaptation Planning for New Brunswick Communities, 2023).

An infrastructure risk assessment for climate change and extreme weather should answer three main questions:

- ▶ Is there a climate-asset interaction? (Exposure),
- ▶ How likely is it for an EWE to occur? (Likelihood), and
- ▶ If an EWE has already happened, what would the consequences be? (Severity)



The risk associated with a climate-asset interaction is a function of the probability of an event taking place and the extent to which said event will affect an asset, community, health, or the environment. Risk in a PIEVC risk analysis is simply the product of the likelihood of an event occurring and the severity of the events impact.



The likelihood scores for each climate change and extreme weather parameter are presented in **Table 2-5**.

A good rule of thumb is to assume that an asset exposed to an extreme weather event is at risk. However, that may not always be the case. For instance, an infrastructure asset located inland may not necessarily be affected by sea level rise. The risk calculation presented above assumes that there is an exposure. For any asset without an exposure to the climate change or extreme weather event, or with an exposure that is considered to be sufficiently low, that interaction is screened out and will not proceed to the risk assessment.

The first step during a PIEVC risk assessment is to recognize if there is a potential relationship between the identified assets and the weather parameter against which each asset is assessed. By creating the risk assessment table with the assets in the columns and the weather parameters on the rows, climate interactions can be visualized. Climate-asset interactions were evaluated based on background information provided by the Municipality, literature review conducted by CBCL, feedback provided by the steering committee, and professional engineering judgement. The interactions are detailed in the Risk Matrix (Appendix B).

3.1 Impact Assessment

Vulnerability assessments are conducted for each climate-asset interaction identified to quantify the potential impacts that might occur from each interaction. Assets may exhibit vulnerability to weather hazards in several ways and are broadly categorized into three types of vulnerability for the purpose of this assessment:

- ▶ Infrastructure (physical and operational vulnerabilities)
- ▶ Health, Safety, Environment
- ▶ Socio - Economic

This impact is quantitatively represented through an assigned consequence score ranging from one to five. The scores include considerations for existing condition/performance of the asset, operations/operator experience, professional judgement, owner history, and input from the Steering Committee.

For some impacts, such as social and cultural impacts, a qualitative assessment of risk is the most practical approach. For some assets, such as the Burpee Bridge for example, the significance of the impact may be more closely tied to the social and cultural implications, rather than a loss of function. The bridge was built in 1913 and is of historical and cultural significance to the local community. The 2018 flood maps released by The Department of Environment and Local Government indicate that the flood waters stopped just a few kilometers from the structure. However, future climate projections show that the floods will surround the bridge (New Brunswick Flood Hazard Maps, n.d.). While assessing the impact severity on this bridge due to riverine flooding, the age of the bridge, along with examples of other historic covered bridges in the area subjected to flooding, were also considered.

Starkey Bridge in Codys, built in 1912, is one of the two covered bridges still standing in Queens County (the other one being Burpee Bridge). It was temporarily closed to undergo repairs after suffering structural damages caused by the 2018 floods and was opened to the public in 2024 (MacRae, 2024). On the other hand, The Bell Bridge in Hoyt, built in 1931, was damaged so severely from the 2018 floods that it was deemed unsalvageable and had to be replaced the same year to provide access to the local community (The Weather Channel, 2018). Reportedly, New Brunswick had about 340 to 350 covered bridges around 1950. The province lost three covered bridges in 2025 alone due to deteriorating conditions and only 56 remained towards the end of that year (Haggett, 2025). This serves as an example of how social and community connections are valuable inputs into the risk assessment.

Table 3.1 Severity Scoring Scale

| Score | Impact Description | | |
|-----------------------|---|---|---|
| | Infrastructure | Health, Safety, Environment | Socio-Economic |
| 1 Very Low | <ul style="list-style-type: none"> • Typical wear and tear to infrastructure. | <ul style="list-style-type: none"> • No measurable change in environmental conditions. • No additional impact on human health and safety beyond what already exists. | <ul style="list-style-type: none"> • Little to no financial impact on municipality or residents. • No service disruptions. |
| 2 Low | <ul style="list-style-type: none"> • Minor physical impacts (damage) to infrastructure. No change to performance or capacity. • No impact on services, recreational areas, etc. | <ul style="list-style-type: none"> • Some measurable changes in environmental conditions. • No additional impact on human health and safety beyond what already exists. | <ul style="list-style-type: none"> • Damage/repairs within range of insurance coverage (e.g., up to \$250k). • No significant impact on municipal budgets. • Little to no additional funding required (e.g., provincial or federal). |
| 3 Moderate | <ul style="list-style-type: none"> • Moderate physical impacts to infrastructure assets that may result in minor loss of function or capacity. • Some disruption to services. | <ul style="list-style-type: none"> • Some impact on the environment. • Possible health and safety risk to residents or visitors, though hospitalizations or medical emergencies are unlikely. | <ul style="list-style-type: none"> • Damage/repairs exceeding insurance coverage (e.g., \$250k - \$500k). • Outside funding resources may be required (i.e., insufficient municipal resources). • Intervention may be required to restore/maintain services. |
| 4 High | <ul style="list-style-type: none"> • Major physical damage resulting in substantial loss of asset function or capacity. • Short term closure of services/ municipal areas (hours up to a day). | <ul style="list-style-type: none"> • Significant impact on the environment. • Possible risk of hospitalizations or medical emergencies (though infrequent). | <ul style="list-style-type: none"> • Damage/repairs far exceeding insurance coverage (e.g., between \$500k - \$1M). • Outside funding and/or resources (e.g., contractors) are required to conduct repairs or re-establish services. |
| 5 Extreme | <ul style="list-style-type: none"> • Extreme damage beyond repair. • Complete loss of function/ critical asset. • Closure of services/ municipal areas for extended period (e.g., days). | <ul style="list-style-type: none"> • Catastrophic impact on the environment. • Major health and safety risk to residents and visitors. • Medical emergencies/ hospitalizations likely. | <ul style="list-style-type: none"> • Damage/repairs required >\$1M. • Federal or provincial funding is required to rebuild assets. • Long-term disruption of services. |

3.2 Community Consultation

The severity of potential climate impacts to the community can be better understood by including the knowledge, experiences, and concerns of residents and visitors to the Municipality of Grand Lake. A survey was developed using Microsoft Forms by CBCL and provided to the Municipality to circulate to community members for voluntary online participation. Questions related to extreme weather events experienced by the community and the impacts that those events had on their health, property, finance, and/or business were presented. These questions aim to bring out different perspectives of the severity of the events and assign priority. Some questions were targeted to assess the preparedness of the individual during extreme weather events. Finally, participants were asked what climate-related issues they would like to see addressed in their municipality's CCAP. CBCL also solicited feedback from Steering Committee members.

To date, the following feedback has been logged:

General

- ▶ The 2025 season has highlighted concerns related to a changing climate. It is evident that the climate is certainly in flux.

Flooding

- ▶ When highlighting the damages done by the flooding in the Grand Lake area in 2018 and 2019, there were many cottages and homes destroyed when the waves knocked the homes off their foundations or collapsing walls and basements.
- ▶ In the 2018 floods, people were trapped by flood water and had to use boats to get to work.
- ▶ There is an ongoing challenge for residents who can't sell their homes due to past flooding and don't know how, if its possible, to reduce future flood risk.
- ▶ There is sensitivity and stress related to flooding across the community. Will it be my home next year? Will the next flood be worse? The community needs more education on the extent, likelihood, and frequency of flooding in the future.
- ▶ Some people have invested in raising their homes, but what is the right elevation? How will this impact emergency response? What about waves?
- ▶ Some residents noted concerns about the way water is managed in the Saint John River (by NB Power) at the Mactaquac dam. They feel priority is given to reducing water levels upstream of the dam, which leaves homes caught between the dam and the Reversing Falls (at the Saint John Harbour), vulnerable to flooding.

Extreme Temperatures and Heatwaves

- ▶ Community members are concerned over the 2025 heat wave and the associated wildfires.

- ▶ The current estimates for the Grand Lake region are in the range of 96 persons per year who go to the hospital for heat-related injury or illness each year.
- ▶ Heat related stress, illness, and injury have been observed in the community. This is particularly relevant for the elderly or those with chronic conditions.
- ▶ Many retired folks don't have AC and don't have the income to support that kind of upgrade. In the past, extended periods of high temperatures weren't common, so people don't know how to behave. For example, people may open their windows when it's 35 degrees out (with humidity) and it warms up their home even more than with the windows closed. People aren't generally educated on the risks and therefore don't know what to do when it happens.
- ▶ The number of consecutive hot days in a row is relatively new for our region. Especially where the heat doesn't break at night to cool down the house. This has a big impact on indoor temperature and becomes dangerous for some. Some seniors also don't have internet, and they don't know who to call or where to go in these circumstances.
- ▶ For some people, there is a stigmatization related to seeking relief at a cooling center. It might imply that a person can't afford cooling equipment at home or that they're incapable of helping themselves, among other thoughts. Having a community area where people can casually seek relief from the heat without it being labeled as an emergency would be a good option.

Emergency Response Plans

- ▶ There is a general lack of knowledge or understanding of extreme weather-related plans or emergency response protocols. There is a lack of public awareness of the plans (if they exist) and what to expect in an emergency.
- ▶ There is generally no public knowledge on where the warming and cooling or charging stations exist for extreme events. Some people have adapted by purchasing generators or wood stoves in their homes, but many rely on their social network during an extreme event, such as a power outage.
- ▶ Rural communities are generally more resilient as people are accustomed to maintaining their own properties and relying on neighbors. People can handle routine extreme weather for the most part, but there are some that are left behind and for these folks the community knowledge isn't there.
- ▶ The population of Minto is aging. The demographic is older than many municipalities in New Brunswick and is the oldest health zone in the province. Relying on social networks may fail in the future and better communication with these groups is important.
- ▶ Better education is required on when to go to the hospital, or to seek other intermediate steps. Right now, it's either stay home or call 911 and go to the hospital. In some circumstances, that may not be necessary and is placing additional strain on our public health resources. Having an intermediate level of intervention through a senior's resources centre or community centre, such as at the library, would be helpful. Having a public health nurse present could also be beneficial.

Drought

- ▶ Community members raised concerns about water levels in the Salmon River and associated tributaries which lead into the whole Grand Lake. Local observations show the lowest summer water levels in my 10 years on the river.
- ▶ In 2025 there were many locals whose wells went dry and for some they have not yet recovered as of the winter of 2025-2026. The water level at freeze up was also at historical lows. This will impact homeowners and private businesses, including tourism.
- ▶ As emergency responders I think we need to have better access to water, especially in more isolated areas of our community.

Wildfires

- ▶ Looking at what happened in Nova Scotia, that could have happened in Grand Lake too.
- ▶ Forest fires are a top concern for many residents. There was a fire close to Chipman reminded residents of the potential dangers and unpredictability of fires. There is generally a lack of knowledge around emergency response plans during a fire. The community doesn't need all the details but would benefit from a general sense of the plans and procedures and how it would affect them. Also, if there are pockets of the community that is at a greater risk, this should be better communicated.
- ▶ Changing air quality as a result of forest fires, sometimes far away in Quebec dependant on the wind direction, is impact people with existing conditions, such a COPD. If its also hot, then toy can't open your windows to seek relief.
- ▶ Additional community consultant on the implementation plan for recommendations identified in this report is important. The ability and interest of the community in actioning these recommendations depends on seeking their input and gaining buy-in.

3.3 Risk Matrix

Risk assessments are completed for short-, intermediate-, or long-term timelines depending on the expected asset useful life of the asset. Assets are assessed under various climate change scenarios (lower, medium and higher estimates) and related extreme weather events where appropriate.

As described in section 3.1, the risk matrix uses the concepts of severity and probability ratings to determine risk. Severity and probability scores are assigned from 1 - 5 based on site specific analysis and professional judgment of the assessment team and are then validated during a risk assessment workshop involving the infrastructure owners, managers, design team, and operators (etc.).

Table 3.2 Risk Matrix Used in the Study

| | | | | | | |
|---------------------------------------|--|---|----|----|----|----|
| Severity | 5 | 5 | 10 | 15 | 20 | 25 |
| | 4 | 4 | 8 | 12 | 16 | 20 |
| | 3 | 3 | 6 | 9 | 12 | 15 |
| | 2 | 2 | 4 | 6 | 8 | 10 |
| | 1 | 1 | 2 | 3 | 4 | 5 |
| | 1 | 2 | 3 | 4 | 5 | |
| Likelihood | | | | | | |
| Resultant Risk Classification: | | | | | | |
| 1, 2 | Very Low Risk: Controls are not required; no need to include in action plan. | | | | | |
| 3, 4 | Low Risk: Low priority for control measures. | | | | | |
| 6, 8, 9 | Medium Risk: Some controls may be required, use professional judgement to determine if action is necessary. | | | | | |
| 10-16 | High Risk: High priority for controls. Develop options for risk reductions. These interactions are second priority. | | | | | |
| 20-25 | Extreme Risk: Highest priority for controls. Develop options for risk reduction. | | | | | |
| 5 | Special Case: Requirements for control are considered on a case-by-case basis. | | | | | |

The risk matrix is presented in Appendix A. The following section summarizes the results.

3.4 Prioritization of Risks

Based on the assessment of risk, the following are the highest ranked risks in the community:

| # | Climate Parameter | Affected Asset or Environment |
|----------------------------------|--------------------------|--|
| Extreme Risk (score = 20) | | |
| 1 | Riverine Flooding | Emergency Response High Risk Facilities* Roads and Bridges Residential and Commercial Buildings |
| 2 | Extreme Heat | High Risk Facilities* |

| # | Climate Parameter | Affected Asset or Environment |
|--------------------------------------|--------------------------|--|
| High Risk (score = 15 and 16) | | |
| 3 | Riverine Flooding | Wastewater collection Recreation and culture Land-use Policies |
| 4 | Extreme Heat | Emergency Response Tourism |
| 5 | Extreme Rainfall | Emergency Response High Risk Facilities* Roads and Bridges Wastewater Collection Stormwater Management Recreation and Culture Residential and Commercial Buildings |
| 6 | Winter Storms | Emergency Response |
| 7 | Wildfires | Emergency Response High Risk Facilities* Potable Water Supply Residential and Commercial Buildings |
| 8 | Drought | Potable water supply |

* Community health centers, senior care facilities, schools, daycares

4 Adaptation Plan

Climate adaptation plans help communities respond to risks and vulnerabilities. Adaptation refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change (UNFCCC, 2025). This Chapter outlines a series of adaptation actions for the top priority risks determined through the risk assessment process. Each of the high and extreme risks identified during the risk assessment are addressed in the subsequent sections, with recommendations for adaptation aimed at reducing the impacts to an acceptable level.

The purpose of each recommended action is to improve community resilience to climate change and provide direction towards implementing these actions. The adaptation measures to address each risk were developed based on information received throughout the risk assessment process from background documents and input from community organizations, public input, as well as the professional judgment of the risk assessment team.

Recommended adaptation actions have been grouped into categories, with multiple recommendations provided in each category to address an overarching community asset or features. The categories included are as follows:

- ▶ Riverine Flood Preparedness and Mitigation
- ▶ Emergency Response Preparedness
- ▶ Heat-related risks and Preparing for Heatwaves
- ▶ Extreme Rainfall Resilience
- ▶ Wildfire Resilience Planning
- ▶ Drought Management Planning

Recommendations include monitoring and maintenance, planning initiatives, communication, education, and/or additional studies. Each action item is summarized in a table at the end of each recommendation section that includes the following information to support its implementation:

- ▶ **Action Item:** Number as listed in the report.
- ▶ **Description:** Short description of the action item.
- ▶ **Implementation Lead:** Organization responsible for initiating the actionable item.

- ▶ **Potential Partner(s) and Resources:** Organizations or community groups who can potentially be leveraged for support in implementing actionable items.
- ▶ **Timeline:** Recommended timeframe for implementation as follows:
 - Ongoing: Actions that are currently being taken and should be continued or expanded
 - Short Term: 1-3 years
 - Medium Term: 3-7 years
 - Long Term: 7+ years.
- ▶ **Estimated Level of Effort**
 - Low: Easy to implement/Low Cost
 - Moderate: Doable, but difficult/Moderate Cost
 - High: Very Difficult/High Cost

Timelines recommended for each action item are generally based on the timeframe associated with each risk as determined through the risk assessment. For example, risks that present themselves in the short-term are typically higher priority and therefore have shorter timelines for implementation, whereas medium-term or long-term risks have a lower priority and therefore longer timeframe for implementation. The estimated level of effort is based on an estimate of the lead organizations readiness to execute the actionable item.

4.1 Priority Based Adaptation Actions

Many priority risks have overlapping adaption actions. For this reason, the following section combines risks together into adaption priorities. The following sections outline the recommended actions to address each of the high and extreme risks identified during the risk assessment. A summary table of all action items is included in Appendix C.

4.1.1 Riverine Flood Preparedness and Mitigation

Action 1.1: Adopt updated land use plans for flood resilience

Riverine flooding is a major source of flooding with significant impacts to built infrastructure, emergency response, and community wellbeing. The areas adjacent to Salmon River and Grand Lake are vulnerable to flooding events and the frequency and intensity of such events in the future are projected to increase significantly towards the end of the century. The region would greatly benefit from adopting land use policies that are crafted to reflect the changing climate, thereby eliminating or reducing the risks to public safety, infrastructure, and disruptions to emergency services.

Updating zoning by-laws for flood risk reduction in new development is an ongoing priority for Grand Lake. The community is currently considering draft by-law amendments that

would establish a floodplain overlay to limit certain types of development in flood risk areas. It is recommended to:

- ▶ Differentiate the floodway and flood fringe areas as defined in the statements of provincial interest (New Brunswick Statements of Public Interest User Guide, n.d.,) (see Figure 4-1). Those include:
 - FH.1: identify flood and natural hazard areas using the provincial flood hazard mapping, provincial erosion mapping, and other resources.
 - FH.2: Promote land use and development in areas other than flood and natural hazard areas.
- ▶ Consider what flood proofing measure, if any, are acceptable for development within the flood fringe overlay. For example: *It shall be the policy of council to limit the types of land use permitted and require appropriate floodproofing measures be detailed as part of any development application taking place within the flood fringe area overlay.*
- ▶ Consider restricting development in the floodway. For example: *It shall be the policy of council to prohibit development within the floodway area overlay.*
- ▶ Consider that the flood hazard maps developed by the Government of New Brunswick do not include waves, which have historically been an impactful contributor to flood hazard in the community. See Action 1.2 for additional details on this.

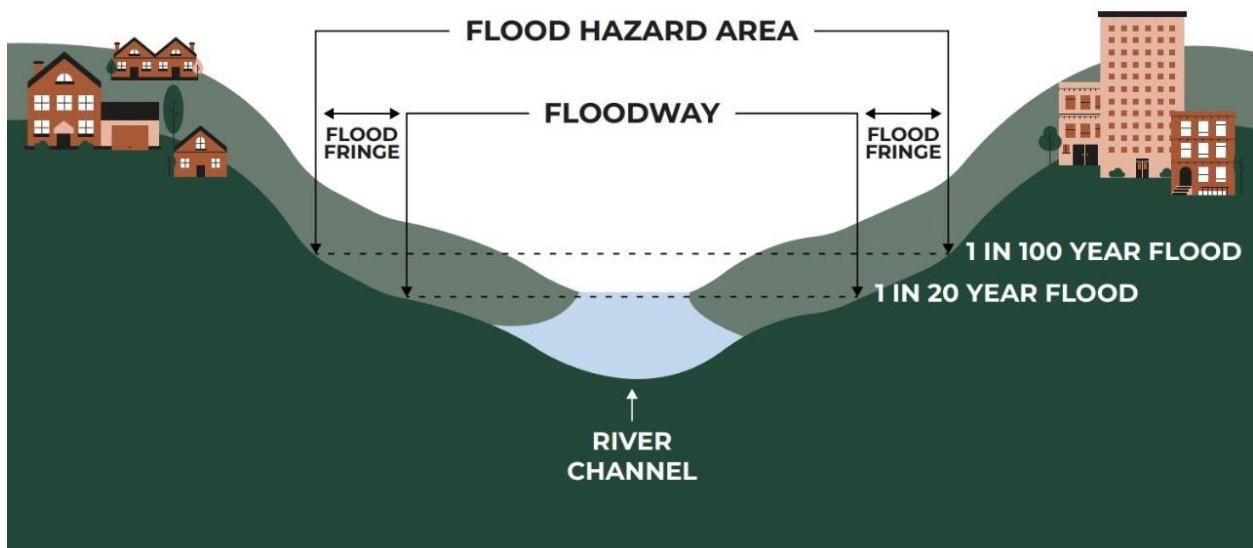


Figure 4-1 Depiction of Flood Hazard Area (Government of New Brunswick, 2018)

Action 1.2: Updating flood lines to include wave analysis

High winds can significantly worsen flooding by generating waves which have the potential to exacerbate damage to built infrastructure. Wave action can undermine foundations, damage roads and buildings, and erode shorelines. Residents emphasized that strong winds and wave run-up were major contributors to the severe property damage experienced during the 2018 and 2019 flood events highlighting the need to incorporate

wave effects into the rural plan floodplain overlay. It should be noted that the Risk Assessment conducted by CBCL is based on the provincial 100-year flood hazard map.

A preliminary assessment of return-period waves on Grand Lake suggests that wave run-up could add approximately 1.0 to 1.5 meters to projected flood levels. As climate change is expected to increase the frequency of intense storms and high-wind events, the contribution of waves to overall flood hazard may also grow over time. To ensure accurate risk identification and appropriate adaptation planning, it is recommended that flood risk mapping for the municipality be updated to include wave effects.

Integrating wave run-up into flood line delineation will provide a more realistic representation of flood extents, particularly for communities along Grand Lake and assets such as Princess Park Campgrounds. Updated mapping can also inform land-use planning, emergency response procedures, operational protocols, and the design of flood-resilient infrastructure and erosion protection.

Incorporating wave analysis into flood mapping is a cost-effective step that will allow Grand Lake to better anticipate future flood conditions and make informed decisions about mitigation, development, and community safety.

Action 1.3: Completion of emergency response and infrastructure assessment

It is recommended that Grand Lake complete an emergency response assessment to strengthen preparedness for future extreme weather events, including flooding. This assessment should evaluate current protocols, resources, and coordination among emergency services. In addition, a detailed transportation study can analyze how flooding may affect access in and out of communities, identify areas at risk of isolation, and highlight road and bridge segments that require upgrades to maintain safe, reliable emergency access during severe weather conditions.

Several parts of the municipality have been severely affected by spring freshets in the past decade, with one instance isolating the entire (former) Village of Chipman due to flooded roads that connect the village to its surrounding regions. A map that indicates sections of roads that are at risk of being flooded is shown in **Figure 2-11**. Notably, a section of NB-123 just north of Chipman United Church Redbank Cemetery is in the projected flood zone such that at least 8 houses lie between the flooded northern and southern parts of the highway (see **Figure 4-2** below) isolating these residents.



Figure 4-2 Map showing a neighbourhood north of Chipman United Church Redbank Cemetery at risk of being isolated during a projected flooding event (New Brunswick Flood Hazard Maps, n.d.). Location of the community is marked in yellow.

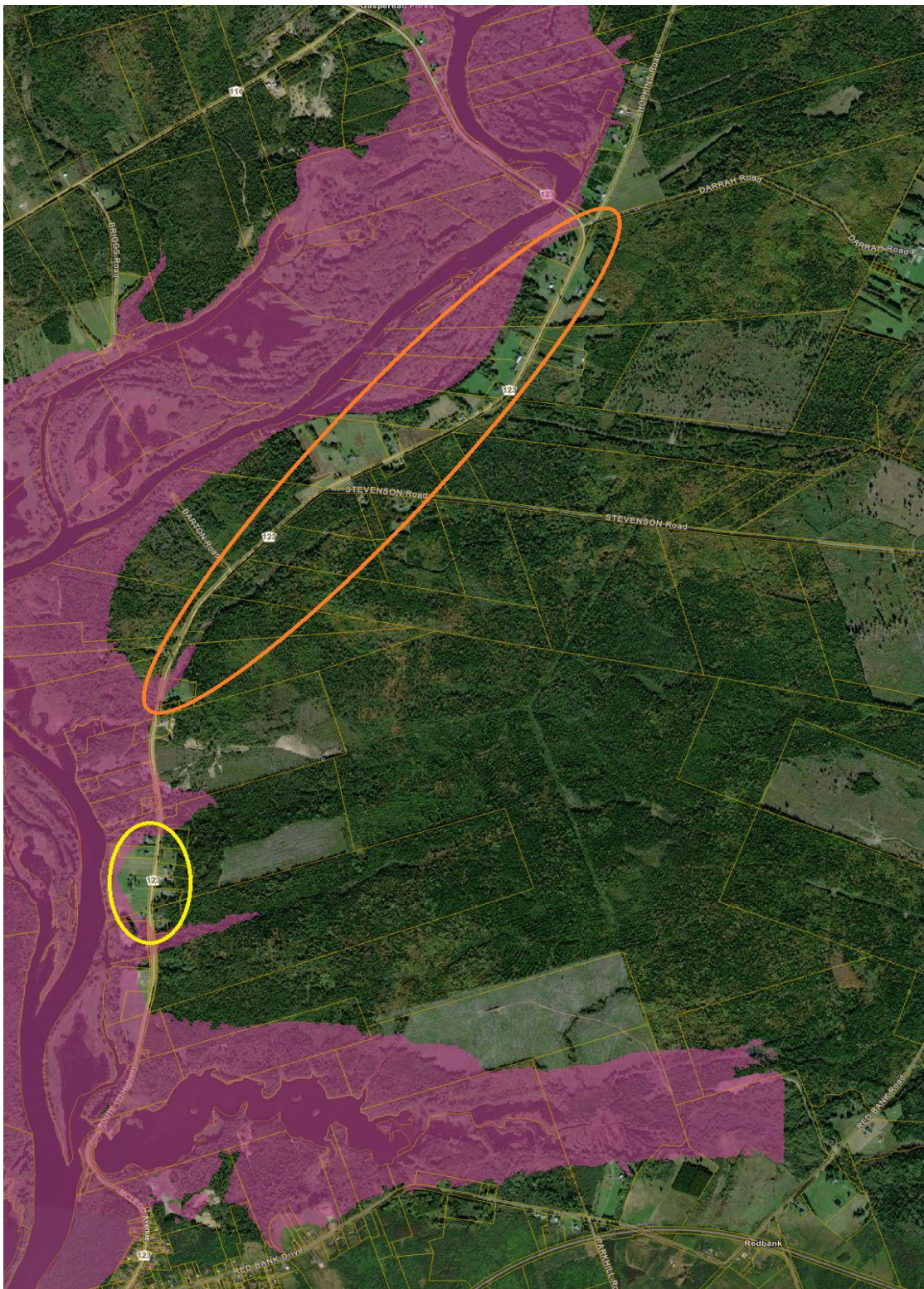


Figure 4-3 Map showing homes along route 123 (marked in orange) that could potentially lose access to both Chipman village and further north of the community due to flooded bridges (New Brunswick Flood Hazard Maps, n.d.).

There was only one access route noted for the community marked in orange as shown on **Figure 4-3** for emergency purposes. These residents may take Stevenson Road and head east to connect with Red Bank Road (also called Harley Road) and travel south, connect with Bronson Settlement Road, and stay on it moving northeast until they reach Route 116 at the intersection of Bronson Road and 502 Rd. It is not confirmed whether the entirety of Bronson Settlement Road is paved, or accessible in the spring, since this will be a critical route for emergency response teams to access Chipman from outside the municipality. Note: The smaller community noted previously in **Figure 4-2** is marked yellow in **Figure 4-3**.

Likewise, the former Village of Chipman east of the river is at risk of being cut off from the rest of the province (see **Figure 4-5**) similar to the 2018 and 2019 flood events. Note that the following bridges that provide access in and out of this community are expected to be inundated during the 100-year flood:

- ▶ NB-123 Bridges connecting Chipman to the north
- ▶ Coal Creek Bridge No. 1 to the south
- ▶ NB-10 bridge which is the quickest exit out of Chipman. A new bridge is currently being built which has a design lifespan of 75 years. Therefore, it is presumed that the new bridge is built above future flood levels (Government of New Brunswick, 2026). However, access to this bridge via Bridge Street may not be available unless the roads are raised above the projected high water levels.

There is a small bridge noted along Bronson Settlement Road for vehicles to pass over a small creek (see **Figure 4-4** below). The condition of the bridge is not known.



Figure 4-4 Wooden Bridge above a creek noted along Bronson Settlement Road (Google Maps, 2024)



Figure 4-5 Map showing bridges providing access in and out of Chipman that will be inundated during 100-year flood event (New Brunswick Flood Hazard Maps, n.d.).

Homes along route NB-116 between Briggs Corner and Gaspereau Forks also have the potential to be temporarily cut off from Chipman (See **Figure 4-6**). Note that the bridge on route NB-116 past Gaspereau Forks, even if it is not inundated, may still be closed for safety reasons. The other bridge on route NB-123 to the southeast of Gaspereau Forks connecting the community to Chipman will be heavily inundated and so it will not be open to traffic either. Access to Briggs Corner could be available as soon as the floods recede, allowing emergency responses from Minto possible. However, until such time, access to these homes may be limited.



Figure 4-6 Chipman community along route 116 at risk of being isolated marked in white events (New Brunswick Flood Hazard Maps, n.d.).

All properties along Grand Lake's shores will be inundated. Particularly, those in Princess Park will be severely affected due to the only access route – Route 690 – being fully submerged during the 100-year flooding event (**see Figure 4-7**). Evacuation of this area is highly recommended as soon as the flood warning is issued. It should be noted that strong winds during flooding events, similar to the 2018 floods, can give rise to waves which have the potential to cause further damage to properties and pose considerable risk to emergency and rescue operations. Communication to the residents about forecasted floods, evacuation routes, and shelter options can be made through the Voyent Alert! platform as discussed in Action 2.5.

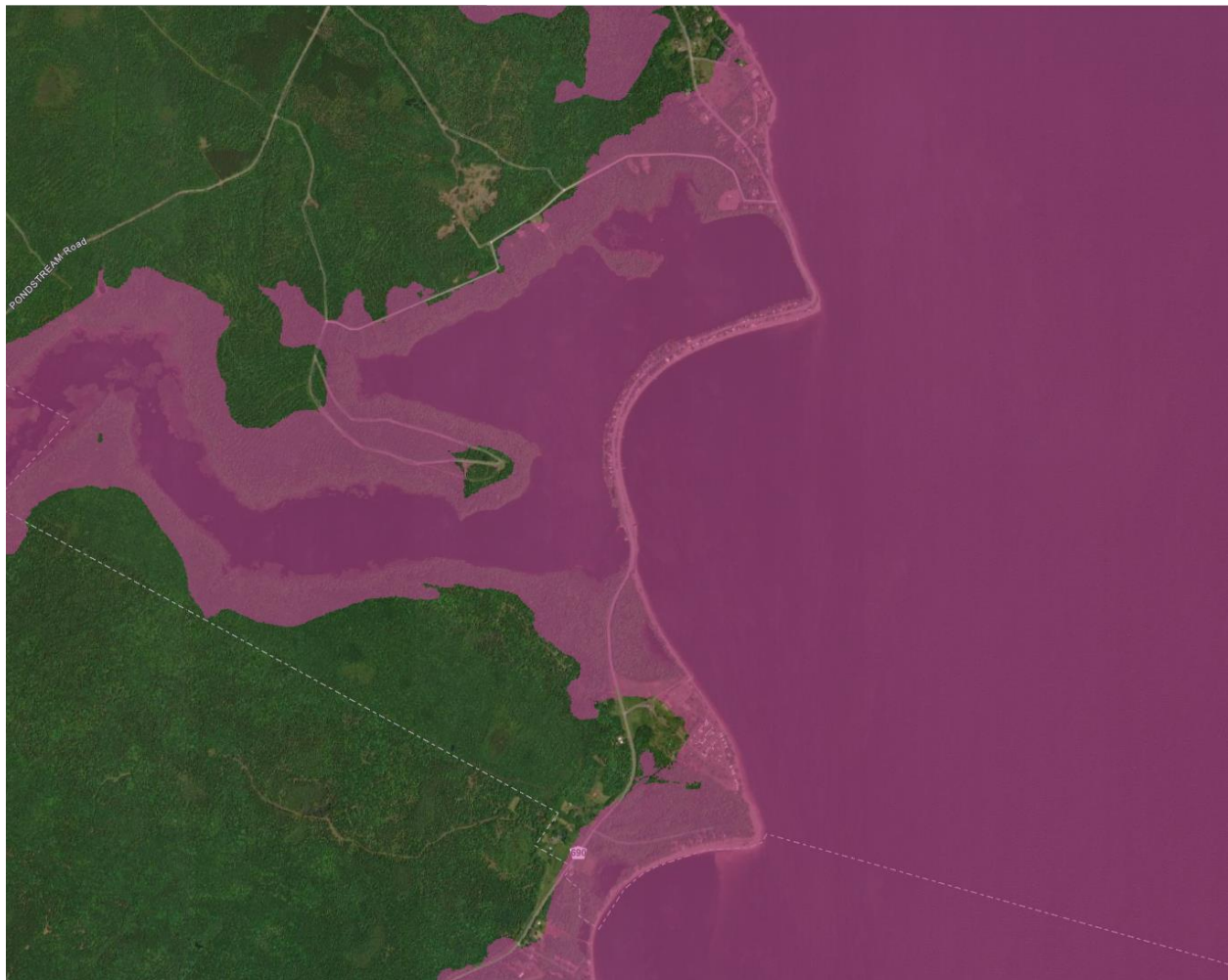


Figure 4-7 Inundation across Princess Park submerging the area with potential wave action during high winds (New Brunswick Flood Hazard Maps, n.d.).

To ensure effective emergency response, EMOs including fire, RCMP, and ambulance services should be fully aware of these vulnerable locations and develop contingency plans for accessing them when frequently used road routes are cut off. A detailed transportation evaluation of emergency routes can identify high risk sections of roads and aid in developing mitigation plans for such sections including raising the affected sections, identifying alternative routes during emergencies, updated asset management plans, and

changes to development plans (i.e. restrict certain development in flood prone and isolated areas). Risks may be best discussed in a workshop setting.

The following is a list of the roads within the flood line:

- ▶ NB10 – NBDTI
- ▶ NB116 – NBDTI
- ▶ NB123 – NBDTI
- ▶ NB690 – NBDTI

In addition to flooded roads, Bronson Settlement Road, which is maintained by Grand Lake, is noted to be an important emergency response route. The road is unpaved.

Action 1.4: Adapting vulnerable infrastructure and community assets

When used in conjunction with the updated flood map to include the risk of wave runup, adaptation actions can follow the PARA (Protect, Accommodate, Retreat, and Avoid) adaptation framework as outlined by CLIMAtlantic (CLIMAtlantic, 2023). **Figure 4-8** describes each option for flood resilience followed by a brief explanation of the framework.



Figure 4-8 Graphical depiction of flood projection option for existing infrastructure in the flood line.

- ▶ **Protect** – Use of engineering solutions can be adopted in instances where none of the following three measures are feasible to prevent risks due to flooding. Installation of flood protection structures such as armouring, berms, flood walls, dikes, etc. is an example of hard engineering solutions. Due to the long stretches of river and shores of Grand Lake's, such structures are very unlikely to be optimal, efficient, or cost-effective solutions. Riparian buffers exist along the river but adding sustainable soft engineering

solutions such as wetland restoration where possible may help further to mitigate the impact of smaller return period flood-related risks.

- ▶ **Accommodate** – Where the risk of flooding is understood and accepted, and where retreat may not be an option or preferred, the risk to existing infrastructure may be overcome or reduced by modifying them to accommodate their respective impacts. Example: elevating the main floor level above the 100-year flood levels.
- ▶ **Retreat** –Where possible, this measure entails moving buildings and essential infrastructure and services to a higher ground and out of the floodplain. This also include property purchase where appropriate.
- ▶ **Avoid** – Preventing new developments within flood-prone areas is the most common and effective way to eliminate infrastructure risks associated with flooding, and it may be refined further. Restricting all new development within the floodway and restricting development in flood fringe to non-essential uses are some examples of this measure.

The preferred option for each asset may be chosen upon completion of a cost-benefit analysis, which weighs the losses avoided against the costs of adapting each asset. The following table provides additional information on each of the four adaptation approaches mentioned above.

Table 4.1 Adaptation approaches to flooding

| Approach | Benefit | Drawback | Cost |
|--------------------|--|--|----------|
| Protect | Doesn't require new land purchase or any modification to existing buildings. | Engineering methods are expensive to construct and require on-going maintenance. The water frontage is not as enjoyable. | Extreme |
| Accommodate | Doesn't require new land purchase | Maintains some exposure to flooding | Moderate |
| Retreat | Low exposure to flooding | Required public buy-in and available space to relocate buildings | High |
| Avoid | Lowest exposure to flooding | Doesn't deal with existing infrastructure | Low |

It is understood that Grand Lake is considering replacement works in the Chipman Wastewater Treatment Plant, which includes the construction of two new sanitary lagoons, decommissioning of sand drying beds, and replacement of 6 monitoring wells. In June 2026, the municipality is also planning on the construction of earthen berm cells for the two above-grade aerated lagoons with berm heights averaging 4.5 m.

The projected 100-year flood zone covers the entirety of the existing operational facility (see **Figure 4-9** below). Grand Lake is encouraged to consider the PARA framework for potential options for adaptation of the two pumpstations at Bridge Street and the pumpstation near the Wastewater Treatment Plant, as well as selection of the berm height.



Figure 4-9 Chipman WWTP with flood zone overlay of the 2018 floods (blue) and the projected 100-year flood (pink) for 2100 (New Brunswick Flood Hazard Maps, n.d.).

Minto’s WWTP is located outside of the projected flood line such that no adaptation measures are recommended. It is noted there is a small possibility that accessway to the plant might be inundated but it is unlikely that it could pose a risk or stay inundated for extended periods. It is recommended to monitor the performance of the culvert under the access road and adapt as necessary. However, adaptation measures, if necessary, will be case-specific. Minto’s pumpstation remains unaffected



Figure 4-10 Minto WWTP with flood zone overlay of the projected 100-year flood for 2100 (New Brunswick Flood Hazard Maps, n.d.).

from the floods due to its location.

Princess Park Campgrounds is a major tourist attraction for the region offering a variety of recreational activities on the lake such as kayaking, fishing, boating and swimming. The park also provides space for camping and RVs. Other amenities include playgrounds for kids and the long stretch of the beach along the lake. The park is within the projected 100-year flood zone and poses potential risks for the staff, campers, and onsite infrastructure. Hard engineering solutions to limit inundation on the campground is likely cost prohibitive. It is recommended to consider operational strategies to reduce risk, such as seasonal operational restrictions for safety.



Figure 4-11 Princess Park Campground with flood zone overlay of 2018 floods (blue) and projected 100-year flood for 2100 (pink) (New Brunswick Flood Hazard Maps, n.d.).

Burpee Bridge has cultural significance and historical value to the community. Although the 2018 floods did not affect the bridge, the projected 100-year flood zone surrounds the bridge and has the potential to cause structural damage similar to Bell Bridge and other historic covered bridges in the province that were washed away during flooding events. Grand Lake can work with the following groups to preserve the bridge:

- ▶ NBDTI to report any damage or structural deficiencies

- ▶ Department of Tourism, Heritage, and Culture to assess plans for the restoration and preservation of the bridge (and Princess Park) as needed
- ▶ Covered Bridges Association of New Brunswick, a not-for-profit organization that works towards protecting and preserving covered bridges by having them declared as heritage sites.



Figure 4-12 Burpee Bridge (Gaspereau Bridge) with flood plain overlay of the projected 100-year flood for 2100 (New Brunswick Flood Hazard Maps, n.d.).

Action 1.5: Community education and engagement

Grand Lake may further educate and engage residents on projected flood lines (i.e. how CC adjusted flood lines are produced) and in-home flood proofing measures. At this meeting it is encouraged to reiterate emergency planning protocols during extreme flood events as this was noted to be an area for improvement during consultation.

The workshop may cover the following:

- ▶ **Flood maps:** Encouraging use of publicly available resources such as New Brunswick Flood Hazard maps that outline the areas vulnerable to flooding so that the residents may be aware of any potential direct impacts from riverine flooding.
- ▶ **Adaptation measures:** Providing accessible materials that explain flood-related risks to the residents.
- ▶ **Post-event protocols:** Educating the community on post-flooding cleanup and maintenance, safety protocols, and providing resources pertaining to flood recovery such as the one developed by NBEMO (Flood Recovery Everything You Need to Know, n.d.)

It is recommended that the municipality host a workshop similar to the one held by Jemseg Grand Lake Watershed Association on flood resilience strategies in 2020 on a routine basis (i.e. every 5 years) by partnering up with NGOs as well as relevant provincial and federal government departments. Additionally, community engagement could further describe the provincial approach to flood management and dispel any misconceptions. Emergency response planning is further discussed in section 4.1.2.

Summary of Riverine Flood Preparedness and Mitigation Recommendations

Table 4.2 Summary of recommended action items to address flooding risks.

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|--|--|---|-------------|---------------------------|
| 1.1 | Adopt updated land use plans for flood resilience | Capital Region Service Commission (CRSC) | DELG; Grand Lake Economic Development Officer | Ongoing | Low |
| 1.2 | Updating flood lines to include wave analysis | CRSC – Planning and Development | DELG; Grand Lake EMO Coordinator | Short-term | Moderate |
| 1.3 | Completion of emergency response and infrastructure assessment | EMO Coordinator; NBDTI | Fire Department; Horizon Health Network Community Development | Short-term | Low |
| 1.4 | Adapting vulnerable infrastructure | Grand Lake Engineering | EMO Coordinator; Department of Tourism, Heritage, and Culture; NBDTI; Covered Bridges Association of New Brunswick; FCM Funding | Medium-term | High |

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|------------------------------------|---------------------|---|----------|---------------------------|
| 1.5 | Community education and engagement | EMO Coordinator | Jemseg Grand Lake Watershed Association | Ongoing | Moderate |

4.1.2 Emergency Response Planning

Action 2.1: Development of a Local Emergency Response Plan

Grand Lake does not have a municipal emergency plan. The province developed the 2016 NB EMO Regional Response Plan that provides guidelines on what to do, who should do it, and other related procedural information for extreme events. Residents noted that a tailored Emergency Response Plan to the region for specific extreme weather events, such as floods, ice storms, and wildfires, would be beneficial for the community.

Additionally, Grand Lake may establish consistent, two-way communication with NBDTI to support information sharing on condition of roads, bridges, and other associated infrastructure. This can involve defining points of contact, clear procedures for reporting observed issues (e.g., flooding, washouts, debris, culvert blockages, or structural concerns), expected response pathways, and methods to share and receive updates from NBDTI during and after significant flooding events.

It is recommended that Grand Lake:

- ▶ Co-ordinate and prepare a municipal Emergency Response Plans (ERP), training, and exercises, with community involvement (a workshop session).
- ▶ Oversee on-going public education and awareness relevant to emergency preparedness.
- ▶ Work with volunteer firefighters and other agents/agencies to develop a specific emergency response plans, referencing flood lines and evacuation routes presented in section 4.1.1.
- ▶ Assess the performance of the ERP during and after each emergency event and update the plan to increase its effectiveness and to address any shortcomings identified during the assessment.

Action 2.2: Adapting emergency shelters for thermal comfort and air quality

Shelters are crucial for vulnerable populations, especially during extreme weather events such as winter storms or heatwaves, that may coincide with a power outage or air quality issues from fires in other regions. Emergency shelters can also serve as refuge to people affected by floods and poor air quality from wildfires, bridging the gap between the occurrence of an extreme weather event and restoration of normalcy. They may even be used as disaster coordination centres where relief supplies can be received and arranged to be transported to people in need.

A community emergency shelter is often dual-purpose facility, such as a community centre or recreation centre. Chipman Community Heritage Centre, constructed in 1939 and formally recognized as one of Canada's Historic Places in 2009, is identified to possess backup power. However, due to its proximity to the projected flood line and its age, the building is not an ideal emergency shelter.



Figure 4-13 Map of 2018 floods (blue) and predicted 100-year flood by 2100 (pink) near Chipman Community Heritage Centre circled in yellow (New Brunswick Flood Hazard Maps, n.d.).

If Grand Lake is considering construction of a recreation or multipurpose centre in the future, the facility may be designed as a dual-purpose community emergency shelter. Funding may be available to assist with a project of this nature, such as through the Federation of Canadian Municipalities (FCM). Funding opportunities are available for both new construction of a municipal building and its feasibility study. For example:

For the selected building, it is important that backup power systems and a reliable fuel source (or storage) is available. Access routes to and from the centre should be verified outside of the flood line and advanced air filter systems can be installed to reduce wildfire smoke and provide better indoor air quality, which may occur during a heat wave. The centre should be equipped with reliable cooling and heating systems, and a lightning protection system. There will continue to be a need for transportation infrastructure upgrade to Chipman from a proposed centre, working with NBDTI.

It is noted that currently, there are backup generators present in the following locations:

- ▶ Chipman Community Heritage Centre for medications at Shoppers Drug Mart in the event of an extended power outage.
- ▶ Chipman Fire Hall
- ▶ Minto Municipal office
- ▶ An additional, portable generator that can power one of Grand Lake's arenas to provide shelter
- ▶ Some of the senior resident buildings currently possess or are installing backup power

Note: Unconfirmed if Minto Fire Hall has backup power.

In the event of an extended power loss during a heatwave or a cold snap, these backup power systems can provide crucial cooling/warming. Grand Lake may consider utilizing existing facilities such as the former village libraries and arenas to act as temporary shelters or cooling centres. It is noted that both the libraries meet accessibility requirements and have air conditioning capacity to provide relief during summer.

During consultation, it was noted that a barrier to the use of "cooling centres" is the branding of the centre as a shelter. Some residents who may be struggling at home, may opt not to use the facility if the optics are that the shelter is only open to those who need critical assistance. Equipping the library as a cool and inviting space for seniors to gather would be preferred. There is an option to station a public health nurse at the cooling centre during heatwaves to facilitate.

Moreover, it is advised to maintain adequate amount of N95, P100 or other appropriate masks at the emergency shelter to be supplied to anyone who may need it.

Action 2.3: Work with care facilities to reinforce emergency procedures

Chipman community health centre is in the heart of the former village. Access to the facility would be limited to those residents east of the river during an extreme flooding event due to the temporary loss of access to the three bridges mentioned in Action 1.3.



Figure 4-14 Queen's North Community Health Center in North Minto (Horizon Health Network, 2026)

With wildfire events expected to rise in Quebec and other neighbouring provinces in the coming decades, poor air quality is an increasing risk. Senior homes, community health centres, and other facilities that host vulnerable people may need to install or upgrade their existing filters to MERV 13 (replacing MERV 8) or HEPA (for critical healthcare applications) or other appropriate installations to protect indoor air quality. It is acknowledged that for a retrofit application, replacing a lower rated filter is often not possible without increasing the size of the fan motors to account for the additional pressure drop. Additionally, reinforcing emergency procedures during a wildfire event with facility operators and emergency responders in the emergency response plan is also recommended.

Action 2.4: Post-event cleanup procedures

Flood events often leave behind significant amounts of debris, including vegetation, damaged building materials, household waste, and sediments. This debris can obstruct roads, damage infrastructure, and create health and safety hazards, making cleanup both labour-intensive and costly. It is recommended that the EMO Coordinator establishes standard operating procedures (SOPs) for post-event cleanup to help the municipality respond more efficiently and safely. These SOPs should outline debris-removal protocols tailored to different events—such as flooding, wildfires, or hurricanes—since each produces distinct types of waste and contamination risks. For flood events, procedures should also address the increased likelihood of mould growth, sewage contamination, and hazardous materials entering homes, businesses, and waterways.

Grand Lake can work with the Government of New Brunswick and provincial emergency management resources to provide community education on well water contamination following floods. This may include guidance on testing private wells, recognizing signs of

bacterial or chemical contamination, and safely “shocking” a well to restore water quality. Similar educational efforts can help residents understand potential water and air contamination risks following wildfire events, such as ash infiltration, chemical runoff, or degraded air quality.

To support proactive planning, the municipality can use flood hazard mapping to identify potential contamination sources in advance, such as fuel tanks, septic systems, or industrial sites located within projected flood zones. This information can guide both emergency planning and long-term mitigation efforts, reducing risks to drinking water supplies and improving the speed and effectiveness of post-event recovery.



Figure 4-15 Flood cleanup near Grand Lake, 2018 (CBC, 2018)

Action 2.5: Voyent Alert! and communications system

‘Voyent Alert!’ is the primary means of Grand Lake to inform its residents of an emergency. It is recommended that the municipality encourage residents to install and use the application to allow for emergency communications. According to the Voyent Alert! website, the app has the following features that the municipality can use in times of extreme weather events such as riverine flooding, extreme rainfall, winter storms, wildfires, heatwaves, and more. Some features that Grand Lake can utilise in its disaster management plan and everyday function are:

- ▶ **Geo-locked notifications** – communications can be targeted to a specific location, service line, or work area. These could be useful for updates on road closures due to flooding or maintenance events.
- ▶ **Multi-channel delivery** – notifications can be sent via mobile app, text/SMS, phone call, or email so that emergency updates are not restricted to internet connectivity.

- ▶ **Two-way communications** - status updates and responses from recipients and team members can be received to gain real-time insights and make quicker, more informed decisions.

For example, during extremely hot days, the municipality can send out notifications encouraging residents to check in on their neighbours, particularly the elderly, low-income residents, and those who live by themselves.

Summary of Emergency Response Planning Recommendations

Table 4.3 Summary of recommended action items for Emergency Response Planning.

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|---|--|--|-------------|---------------------------|
| 2.1 | Develop a Grand Lake Emergency Response Plan | EMO Coordinator | Fire Department; Horizon Health Network Community Development; NBEMO | Short-Term | Moderate |
| 2.2 | Adapting emergency shelters for thermal comfort and air quality | Horizon Health Network Community Development | EMO Coordinator | Medium-term | High |
| 2.3 | Work with care facilities to reinforce emergency procedures | Horizon Health Network Community Development | EMO Coordinator | Short-term | Low |
| 2.4 | Post-event cleanup procedures | Grand Lake Operations | Fire Department | Short-term | Moderate |
| 2.5 | Voyent Alert! and communications system | EMO Coordinator | Fire Department; Horizon Health Network | Ongoing | Low |

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|-------------|---------------------|------------------------------|----------|---------------------------|
| | | | Community Development; NBEMO | | |

4.1.3 Preparing for Heatwaves

Action 3.1: Install outdoor cooling facilities where needed

Most of the municipality's land area is made up of trees and other vegetation, therefore the urban heat island effect is low. Additionally, there is ample access to recreational sites near water, including beaches and marinas, as well as a local splash pad.

With climate change, the number of days with over 30 °C is expected to rise in the coming decades, and it is recommended to implement the following adaptation measures:

- ▶ Providing information to residents and business owners on heat pump programs, or other passive cooling techniques
- ▶ Educating the community on the health risks during hot days
- ▶ Coordination with first responders during heatwaves

As discussed in 4.1.1, identifying public places or facilities that are equipped with cooling facilities, such as libraries and arenas, can help alleviate the ill effects of heat-exposure.



Figure 4-16 Chipman Marina (Chipman Marina, 2025)

Action 3.2: Blue green algae in Grand Lake

Outbreaks of harmful algal blooms (HABs) can be a risk to children, animals, and persons with compromised immune systems. HABs can also negatively affect local tourism, and impact revenue for the local businesses and the municipality. High levels of Phosphorous and Nitrogen, warm water temperatures, longer periods of sunlight, and calm water surface are some of the more common factors that lead to HABs. Generally, these outbreaks tend to occur during the summer- fall period.

Jemseg Grand Lake Watershed Association continues to monitor the lake for HABs using CyanoTracker in partnership with Hammond River Angling Association, with the latest reported surface bloom occurring in August 2025. It is recommended that Grand Lake continue to work with the association to keep the public informed of any new and existing HAB advisory in the lake via Voyent Alert! Some ways to reduce risk of HABs include:

- ▶ Reducing use of fertilizers and herbicides to limit nutrient loads to the lake via runoff
- ▶ Improving stormwater runoff quality
- ▶ Regular maintenance of septic systems located near the lake to eliminate effluent leakage

Additionally, the municipality can educate the residents on the health risks from interacting with HABs in partnership with provincial or non-governmental agencies.

Summary of Heatwave Adaptation Recommendations

Table 4.4 Summary of recommended action items to address extreme heat risks

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|------------------------------|---|---|------------|---------------------------|
| 3.1 | Establish cooling facilities | EMO Coordinator | Community Health Centers, Fire Department | Short-Term | Moderate |
| 3.2 | HAB monitoring | Jemseg Grand Lake Watershed Association | Department of Tourism, Heritage, and Culture; DELG; Voyent Alert! | Ongoing | Moderate to High |

4.1.4 Extreme Rainfall Resilience

Action 4.1 Stormwater management plan

New development reduces natural infiltration and consequently, peak runoff volumes increase. Climate change will further intensify extreme rainfall, placing additional pressure on existing drainage systems, increasing the likelihood of localized flooding. It is recommended that Grand Lake consider developing a stormwater management plan to better understand system capacity, identify undersized or disconnected infrastructure, and support long-term asset management.

A stormwater management plan would include identifying, surveying, and mapping key assets such as ditches, culverts, sewers, and bridges, followed by developing a hydrologic and hydraulic model to evaluate system performance under current and future conditions. This modelling would assess how the network responds to various climate and development scenarios, enabling the municipality to prioritize upgrades. The plan should also evaluate infrastructure age and condition to develop a strategic replacement schedule.

Incorporating stormwater storage, low-impact development practices, and nature-based solutions (such as bioswales, constructed wetlands, or enhanced riparian buffers) can help improve water quality in Grand Lake, increase groundwater recharge, and reduce peak flows. Since drought conditions are expected to worsen over the decades, systems that improve infiltration can also help with ground water levels. Funding opportunities from FCM's GMF program are summarized below:

- ▶ **Feasibility Study:** Grand Lake is eligible for at least 90% of the eligible costs, up to a maximum of \$ 70,000. Funding is scheduled to open in 2026. Eligible projects for this study are those that are eligible for the implementation project (Feasibility Study, 2025).
- ▶ **Implementation Project:** Grand Lake is eligible for a grant of 70% of eligible costs (it can reach 100% under certain conditions) up to a maximum of \$1M (Implementation Projects, n.d.). From the website: "*Projects can involve measures such as improving infrastructure to withstand extreme weather, installing new measures to reduce impacts on the community, modifying the landscape to reduce wildfire risks, or bolstering municipal services to better support vulnerable community members. They are intended to be smaller in nature, with maximum eligible expenses of \$1 million and, upon completion, must have implemented on-the-ground solutions to respond to climate risk.*"

Additionally, completing an inflow and infiltration (I&I) study for the sanitary sewer collection system can help identify sources of stormwater entering the wastewater system. Reducing or eliminating instances of infiltration can improve sewer capacity, lower flood risk, and decrease pumping and treatment demands. This study would involve surveying sewer infrastructure, installing flow meters to capture system response during rainfall events, and isolating the most likely points of stormwater intrusion. Together, these efforts would strengthen municipal resilience to extreme rainfall and support cost-effective planning.



Figure 4-17 An example of a rain garden that slows runoff, recharges groundwater, and beautifies the area (Nature Trust, 2022)

Action 4.2 Stormwater management by-laws

Stormwater management by-laws ensures that post-development runoff does not far exceed pre-development levels. As climate change brings more frequent and intense rainfall events, placing additional pressure on existing drainage systems, it is important to plan ahead through policies and bylaws to reduce or eliminate stress on drainage systems. Without appropriate controls and checks in place, new developments can increase impervious surfaces, reduce natural infiltration, and accelerate runoff, contributing to localized flooding and downstream impacts.

Adopting clear pre- and post-development stormwater management criteria will help Grand Lake proactively manage these risks. Such criteria require developers to incorporate on-site stormwater controls (such as ponds, bioswales, rain gardens, or permeable surfaces) to capture, slow down, and treat runoff before it enters municipal drainage systems. These measures not only help maintain pre-development flow rates but also improve water quality and support groundwater recharge.

Integrating stormwater requirements into subdivision approvals, zoning bylaws, and development agreements will ensure consistent application across future projects. This will help prevent downstream flooding, reduce long-term maintenance costs, and support

climate-resilient growth. As Grand Lake continues to expand, these standards will be important for managing cumulative impacts and protecting both municipal infrastructure and natural waterways.

Summary of Extreme Rainfall Preparedness Recommendations

Table 4.5 Summary of recommended action items to address Extreme Rainfall

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|--|-------------------------------------|--|-------------|---------------------------|
| 4.1 | Stormwater management plan and I&I study | Grand Lake Engineering | Capital Region Service Commission (CRSC) | Medium-term | Moderate |
| 4.2 | Stormwater management by-laws | Grand Lake Planning and Development | Capital Region Service Commission (CRSC) | Medium-term | Low |

4.1.5 Wildfire Resilience Plan

Action 5.1 Firesmart community designation

Grand Lake can enhance its preparedness for wildfires and wildfire smoke by adopting guidance from FireSmart NB and FireSmart Canada. These programs provide practical tools, educational materials, and community-level strategies designed to reduce wildfire risk and improve resident awareness. Using these resources, the municipality can create public awareness campaigns including encouraging property-level actions such as removing combustible vegetation, maintaining defensible space around structures, and ensuring safe storage of fuel sources.

Developing a wildfire response plan is also recommended. This plan should outline clear procedures for detection, communication, evacuation, and resource mobilization during a wildfire or smoke event. It should identify high-risk neighbourhoods, establish evacuation triggers and routes, designate emergency shelters, and clarify responsibilities among fire services, emergency management staff, and public works. Preparing these plans supports faster, coordinated response during high-risk conditions. Voyent Alert! can be used to address communication needs and where it cannot, the municipality may work with the software team to identify and address such needs.

The EMO coordinator, in collaboration with the Fire Department, would be responsible for program coordination, community outreach, wildfire response plan, and tracking progress toward wildfire-resilience goals. Collaboration between municipal departments, volunteer firefighters, and local organizations will be essential for implementing these initiatives effectively.

Ensuring that the fire department has reliable access to water is critical, particularly during drought. Low water levels can limit firefighting capacity, so it is recommended to identify and map viable water sources suitable for drafting. Where gaps exist, the municipality may consider installing additional dry hydrants, improving access to natural water sources, or coordinating with adjacent fire services for supplemental support.

The recommended emergency response assessment (Section 4.1.2) will help evaluate preparedness, response capacity, and communication systems, while the transportation study will identify road segments or bridges that may become inaccessible during a wildfire event. Understanding these vulnerabilities will enable Grand Lake to plan alternate routes, prioritize upgrades, and ensure that emergency crews can reach isolated or at-risk communities. It is noted that the municipality is also likely to experience wildfire smoke from fires burning in neighboring communities and provinces (depending on wind direction).

Finally, updating municipal planning documents is an important long-term adaptation measure. Growth and development in forested areas can increase exposure to wildfire hazards, particularly where homes and infrastructure intersect with dense vegetation. Integrating wildfire-resilience considerations into zoning bylaws and land-use planning can help avoid high-risk development patterns and single access streets. This may include setting minimum setbacks from forests, requiring fire-resistant landscaping, and ensuring adequate access routes for emergency vehicles and evacuations.



Figure 4-18 A water bomber scoops up a load from Grand Lake to drop on the province's massive out-of-control wildfire southeast of Chipman in September 2025 (Daigle, 2025)

Summary of Wildfire Resilience Plan Recommendations

Table 4.6 Summary of recommended action items to address Wildfire risks

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|--------------------------|---------------------|---|------------|---------------------------|
| 5.1 | Wildfire Resilience Plan | EMO Coordinator | Fire Department; NB Wildfire Management Branch; FireSmart NB; FireSmart Canada; NBEMO | Short-term | Medium |

4.1.6 Drought Management Plan

Action 6.1 Yield assessment

When groundwater is withdrawn from a well at a rate that exceeds its natural yield, the aquifer cannot recharge quickly enough to meet ongoing demand. Over-extraction reduces groundwater levels, often forcing well users to deepen existing wells and/or install additional wells in new locations to secure adequate supply. This accelerates the decline of the local water table and exacerbates community-wide water scarcity. Additionally, periods of prolonged drought combined with rising annual mean temperatures are expected to increase evapotranspiration rates and decrease aquifer recharge. Under these conditions, groundwater levels may fall below the operational depth of existing shallow wells, resulting in reduced water availability for households and businesses.

Reports of wells in the region, including Chipman, running dry have been recorded (Sweet, 2025). As the frequency and intensity of droughts are projected to increase over the coming decades, it is recommended that Grand Lake undertake a well yield assessment to determine the sustainable, long-term productivity of local groundwater sources. Conducting a formal yield assessment will provide quantitative insight into aquifer capacity, recharge rates, and seasonal variability. Establishing a network of long-term monitoring wells will enable the municipality to identify emerging trends, detect early signs of aquifer stress, and forecast potential drought impacts with greater accuracy. This information will be essential for planning targeted adaptation measures, such as water conservation

initiatives, drought response protocols, establishing additional water sources, and land-use planning decisions.

In addition to supporting residential water security, a detailed understanding of groundwater availability will help develop supportive proactive and informed decisions on future industrial and commercial development strategies. By integrating groundwater yield data into municipal planning, Grand Lake can balance development objectives with responsible water management, ensuring long-term resilience of both the community and its natural water systems.

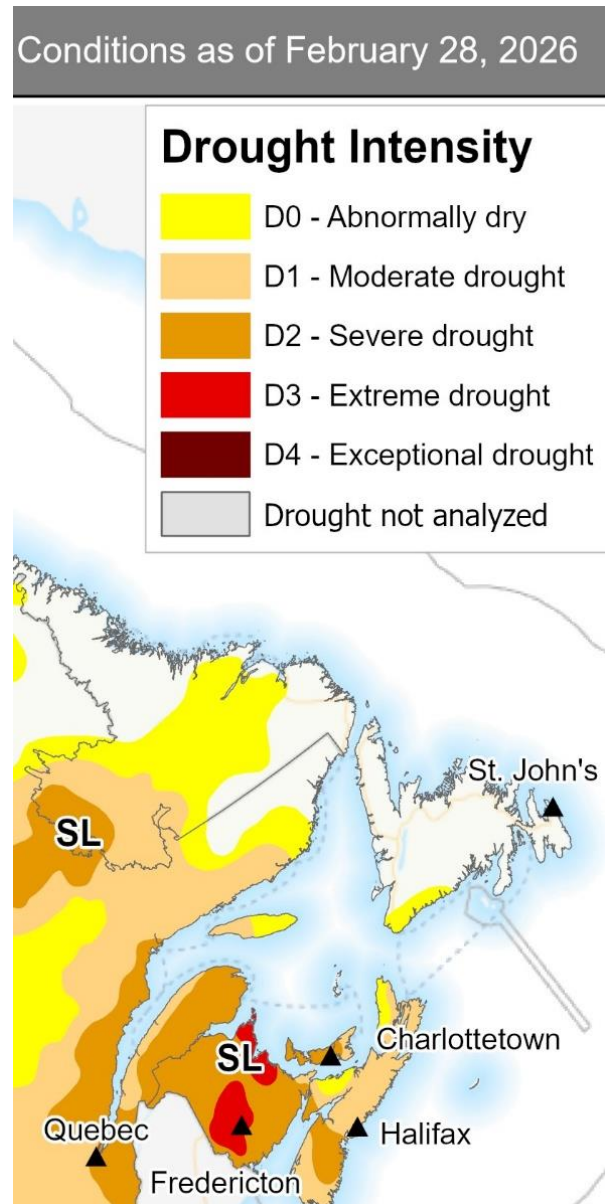


Figure 4-19 Map showing drought conditions within the province as of February 28, 2026 (Agriculture and Agri-Food Canada, 2026)

Action 6.2 Drought preparedness at home

The municipality can encourage residents to adopt lower water use practices at home (car washing, landscaping, etc.) during or leading up to drought seasons. Xeriscaping, which is designing yards and gardens to require minimal irrigation, reduces reliance on groundwater and supports long-term water conservation. By promoting drought-tolerant plants, efficient soil management, and thoughtful yard design, the community can lower overall water use without compromising aesthetic appeal. Increasing public awareness of xeriscaping principles can help households make lasting changes that ease pressure on local aquifers. This should be done in consultation with FireSmart landscaping recommendations.

In addition to landscape changes, the municipality can educate residents on day-to-day water-saving habits that contribute to broader community resilience. Relevant resources, workshops can highlight simple water conservation actions. Residents may also consider installing rain harvesting barrels to store water for landscaping during drought periods.

To complement these household-level measures, the municipality may recommend water use restrictions during periods of reduced water availability. Temporary restrictions, such as limiting outdoor watering or adjusting irrigation schedules, can significantly reduce peak demand on groundwater systems. The municipality can also promote voluntary conservation programming that encourages residents and businesses to adopt habits that lower consumption throughout the year, not just during drought conditions.

A broader drought-preparedness program could also explore additional water-saving techniques and infrastructure. These may include the use of low-water-use appliances, installation of rain barrels for capturing roof runoff, creation of rain gardens to promote infiltration, and implementation of low-impact development (LID) landscaping approaches. Such measures not only conserve water but also support stormwater management, groundwater recharge, and local ecosystem health. Together, these actions can increase community resilience and help ensure long-term sustainability of water resources.



Figure 4-20 An example of a sustainable Xeriscaping design (Assiniboine.com, 2016)

Summary of Drought Management Plan Recommendations

Table 4.7 Summary of recommended action items for drought management

| Action # | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|----------|------------------------------|------------------------|--|------------|---------------------------|
| 6.1 | Yield assessment | Grand Lake Engineering | DELG; Capital Region Service Commission (CRSC) | Long-term | Moderate |
| 6.2 | Drought preparedness at home | EMO Coordinator | Jemseg Grand Lake Watershed Association | Short-term | Low |

4.2 Monitoring and Implementation

The following actions are assigned to each respective department or association:

| Action No. | Summary of Action | Departmental Lead or Representative |
|------------|---|---|
| 1.1 | Adopt updated land use plans for flood resilience | Capital Region Service Commission (CRSC) |
| 1.2 | Updating flood lines to include wave analysis | CRSC – Planning and Development |
| 1.3 | Completion of emergency response and infrastructure assessment | EMO Coordinator; NBDTI |
| 1.4 | Adapting vulnerable infrastructure | Grand Lake Engineering |
| 1.5 | Community education and engagement | EMO Coordinator |
| 2.1 | Develop a Grand Lake Emergency Response Plan | EMO Coordinator |
| 2.2 | Adapting emergency shelters for thermal comfort and air quality | Horizon Health Network Community Development |
| 2.3 | Work with care facilities to reinforce emergency procedures | Horizon Health Network |

| Action No. | Summary of Action | Departmental Lead or Representative |
|------------|---|---|
| | | Community Development |
| 2.4 | Post-event cleanup procedures/ best practices | Grand Lake Operations |
| 2.5 | Voyent Alert! and communications system | EMO Coordinator |
| 3.1 | Set up a cooling facility | EMO Coordinator |
| 3.2 | HAB monitoring program | Jemseg Grand Lake Watershed Association |
| 4.1 | Stormwater management plan and I&I study | Grand Lake Engineering |
| 4.2 | Stormwater management by-laws | Grand Lake Planning and Development |
| 5.1 | Wildfire Resilience Plan | EMO Coordinator |
| 6.1 | Yield assessment | Grand Lake Engineering |
| 6.2 | Drought preparedness at home | EMO Coordinator |

Ongoing monitoring and evaluation are essential to ensure that the adaptation plan remains effective, relevant, and responsive to evolving climate conditions. As climate projections and community needs change over time, regular review allows the municipality to adjust actions based on performance, new information, available funding, and shifting priorities.

Progress toward CCAP goals can be assessed by:

- ▶ Tracking completion of action items against the proposed implementation timeline.
- ▶ Monitoring changes in community vulnerability, infrastructure performance, and key environmental indicators.
- ▶ Reviewing whether partners' roles and responsibilities continue to be appropriate and effective.
- ▶ Documenting lessons learned, challenges encountered, and opportunities identified during implementation.

Where possible, measurable indicators should be used to evaluate progress and guide future updates to the plan, such as:

- ▶ Number of wells tested,
- ▶ Residents engaged through education initiatives, or
- ▶ Infrastructure improvements completed

5 Conclusions

The Municipality of Grand Lake faces a broad spectrum of climate-related risks, including flooding, extreme heat, intense rainfall, drought, and wildfire smoke, with most of the severe risks associated with riverine flooding and wildfire. The assessment completed through this project illustrates how these hazards interact with municipal infrastructure and services, natural assets, and community health and safety. While some of these risks have been experienced as recently as 2018, projections indicate that climate change will continue to intensify these challenges in the coming decades, if adaptation isn't prioritized.

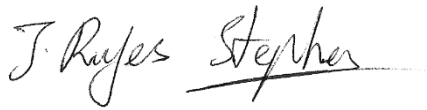
The seventeen adaptation measures presented in this plan offer a clear and actionable pathway for reducing vulnerabilities, improving emergency preparedness, and enhancing long-term resilience. These actions reflect Grand Lake's priorities and address the identified risks. Successful implementation will require ongoing coordination, strategic planning, and sustained commitment across all levels of government.

The adaptation strategy must remain flexible and responsive as climate conditions, development patterns, and community needs evolve. Periodic progress reviews, updates to risk information, and assessment of the effectiveness of implemented actions will help ensure that the adaptation plan remains current, effective, and responsive to emerging conditions.

Although climate change presents long-term and complex challenges, proactive adaptation can significantly mitigate potential impacts and create opportunities for a safer and more resilient future. It is recommended that Grand Lake prioritize actions with the greatest near-term benefits, pursue the stated and any further funding and partnership opportunities to support implementation. It is also suggested that the municipality continue to build community awareness and adaptive capacity.

By maintaining momentum and periodically revisiting this plan, Grand Lake can strengthen its resilience and ensure that residents, infrastructure, and natural systems are better prepared for the changing climate.

Prepared by:



Stephen Sundarraaj
Climate Resilience Specialist

Reviewed by:



Lindsay Bolton
Manager, Water Resources & Climate Change

This document was prepared for the party indicated herein. The material and information in the document reflects CBCL Limited's opinion and best judgment based on the information available at the time of preparation. Any use of this document or reliance on its content by third parties is the responsibility of the third party. CBCL Limited accepts no responsibility for any damages suffered as a result of third-party use of this document.

References

- A Guide for Climate Change Adaptation Planning for New Brunswick Communities. (2023). <https://www2.gnb.ca/content/dam/gnb/Departments/env/pdf/Climate-Climatiques/guide-for-climate-change-adaptation-planning.pdf>
- About Us - Municipality of Grand Lake. (2023, October 31). Municipality of Grand Lake. <https://municipalityofgrandlake.ca/about-us/>
- Agriculture and Agri-Food Canada. (2026). Current drought conditions - agriculture.canada.ca. Canada.ca. <https://agriculture.canada.ca/en/agricultural-production/weather/canadian-drought-monitor/current-drought-conditions#a6>
- Assiniboine.com (2016). Xeriscaping - Assiniboine Landscapes. [online] Assiniboine Landscapes. Available at: <https://assiniboine.com/xeriscaping/> [Accessed 20 Mar. 2026].
- Aubé, M., Hébert, C., & Sonier, T. (2018). Regional Action Plan Regarding Climate Change Adaptation Phase 1: Risk and Vulnerability Assessment.
- Blanch, V., & Fraser, E. (2017, February 14). Keep digging: Monday's blizzard forces more closures into Tuesday. CBC. <https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-weather-brennan-allen-1.3981534>
- Boating - Municipality of Grand Lake. (2023, October 18). Municipality of Grand Lake. <https://municipalityofgrandlake.ca/boating/>
- Bonsal, B. R., Wheaton, E. E., Chipanshi, A. C., Lin, C., Sauchyn, D. J., & Wen, L. (2011). Drought research in Canada: A review. *Atmosphere-Ocean*, 49(4), 303-319.
- Bosse, A., & Morin, S. (2019, April 27). Heavy winds and high waves hit Grand Lake residents. CBC. <https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-flood-rain-1.5113884>
- Brown, S. (2025, September 27). Abrupt closure of Minto-area bridge leaves neighbourhood without paved road access. CBC. <https://www.cbc.ca/news/canada/new-brunswick/minto-bridge-closed-1.7644556>
- Building Grand Lake. (n.d.). Retrieved January 23, 2026, from <https://municipalityofgrandlake.ca/wp-content/uploads/2025/04/Building-Grand-Lake-Project-Update-Community-Progress.pdf>
- Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.
- Campbell, M. (2019, April 29). Grand Lake, N.B. takes severe beating as waves destroy shoreline homes and cottages. Global News. <https://globalnews.ca/news/5217244/grand-lake-flood-damage/>

- Cannon, A. J., Jeong, D. Il, Zhang, X., & Zwiers, F. W. (2020). Climate-Resilient Buildings and Core Public Infrastructure: an assessment of the impact of climate change on climatic design data in Canada. <https://climate-scenarios.canada.ca/?page=buildings-report-overview>
- CBC News. (2009). 'Snow bomb' brings record snowfall across New Brunswick. <https://www.cbc.ca/news/canada/new-brunswick/snow-bomb-brings-record-snowfall-across-new-brunswick-1.840116>
- CBC. (2013, July 22). Tornado confirmed in New Brunswick. CBC. <https://www.cbc.ca/news/canada/new-brunswick/tornado-confirmed-in-new-brunswick-1.1332821>
- CBC News. (2015). Fredericton area still feeling effects of intense storm. <https://www.cbc.ca/news/canada/new-brunswick/fredericton-area-still-feeling-effects-of-intense-storm-1.3092389>
- CBC. (2017, August 14). "Swirling" wind storm hits Grand Lake area property. CBC. <https://www.cbc.ca/news/canada/new-brunswick/grand-lake-squall-damage-1.4246104>
- CBC. (2018, May 22). Flood debris pickup at Grand Lake has company working flat-out. CBC. <https://www.cbc.ca/news/canada/new-brunswick/flood-cleanup-alternate-waste-minto-grand-lake-1.4672733>
- CBC. (2019, April 29). Wind still a concern as emergency officials survey flood damage in Grand Lake. CBC. <https://www.cbc.ca/news/canada/new-brunswick/grand-lake-flood-wind-waves-damage-wellness-checks-douglas-harbour-minto-fire-1.5115799>
- CBC. (2019, May 10). From 36K in flood damage to \$143: How small changes saved one family heartache — and money. CBC. <https://www.cbc.ca/news/canada/new-brunswick/grand-lake-flood-proof-home-1.5129918>
- CBC. (2021, August 25). Major heat wave to hit southern and central New Brunswick this week. CBC. <https://www.cbc.ca/news/canada/new-brunswick/heat-warning-environment-canada-1.6152349>
- Chartrand, J., Thériault, J. M., & Marinier, S. (2022). Freezing Rain Events that Impacted the Province of New Brunswick, Canada, and Their Evolution in a Warmer Climate. *Atmosphere-Ocean*, 61(1), 40–56. <https://doi.org/10.1080/07055900.2022.2092444>
- Chipman marina. (2025). Marinas.com. https://marinas.com/view/marina/x1cym9_Chipman_Marina_Chipman_NB_Canada
- ClimateData.ca. (2024a). Climate Change and Thunderstorms. <https://climatedata.ca/climate-change-and-thunderstorms/>
- ClimateData.ca. (2024b). Hurricanes and Climate Change in Atlantic Canada. https://climatedata.ca/hurricanes-and-climate-change-in-atlantic-canada/#_ftn7
- ClimateData.ca. (2026). Climatedata.ca. https://climatedata.ca/maps/?var=mean_temp&th=tg_mean&scen=ssp585&dateRan

[ge=2070%2C2100&dataset=216&dataOpacity=100&labelOpacity=100&lat=45.58867&lng=-66.87607&zoom=6](https://climatedata.ca/maps/?var=freeze_thaw_cycles&th=dlyfrzthw_tx0_tn-1&dataset=216&dataOpacity=100&labelOpacity=100&lat=45.58867&lng=-66.87607&zoom=6)

ClimateData.ca. (2026). Climatedata.ca.

https://climatedata.ca/maps/?var=freeze_thaw_cycles&th=dlyfrzthw_tx0_tn-1&dataset=216&dataOpacity=100&labelOpacity=100&lat=45.58867&lng=-66.87607&zoom=6

CLIMAtlantic. (2023). [MANAGED] RETREAT: THE ELEPHANT IN THE ADAPTATION FRAMEWORK Prepared for CLIMAtlantic by DV8 Consulting.

<https://climatlantic.ca/wp/wp-content/uploads/2023/05/CLIMAtlantic-Managed-Retreat-Discussion-Paper-FINAL-March-15-2023.pdf>

Covered Bridges - Municipality of Grand Lake. (2023, October 18). Municipality of Grand Lake. <https://municipalityofgrandlake.ca/covered-bridges/>

CSA (2019). CAN/CSA-S6-19, Canadian Highway Bridge Design Code. CSA Group.

Cunningham, S. (2026, January 22). Minto jail project delayed until fall 2027: MLA. Tj; Telegraph-Journal. <https://tj.news/fredericton-west/minto-jail-project-likely-delayed-till-fall-2027-mla>

Daigle, M. (2025, September 23). Latest massive N.B. wildfire bigger than first thought. Tj; Telegraph-Journal. <https://tj.news/fredericton-west/trio-of-wildfires-burning-out-of-control-in-n-b>

DeLong, N. (2025, April 17). Grand Lake buys campground to turn into public park. Tj; Telegraph-Journal. <https://tj.news/fredericton-west/grand-lake-buys-campground-to-turn-into-public-park>

El-Jabi, N., Turkkan, N., & Caissie, D. (2016). Water Availability and Security in New Brunswick.

Feasibility study. (2025, December 9). Adaptation in Action | Green Municipal Fund. Greenmunicipalfund.ca. <https://greenmunicipalfund.ca/funding/study-adaptation-action>

Flannigan, M., Cantin, A. S., de Groot, W. J., Wotton, M., Newbery, A., & Gowman, L. M. (2013). Global wildland fire season severity in the 21st century. *Forest Ecology and Management*, 294, 54–61. doi:10.1016/j.foreco.2012.10.022

Environment and Local Government. (2019) Flood Details - 2019-04-19 - 2019-05-06. (2019). Elgegl.gnb.ca. <https://www.elgegl.gnb.ca/0001/en/Flood/Details/380>

Flood Recovery Everything you need to know. (n.d.). https://www2.gnb.ca/content/dam/gnb/Departments/pa-ap/pdf/Report_Damages/FloodRecovery-e.pdf

Fowler, S. (2018, May 10). Upright and intact cottage floats across province's largest lake. CBC. <https://www.cbc.ca/news/canada/new-brunswick/castaway-cottage-grand-lake-1.4657747>

- Freezing rain. (2023). Ouranos. <https://www.ouranos.ca/en/climate-phenomena/freezing-rain-background>
- GeoNB. (2026). Local Government Climate Change Adaptation Plans. Geonb.snb.ca. https://geonb.snb.ca/elg_ccap/index.html
- Google Maps. (2024). <https://maps.app.goo.gl/dtGFsrLVQyJxMEmz8>
- Government of New Brunswick. (2018). Flood risk information and history - gnb.ca. [Www.gnb.ca. https://www.gnb.ca/en/topic/laws-safety/emergency-preparedness-alerts/flooding.html](https://www.gnb.ca/en/topic/laws-safety/emergency-preparedness-alerts/flooding.html)
- Government of New Brunswick. (2023). Investment in new Grand Lake wastewater treatment facility. [Www2.Gnb.ca. https://www2.gnb.ca/content/gnb/en/departments/regional_development/news/news_release.2023.11.0544.html](https://www2.gnb.ca/content/gnb/en/departments/regional_development/news/news_release.2023.11.0544.html)
- Government of New Brunswick. (2026). Cyanobacteria (blue-green algae). Government of New Brunswick. <https://www.gnb.ca/en/topic/laws-safety/health-environment-advisories/cyanobacteria.html>
- Government of New Brunswick. (2026). Salmon River Bridge. Government of New Brunswick. <https://www.gnb.ca/en/topic/driving-transportation/transportation-projects/salmon-river-bridge.html>
- Groisman, P. Y., Bulygina, O. N., Yin, X., Vose, R. S., Gulev, S. K., Hanssen-Bauer, I., & Førland, E. (2016). Recent changes in the frequency of freezing precipitation in North America and Northern Eurasia. *Environmental Research Letters*, 11(4). <https://doi.org/10.1088/1748-9326/11/4/045007>
- Gu, L., Yin, J., Slater, L. J., Chen, J., Do, H. X., Wang, H. M., ... & Zhao, T. (2023). Intensification of global hydrological droughts under anthropogenic climate warming. *Water Resources Research*, 59(1), e2022WR032997.
- Haggett, D. (2025, July 29). "It's life for us": Trump's tariffs a big concern in N.B. community. CTVNews. <https://www.ctvnews.ca/atlantic/new-brunswick/article/its-life-for-us-trumps-tariffs-a-big-concern-in-nb-community>
- Haggett, D. (2025, December 3). "It's sad": Third covered bridge to be torn down in New Brunswick in less than a year. CTVNews. <https://www.ctvnews.ca/atlantic/new-brunswick/article/its-sad-third-covered-bridge-to-be-torn-down-in-new-brunswick-in-less-than-a-year/>
- Harding, G. (2020, August 14). "Good progress" made on 2 forest fires in Miramichi region. CBC. <https://www.cbc.ca/news/canada/new-brunswick/nb-two-forest-fires-out-of-control-1.5686764>
- Horizon Health Network. (2026, February 2). Queens North Community Health Centre – Horizon Health Network. <https://horizonnb.ca/facilities/queens-north-community-health-centre/>

- Ibrahim, H. (2018, May 18). Grand Lake campground could be “total loss.” CBC. <https://www.cbc.ca/news/canada/new-brunswick/flood-damage-business-princess-park-camping-1.4668710>
- Implementation projects. (n.d.). Greenmunicipalfund.ca. <https://greenmunicipalfund.ca/funding/implementation-project-adaptation-action>
- IPCC, 2023: Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647
- Klima, K., & Morgan, M. G. (2015). Ice storm frequencies in a warmer climate. *Climatic Change*, 133(2), 209–222. <https://doi.org/10.1007/s10584-015-1460-9>
- Knutson, T., Camargo, S. J., Chan, J. C., Emanuel, K., Ho, C. H., Kossin, J., ... & Wu, L. (2020). Tropical cyclones and climate change assessment: Part I: Detection and attribution. *Bulletin of the American Meteorological Society*, 100(10), 1987-2007.
- Local Governments Establishment Regulation – Local Governance Act (2022, August 30). <https://laws.gnb.ca/en/showfulldoc/cr/2022-50>
- MacRae, A. (2024, January 22). New Brunswick covered bridge reopens after being closed since 2018. CTVNews. <https://www.ctvnews.ca/atlantic/article/new-brunswick-covered-bridge-reopens-after-being-closed-since-2018/>
- McCray, C. D., Schmidt, G. A., Paquin, D., Leduc, M., Bi, Z., Radiyat, M., ... & Brettschneider, B. R. (2023). Changing Nature of High-Impact Snowfall Events in Eastern North America. *Journal of Geophysical Research: Atmospheres*, 128(13), e2023JD038804.
- Municipal Planning - Municipality of Grand Lake. (2023, October 17). Municipality of Grand Lake. <https://municipalityofgrandlake.ca/services/municipal-planning/>
- Municipality of Grand Lake NB. (2026). Facebook.com. <https://www.facebook.com/municipalityofgrandlakenb/posts/an-important-read-your-guide-to-emergency-preparedness-from-nbemofollow-this-link/573993888099672/>
- Natural Resources Canada (2009). Forest Fire Severity Level, 2090-2099. <https://open.canada.ca/data/en/dataset/de7981f0-8893-11e0-9245-6cf049291510>
- NAV Canada (2001). The weather of Atlantic Canada and Eastern Quebec. <https://www.navcanada.ca/en/lawm-atlantic-en.pdf>
- Nature Trust. (2022, February 17). A Rain Garden Revisited - The Nature Trust of British Columbia. The Nature Trust of British Columbia. <https://www.naturetrust.bc.ca/news/a-rain-garden-revisited>
- NB Power (2019). Extreme weather: climate change and your power. New Brunswick Power Corporation. https://www.nbpower.com/media/1489807/191220-extreme-weather-report_final-en.pdf

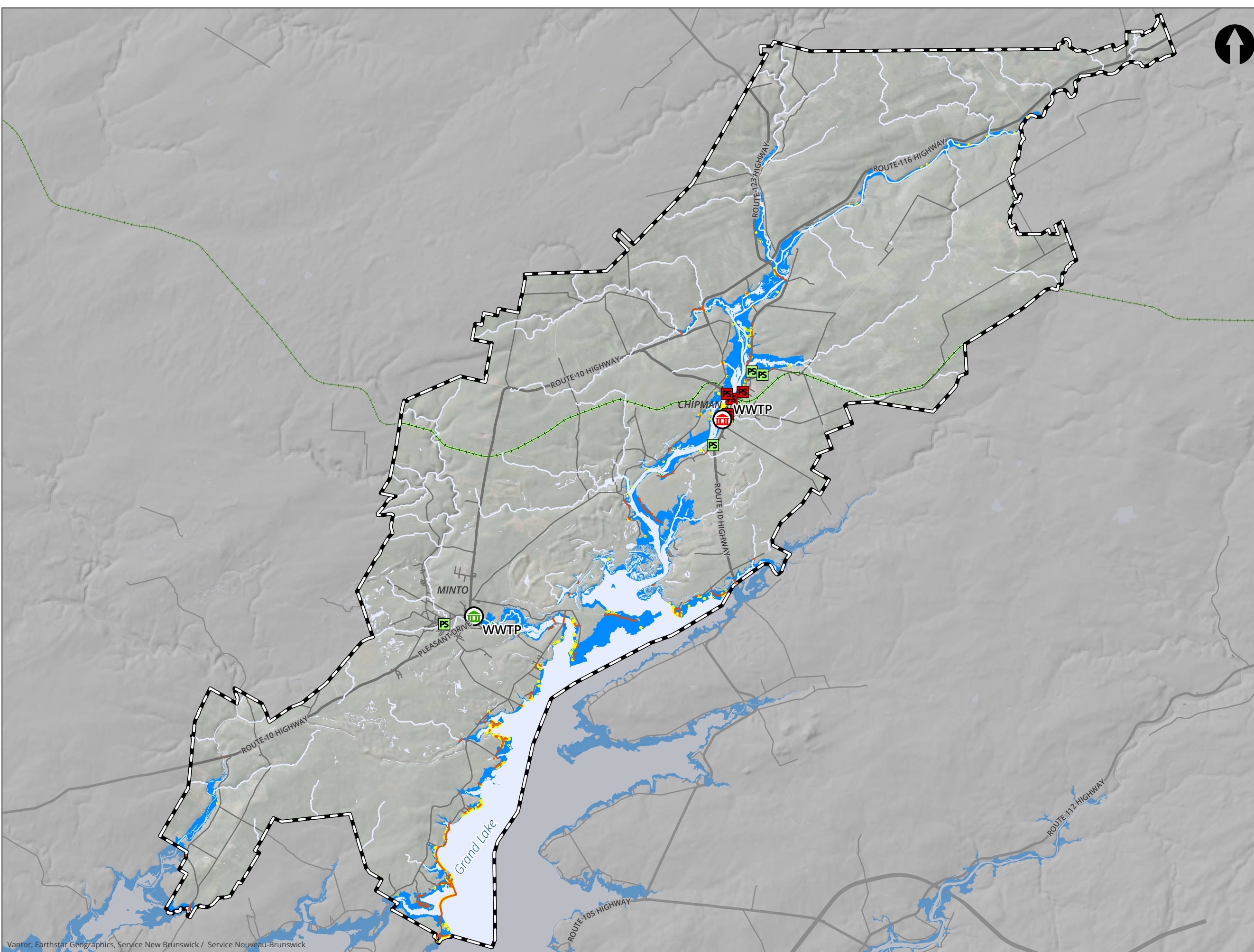
- NBEMO (n.d.). https://www2.gnb.ca/content/dam/gnb/Departments/emo-omu/PDF/nb-emo_booklet-e.pdf
- New Brunswick Flood Hazard Maps. (n.d.). Geonb.snb.ca. https://geonb.snb.ca/flood_hazard_maps/index.html
- New Brunswick Preparedness and Response Spring Freshet 2018 Flood After Action Review -Advice to Minister. (n.d.). <https://www2.gnb.ca/content/dam/gnb/Departments/emo-omu/PDF/report-2018-floods.pdf>
- New Brunswick Statements of Public Interest User Guide. (n.d.). New Brunswick Statements of Public Interest. Retrieved March 17, 2026, from <https://www.gnb.ca/content/dam/GNB3/t/fhc-fmc/land-use-planning/docs/user-guide.pdf>
- Our Pathway Towards Decarbonization and Climate Resilience. (n.d.). Retrieved February 9, 2026, from <https://www.gnb.ca/content/dam/GNB3/org/elg-egl/doc/climate-change-action-plan.pdf>
- Perry, B. (2019, April 26). Chipman Nearly Isolated By Flooding - Your Saint John. Your Saint John. <https://yoursaintjohn.ca/chipman-nearly-isolated-by-flooding/>
- Poirier, C., Fortin, G., & Dubreuil, V. (2023). Spatial and temporal characteristics of past droughts in New Brunswick (1971–2020). *International Journal of Climatology*, 43(15), 7183-7198.
- Prapti Bamaniya. (2022, August 8). 700 kilograms of old flood debris found in Grand Lake-area woods. CBC. <https://www.cbc.ca/news/canada/new-brunswick/grand-lake-flood-debris-cleanup-1.6544956>
- Previl, S. (2017, January 27). 2 dead, 2 in hospital in wake of devastating New Brunswick ice storm. Global News. <https://globalnews.ca/news/3210326/2-dead-2-in-hospital-in-wake-of-devastating-new-brunswick-ice-storm/>
- RetroNB. (2018, May 10). NB Flood 2018 Princess Park Grand Lake. YouTube. <https://www.youtube.com/watch?v=3069rarjqQk>
- RetroNB. (2019, May 9). Post Flood 2019 at Princess Park NB. YouTube. <https://www.youtube.com/watch?v=ttjN6G9Awo>
- Rewind 95.9. (2026). Facebook.com. <https://www.facebook.com/rewind959/posts/there-is-a-new-out-of-control-wildfire-burning-in-the-northumberland-countyit-is/1373528988002494/>
- Roy, P., & Huard D. (2016). *Future Climate Scenarios – Province of New Brunswick*. Montreal: Ouranos. 46 p. + Appendixes
- Sills, D. (2013). *Tornadoes in Canada: Improving our Understanding*.
- Stuart, R. A., & Isaac, G. A. (1999). Freezing precipitation in Canada. *Atmosphere-Ocean*, 37(1), 87-102.

- Sweet, J. (2025, October 23). Drought has dried many wells all over New Brunswick, groundwater association says. CBC. <https://www.cbc.ca/news/canada/new-brunswick/nb-drought-causing-dry-wells-says-groundwater-association-9.6950670>
- Tam, B. Y., Szeto, K., Bonsal, B., Flato, G., Cannon, A. J., & Rong, R. (2018). CMIP5 drought projections in Canada based on the Standardized Precipitation Evapotranspiration Index. *Canadian Water Resources Journal/Revue canadienne des ressources hydriques*, 44(1), 90-107.
- Telegraph-Journal. (2025, September 24). Massive out-of-control N.B. fire grows even bigger, bad air a concern. Tj; Telegraph-Journal. <https://tj.news/fredericton-west/massive-out-of-control-n-b-fire-grows-even-bigger-bad-air-a-concern>
- The Weather Channel (2018, January 16). Historic Covered Bridge to be Destroyed | Weather.com. The Weather Channel. <https://weather.com/en-CA/canada/news/news/2018-01-16-covered-bridge-new-brunswick-destroyed>
- The Weather Network (2020, March). After two years of flooding, Grand Lake residents brace for spring. The Weather Network. <https://www.theweathernetwork.com/en/news/weather/forecasts/after-two-years-of-flooding-grand-lake-residents-brace-for-spring-new-brunswick>
- UNFCCC. (2025). Adaptation and Resilience. Unfccc.int. <https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/introduction>
- Voyent Alert - Municipality of Grand Lake. (2025, April 28). Municipality of Grand Lake. <https://municipalityofgrandlake.ca/services/voyent-alert/>
- Water Quality Monitoring. (2024, December 20). Jemseggrandlakewatershed.ca. <https://jemseggrandlakewatershed.ca/projects/water-quality-monitoring/>
- Waugh, A. (2025, July 15). *Warnings issued as multi-day heatwave hits N.B.* Tj; Telegraph-Journal. <https://tj.news/new-brunswick/warnings-issued-as-multi-day-heatwave-hits-n-b>
- Waugh, A. (2026, January 26). Big storm sparks warnings, closes schools, cancels flights. Tj; Telegraph-Journal. <https://tj.news/new-brunswick/big-storm-sparks-warnings-closes-schools-cancels-flights>
- Westra, S., Fowler, H. J., Evans, J. P., Alexander, L. V., Berg, P., Johnson, F., Kendon, E. J., Lenderink, G., & Roberts, N. M. (2014). Future changes to the intensity and frequency of short-duration extreme rainfall. *Reviews of Geophysics*, 52(3), 522-555. <https://doi.org/10.1002/2014RG000464>
- Wotton, B. M., Flannigan, M. D., & Marshall, G. A. (2017). Potential climate change impacts on fire intensity and key wildfire suppression thresholds in Canada. *Environmental Research Letters*, 12(9), 095003.
- Yoursaintjohn.ca. (2018, May 5). Chipman Residents Cut Off Due To Flooding - Your Saint John. Your Saint John. <https://yoursaintjohn.ca/chipman-residents-cut-off-due-to-flooding/>

APPENDIX A

Flood Risk Maps

Path: Y:\Halifax\Data\Projects\2026\261201.00 Grand Lake CCAP\GIS\PRO\261201 Grand Lake CCAP Mapping.aprx



Legend:

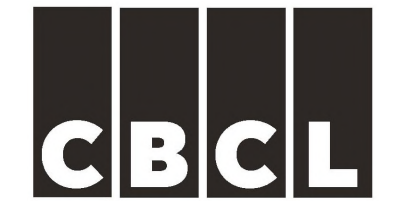
- At Risk Pumping Station
- Treatment Plant
- Pumping Station
- Treatment Plant
- At Risk Roads
- At Risk Building
- Flood Extent
- Watercourse
- Waterbody
- Rail
- Municipality of Grand Lake Boundary

| No | Date | Issue/Revision |
|----|-------------|-------------------------|
| 3 | Mar 31 2026 | Issued for Final Report |
| 2 | Mar 16 2026 | Issued for Draft Report |
| 1 | Feb. 3 2026 | Issued for Report |



Project:
Municipality of Grand Lake
CCAP

Drawing Title:
Flood Risk
1 in 100 year storm
with Climate Change



| | | | |
|-------------|-----------|------------|-----------|
| Date: | FEB 2026 | Scale: | 1:180,000 |
| Drawn: | SMO | Approved: | LNB |
| Project No: | 261201.00 | Figure No: | B1 |

APPENDIX B

Risk Assessment Matrix

| Asset Group | Asset/Service | Risk = L x C | Riverine Flooding | | | | Temperature | | | | Precipitation | | | | | | | | Wind and Storms | | | | Other Hazards | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------------------|---|--------------|--|---|---|---|--|---|---|--|---|---|--|---|--|---|--|---|--|---|--|---|--|--|--|---|--|--|---|-------|----------------------------|-------|-------|-------|-----------------------------------|-------|-------|-------|----------------------------|-------|-------|-------|---------------------|-------|-------|-------|---------------------|-------|-------|-------|-------------------------------|-------|-------|-------|---|-------|----|-------|---------------------|-------|--|--|
| | | | Riverine Flooding | | | | Extreme Heat | | | | Cooling Degree Days | | | | Freeze-Thaw Cycles | | | | Extreme Rainfall | | | | Snowfall | | | | Ice Accretion | | | | Wind Load | | | | Winter Storms | | | | Hurricanes/Tropical Storms | | | | Lightning | | | | Wildfire | | | | Drought | | | | | | | | | | | |
| | | | 1 in 100 | | | | Days > 30 °C | | | | Days > 18 °C | | | | Annual Freeze-Thaw Cycles | | | | 1 in 10 year 24 hour | | | | 1 in 100 year 24 hour | | | | Days with Snowfall > 10 cm | | | | 1 in 20 year Ice Thickness | | | | 1 in 50 Year Hourly Wind Pressure | | | | Frequency/Intensity | | | | Frequency/Intensity | | | | Frequency/Intensity | | | | Lightning Strikes within 25km | | | | Frequency/Intensity (incl. Air Quality) | | | | Frequency/Intensity | | | |
| | | | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | |
| Likelihood: | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | |
| Emergency Response and Management | Emergency Response and Community Health Centres (Chipman Health Center, Queens North Community Health Center) | Interaction | Potential for residents to be cut off or isolated because of flooded roads or access routes, temporarily limiting access to essential services (similar to the 2018 flood events where the village of Chipman was effectively cut off from the rest of the province due to closure of all roads leading in and out of the village). | Potential for power outages and loss of communications for effective relief and rescue operations. | The municipality does not have a designated emergency shelter. | Extreme temperatures may result in possible power outages lasting for extended period of time due to overloading and possible failure of utility systems. Emergency cooling/warming centres may be required in these scenarios. | The municipality has backup power. This could reduce vulnerability of potential emergency centres and residents during widespread power outages. | Grant Lake does not have an EMO plan, however there is a provincial plan (NBEMO). Extreme Heat or Cold is not included in NBEMO Plan as a potential hazard. No criteria is outlined for establishing cooling or warming centres. It is noted that including such criteria in EMO plans is becoming more common in municipalities throughout Canada. | Residents facing extreme heat or cold temperatures may result in increased response calls for EMO. During extreme heat events, the Metro clinic's capacity may be exceeded. | Potential for delayed services during emergency due to icy road conditions. | Infrastructure flood risk. Potential for isolation of remote residential areas without access to essential services due to culvert or bridge washout. | Potential for limited mobility within the municipality for relief and rescue efforts. | Potential for delayed services during emergency. | Roads of buildings may need immediate clearing during high precipitation events. | Ice storms may result in increased public safety incidents and EMO response calls. | The municipality has backup power for an emergency warming centre in the event of a widespread power outage lasting extended periods of time. Note that the municipality does not have a designated emergency shelter but Chipman Fire Station was used as a warming shelter during the 2017 ice storm. | External resources (e.g., Red Cross, adjacent municipalities) may be required for support. | Winter storms may result in increased public safety incidents and EMO response calls. | Possible power outages lasting for extended period of time. Emergency warming centres may be required. | Municipality has backup power for an emergency warming centre in the event of a widespread power outage. Chipman Fire Station was used as a warming station in 2017. External resources (e.g., Red Cross, adjacent municipalities) may be required for support or evacuation. | Hurricane events may result in increased public safety incidents and EMO response calls. | Possible power outages lasting for extended period of time. | Municipality has backup power in the event of a widespread power outage. | External resources (e.g., Red Cross, adjacent municipalities) may be required for support or evacuation. | Unknown if EMO buildings are equipped with lightning protection devices. | Wildfire events may result in increased public safety incidents and EMO response calls. Hospitals and other facilities without adequate HVAC filters (MERV 13 or higher) could be at a higher risk for air quality impacts. | External resources (e.g., Red Cross, adjacent municipalities) may be required for support or evacuation. | NBEMO Plan does not currently address potential hazards related to drought and loss of water supply for residents. | No official plan for backup water source for residents if wells were to dry up during a period of drought. Statement of Hospitals and other critical buildings have water resiliability challenges. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | |
| | | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | |
| | | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | |
| | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | |
| Transportation | Roads | Interaction | Potential flooding of major roads impacting mobility throughout the Municipality and potentially isolating residents and businesses similar to 2018 and 2019 floods. Those 10 (multiple sections of the highways) in Chipman, Route 600 in Princess Park, and Newcastle Rd connecting Newcastle Centre to Newcastle Creek are at highest risk. Erosion and damage to roadways from floodwater may require repairs and debris cleanup. Residents may need to depend on service (gravel) roads which may be unsafe to use. | Vulnerable population are more prone to heat stress and heat exhaustion without proper cooling mechanisms in place. Care facilities may require additional capacity during heatwaves. | Potential for additional electrical loads due to active cooling efforts (if any). | Potential for higher slips and falls due to icy pavements, putting everyone at risk, particularly the elderly. Proper maintenance of walking surfaces can alleviate the risk. | Potential for building crafty damages but this can be reduced or eliminated through proper maintenance. | Potential flooding that could lead to reduced mobility throughout the community for emergency and other critical services. | Potential for school closures due to high snow event. | Power outages can put residents in senior care and hospitals at risk if backup power is not available. | Potential for minor building damages from repeated setup or flying debris. | Potential for school closures. | Possible utility damage and extended power outages. Emergency centres may be required. Municipality has backup power for an emergency warming centre in the event of a widespread power outage. Potential for delayed services during emergency. | Potential for school closures. | Utility damage and extended power outages. Emergency centres could be required. Possible damage to infrastructure. Debris cleanup. | Potential for closure of schools. | Care facilities without adequate HVAC filters (MERV 13 or higher) could be at a higher risk. | Care facilities may need to supplement water. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | | | | | |
| | | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | |
| | | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | Likelihood | 1 | 2 | 3 | 4 | 2 | 3 | 3 | 4 | 3 | 5 | 5 | 5 | 3 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 1 | 2 | 3 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| Water and Sewer | Private Water Supply (Wells, Tanker companies) | Interaction | Temporary flooding of area surrounding well. Possible contaminant infiltration into wells causing temporary unsuitable water quality. Testing/intervention may be required to restore water supply. Several homes and businesses that rely solely on wells will be hit particularly hard for extended period of time during high consumption events. | Repeated freeze-thaw can lead to cracking around the well seal, which can create pathways for water contaminants. | Increased risk of septic system effluent reaching groundwater supplies. | Surface water infiltration can carry bacteria, nutrients, and chemical into wells. Shallow or poorly sealed wells are especially vulnerable to contamination. | Increased risk of septic system effluent reaching groundwater supplies. | Potential extended power outages resulting in disruption of potable water supply to residences and businesses. | Potential extended power outages resulting in disruption of potable water supply to residences and businesses. | Potential extended power outages resulting in disruption of potable water supply to residences and businesses. | Temporary flooding of area surrounding well. Possible infiltration of contaminant into well causing temporary unsuitable water quality. Testing/intervention may be required to restore water supply. | Temporary flooding of area surrounding well. Possible infiltration of contaminant into well causing temporary unsuitable water quality. Testing/intervention may be required to restore water supply. | Potential extended power outages resulting in disruption of potable water supply to residences and businesses. | Possible contamination from wildfire event. Testing likely required before water is deemed safe to consume. | Declining groundwater levels may reduce yield or cause wells to go dry. Concentration of minerals and contaminants may increase. Currently no formal backup potable water supply in the municipality in case the wells can dry. Some residents may use local springs, which may not regularly be tested for water quality. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | | | | | |
| | | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | |
| | | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | |
| | | Likelihood | 1 | 2 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | Likelihood | 1 | 2 | 3 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | RL | 2030s | 2050s | 2080s | | | | | | | | | | | | | | | | | |
| | Consequence | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |
| | Risk | 5 | 10 | 15 | 20 | 6 | 12 | 12 | 16 | 6 | 10 | 10 | 10 | 6 | 8 | 8 | 8 | 8 | 8 | 10 | 10 | 4 | 6 | 12 | 16 | 3 | 3 | 3 | 2 | 12 | 12 | 8 | 6 | 3 | 3 | 3 | 3 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 3 | | | | | | | | | | | | | | | | | |

APPENDIX C

Summary of Recommended Action Items

| Action Item | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|---|---|--|--|-------------|---------------------------|
| Riverine Flood Preparedness and Mitigation | | | | | |
| 1.1 | Adopt updated land use plans for flood resilience | Capital Region Service Commission (CRSC) | DELG; Grand Lake Economic Development Officer | Ongoing | Low |
| 1.2 | Updating flood lines to include wave analysis | CRSC – Planning and Development | DELG; Grand Lake EMO Coordinator | Short-term | Moderate |
| 1.3 | Completion of emergency response assessment | EMO Coordinator; NBBDTI | Fire Department; Horizon Health Network Community Development | Short-term | Low |
| 1.4 | Adapting vulnerable infrastructure | Grand Lake Engineering | EMO Coordinator; Department of Tourism, Heritage, and Culture; NBBDTI; Covered Bridges Association of New Brunswick; FCM Funding | Medium-term | High |
| 1.5 | Community education and engagement | EMO Coordinator | Jemseg Grand Lake Watershed Association | Ongoing | Moderate |
| Emergency Response Planning | | | | | |
| 2.1 | Develop a Grand Lake Emergency Response Plan | EMO Coordinator | Fire Department; Horizon Health Network Community Development; NBEMO | Short-Term | Moderate |
| 2.2 | Adapting emergency shelters for thermal comfort and air quality | Horizon Health Network Community Development | EMO Coordinator | Medium-term | High |

| Action Item | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|------------------------------------|---|--|---|-------------|---------------------------|
| 2.3 | Work with care facilities to reinforce emergency procedures | Horizon Health Network Community Development | EMO Coordinator | Short-term | Low |
| 2.4 | Post-event cleanup procedures | Grand Lake Operations | Fire Department | Short-term | Moderate |
| 2.5 | Voyent Alert! and communications system | EMO Coordinator | Fire Department; Horizon Health Network Community Development; NBEMO | Ongoing | Low |
| Heatwave Adaptation | | | | | |
| 3.1 | Establish cooling facilities | EMO Coordinator | Community Health Centers, Fire Department | Short-Term | Moderate |
| 3.2 | HAB monitoring | Jemseg Grand Lake Watershed Association | Department of Tourism, Heritage, and Culture; DELG; Voyent Alert! | Ongoing | Moderate to High |
| Extreme Rainfall Resilience | | | | | |
| 4.1 | Stormwater management plan and I&I study | Grand Lake - Engineering | Capital Region Service Commission (CRSC) | Medium-term | Moderate |
| 4.2 | Stormwater management by-laws | Grand Lake Planning and Development | Capital Region Service Commission (CRSC) | Medium-term | Low |
| Wildfire Resilience Plan | | | | | |
| 5.1 | Wildfire Resilience Plan | EMO Coordinator | Fire Department; NB Wildfire Management Branch; FireSmart NB; FireSmart Canada; NBEMO | Short-term | Medium |

| Action Item | Description | Implementation Lead | Partners & Resources | Timeline | Estimated Level of Effort |
|--------------------------------|------------------------------|------------------------|--|------------|---------------------------|
| Drought Management Plan | | | | | |
| 6.1 | Yield assessment | Grand Lake Engineering | DELG; Capital Region Service Commission (CRSC) | Long-term | Moderate |
| 6.2 | Drought preparedness at home | EMO Coordinator | Jemseg Grand Lake Watershed Association | Short-term | Low |



Solutions today | Tomorrow **IN** mind

[f](#) [t](#) [v](#) [in](#)
www.CBCL.ca