# CLIMATE CHANGE ADAPTATION PLAN FOR **QUISPAMSIS**

Brogan, Bailey
McDonald, Jamylynn
MacKinnon, Roxanne

2021

Published by:
Atlantic Coastal Action Program [ACAP] Saint John, Inc
139 Prince Edward Street, Suite 323
Saint John, NB
Canada E2L 3S3
Tel: (506) 652-2227
office@acapsj.org

ACAP
SAINT JOHN

**Climate Change Adaptation Plan for The Town of Quispamsis**

Brogan, Bailey
McDonald, Jamylynn
MacKinnon, Roxanne

2021

Published by:

Atlantic Coastal Action Program [ACAP] Saint John Inc.
139 Prince Edward Street, Suite 323
Saint John, New Brunswick
Canada E2L 3S3
Tel: (506) 652-2227
Fax: (506) 801-3810
E-mail: office@acapsj.org
Web: www.acapsj.org

# Acknowledgements

The Quispamsis Climate Change Adaptation Plan has been developed in collaboration with the Town of Quispamsis and the New Brunswick Climate Change Secretariat. ACAP Saint John is very grateful for the financial support of the province through the New Brunswick Environmental Trust Fund.

This work would not have been possible without the support of our Steering Committee members Cathy Snow, Trevor Murray, Sherry Levesque, Libby O'Hara, Dwight Colbourne, and Gary Losier. A special thank you to Aaron Kennedy of the Communications department for sharing our work with Quispamsis residents and Chrissy Scott of the GIS department, for her contributions to the mapping analysis.

The development of this Adaptation Plan and the success of its implementation is due to the continued collaboration between the federal, provincial, and municipal government and the community and Non-Governmental Organizations.


# Table of Contents

# Executive Summary

Climate Change in Quispamsis will result in an increase in temperature, precipitation, and more frequent extreme weather such as post-tropical storms and ice storms. This shift in weather patterns will cause flooding, damage infrastructure, destroy habitats, isolate neighbourhoods, and create public health challenges. The Climate Change Adaptation Plan focuses on specific risks and actions that will be required to reduce the negative impacts of these changes on the natural and built environment.

ACAP Saint John has conducted extensive research to identify areas of concern throughout the Town. A gap analysis of existing initiatives was completed by reviewing municipal by-laws and existing municipal and provincial initiatives to identify available resources and reveal gaps in legislation. Research also involved online and in-person community engagement which helped to voice public concerns. The public responses were included in the Vulnerability and Risk Assessment to highlight high risk issues in Quispamsis and guide the development of the Action Register, which provides 48 adaptation recommendations. The recommended actions are organized into four strategies:

- Strategy 1: Modifying policies, plans and procedures;
- Strategy 2: Building or infrastructure upgrades;
- Strategy 3: Improving community awareness and public education; and
- Strategy 4: Building resilience to climate impacts.

As municipal plans and policies are updated, the Climate Change Adaptation Plan can be integrated, and serve as a guide for the Town of Quispamsis to increase the resiliency of the community. Climate Change adaptation in Quispamsis will embrace and celebrate the natural environment to support a sustainably healthy, vibrant, and safe community.

Model Farm Rd. Brian Comeau

# Introduction

Climate Change refers to variations in the average weather patterns that occur over time. The increasing concentration of greenhouse gases (GHGs) in the Earth's atmosphere are a result of both natural processes and human activity (mostly related to fossil fuel use) and have resulted in a rise in global temperatures. Not only is the world becoming warmer due to the higher concentration of GHGs in the atmosphere, this warming is leading to the increased frequency and severity of weather-related events around the world. Sea levels are rising, seasonal patterns are shifting, and regional precipitation events are becoming increasingly dramatic and unpredictable (Bush et al., 2019).

In recent years, New Brunswick has experienced large fluctuations in river runoff, more frequent winter thaws, and an increased risk of ice jams. As a result, washouts, flooding of dwellings, service interruptions, sewage backup in basements, and water contamination are more frequently experienced in the province. Damage and recovery costs associated with these events are rising. From 2008 to 2012 the estimated total cost of flood related damage in this province exceeded $100 million (Government of New Brunswick, 2014). In the spring of 2018, riverside neighbourhoods of the Town of Quispamsis (the Town) saw historical levels of flooding where many homes and critical infrastructure were inundated by the Kennebecasis River with an estimated recovery cost of $80 million across the province (Fraser, 2018).

While we know that precipitation patterns are changing and that extreme weather events will become more frequent with a changing climate, the impacts this will have on the ground in Quispamsis have yet to be analyzed. The Town recognizes the need for climate action and has created programs to reduce greenhouse gas (GHG) emissions, increase active transportation and reduce waste. Community level action is recognized and encouraged through these municipal strategies.

This Climate Change Adaptation Plan identifies specific actions to be taken in high-risk areas through collaboration between community partners, ACAP Saint John, and the Town of Quispamsis. This project includes gathering knowledge of municipal staff from multiple departments to understand current opportunities, restraints, and vulnerabilities. Furthermore, local knowledge of areas at risk and natural assets in neighbourhoods were collected through community engagement events to identify opportunities for demonstration sites to manage stormwater in suburban areas. ACAP Saint John will also share background information on local climate change impacts with decision makers, town staff, consultants, community members, and other stakeholders including residents, landowners, and business owners to increase awareness of local vulnerabilities.

# Methodology

The adaptation toolkit *Building Adaptive and Resilient Communities* by the International Council for Local Environmental Initiatives (ICLEI), has been implemented by municipalities in British Columbia, Ontario, and Newfoundland. ACAP Saint John has selected this toolkit to guide the adaptation planning process for the Town. The framework consists of five key Milestones which incorporate science and lessons learned to direct adaptation and implementation (Figure 1).

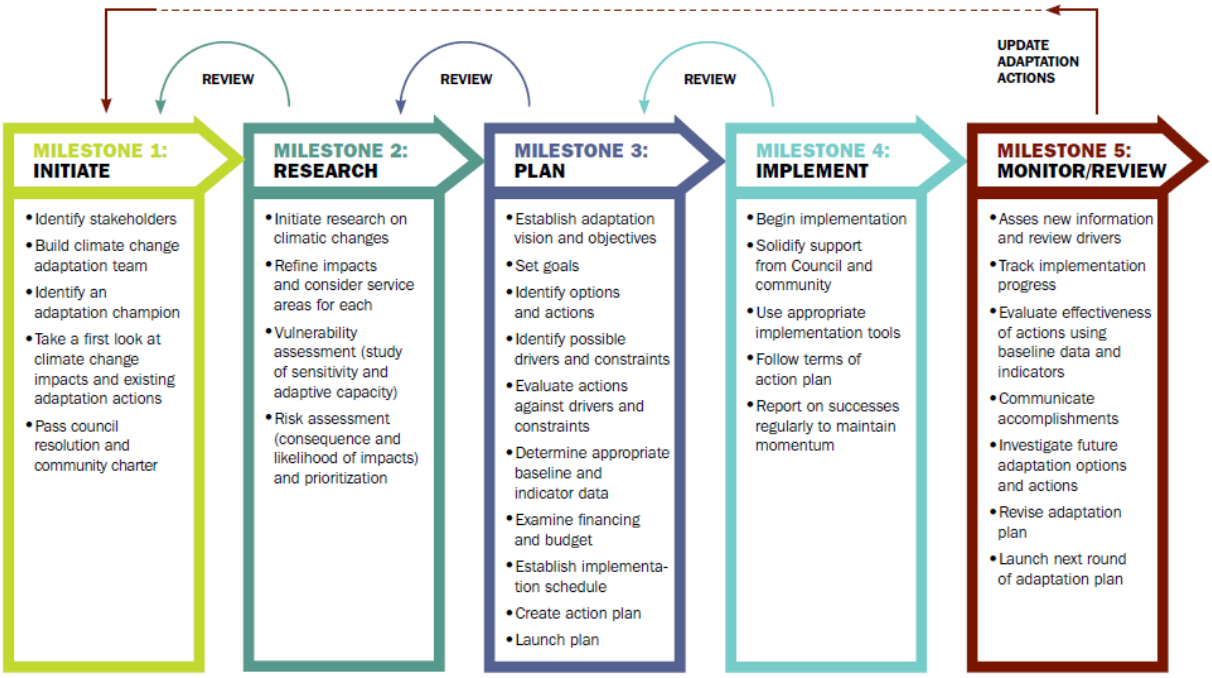


*Figure 1: Five key Milestones for Climate Change adaptation beginning with initiate, followed by research, plan, implement, and monitor/review. (ICLEI-Canada, n.d.).*

ACAP Saint John has completed Milestones 1-3 (Initiate, Research, and Plan) through the development and adoption of this adaptation plan. Another ICLEI guide that was used was *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptatio*n to complete Milestones 2 and 3 (ICLEI-Canada, n.d.). The remainder of the milestones (Milestone 4: Implementation & Milestone 5: Monitor/Review) will fall to the Town to ensure that the adaptation plan continues to serve as a guide for community climate change adaptation. This process is meant to be iterative, and requiring updates as climate conditions and community circumstances change, therefore, this plan will be a living document.

# Project Timeline

In 2020, ACAP Saint John received funding from the New Brunswick Environmental Trust Fund to complete the Climate Change Adaptation Plan for the Town of Quispamsis. The project was

initiated by developing the steering committee (Milestone 1: Initiate) of municipal staff representing various municipal departments. All steering committee members were asked to complete a survey to gather information about recent climate impacts in the Town, as well as adaptation actions that have already been completed. A list of the survey questions can be found in Appendix C.

ACAP Saint John reviewed relevant reports, by-laws, and planning documents to recognize actions that increase the Town's resilience to climate change, as well as to identify any gaps in legislation or procedures (Milestone 2: Research). The research milestone of this framework is critical to identify and prioritize risks, vulnerabilities, and adaptation opportunities. This data as well as local climate projections were used to develop the vulnerability and risk assessment to identify the most severe climate impact in the community (Appendix A).

Public surveys and participation in community markets were used throughout the summer and fall of 2020 to engage the community in the Milestone 3: Plan, to help establish goals and develop adaptation actions. Using input collected from the community and the steering committee, ACAP Saint John developed a list of 48 adaptation actions that make up the Action Register (Section 3.3). The Action Register describes the adaptation actions recommended, risk ratings of associated climate impacts, the lead department responsible for completing actions, costs, and completion targets. Adaptation actions are referenced throughout the report as "Strategy X.XX."

# Chapter 1: Introduction to The Town of Quispamsis

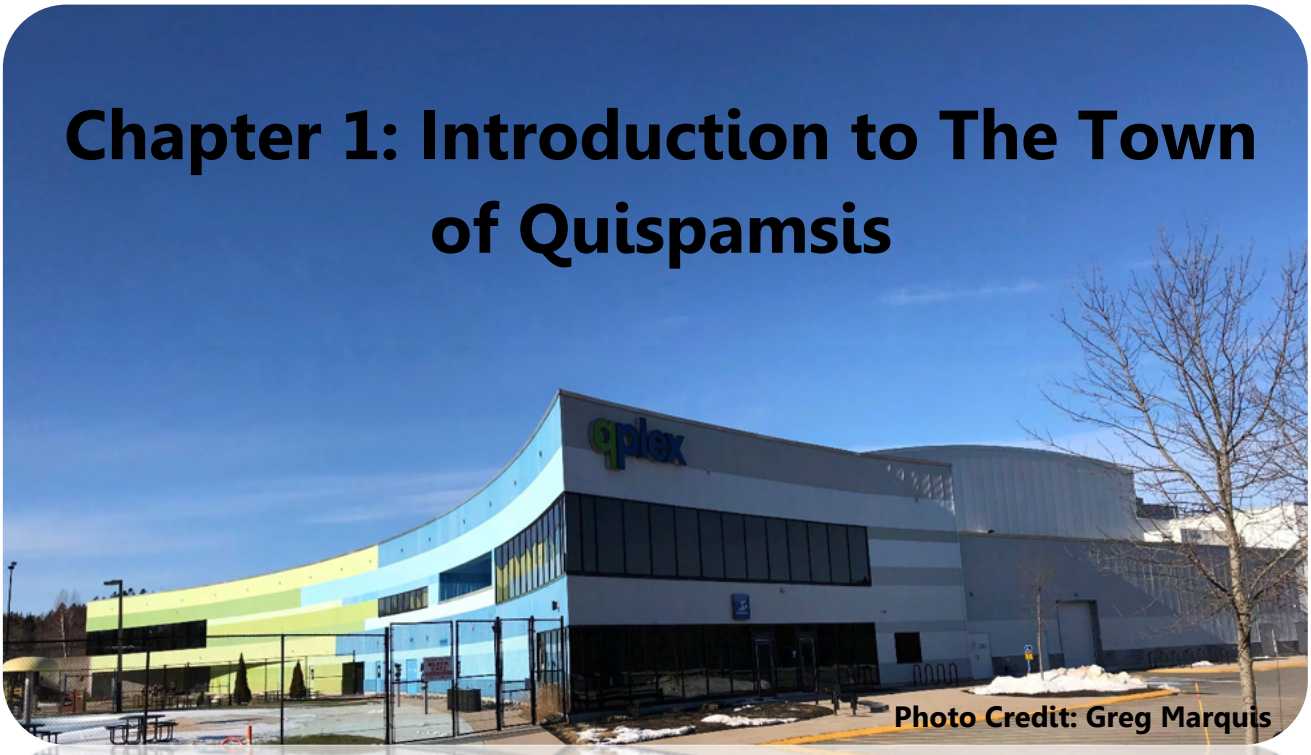

Photo Credit: Greg Marquis

## 1.1 Municipal Background

The Town of Quispamsis (the Town) is a large suburban community neighbouring the City of Saint John, located approximately 22 km northeast of Saint John, between the Hammond River and the Kennebecasis River. The Town of Quispamsis is proud to be recognized as a "forward-thinking community where families enjoy a safe, friendly and active lifestyle surrounded by a beautiful, natural environment" (Town of Quispamsis, 2018a). The community is the sixth largest municipality in New Brunswick with a population of 18,245, which has increased by 1.7% since 2011 (Statistics Canada, 2016). Approximately 15% of the population is above the age of 65, and there are two special care homes and two nursing homes located within the Town.

Land use within the Town is predominantly residential and transforms from rural in the northern portion to residential further south, with strips of commercial businesses, conservation areas, and parkland located throughout the municipality. Business parks are located adjacent to the MacKay Highway, along Millennium Drive. Industrial operations are limited to an industrial park on the Palmer Brook Road, in the Northeast portion of the Town. Natural Assets within the Town include forested areas in the northern portion of the Town, the Kennebecasis River, Mud Lake, Ritchie Lake, Meenan's Cove, MacFarlane Lake, and tributaries of the Kennebecasis and Hammond Rivers.

## 1.2 Climate Change in Quispamsis

Climate Change is one of the greatest challenges facing human civilization today. It directly impacts fundamental resources like food, water, and shelter globally. The impacts of climate

change in Canada are already evident, through increased temperatures, shorter snow and ice cover seasons, earlier spring peak streamflow, and a shift in precipitation patterns (Bush et. al, 2019). The Intergovernmental Panel on Climate Change (IPCC) is a United Nations scientific body and the foremost authority on Climate Change science. In its most recent report, the Fifth Scientific Assessment Report (AR5), the IPCC finds that warming of the climate system as a result of increased greenhouse gas (GHG) emissions is irreversible, and Canada is warming at approximately twice the global average (Bush et al., 2019; IPCC, 2014). Higher concentrations of GHGs in the atmosphere have led to an increase in global temperatures with 2016, 2019, and 2020 being the hottest years on record (WMO, 2021). This aligns with a trend in global warming that has been observed over the last 60 years (Figure 2).

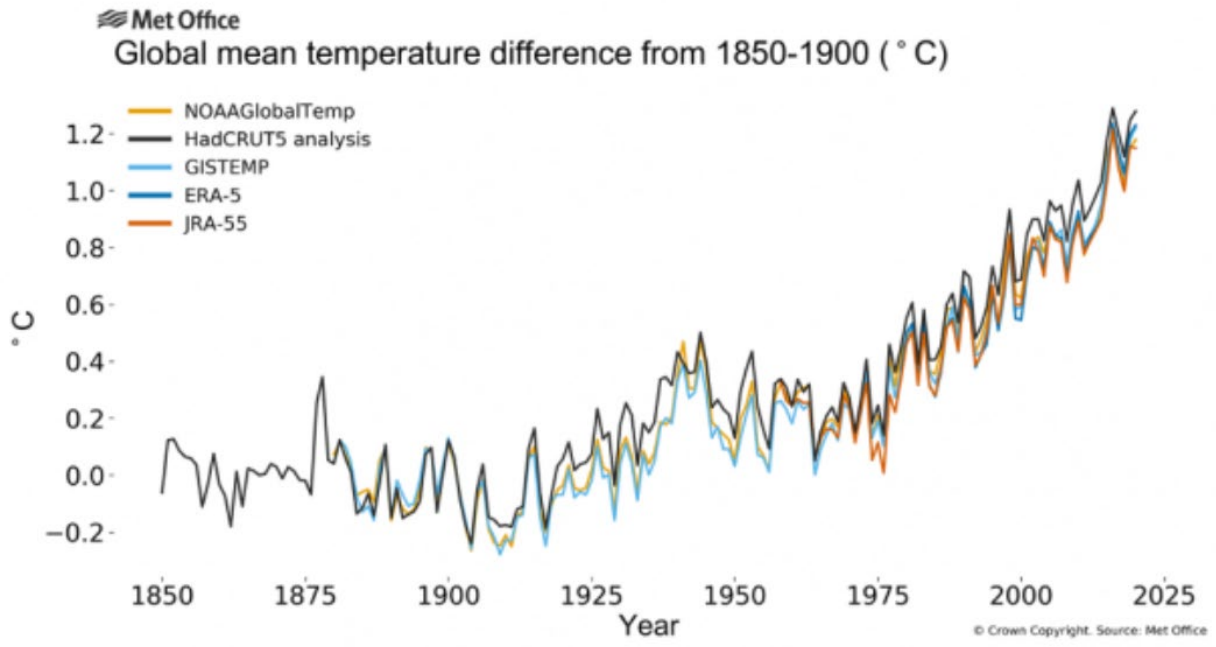


*Figure 2: Temperature trends from 1850-2020 (WMO, 2021).*

The climate challenges facing the Town of Quispamsis include extreme precipitation events, inland flooding from spring freshets, as well as heavy rainfall, and an increase in mean annual temperature (Figure 3). For communities located within the Kennebecasis River Valley, flooding can be anticipated within the floodplain and diligent planning can reduce damage to infrastructure. Impacts of increased annual temperature include winter rain events, heat stress during summer months, and periods of drought. The Climate Change Adaptation Plan will provide recommendations for the Town to develop innovative solutions and integrate adaptation into existing programs while continuing to thrive as a positive, sustainable community.

Figure 3 provides an overview of the local Climate Change projections for Greater Saint John. For more information, ACAP Saint John has completed a background report *Understanding Climate Change in Saint John* (2020), that provides a more in-depth analysis of climate change projections and the associated impacts. Climate projections are also listed in Appendix A.

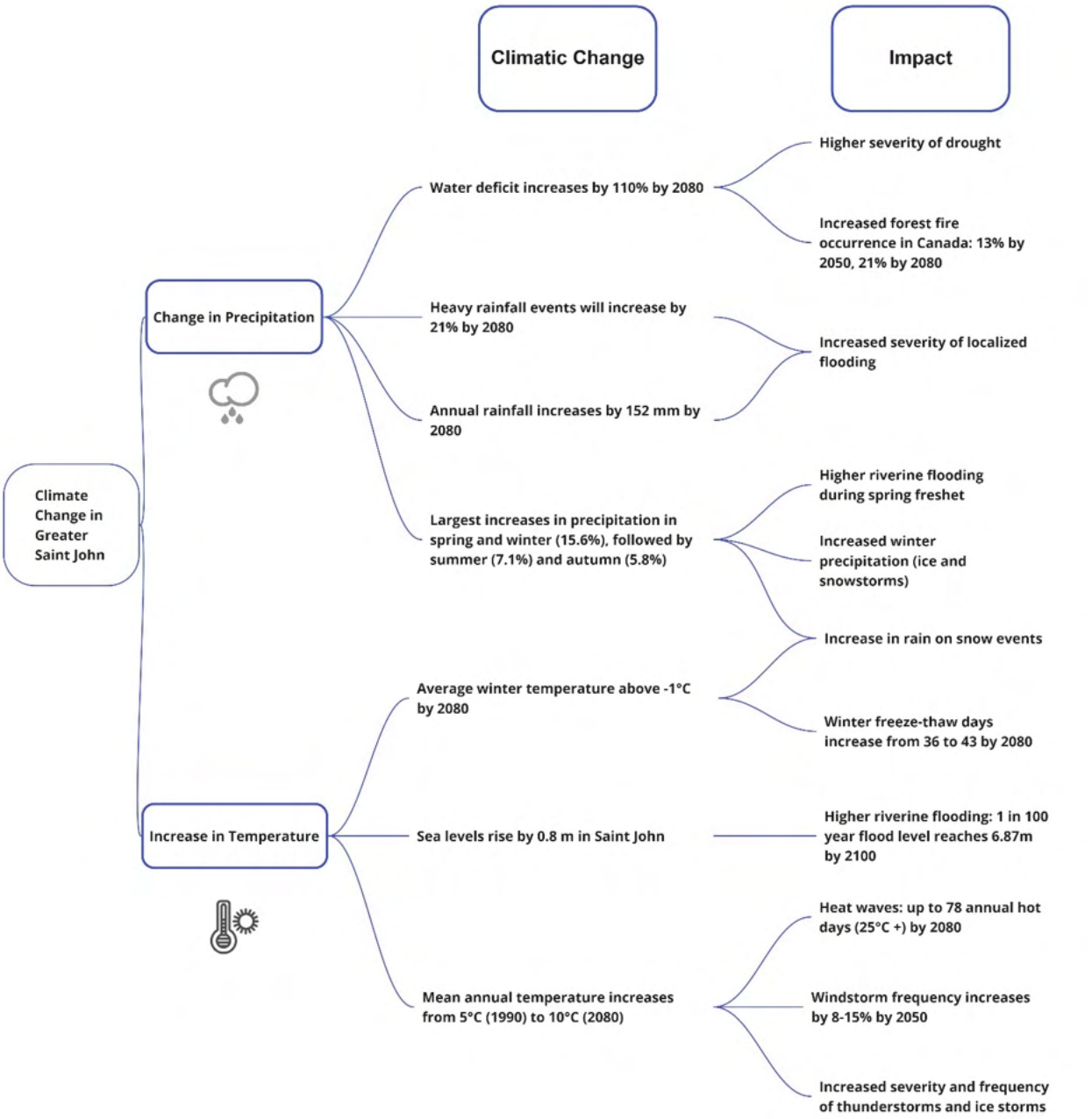


*Figure 3: Climate Change impacts and outcomes for the Greater Saint John Area (QUEST, 2018; Roy and Huard, 2016; Bruce, 2011; Wang et al., 2015; PCC, 2019; Daigle, 2020).*

## 1.3 Gap Analysis

ACAP Saint John has reviewed relevant reports, by-laws, and policies followed by the Town of Quispamsis to develop a preliminary risk assessment. This analysis will help identify climate adaptation initiatives that are already taking place, and to help provide recommendations to the Town for adaptation. The following is a summary of this review. Table 6 in Appendix B highlights

climate impacts that have been identified by the Town through previous work, as well as additional climate impacts that have not yet been addressed.

### 1.3.1 Climate Change Mitigation

The Town of Quispamsis is a founding member of the Federation of Canadian Municipalities Partners for Climate Protection Program and has addressed the need for Climate Change adaptation in the Municipal Plan (2018-2028) with a focus on sustainable development and growth. Using 2015 emissions as a baseline, the Town committed to reducing corporate emissions by 12% by 2025, as well as reducing community emissions 8% by 2025, and 16% by 2035 (YHC Environment, 2018). The Town has already achieved energy efficiency projects such as the construction of the Q-Plex, a LEED certified building, three electric car charging stations, and by adopting minimum energy standards for housing and small-scale commercial buildings (Town of Quispamsis, 2019). The Town has a desire to holistically respond to climate change by using low carbon solutions to adaptation such as maintaining green areas, ecosystems, and watersheds, as well as continuing to develop active transportation infrastructure. Adaptation actions that support reducing GHG emissions and increase resiliency include developing neighbourhoods that encourage multi-modes of active transport (Strategy 1.9), and to diversify energy supply to reduce energy usage by integrating green energy into Town infrastructure (Strategy 4.46).

### 1.3.2 Municipal Plan

The Town updated its Municipal Plan in 2018 that will guide development from 2018-2028. The next update will be completed in 2022. Community visions listed in the Municipal Plan include maintaining and enhancing the natural environment, and building a sustainable, healthy, vibrant, inclusive, and safe community. These visions fall in line with developing a climate change adaptation plan for the community. Section 5.5.5 of the Municipal Plan states support for an adaptation plan "It shall be a policy of Council to: Undertake the development of a Climate Change Adaptation Plan to assist in the identification of land uses and infrastructure that are climate adaptation priorities (i.e., highly vulnerable with a high degree of risk)" (Town of Quispamsis, 2018a). The Municipal Plan also supports incorporating considerations for climate change impacts into new regulations as well as the design and development of new infrastructure (Strategies 1.5, 2.14).

Section 5 of the Municipal Plan, "Environmental Policies" references policies that will support community adaptation, such as a public education program to reduce water usage during dry periods, encouraging stormwater management that promotes groundwater infiltration, and to consider the impacts of climate change and adaptation in the development of any major new infrastructure projects (Strategies 3.32, 4.42). The Town relies entirely on groundwater resources for freshwater supply, meaning protecting groundwater in a changing climate will be essential. The Town has seen significant growth in the last 10-15 years, and this trend is likely to continue in the future. Water studies conducted in 2005 and 2011 stated that two potential water sources in the Palmer Brook Watershed and areas in proximity to Millennium Drive could support further development in the Town. Council committed to a re-examination of the previous two studies

and into wellfield capacities to service current and future demands. This new study should account for climatic changes that may deplete groundwater resources due to increased temperatures and dry periods (Strategy 1.8).

A Stormwater Management Plan is to be completed and will recommend that new developments maintain a net-zero balance between pre- and post-development flow. A study will also need to be conducted to determine ways to implement stormwater management practices to mitigate climate change impacts such as heavy periods of rainfall, and to protect environmentally sensitive areas. Council proposed to "Undertake the development of a Municipal Watershed Mapping and Stormwater Management Program that will identify the key natural drainage areas and basins across the municipality as well as identify the predictive storm flows at a 1-100 years plus 20% to identify areas within the Municipality that are prone to flooding" (Town of Quispamsis, 2018a). Community members should be engaged when completing the stormwater management plan to help identify areas that require attention and to educate the public about the importance of managing increasing stormwater volumes (Strategy 3.30).

As part of this directive, the Town has worked with Dr. Paul Arp from UNB's Watershed Forest Research Center to develop a flood layer that predicts areas at risk during heavy rainfall events. This information identifies watercourses, drainage channels, and wet areas that are not recognized in provincial mapping to assist in planning new subdivisions out of risk areas. The Town has been able to locally protect certain waterways through this process to avoid flooding during heavy rainfalls (Strategy 4.43).

### 1.3.3 Zoning By-Law

The Town of Quispamsis Zoning By-Law was enacted in 2009 and recently amended in 2019. The Zoning By-Law dictates development policies within the Town of Quispamsis. Policies of note include restrictions for waterfront properties, where no alteration of existing waterfront buildings or land can be completed without approval by the Planning and Advisory Committee (PAC) (Town of Quispamsis, 2009). The PAC may also request that an Environmental Impact Assessment or a Wetland and Watercourse Alteration Permit be obtained before granting or denying a variance request. The Zoning By-Law is currently being updated. Updating zoning within flood zones to restrict development within flood prone areas (accounting for 7m flood elevation and 1 in 100 +20% storms) will help to avoid damages to new developments in the Town (Strategy 1.1).

### 1.3.4 Commercial Development

The Town of Quispamsis drafted the Millennium Drive Development Scheme in 2000 to guide commercial development on Millennium Drive. The scheme includes best management practices on chemical storage, landscaping, and stormwater management (Town of Quispamsis, 2000). Millennium Drive is a commercial strip adjacent to the MacKay Highway, and therefore this guide only applies to a small area of the Town. Best practices in the development scheme should be expanded to include all commercial areas within the Town (Strategy 1.10). Developing more

ambitious design standards for commercial properties that includes low impact development design is another, more ambitious goal to help manage increased stormwater flow (Strategy 1.7).

### 1.3.5 Asset Management

The Town's Asset Management Plan includes the Asset Management Policy (2018), Asset Management Strategy (2018), State of the Infrastructure Report (SOI) (2018), and a Comprehensive Asset Management Plan (CAMP) (2019). The SOI and CAMP were both prepared by R.V. Anderson & Associates. The Asset Management Policy will be reviewed every 5 years. Natural Assets are not included in the first iteration of the asset management program, but consideration will be given to including them in future versions. Under the SOI Report the Town's infrastructure received an overall grade of A-, meaning that infrastructure is in a very good state of repair, with only 3% of infrastructure rated as poor or worse, 6% rated as fair, 35% rated as good, and 56% rated very good. The current state of infrastructure helps to determine whether climate risks will exacerbate infrastructure deficiencies or determine the likelihood of failure of an asset due to climate impacts. Under the CAMP, two types of risk events have been identified: 1. Failure due to asset deterioration and 2. Failure due to extreme weather events. This analysis will give the Town a better understanding of how climate impacts will affect infrastructure. Within risk event 2 (extreme weather events), eight significant risks were identified:

1. "Extreme rainfall causing overtopping of culverts
2. Fluvial (River) flooding causing Gondola Point Road washout
3. Fluvial (River) flooding causing flooding of WW Pumping Stations along Gondola Point Road
4. Fluvial (River) flooding causing flooding of Meenan's Cove Beach House
5. Extreme temperature limiting Q-Plex ice making
6. Blockage of stormwater drainage channels due to snow and ice accumulation
7. Snow accumulation leading to building roof collapse
8. High winds causing loss of power at Q-Plex" (R.V. Anderson, 2019b).

In the future, Town staff will ensure infrastructure investments are based on asset management data and information such as remaining lifespan, level of service provided to the community, and risk of failure. The asset management plan is part of the Town's efforts to address potential infrastructure damages due to more severe weather events. Identifying and integrating municipally owned natural areas into the asset management plan will help to manage natural assets that provide ecosystem services to the Town and help lengthen the life of traditional infrastructure (Strategies 1.3, 1.4).

### 1.3.6 Water Supply Study

A Water Supply and Distribution Study was completed by CBCL in 2019 on behalf of the Town. The purpose of the study was to determine the feasibility of area aquifers to support future growth and development. The study found that area aquifers can sustain current usage rates of water within the Town, however, several additional wells would be necessary to accommodate the entire Town on the municipal water system. Areas that have potential to be high yielding aquifers were

identified for further study. The model was completed under long term, steady state conditions, and therefore did not consider the reduction of groundwater that the Town will experience under future climate conditions. CBCL recommended that the Town identify areas that are experiencing poor water quality or quantity and to develop a questionnaire for potential customers to determine interest in connecting to the municipal water system (Strategy 2.20).

### 1.3.7 Emergency Measures Plan

The Town of Quispamsis Municipal Emergency Measures Plan was developed in collaboration with the New Brunswick Emergency Measures Organization (NB EMO) in 2018. The plan was developed to guide the Town and the Quispamsis Emergency Measures Organization (QEMO) through emergency situations. This plan included the completion of a hazard assessment and response actions for specific climate hazards such as blizzards/ice storms, erosion, flooding, heat waves, severe weather (i.e. hurricane, post-tropical storm, tornado, thunderstorm), wildfires, and critical infrastructure failures (Town of Quispamsis, 2018c).

As part of a continuous improvement process, the QEMO Plan and execution is evaluated after each event to identify what was successful and what responses could use improvement. For example, an emergency response plan has been developed to respond to riverine flooding after the 2018 spring flood event so that the Town can respond more effectively during future flood events. This plan can be a good reference for responding to climate related hazards and should be reviewed and updated on an annual basis (Strategy 1.2).

### 1.3.8 Spring Freshet Flooding

Following spring freshet flooding in 2018, the Town retained Brunswick Engineering to complete a Geotechnical Inspection & Rehabilitation Design for flood impacted infrastructure. Five sites were selected for rehabilitation work:

- 507 Gondola Point Road – Lift Station
- 556 Gondola Point Road – Roadway Fore-slope
- 565 Gondola Point Road – Lift Station and Parking Area
- 623 Gondola Point Road – Lift Station and Roadway Fore-slope
- Matthews Cove – Channel and Fish Ladder.

Engineering, Public Works, and Community Services are continually striving to mitigate damages during extreme events. Following the 2018 and 2019 spring freshet flooding, the Town installed a berm around the Meenan's Cove Beach House to protect the building from future flood events. The Town has also refined its sandbagging process and mapped critical transportation routes that are impacted by riverine flooding. Other flood resiliency measures completed by the Town include road stabilization along the river, working to relocate and retrofit wastewater pumping stations along the Gondola Point Road abutting the Kennebecasis River as well as generators for wastewater pumping stations. Adapting nationally recognized (CSA) standards for flood resilience and stormwater management in flood risk areas for new developments will increase resilience to flooding in the Town of Quispamsis (Strategy 1.17).

# Chapter 2: Climate Change Adaptation in Quispamsis

Adaptation planning is a process that enables communities to deal with the impacts, challenges and opportunities presented by climate change, while maintaining the level of service and credibility that the municipality is known for. This section will identify local risks in the Town of Quispamsis to work toward reducing vulnerabilities and building a more resilient community.

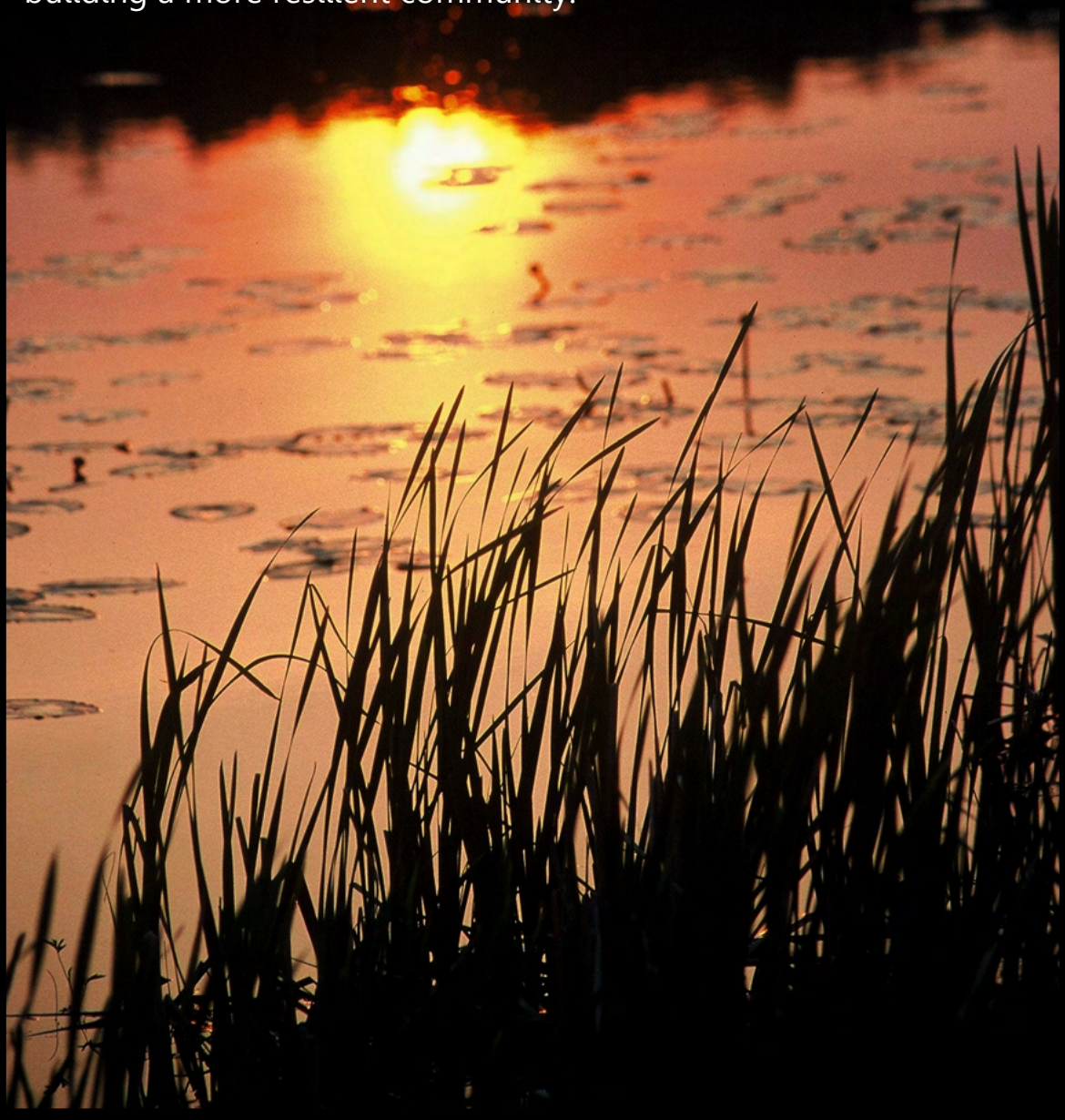

Photo Credit: Brian Comeau

## 2.1 Community Engagement

The Kennebecasis Valley community was engaged through an online participatory mapping exercise that asked participants to identify their favourite spaces, areas where they have observed climate impacts, as well as areas they would like to see environmental enhancement projects. Approximately 33 community responses were received from the survey. Participants identified the Q-Plex Recreation Complex, Gondola Point Beach, and Meenan's Cove as favourite places in the Town. Seasonal flooding was also identified as the largest climate change impact in the community, followed by heavy rainfall (Figure 4). The virtual exercise concluded by asking the participant a series of focused questions about adaptation and what barriers might exist. This survey provided support for significant areas that should be prioritized in the adaptation plan as well as identifying any local challenges that may be less obvious. Results from this survey were shared on ACAP Saint John's social media platforms and at the Kingston Farmers Market (Figure 4).

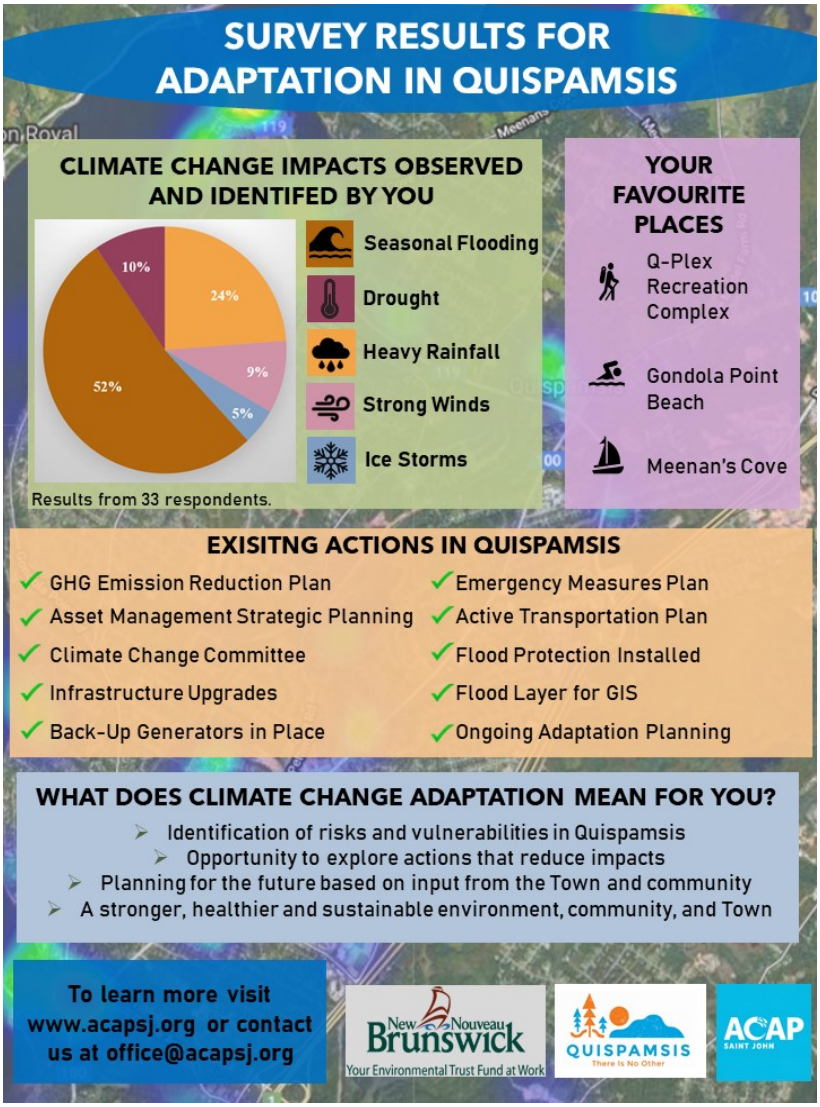


*Figure 4: Results from steering committee and summer online community surveys.*

After developing and reviewing the adaptation actions with the Steering Committee, ACAP Saint John used online engagement once again in January 2021 to update the community on the progress of the planning, to present the actions, and to provide an opportunity for feedback. Climate change impacts in the region were presented to give context for the suggested actions and educate participants about local changes. The exercise showcased actions that involve community engagement including workshops and awareness campaigns, as well as actions that fall under municipal services such as infrastructure upgrades and policy changes. Through this engagement tool, ACAP Saint John was able to build awareness about adaptation planning and provide an opportunity for community input on recommended actions.

Over 200 residents of the Town of Quispamsis accessed the January online survey to review projected climate change impacts to the community. Comments from focused survey questions were collected and analyzed using a word cloud (Figure 5). Common themes included increasing or maintaining greenspace, reducing litter, avoiding development within the floodplain, and reducing greenhouse gas emissions. Responses pertaining to specific actions in the Action Register are discussed in Section 3.3.

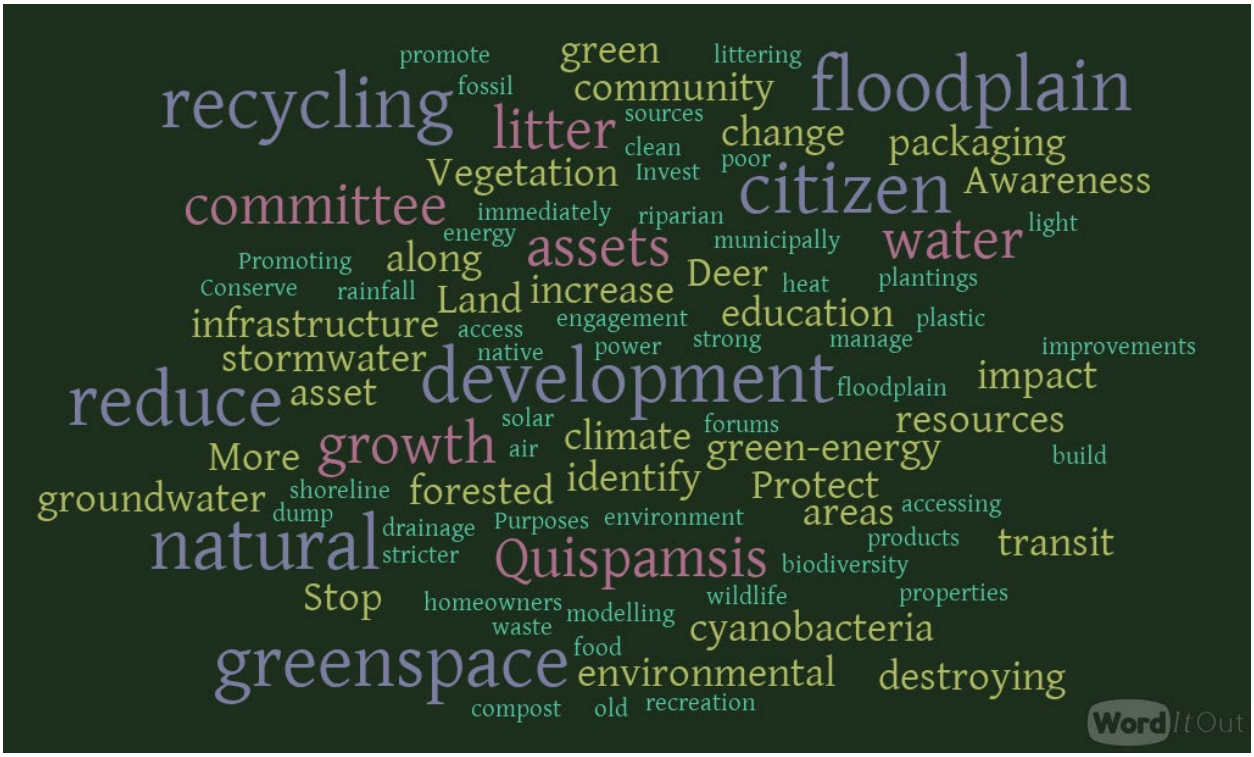

*Figure 5: Key words from ACAP Saint John's community survey in January 2021.*

### 2.1.1 Kingston Farmers Market

ACAP Saint John attended the Kingston Farmers Market for two weekends in October 2020 to bring awareness about the adaptation planning being completed in Quispamsis (Figure 6). Results from the online engagement and Steering Committee questionnaires were presented in an infographic format (Figure 4) that was available for community members to take home, along with ACAP Saint John's report *Understanding Climate Change in Saint John*. These resources will help increase community knowledge about climate change and highlight the importance of awareness and adaptation.


*Figure 6: Community engagement at the Kingston Farmers Market, October 2020.*

The Climate Change Team also presented adaptation actions that can be implemented with respect to specific climatic changes such as riverine flooding and increasing temperatures. Community members were encouraged to use stickers to mark the actions they think are important for protecting the Town and building resilience to changing climate (Appendix C, Figure 16). Using rain barrels and rain gardens to manage heavy precipitation was the most popular response from suggested adaption actions (Table 1).

*Table 1: Community responses for suggested adaptation actions from ACAP Saint John's outreach at the Kingston Farmers Market. Note: these responses are from both residents of Quispamsis and Rothesay.*

| Climate Change Adaptation Action | Number of Votes |
|---|---|
| *Increase in heavy precipitation* | |
| Rebated installation of backwater valves | 2 |
| Storm preparedness | 2 |
| Clear debris from clogged basins | 0 |
| Snow removal off buildings and structures | 0 |
| Increase natural water infiltration | 4 |
| Rain barrels and rain gardens | 6 |
| *Higher riverine flooding* | |
| Education about flood preparedness | 2 |
| Raising berms around sewage lagoons | 1 |
| Raising road infrastructure | 0 |
| Changing development patterns | 3 |
| *Increased Temperature* | |
| Education about invasive species | 3 |
| Designated cooling centers | 0 |
| **Total Responses** | **23** |

## 2.2 Vulnerability and Risk Assessment

A Vulnerability and Risk Assessment was developed to rank the severity of the Climate Change risks in the Town of Quispamsis. This process followed the ICLEI *Changing Climate, Changing Communities: Guide and Workbook for Municipal Adaptation* and falls under Milestone 2 of the adaptation framework: Research.

### 2.2.1 Impact Statements

To begin the Vulnerability and Risk assessment, ACAP Saint John developed a series of impact statements taking into consideration the input from Steering Committee members and community engagement. The impact statements describe an effect of changing climate and are broken into two categories of climatic changes: changing precipitation and increasing temperature. For each impact statement, the service areas (or municipal services) that would be affected were identified and assessed. The impact statements are used throughout the risk and vulnerability assessment and are included in Tables 9 and 10 in Appendix D.

### 2.2.2 Vulnerability Assessment

Vulnerability in this context refers to the susceptibility of a given service area to harm arising from Climate Change impacts (ICLEI-Canada, n.d.). Vulnerability is a function of the **sensitivity** of a

service area to climate impacts and the **adaptive capacity** of the service area (*Vulnerability = Sensitivity x Adaptive Capacity*). Higher vulnerability is associated with high sensitivity and low adaptive capacity; the system cannot respond. The sensitivity of each service area was assigned by determining how the function of each sector would be affected and whether the service area is already experiencing stress. Sensitivity was rated on a scale from 1-5 with 1 meaning the "functionality will stay the same," and 5 meaning the "functionality will become unmanageable" (Figure 7). For example, localized flooding due to increased rainfall intensity will impact transportation infrastructure, and functionality of transportation infrastructure will get worse (S4).

| If the impact occurs, will it affect the functionality of the service area? | | | | |
|---|---|---|---|---|
| No – Functionality will stay the same (S1) | Unlikely – Functionality will likely stay the same (S2) | Yes – Functionality is likely to get worse (S3) | Yes – Functionality will get worse (S4) | Yes – Functionality will become unmanageable (S5) |

*Figure 7: Scale to determine the sensitivity of a service area due to Climate Change impacts (ICLEI-Canada, n.d.).*

Adaptive capacity identifies the service area's ability to adjust to a climate impact with minimal cost and disruption. Adaptive capacity is rated on a scale from 1-5 with 1 meaning substantial costs and staff intervention will be required, and 5 meaning little to no cost or staff intervention is necessary to adapt to Climate Change impacts (Figure 8). For example, impacts associated with heavy rainfall and localized flooding, the adaptive capacity of the transportation service area was rated AC1; whereby substantial costs and staff will be required if the impact occurs.

| Can the service area adjust to the projected impact with minimal cost and disruption? | | | | |
|---|---|---|---|---|
| No – Will require substantial costs ($$$$$) and staff intervention (AC1) | No – Will require significant costs ($$$$) and staff intervention (AC2) | Maybe – Will require some costs ($$$) and staff interven-tions (AC3) | Yes – But will require some slight costs ($$) and staff intervention (AC4) | Yes – No to little costs ($) and staff intervention are necessary (AC5) |

*Figure 8: Scale to determine the adaptive capacity of a service area due to Climate Change impacts (ICLEI-Canada, n.d.).*

Combining the sensitivity rating with the adaptive capacity provides the level of vulnerability for each impact (Figure 9). Using our increased precipitation example, where the transportation service area will be impacted by localized flooding (sensitivity=S4; adaptive capacity=AC1), the vulnerability rating equals V5, or "high." Appendix D, Table 9 includes the sensitivity and adaptive capacity ratings that were assigned to each impact to determine the level vulnerability. Service areas with low adaptive capacity and high sensitivity have a higher vulnerability to Climate Change impacts, whereas service areas with higher adaptation capabilities and lower sensitivity have a lower vulnerability rating.

Sensitivity and Adaptive Capacity Matrix

| | S1 | S2 | S3 | S4 | S5 |
|---|---|---|---|---|---|
| AC1 | V2 | V2 | V4 | V5 | V5 |
| AC2 | V2 | V2 | V3 | V4 | V5 |
| AC3 | V2 | V2 | V3 | V4 | V4 |
| AC4 | V1 | V2 | V2 | V3 | V3 |
| AC5 | V1 | V1 | V2 | V3 | V3 |

V1 = Low Vulnerability
V2 = Medium-Low Vulnerability
V3 = Medium Vulnerability
V4 = Medium-High Vulnerability
V5 = High Vulnerability

*Figure 9: Scale to determine the vulnerability of a service area due to Climate Change impacts based on levels of sensitivity (S1 – S5) and adaptive capacity (AC1 – AC5; ICLEI-Canada, n.d.).*

### 2.2.3 Risk Assessment

The same impacts identified in the vulnerability assessment were assigned a risk rating by developing an understanding of the **likelihood** (probability) and **consequences** of occurrence (*Risk = likelihood x consequence*).

The likelihood of an impact occurring is determined by the Climate Change projection data (Appendix A) and is ranked from 1-5, with 1 meaning an impact is "rare" and 5 meaning an impact is "almost certain" (Figure 10). To use our example from above, the likelihood of damage to the transportation service area due to localized flooding is 5 (almost certain to happen more than once a year).

| LIKELIHOOD RATING | RECURRENT IMPACT | SINGLE EVENT |
|---|---|---|
| **Almost Certain**<br>**5** | Could occur several times per year | More likely than not- probability greater than 50% |
| **Likely**<br>**4** | May arise about once per year | As likely as not – 50/50 chance |
| **Possible**<br>**3** | May arise once in 10 years | Less likely than not but still appreciable – probability less than 50% but still quite high |
| **Unlikely**<br>**2** | May arise once in 10 years to 25 years | Unlikely but not negligible – probability low but noticeably greater than zero |
| **Rare**<br>**1** | Unlikely during the next 25 years | Negligible – probability very small, close to zero |

*Figure 10: Scale to determine the likelihood of Climate Change impacts occurring (ICLEI-Canada, n.d.).*

ACAP Saint John modified the consequence table provided in the ICLEI Guide to support local assets and needs (Appendix D, Table 8). Each category represents a different community impact: health & safety; public services (power, sewer, water etc.); community lifestyle; natural environment; and infrastructure, and are ranked from 1-5, with 1 being an insignificant consequence and 5 being a catastrophic consequence. Each impact is assessed in all five categories to give a total consequence value out of 25.

To illustrate how these methods were applied, the consequences of damage to the transportation service area due to localized flooding are represented in Table 2. A summary of the consequence and likelihood tables for other impacts in the Town is included in Appendix D (Table 10).

*Table 2: Consequences of damage to transportation infrastructure due to localized flooding under the increased precipitation climatic change (V5). Each consequence category is rated from 1-5 based on the severity of each consequence (values are outlined in Appendix D, Table 8).*

| **Impact Statement: Damage to transportation infrastructure due to localized flooding under the increased precipitation climatic change.** | |
|---|---|
| **Consequence Categories** | **Consequence Value (1-5)** |
| Health and safety | 3 - Noticeable mental health impacts, non life-threatening injury. |
| Loss of service | 2 - Significant disruption and stress on public administration. |
| Community and lifestyle | 4 - Long-term disruption to routine. Recovery in months. |
| Natural environment | 1- No impact on the environment. |
| Damage & recovery | 3 - Moderate damage and high repair costs. |
| **TOTAL** | **13** |

The likelihood rating was multiplied by the consequence value to give a risk value that falls into a spectrum ranging from very low risk to extreme risk (Figure 11). For our example (Table 2), multiplying the likelihood and consequences of damage to the transportation service area due to localized flooding (likelihood=5; consequence=13) provided a risk rating of 65, or a medium risk.


*Figure 11: Risk rating spectrum to rank Climate Change impacts (ICLEI-Canada, n.d.).*

The interpretation of the risk levels is as follows:

- **Extreme** risks demand urgent attention at the most senior level and cannot be simply accepted as part of the routine operations without executive sanction.
- **High** risks are the most severe that can be accepted as part of the routine operations without excessive sanction, but they will be the responsibility of the most senior operational management and reported on at the executive level.
- **Medium** risks can be expected to form part of routine operations, but they will be explicitly assigned to relevant managers for actions, maintained under review and reported upon at senior management levels.
- **Low** risks will be maintained under review, but it is expected that existing controls will be sufficient, and no further action will be required to treat them unless they become more severe (ICLEI-Canada, n.d.).

### 2.2.4 Priority Impacts

Priority risks were determined by the vulnerability and risk assessment. Impact statements that were rated as medium-high or high vulnerability, and medium to medium high risk are identified in Table 3. **It is important to note that there were no risks identified in the "Extreme" or "High" risk categories**. The highest risk level identified was "Medium-High," and therefore, actions associated with these impacts were prioritized in the Action Register (Section 3.3, Appendix F). Further analysis of priority risks is discussed below.

*Table 3: Summary of high vulnerability and risk service areas in the Town of Quispamsis. The complete results from the vulnerability and risk assessment can be found in Appendix D Tables 9 and 10. Note: Increased storm events was rated medium-high risk with medium vulnerability.*

| IMPACT STATEMENT | | | Medium-High Vulnerability Service Areas | High Vulnerability Service Areas | Risk Rating |
|---|---|---|---|---|---|
| CHANGE IN PRECIPITATION | **Higher Riverine Flooding** | Damages to infrastructure/ properties due to flooding and/or erosion | Drinking water, storm system, municipal buildings | Sanitary system, transportation, private buildings | Med-High |
| | **Heavy rainfall Flooding** | Damages to infrastructure/ properties due to flooding and/or erosion | Drinking water, storm system, municipal buildings | Sanitary system, transportation, private buildings | Medium |
| | **Winter rain** | Flooding due to clogged catch basins (rain on snow event) | | Municipal & private buildings | Medium |
| | | Ice accumulation due to freezing rainstorms/flash freezing | Energy management | | Medium |
| | **Increased snowfall** | Infrastructure damage due to increased snow loading on buildings | Municipal & private buildings | | Medium |
| | **Drought** | Increased depletion of water supply for property owners with private wells | | Drinking water system | Medium |
| | | Increased forest fire potential | Parks and recreation, environment | Municipal & private buildings | Low |
| INCREASED TEMPERATURE | **Increased storm events** | Infrastructure damage due to increased storms | | | Med-High |
| | **Increased heat waves** | Stress on habitat for cold water species due to loss of cool streams for refuge | Environment | | Medium |
| | **Increasing average winter temperature** | Invasive species migration due to warmer winters | Parks and recreation | | Medium |

## Change in Precipitation

Annual precipitation is projected to increase by approximately 150 mm by 2080, and heavy rainfall events (more than 20 mm in 24 hours) will increase by 21% by 2080 (Figure 3). Even though precipitation is expected to increase overall, the greatest increases will occur in the winter and spring, followed by the summer, and then fall. This means that winters will become wetter with more snow, freezing rain and rain events, and spring will see heavy precipitation and increased

snowmelt rates, leading to increased risk of riverine and inland flooding, flooding due to catch basins being clogged with snow and ice, ice accumulation on infrastructure and increased snow loading on buildings (Medium to Low Risks; Table 3). Summer and fall will become drier and the water deficit will increase 110%, therefore increasing risk of drought and forest fires (Medium to Low Risk; Figure 3, Table 3).

The Town of Quispamsis currently has a list of priority areas that are prone to flooding during heavy rainfalls. These areas are regularly maintained and monitored closely before, during and after a rain event to ensure that critical infrastructure is not heavily impacted (Strategy 1.11). Upsizing stormwater management infrastructure to handle larger stormwater flows during end-of-life replacements will help manage heavy rainfall in the future (Strategy 2.18).

The Town's wet areas mapping layer completed by UNB also helps to envision areas that are more prone to flooding and will help the Town avoid infilling drainage channels when planning new developments. This mapping will be used to develop the watershed stormwater management plan that the Town has committed to in the Municipal Plan (Strategy 1.6). All of the impacts that ACAP identified from stormwater flooding were rated Medium in the risk assessment (Table 3).

### Riverine Flooding

In the spring of 2018 and 2019, New Brunswick experienced record spring freshet flooding across the Wəlastəkw (St. John River) watershed, impacting infrastructure along the Kennebecasis River. The 2018 flood reached 5.73 m above sea level measured at the "St. John River at Saint John" hydrometric data station whereas the 2019 flood peaked at 5.55 m. For the remainder of this Section, "historical flooding" will refer to the 2018 flood since this is the highest level reached during both flood events.

As a result of rising sea levels, the tidal influence of the Bay of Fundy on the Wəlastəkw and Kennebecasis Rivers can increase the severity of riverine flooding. In 2100, a 1 in 100 year (1%) flood in the Town of Quispamsis is projected to experience flood levels of 6.87m (Daigle, 2020). ACAP Saint John compared the infrastructure that will be impacted at a flood elevation of 7m to illustrate what infrastructure will need to be updated to reach the Town's goal of updating infrastructure above future flood levels (Strategy 1.1). Using this elevation will protect infrastructure in the long term.

According to the risk assessment, the Town is at a Medium-High risk of damage to infrastructure due to riverine flooding (Table 3). Approximately thirteen Critical Areas were identified using the Town of Quispamsis GIS where roadways, sewers, stormwater culverts, and sewage lift stations were impacted by flooding in the spring of 2018. Seven of these critical locations were on the Gondola Point Road, two on the Gondola Point Arterial (including the ferry landing), three in the Meenan's Cove area, and two on Hampton Road near Palmer Brook. These areas are likely to be impacted by flooding in the future as winter and spring precipitation increases, and sea levels south of the Town continue to rise. To illustrate future impacts, these locations were compared to the 7m flood scenario (Appendix E, Figures 17-20).

In this analysis flooding was observed to impact eleven roads; 77m or roadway was impacted by historical flooding and 2.75 km were impacted by the 7m flood scenario (Appendix E: Table 11). Roadway flooding will impact accessibility and mental health in these areas (Medium risk) and cause damage to infrastructure (Medium-High risk). A summary of locations are noted in Table 4, and maps depicting these areas along with a detailed list of impacted infrastructure are listed in Appendix E. Raising roadways and protecting wastewater pumping stations within these flood areas will help to reduce damage and isolation due to riverine flooding (Appendix E: Tables 11-14; Strategies 2.15, 2.16). Publicly identifying alternate routes for transportation when these routes are flooded will reduce isolation during flood events (Strategy 4.44). The Town of Quispamsis has already begun to analyze the impacts of riverine flooding in the Town through the Geotechnical Inspection & Rehabilitation Design Report by Brunswick Engineering (Section 1. 3.8; 2019b).

During historic flooding many homes (mostly along the Gondola Point Road) were observed in aerial photos to be impacted by flooding, but an assessment was not completed due to a lack of data. Through correspondence with municipal staff, it was determined that approximately 36 homes were directly impacted by flooding in 2018. Increasing awareness and availability of flood mapping and forecasting (Appendix E) will avoid new development within the flood zone (Strategy 3-25). Currently, any new buildings within 30m of a waterway are required to be approved by the Province of New Brunswick as well as the Planning and Advisory Committee, but there are few methods available to the municipality to increase flood resiliency on private property where structures already exist. In essence, it is up to the homeowner to adapt their properties to the impacts of flooding, which makes education and awareness a key goal of the adaptation plan (Strategy 3: Improving community awareness and public education).

*Table 4: Summary of Critical Areas and municipal infrastructure impacted by both historical flood levels (5.73m) and projected sea level rise to 2100 (7m) (Medium-High Risk). See Appendix E for a more detailed analysis. Road sections marked with * were not impacted by historical flooding, but are at risk to flooding in the future.*

| Location | Impacted Infrastructure | Vulnerability Details |
|---|---|---|
| 623 Gondola Point Road | Sewage lift station, road, stormwater culverts, nearby homes | Erosion to bank/road shoulder. Lift station building could be fully encompassed by water in 7m flood scenario. Recommended for rehabilitation (Brunswick, 2019b). |
| 586 Gondola Point Road* | Sewer lines, stormwater culverts, road, nearby homes. | Roadway completely flooded in 7m scenario. |
| 575 Gondola Point Road* | Stormwater culvert, nearby homes | Roadway completely flooded in 7m scenario. |
| 565 Gondola Point Road | Sewage lift station, nearby homes | Lift station building could be fully encompassed by water in 7m flood scenario. Rehabilitation recommended (Brunswick, 2019b). |
| 547-558 Gondola Point Road | Stormwater culverts, overhead utility lines, road, nearby homes | Erosion on the stream bank is causing tension cracks in the roadway. Recommended for rehabilitation (Brunswick, 2019b). Roadway completely flooded in 7m scenario. |
| 507 Gondola Point Road | Sewage lift station, road, stormwater culverts, nearby | Stormwater outlet is eroded. Recommended for rehabilitation (Brunswick, 2019b). The lift |

| | | |
|---|---|---|
| | homes | station and roadway are completely flooded in 7m scenario. |
| 495 Gondola Point Road* | Stormwater culvert, nearby homes | Roadway completely flooded in 7m scenario. |
| 282 Gondola Point Arterial | Gondola Point Ferry landing, Gondola Point Beach/trail, Beach bathrooms. | Major connector to the Kingston Peninsula. Beach bathroom structure is completely encompassed. |
| Gondola Point Ferry Arterial (Matthew's Cove) | Road, Matthew's Cove Trails | Connection to the Gondola Point Ferry, Gondola Point Road. Roadway completely flooded in 7m scenario. More maintenance may be needed for walking trails. |
| Palmer Brook Road at Palmer Brook | Road | Connection to the MacKay Highway. Roadway could be flooded if culvert is blocked. |
| Hampton Road at Palmer Brook | Road (shoulder) | Connection to the Hampton Road, MacKay Highway. Roadway completely flooded in 7m scenario. |
| Hammond River Road (Harding's Pond) | Stormwater culvert, road (shoulder) | Close to flooded on both sides in the 2018 scenario. Roadway completely flooded in 7m scenario. |
| Meenan's Cove Park | Trail, Meenan's Cove Beach House, Stormwater outlet, boat launch | A protective berm was built around the beach house in 2019 to reduce impacts from future flooding. |
| 6 Douglas Drive | Stormwater culvert, road, nearby homes | Roadway flooded in 7m scenario. |
| Hammond River Park | Walking trail | More maintenance may be needed for walking trails (Appendix E, Table 13). |

### Drought

Through consultation with the Steering Committee, there are concerns within the municipality associated with drinking water quantity and quality in private wells throughout the Town during the summer months. Increasing temperatures and decreased summer precipitation can lead to drought conditions in the summer, and this risk has been rated medium in the risk assessment (Table 3). Educating the community about reducing water usage during periods of drought is an important tool to conserve freshwater (Strategy 3-32). Future climate change impacts such as increased temperature and the increased likelihood of summertime drought should be considered in future water supply and distributions studies (Strategy 1.8).

### Forest Fires

Although precipitation is expected to increase due to Climate Change, the rate of precipitation increase does not make up for the rate of temperature changes. Seasonal precipitation increases associated with Climate Change must be 15% higher to offset the dryness brought on by every 1°C rise in temperature (Wotton et al., 2017). Total annual precipitation is expected to increase by 11% from baseline levels by 2080; combined with a projected increase of 5°C from baseline levels by 2080 we can see that increasing temperatures will reduce the overall moisture content of forest soils (Figure 3).

There are currently no fire risk assessment tools available for use in Canada (Johnston et al., 2020). This will be a limitation of this adaptation plan. Through ACAP Saint John's Vulnerability and Risk Assessment, forest fires are rated high vulnerability and low risk (Table 3). This vulnerability is high due to a high wildland/urban interface in the community, and the substantial financial impact of a wildfire, therefore increasing recovery costs and lowering the adaptive capacity of the Town. Forest conditions are monitored in New Brunswick by the Department of Natural Resources and Energy Development, during the fire season (April-October) and when appropriate, will restrict access to Crown land and recreational burning on private land to reduce fire risk (NBDNRED, 2020). Currently, widespread forest fires in southern New Brunswick are not common, therefore the likelihood is low, resulting in a low-risk rating. As conditions change, this could warrant reassessment and further study.

**Understanding Forest Fires in a Changing Climate**

The lower organic layer of the forest floor (duff layer) is monitored in forest fire indexes and can indicate the likelihood of fires occurring due to lightning strikes (Wotton et al., 2010). The moisture of the duff layer as well as medium size woody material on the forest floor is measured using the Duff Moisture Code (DMC) (Figure 12; Natural Resources Canada, 2020). The higher the DMC value, the drier the soil. The dryness of the duff layer is expected to increase by 15% in 2020-2040 and by 60% in 2080-2100 (Wang et al., 2010)

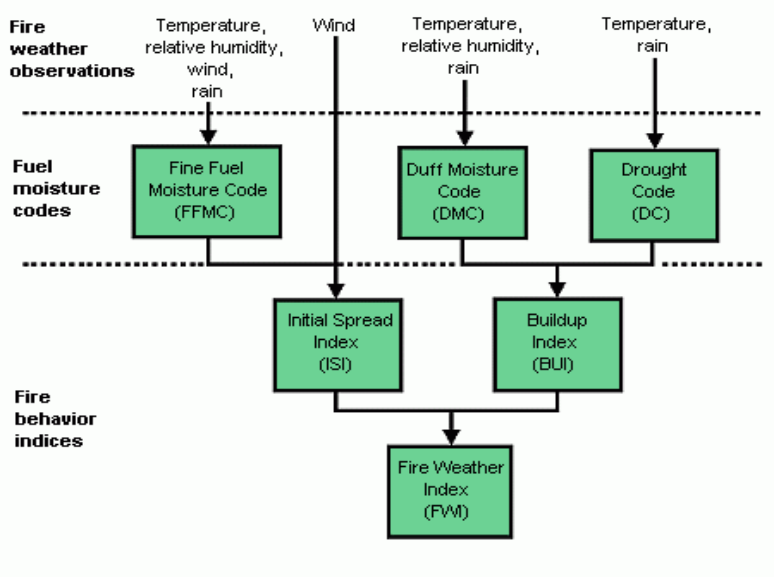


*Figure 12: Structure of the Canadian Forest Fire Weather Index system (Natural Resources Canada, 2020).*

Research has indicated that forest fires will increase by 35-400% across Canada by 2050 (Wang et al, 2015). Fire Weather Indices (FWI) measure fire danger throughout Canada. Parameters that determine FWI include the soil dryness (DMC, Drought Code, Fine Fuel Moisture Code), fuel buildup (Build Up Index) and wind (Initial Spread Index) (Figure 12). The FWI in the Saint John region is expected to increase by 13% by 2050 and 21% by 2080, and although there were no recorded forest fires in the Saint John area in 2020, this could be an issue in the coming years (Wang et al., 2015, NBDNRED, 2020).

### Increase in Temperature

The mean annual temperature in the region is expected to double from 1990 levels (5°C) to 10°C by 2080. This will cause heat waves, increased tropical storm activity and severity, and increased winter temperatures. Increasing temperature can have numerous implications for human and ecological health. Heat stress will disproportionately impact vulnerable populations such as seniors and low-income individuals that may not have access to air conditioners, shelter, or transportation to travel to cooling greenspaces, beaches, or pools (Medium risk; Appendix D, Table 10).

Hotter temperatures can change the habitable conditions of rivers, lakes, and smaller streams, and can result in the loss of habitat for local species (Medium risks; Table 3). Warmer streams can also reduce oxygen availability and increase pollutant transport which can result in harmful levels of environmental contaminants such as ammonia and methylmercury (Pinkney, 2014). Daily municipal function allows staff to observe natural spaces and recognize where habitats are changing and can work with local watershed associations to monitor critical habitats along the Kennebecasis River. This monitoring is significant to protect critical habitats as well as to identify areas where invasive species may become more common (Strategy 4.45).

Temperature changes can create favourable conditions for bacterial growth such as cyanobacteria, which can produce toxins that are harmful to humans, pets, and wildlife (Medium risks; Appendix D Table 10). Cyanobacteria, in the form of blooms or benthic mats can pose a threat to residents and pets, specifically dogs who are attracted to the smell of mat material. Public education is critical to ensure the community is aware of how to reduce their risk when enjoying local waterways. To build awareness the Town can install educational signage at popular sites or in areas where concerns have been expressed (Strategy 3.36).

Increased winter temperatures can impact municipal infrastructure such as roads due to an increase in freeze thaw cycles (FTC). The average winter temperature in 2080 is expected to climb to -1°C, resulting in an increase in FTC by seven cycles annually (Medium risk; Appendix D, Table 10). This will result in an increased need for road repair and will likely impact municipal budgeting.

**Photo Credit: Eric Kennedy**

Canada's Acadian Forest has been identified as an area which will experience ecosystem changes from increased temperatures and Climate Change, including species lost, changes to species habitat range,

productivity changes, damage and loss of trees from invasive insects, and increased storms (Taylor et al., 2017). The Emerald Ash Borer (EAB) is an invasive beetle that was first observed in New Brunswick in the Spring of 2018. The EAB has proven to be devastating in other Canadian municipalities due to the 5 to 10-year terminal lifespan once these trees are infected. The adaptation plan recommends that the Town avoid planting new Ash tree species to mitigate damages cause by the EAB (Strategy 4.47).

### Increased Storm Events

Post-tropical storms and hurricanes will become increasingly common due to rising global temperatures. As a result, the Town will feel the effects of these storms moving up the coast, resulting in increased wind and rainstorm activity. Increased storm activity puts the Town at risk of infrastructure damages (Medium-High risk), power and communications outages (Medium risk) and damages to trees and green spaces (Medium-Low risk; Appendix D, Table 10). Due to the increase of wind and ice storms projected under future Climate Change conditions, working with NB Power to monitor tree growth around overhead utility lines is important for maintaining services for Quispamsis residents and businesses (Strategy 1.12).

The Action Register recommends creating a voluntary signup for individuals who require electricity to run healthcare equipment as well as those who may need assisted evacuation (Strategy 4.41). For this recommendation to be effective, collaboration between healthcare providers, community centers, EMO, and residents is necessary. Promotion of preparing 72-hour preparedness kits and participating in Emergency Preparedness Week will help to prepare residents for more severe storm impacts (Strategies 3.39, 4.40).


## 3.1 A Strong Community Vision

During the development of the Municipal Plan, five foundational statements were written to guide the Plan and were based on community and council input, and consultations with municipal staff and PAC. These are the guiding principles for which the community will be managed in the coming years. Some of these statements include a community vision that "maintains and enhances the natural environment; provides services and facilities critical for a healthy lifestyle; and moves towards and promotes the building of a more sustainably healthy, vibrant, inclusive, and safe community" (Town of Quispamsis 2018). The Town of Quispamsis Climate Change Adaptation Plan will continue to follow these guiding principles. Holistic adaptation to climate change not only protects critical services but uses nature-based solutions to create more resilient, healthy, and vibrant communities.

### 3.1.1 Healthy Living

Adaptation planning is a chance to create a positive and healthy community supporting the vision presented by the Town of Quispamsis. Adaptation can involve encouraging active transportation or building awareness about mental health services and can help protect the community from negative health impacts associated with Climate Change. In Quispamsis, the immediate impacts

to public health include heat stress, exposure to ticks and Lyme disease, flooding contamination, and mental health. Additionally, pre-existing medical conditions can be exacerbated by Climate Change impacts such as floods, degraded air quality, extreme weather events, or by being unable to access regular medical and mental health care (Health Canada, 2013; Burton et al., 2016). These topics are explored further below.

### Heat Stress

Dangerously hot temperatures are not something people in New Brunswick are used to worrying about, but heat waves are becoming increasingly common in Canada. Heat exhaustion and heat stroke (when core body temperatures are above 40°C) can cause serious neurological and cardiac conditions. Signs of heat exposure include rashes, cramps, fainting, exhaustion, and the exacerbation of pre-existing conditions (Heath Canada, 2013). Health Canada studies observe that seniors (especially those over 75 years of age) and young children are more susceptible to the negative health impacts of heat exposure. Checking in on neighbours and family members during periods of extended heat is becoming a common community practice that can have a powerful impact. The Town can help increase awareness of high heat events by sharing heat alerts with the public and communicate the locations of cooling shelters that may be necessary during power outages or extreme temperatures (Strategies 3.34, 3.35).

### Ticks and Lyme Disease

Increasing temperatures and changing precipitation patterns cause shifts in insect migration allowing vector-borne diseases to be more easily transferred (Medium risk) (Ellis, 2007). These environmental changes also have a direct impact on plant growth which can alter the distribution of species' habitat and increase vector survival rates (International Council for Local Environmental Initiatives Canada, n.d.). For the Town of Quispamsis, the species of concern is the Blacklegged Tick (*Ixodes scapularis*), that can carry *Borrelia burgdorferi*, the causative agent of Lyme disease. The Town is recognized by the province as a risk area for tick populations and will need to be proactive as the suitable habitat for ticks is expected to increase significantly by 2080 as the temperatures warm and winters grow shorter (Figure 13; Brownstein, Holford, & Fish, 2005; Government of New Brunswick, 2015). Awareness about tick prevention and Lyme Disease plays a significant role in reducing the impacts of emerging tick populations (Strategy 3.33).

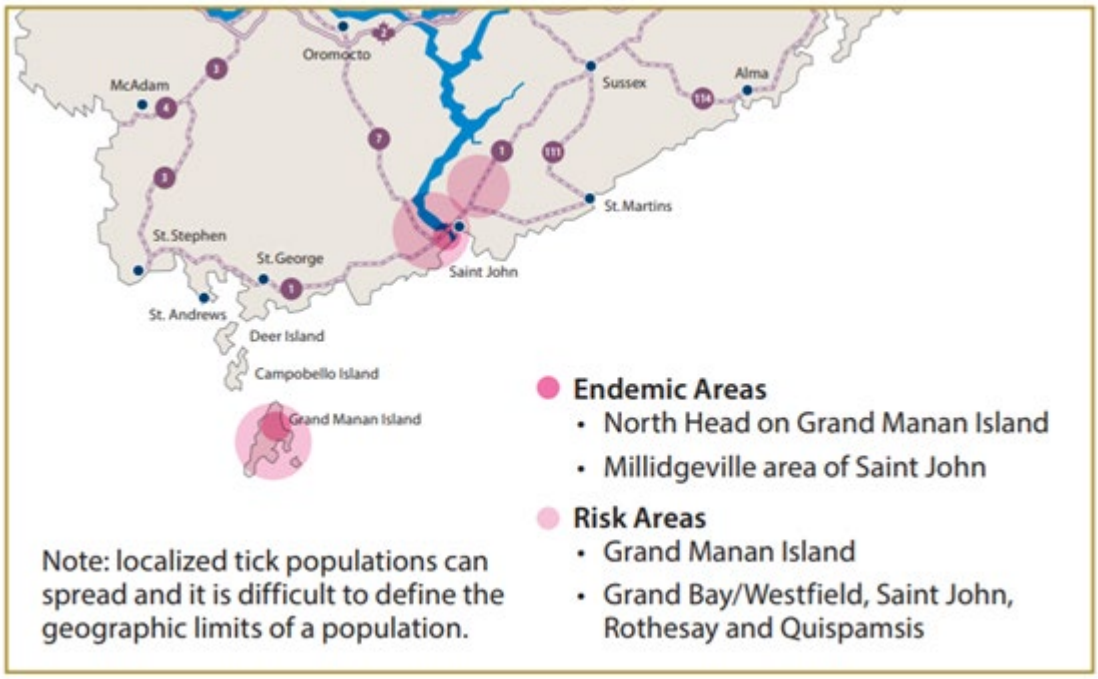


*Figure 13: Areas of established or emerging tick populations in New Brunswick. Quispamsis is considered a risk area (Government of New Brunswick, 2015).*

Lyme disease first presents itself as a rash, shaped like a bullseye that can develop after 3 to 30 days into flu-like symptoms. Fever, chills, headache, fatigue, swollen lymph nodes, and muscle and joint aches are all common symptoms of the disease. In the early stages, these symptoms can be treated with antibiotics for a full recovery. If left untreated, Lyme disease can develop into more severe symptoms (Public Health Agency of Canada, 2017).

### Flooding Injury and Contamination

Flooding events have direct health impacts and serious injury can be experienced directly from flood waters, rockslides, and from an increased risk of electrocution, electrical burns, or fire from damaged power systems (Public Health Agency of Canada, 2018; Burton et al., 2016; Séguin, 2008). Floods can cause mortality from drowning or from acute trauma from high stream velocity flow (Public Health Agency of Canada, 2018). Motor vehicle accidents are a major cause of death or injury during or following a flooding event in North America due to increased risk from impassable roads from washouts, wet driving conditions, and heavy traffic during evacuations. In the United States, 57% of deaths from floods are associated with motor vehicle accidents during and after the event (Public Health Agency of Canada, 2018).

Contaminated flood water is a health concern for anyone making direct physical contact to the water and can result in long lasting impacts such as drinking water contamination (Government of New Brunswick, 2019; NBEMO, n.d.). In the Town of Quispamsis, drinking water is sourced through groundwater wells and has a Low risk to flood-water contamination unless floodwater surrounds a property's wellhead. Educating residents of the risks of well water contamination as

well as providing information for testing after a flood event will help to avoid negative health impacts (Strategy 3.38).

#### Mental Health

Climate change impacts can be very distressing for residents who may have lost their homes or fear for their family's safety. Researchers at the University of New Brunswick in Saint John are investigating the mental health impacts of the 2018 and 2019 Wəlastəkw River spring flooding. Dr. Woodhall-Melnick found that recent flooding events created negative experiences for mental health and well-being and found a need to include mental health into disaster responses (Woodhall-Melnik & Grogan, 2019). These results may encourage the need for support programs to ensure a positive recovery for the community. Youth are especially susceptible to negative mental health impacts following a natural disaster or extreme weather event (University of Miami, 2017).

## 3.2 Climate Change Opportunities

Although Climate Change presents many challenges for municipalities, Climate Change adaptation also creates opportunities for improving the quality of life, recreation, aesthetic values, and social cohesion for the community. The adaptation actions recommended by ACAP Saint John will promote healthy lifestyles and protect the Town from climate-related events in the future. This Section describes some of the co-benefits that adaptation can offer.

### 3.2.1 Green Community Planning

Adaptation planning encourages green development which has many co-benefits including the reduction of GHG emissions, improvements to air quality, enhanced stormwater management, urban cooling and energy savings, protection of biodiversity, and improvement of both mental and physical health (Figure 14; Simon Fraser University, 2017). Green infrastructure such as green roofs, bioswales, bioretention ponds, urban trees, vegetated swales, and rain gardens can be installed to capture, store, and filter stormwater before it re-enters natural water bodies (Simon Fraser University, 2016). Protection of existing natural infrastructure like wetlands will reduce the risks of flash flooding. Conserving open green spaces will increase the Town's stormwater runoff capacity, which will be increasingly burdened by higher annual precipitation levels. There are numerous benefits of green development that can help the Town in achieving both climate change adaptation and mitigation goals. Adaptation recommendations for Quispamsis include the integration of green infrastructure that will help to handle increased precipitation into infrastructure renewals (Strategy 2.19).

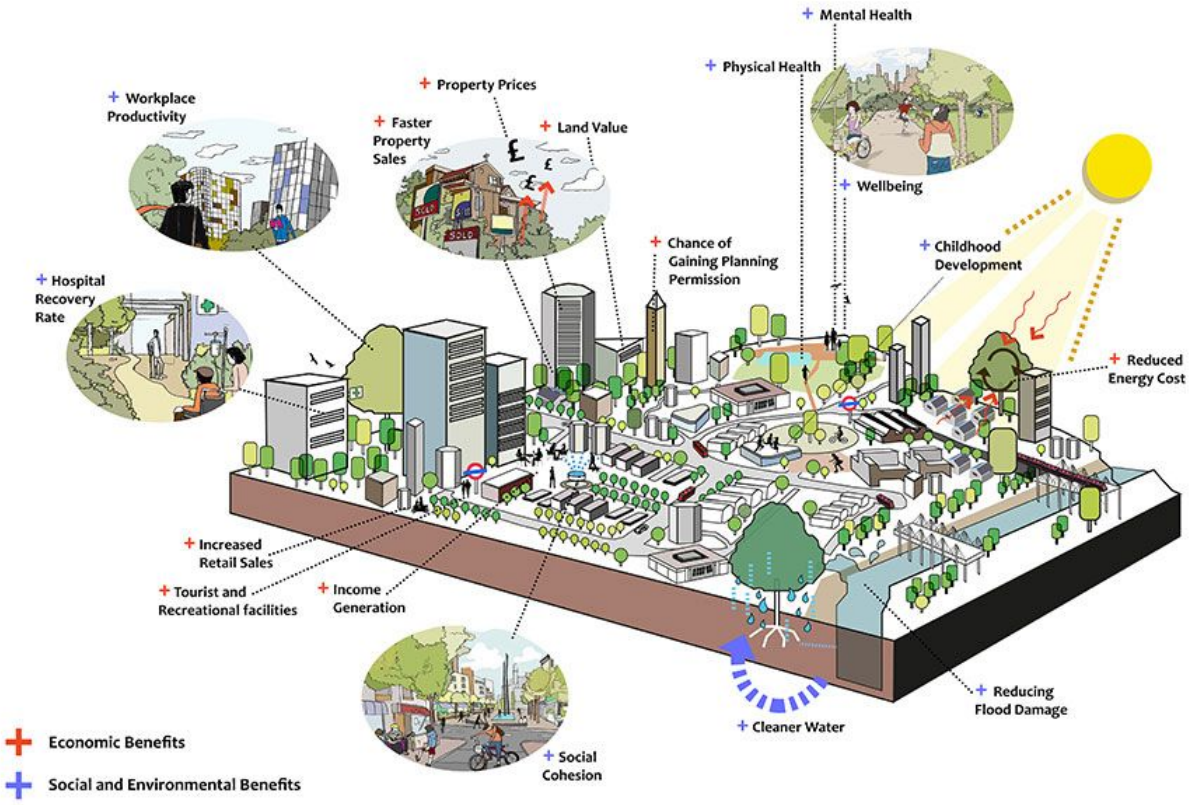


*Figure 14: Economic and social benefits of natural infrastructure in urban centers (Victoria Business Improvement District, n.d.)*

Green development can also play a role with issues around food security, an important issue in New Brunswick which has one of the highest rates of children living in food insecure households (SJHDC, 2014). Community gardens are becoming a growing success in many urban communities and when utilized in priority areas can provide significant amounts of food for the community. In the Town of Quispamsis, a community garden at the Q-Plex has over 100 plots available for residents to grow fruits and vegetables. Food security can be compromised during and after extreme weather events due to power outages at grocery stores, blocked transportation routes, or lack of financial resources that may need to be used to replace damaged homes/vehicles (Low risk). Food shortage is a medium vulnerability in the Town and opportunities to develop community gardens and public food programs can increase resiliency in the community (Strategy 4.48).

### 3.2.2 Public Adaptation Opportunities

At the individual level, there are many opportunities for the public to adapt to climate change. The Action Register recommends education programs around emergency preparedness to reduce the negative impacts during and after flood events (Strategies 3.26, 3.28). When residents are aware of the risks and know how to respond to a hazardous situation, they can plan appropriately to keep themselves and their families safe. As flooding and extreme weather events become more frequently experienced, residents can develop communication networks throughout the

community to check on neighbours, ultimately building community strength. This is a simple adaptation action that has a huge impact.

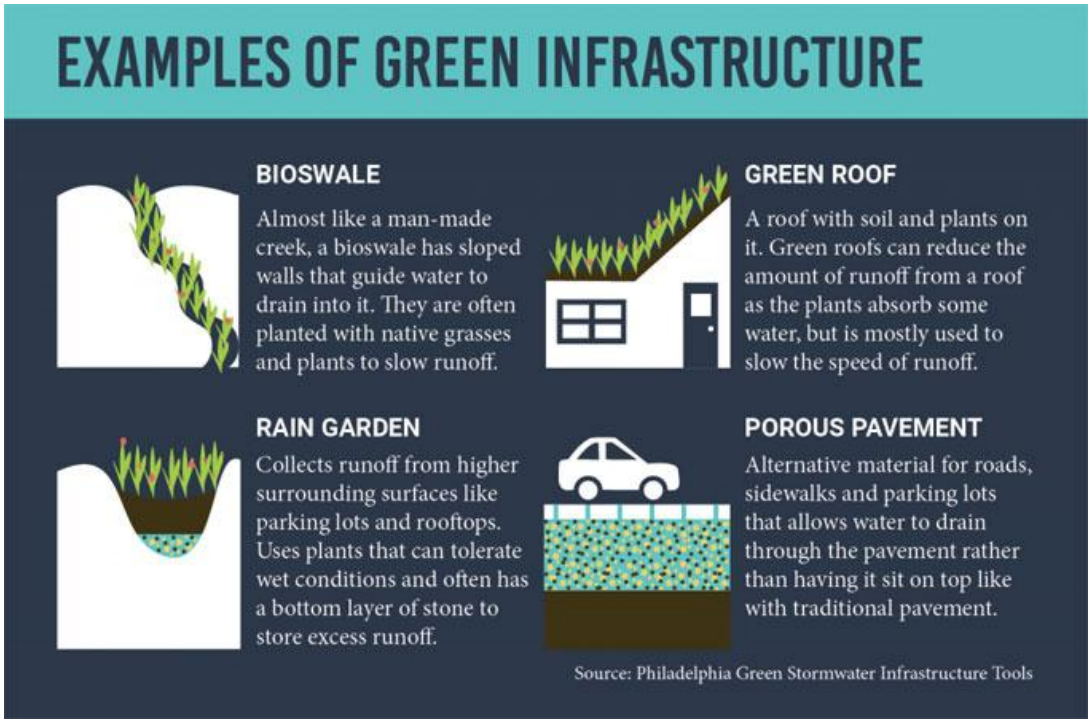


*Figure 15: Examples of green infrastructure that could be implemented by residents (O'Brien, 2018)*

Along the Kennebecasis River, residents can protect existing riparian buffers by monitoring for invasive species and planting native vegetation (Strategies 3.37, 4.43). These actions will reduce the risk of land loss and property damage associated with seasonal flooding. For neighbourhoods experiencing flooding due to increased precipitation, ACAP Saint John promotes installation of water retention and storage devices to reduce property damage (Strategy 4.42). These devices can include rain gardens, which will collect rainfall and increase natural infiltration, or rain barrels that capture runoff from rooftops (Figure 15). The water collected in rain barrels can be used for watering gardens and indoor plants, washing vehicles and other outdoor cleaning and reduce the amount of freshwater used in the summertime. Setting up these devices will help Quispamsis residents adapt to increasing rainfall and conserve freshwater.

### 3.2.3 Corporate Adaptation Opportunities

Adapting to Climate Change presents many opportunities for the Town's municipal operations. Holistic Climate Change adaptation can reduce GHG emissions in municipal buildings, manage stormwater and lengthen the lifespan of traditional infrastructure. For example, improving building practices by increasing insulation and air sealing in municipal buildings and arenas will reduce heating gain during warmer periods, as well as reduce GHG emissions and energy costs (Strategy 2.23).

Parks in the Town of Quispamsis include the Arts and Culture Park, Chelsea Park, Hammond River Park, Matthew's Cove Park, Meenan's Cove Park, and Ritchie Lake. These park spaces add to the ecology and urban forest of the City and contain many mature trees. They are natural assets and are valued for the services they provide including recreation, culture, stormwater management, heat moderation, air purification, and carbon dioxide absorption. Developing demonstration sites that illustrate the function of green infrastructure will showcase the ecosystem services that natural spaces and green infrastructure provide to the Town (Strategy 3.31). Integrating green infrastructure into municipal parks, buildings, and utility rights of way will help avoid flooding damages to infrastructure and reduce the stormwater load that traditional stormwater infrastructure would otherwise be required to handle. Green infrastructure demonstration sites can be used by the municipality to educate real estate agents, building contractors, and developers on changes in building codes that shift toward net-zero runoff requirements and natural strategies to manage stormwater (Strategy 2.22).

## 3.3 Action Register

The Action Register (Appendix F) describes detailed actions that support the adaptation strategies identified by ACAP Saint John. By identifying the lead department/partners, timeframe, costs, and priority level, the Action Register will guide the implementation of the adaptation actions. Some of these actions may already be practised by the Town and are listed as "ongoing" in the Action Register; these were included in the adaptation plan to recognize these actions as adaptations to Climate Change. Supporting initiatives and policies that were identified during the Gap Analysis and consultation with the Steering Committee are also listed in the Action Register. Adaptation actions were developed using the results from the Vulnerability and Risk Assessment, input from the community and Steering Committee, and information from the Gap Analysis.

The Town of Quispamsis Action Register follows four strategies:

- Strategy 1: Modifying policies plans and procedures;
- Strategy 2: Building or infrastructure upgrades;
- Strategy 3: Improving community awareness and public education; and
- Strategy 4: Building resilience to climate impacts.

### Strategy 1: Modifying policies and procedures

Strategy 1 highlights policies and procedures identified in the Gap Analysis and through stakeholder engagement that will be beneficial in adapting to climate change, or can be modified to increase resiliency. This category will ensure that future developments within the Town are proactively protected from known climate risks. Actions in this category include changing zoning in flood prone areas, updating landscaping and sediment control practises, and integrating natural assets into municipal asset management planning.

## Strategy 2: Building or infrastructure upgrades

Strategy 2 includes actions that protect existing infrastructure from further climate impacts. Actions were chosen by assessing climate risks identified in the Vulnerability and Risk Assessment. Actions in this category include raising roadways and other infrastructure within flood risk zones, upsizing stormwater management infrastructure during end-of-life replacements, and integrating green infrastructure into traditional infrastructure projects to help manage increased precipitation.

## Strategy 3: Improving community awareness and public education

Strategy 3 focuses on working with the community to increase awareness to the risks of Climate Change. Since this Strategy requires community participation to be successful, ACAP Saint John reached out to the public for feedback on actions in this Strategy. Through ACAP Saint John's online survey conducted in January 2021, residents were asked to evaluate actions focused on improving community awareness of Climate Change in the community. Participants were asked to choose the three actions that would benefit this community the most (Table 5). Actions that were well received by the community included developing green infrastructure demonstration sites (Strategy 3.31), education about water usage during periods of drought (Strategy 3.32), education about the risks of well water contamination (Strategy 3.38), and increasing the awareness and availability of flood mapping (Strategy 3.25). Public education is an important part of this adaptation plan because community participation is essential to building resilience to Climate Change. The Town could compile many of the actions from Strategy 3 into a Climate Change Communications Strategy to strengthen the impact of their public education efforts.

*Table 5: Results from online survey, January 2021.*

| Strategy 3: Improving community awareness and public education | | | What actions will most benefit the Town? |
|---|---|---|---|
| **Action** | **Cost** | **Risk Rating** | **Total** |
| **25. Increase the awareness and availability of flood mapping and forecasting in Quispamsis (i.e., libraries, social media).** | Low | Medium – High | 13% |
| **26. Provide guidance for flood preparedness, recovery, and restoration to property owners on the Kennebecasis River.** | Low | Medium – High | 1% |
| **29. Educate real estate agents and developers about new municipal climate adaptation regulations** | Low | Medium – High | 11% |
| **31. Develop demonstration sites to illustrate ecosystem services provided by green infrastructure.** | Low - Medium | Medium | 16% |
| **32. Educate community about reducing water usage during periods of drought.** | Low | Medium | 16% |
| **33. Educate the community on the health hazards of ticks and Lyme disease.** | Low | Medium | 7% |
| **34. Alert the public to extreme temperatures (HARS Levels) and highlight methods to stay safe.** | Low | Medium | 4% |
| **37. Educate the community on identifying and removing invasive species.** | Low | Medium – Low | 12% |
| **38. Educate residents about risks of well water contamination.** | Low | Low | 16% |
| **39. Promote preparing 72-hour kits, evacuation plan for extended power outages.** | Low | Low | 4% |

## Strategy 4: Building resilience to climate impacts

Strategy 4 contains actions that help to prepare the community for future climate impacts such as increased precipitation, flooding and more intense storms. Actions in this section include using natural infrastructure to manage rainfall, participating in emergency preparedness weeks, and integrating green energy into the power grid.

## 3.4 Implementation

Implementation and review of the Adaptation Plan will fall to the Town of Quispamsis. The process of monitoring and review is necessary to ensure the Adaptation Plan is working to benefit the Town and reduce the negative impacts associated with Climate Change.

The Action Register recommends the Town of Quispamsis Climate Change Committee ensure actions from the Climate Change Adaptation Plan are being implemented (Strategy 3.27). The Climate Change Committee will ensure that the Adaptation Plan will be updated with the best available science and best management practices. As the recommended actions are implemented, monitoring will allow the Climate Change Committee to review progress and identify challenges and successes. Tracking the process of implementation will also ensure that the underlying information of the Adaptation Plan (climate science and the Vulnerability and Risk Assessment) is up to date and that actions are being completed as scheduled.

The Town can also monitor the effectiveness of the recommended actions to verify if the anticipated outcome is being achieved. If the actions are not increasing adaptive capacity, they should be re-evaluated and updated in the Annual Update Report (Section 3.4.1). Throughout the monitoring process, the Climate Change Committee can explore funding opportunities that might become available as adaptation becomes mainstreamed into municipal planning.

### 3.4.1 Funding Climate Change Adaptation

Funding can be the largest barrier for implementation. Municipal budgets may not be able to provide support for adaptation actions however there are opportunities for funding through the provincial and federal governments. The list below may help to guide the Town when beginning to search for funding. Regional partnerships may be useful for securing funds.

Potential Funding Sources for Climate Change Projects:

- Federal Disaster Mitigation and Adaptation Fund
- National Disaster Mitigation Programme
- Federation of Canadian Municipalities (Green Municipal Fund)
- Environment and Climate Change Canada's Climate Action and Awareness Fund
- The Environmental Trust Fund
- Environmental Damages Fund
- University/college practical projects or research

### 3.4.2 Updating the Adaptation Plan

The Climate Change Committee should produce an Annual Adaptation Update for the plan. This report will summarize the findings from implementation monitoring and inform Town Council about socio-economic changes that may influence the success of recommended actions,

including changes to financial status and shifts in the identified vulnerabilities. Completed items from the Action Register will be identified and celebrated in this Update Report.

The checklist below is useful for drafting the Annual Update Report of the Adaptation Plan:

- Identify accomplishments and on-going work.
- Reaffirm the commitment of the Climate Change Committee.
- Highlight a list of actions that were not successfully implemented. Identify the barriers that exist and evaluate if current conditions will allow implementation now.
- Review the strategies. Are they still relevant? Which strategies are more easily implemented?
- Once the medium-high risk actions are complete, the Climate Change Committee can begin to address lower risk actions.

A full comprehensive review of the Adaptation Plan should be completed (ten years after adoption). As municipal planning documents are updated, the adaptation actions should be integrated. This will help identify opportunities and increase the likelihood of actions being completed, ultimately increasing resilience to climate change in the Town of Quispamsis.

# References


Brownstein, J. S., Holford, T. R., & Fish, D. (2005). Effect of Climate Change on Lyme Disease Risk in North America. EcoHealth, 2(1), p. 38-46.

Bruce, P. (2011). Climate Change Information for Adaptation. Climate trends and projected values for Canada. Institute for Catastrophic Loss Reduction.

Brunswick Engineering. (2019a). 2018 Quispamsis Flood Damage Rehabilitation Design Brief. Brunswick Engineering & Consulting Inc. Town of Quispamsis.

Brunswick Engineering. (2019b). Geotechnical Inspection & Rehabilitation Design 2018 Quispamsis Flood Damage, RFP #2018TQ05-6. Brunswick Engineering & Consulting Inc. Town of Quispamsis.

Burton, H., Rabito, F., Danielson, L., & Takaro, T. K. (2016). Health effects of flooding in Canada: A 2015 review and description of gaps in research, Canadian Water Resources Journal / Revue canadienne des ressources hydriques.

Bush, E. and Lemmen, D.S., editors (2019). Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p.

CBCL. (2019). Town of Quispamsis Water Supply and Distribution Study Preliminary Design Report. Final Report. Town of Quispamsis.

Daigle, R. (2020). Updated Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections 2020. Based on IPCC 5th Assessment Report. R.J. Daigle Enviro. New Brunswick Department of Environment and Local Government

Ellis, K. H. (2007). Climate Changes could increase the risk of infectious diseases. Retrieved July 31, 2018 from https://www.healio.com/infectious-disease/emerging-diseases/news/print/infectious-disease-news/{bf03dffa-31ca-4b44-bb71-031493143262}/climate-changes-could-increase-the-risk-of-infectious-diseases?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Healio__TrendMD_1

Fraser, E. (2018). "Flood recovery costs could hit $80M, minister says." CBC News, New Brunswick.

Government of New Brunswick. (2019). Workers Clean Up After Flood. Office of the Chief Medical Officer of Health, p. 1-3.

Government of New Brunswick. (2015). New Brunswick Disease Watch Bulletin (21st ed., Rep. No. 10280). Office of the Chief Medical Officer of Health, p. 1-7.

Government of New Brunswick. (2014). New Brunswick's Flood Risk Reduction Strategy. Province of New Brunswick. Fredericton, NB.

Health Canada. (2013). Acute Care During Extreme Heat: Recommendations and Information for Health Care Workers. Retrieved May 23, 2018, from https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/climate-change-health/acute-care-extreme-heat-recommendations-information-health-care-workers-fact-sheet-health-canada-2011.html

Intergovernmental Panel on Climate Change. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 p. 1-151.

International Council for Local Environmental Initiatives (ICLEI) Canada. (n.d.). *Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation*.

ICLEI: Local Governments for Sustainability, p. 1-94.

Johnston, L., X. Wang, S. Erni, S. Taylor, C. McFayden, J. Oliver, C. Stockdale, A. Christianson, Y. Boulanger, S. Gauthier, D. Arseneault, M. Wotton, M. Parisien, and M. Flannigan. (2020). "Wildland fire risk research in Canada." *Environmental Reviews* February 2020. Research Press.

Natural Resources Canada. (2020). Background Information: Canadian Forest Fire Weather Index (FWI) System. Government of Canada.

New Brunswick Health Council. (2017). My Community at a Glance. New Brunswick Community Profile Report. https://nbhc.ca/sites/default/files/publications-attachments/My%20Community%20at%20a%20Glance-18a-Saint%20John%2C%20Simonds%20and%20Musquash-NBHC-2017.pdf

New Brunswick Department of Natural Resources and Energy Development (NBDNRED). (2020). New Brunswick Forest Fire Watch.

New Brunswick Emergency Measures Organization. (n.d.). Flood Recovery - Everything you need to know! Retrieved online: https://www2.gnb.ca/content/dam/gnb/Departments/pa-ap/pdf/Report_Damages/FloodRecovery-e.pdf

O'Brien, J. (2018). Examples of Green Infrastructure. Yale Climate Connection. 1118_ISC_story.

Prairie Climate Center. (2019). Climate Atlas of Canada. Municipality: Saint John. BCCAQv2 climate model data. University of Winnipeg.

Pinkney, A. E., Driscoll, C. T., Evers, D. C., Hooper, M. J., Horan, J., Jones, J. W., . . . Sparling, D. W. (2015). Interactive effects of Climate Change with nutrients, mercury, and freshwater acidification on key taxa in the North Atlantic Landscape Conservation Cooperative region. *Integrated Environmental Assessment and Management, 11*(3), 355-369.

Public Health Agency of Canada. (2017). Symptoms of Lyme disease. Retrieved online: https://www.canada.ca/en/public-health/services/diseases/lyme-disease/symptoms-lyme-disease.html

QUEST. (2018). Climate Risk and Resilience Assessment. City of Saint John. QUEST - Quality Urban Energy Systems of Tomorrow.

Roy, P. and Huard D. (2016). Future Climate Scenarios - Province of New-Brunswick. Montreal: Ouranos. Canadian Climate Atlas.

R.V. Anderson & Associates. (2019a). 2018 State of the Infrastructure Report. Town of Quispamsis.

R.V. Anderson & Associates. (2019b). Comprehensive Asset Management Plan (CAMP). Town of Quispamsis.

Saint John Human Development Council (SJHDC). (2014). Vibrant Communities Saint John: A Poverty Outline for Saint John, NB. Saint John, NB: Human Development Council.

Séguin, J. (2008). Human health in a changing climate: A Canadian assessment of vulnerabilities and adaptive capacity. Ottawa, Ont.: Health Canada.

Simon Fraser University. (2017). Taking Action on Green Resilience: Climate Change Adaptation and Mitigation Synergies. Workshop Conclusions: Livable Cities Forum. Vancouver, British Columbia. Green Resilience Strategies & Simon Fraser University.

Simon Fraser University. (2016). Low Carbon Resilience: Transformative Climate Change Planning for Canada. Vancouver, British Columbia: Simon Fraser University, p. 1-40.

Statistics Canada. (2016). Census Profile, 2016 Census. Quispamsis, Town [Census subdivision], New Brunswick and New Brunswick [Province].
Town of Quispamsis. (2018a). *Town of Quispamsis Municipal Development Plan By-law 054.* Enacted October 25, 2019.

Taylor, A. R., Boulanger, Y., Price, D. T., Cyr, D., Mcgarrigle, E., Rammer, W., & Kershaw, J. A. (2017). Rapid 21st century Climate Change projected to shift composition and growth of Canada's Acadian Forest Region. *Forest Ecology and Management, 405*, p. 284-294.

Town of Quispamsis. (2019). Quispamsis Presentation Climate Change Actions.

Town of Quispamsis. (2018a). Municipal Development Plan By-law 054. Enacted February 20, 2018.

Town of Quispamsis. (2018b). *Annual Report 2018.*

Town of Quispamsis. (2018c). Town of Quispamsis Municipal Emergency Measures Plan.

Town of Quispamsis. (2009). Zoning By-Law #38. Enacted January 20, 2009, Most recent amendment: October 15, 2019.

Town of Quispamsis. (2000). Millennium Drive Development Scheme. Enacted November 7, 2000.

University of Miami. (2017). "Psychological impacts of natural disasters on youth: Research examines how a new criterion for studying post-traumatic stress disorder better suited for children exposed to a natural disaster." ScienceDaily. Retrieved online: www.sciencedaily.com/releases/2017/09/170925163227.htm

Victoria Business Improvement District. (n.d.) Green Infrastructure Audit Best Practice Guide. London, United Kingdom.

Wang, X., D. Thompson, G. Marshall, C. Tymstra, R. Carr, M. Flannigan. 2015. "Increasing frequency of extreme fire weather in Canada with climate change." *Climate Change.* 130: 573-586. Springer Science Business Media, Dordrecht.

Woodhall-Melnik, J., & Grogan, C. (2019). Investigating mental health and social capital in communities that experienced residential displacement as a result of the St. John River flood of 2018. Presented to the Institute for Catastrophic Loss Reduction by UNB Urban and Community Studies Institute.

WMO. (2021). "2020 was one of the three warmest years on record." World Meteorological Organization.

Wotton, B.M., M.D. Flannigan and G.A. Marshall. (2017). "Potential climate change impacts on fire intensity and key wildfire suppression thresholds in Canada." *Environmental Research Letters (12).* IOP Science.

Wotton, B.M., C.A. Nock and M. D. Flannigan (2010). "Forest fire occurrence and climate change in Canada." *International Journal of Wildland Fire.* (19) 253-271. CSIRO Publishing.

YHC Environment (2018). Quispamsis's Corporate GHG Inventory & Action Plan. Union of Municipalities of New Brunswick.

# Appendix A: Climate Projections

*Table 6: Climate projections for the Town of Quispamsis, NB.*

| Outcome | Comments/ Criteria | Current Climate | Future Climate |
|---|---|---|---|
| **Changes in Precipitation** | | | |
| Freshet Flooding [1] | Precipitation volume (winter and spring) | 655 mm | 2050: 734 mm<br>2080: 778 mm |
| Intense Rain/flooding [2] | Number of days with rainfall events >20 mm | 15 | 2021-2050: 17 (13%)<br>2051-2080: 18.2 (21) |
| Increase in winter precipitation [1] | Winter precipitation | 343 mm | 2050: 392 mm<br>2080: 413 mm |
| Drought [6] | Water deficit (mm) % increase | 35.42 mm | 2050: 55.8 mm (58%)<br>2080: 74.4 mm (110%) |
| Ice Storm [3] | Time | 50 hours | Little change, but more in winter, less in spring |
| Forest fires [5] | % change | Less than 0-1 occurrence | Increases 13 % by 2050, 21 % by 2080 |
| **Increased Temperature** | | | |
| Heat Waves [1] | Number of hot days (>25℃) | 18 | 2050: 51<br>2080: 78 |
| Winter Freeze thaw cycles (FTC) [1] | # of cycles | 36 | 2050: 41<br>2080: 43 |
| Increased Winter temperature [1] | Average winter temperatures | -6℃ | 2050: -3℃<br>2080: -0.5℃ |
| Tick population [1] | % change in frost free days | Frost free days: 197.5 | 2050: 243 (23%)<br>2080: 266 (35%) |
| Windstorms/ hurricanes [3] | % change | 2-3 occurrences | 8-15% increase (after 2050) |
| Food Security [4] | % change | 11% of the population (Saint John, Musquash, Simonds) | No data |

Data Sources:

(1) Roy and Huard, 2016.
(2) Prairie Climate Center, 2019.
(3) Bruce, 2011.
(4) New Brunswick Health Council, 2017.
(5) Wang et. al, 2015.
(6) QUEST, 2018

# Appendix B: Gap Analysis

*Table 7: Preliminary assessment of climate risks in the Town of Quispamsis.*

| Preliminary Climate Risk Assessment- Town of Quispamsis | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLIMATE PARAMETER | Outcome | Service Area | | | | | | | | | | | | | |
| | | Drinking Water System | Sanitary System | Storm System | Transportation | Buildings (Municipal) | Parks and Recreation | Economic Development and Tourism | Communications | Environment | Planning and Zoning | Emergency Services | Public Health | Energy Management | Buildings (Private) |
| CHANGES IN PRECIPITATION | Riverine Flooding | X | X | X | X | X | X | | X | X | X | X | X | X | X |
| | Heavy rainfall resulting in localized flooding | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| | Increased winter precipitation as snowfall | | | X | X | X | X | X | X | X | | X | X | X | X |
| | Winter precipitation as rain | | X | X | X | X | | X | X | X | X | X | X | X | X |
| | Drought/ decreased frequency in precipitation | X | | | X | X | X | X | | X | X | X | X | X | X |
| INCREASED TEMPERATURE | Heat waves | | X | | | | X | X | X | X | | X | X | X | |
| | Increase in winter temperatures | | | | X | | X | X | X | X | | X | X | X | |
| | Increase in Hurricane and Post Tropical Storm Events, Thunderstorms | | X | X | X | X | X | X | X | X | | X | X | X | X |

Climate issues addressed in the Municipal Emergency Measures Plan

X Impacts identified in previous assessments

X Impact identified by ACAP Saint John

# Appendix C: Community Engagement

# Steering Committee Questionnaire

**Part One: About you**

1. Your Name: Click or tap here to enter text.

2. What is your role in the Town of Quispamsis? Click or tap here to enter text.

3. What type of weather do you enjoy the most? Click or tap here to enter text.

**Part Two: Your Experience with Climate Change in Quispamsis**

4. Have you noticed changes in local weather patterns over time?
   ☐Yes / ☐No
   What changes can you describe? Click or tap here to enter text.

5. Can you recall weather events that may have caused disruptions in services, infrastructure damage, or required additional resources to restore Town services?
   ☐Yes / ☐No
   If yes, what events are you recalling? Click or tap here to enter text.

6. How well do you think the community responds to these types of events? Please select a ranking where:

| ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|
| 1 is very poorly | 2 is poorly | 3 is satisfactory | 4 is well | 5 is excellent |

   Additional comments: Click or tap here to enter text.

7. To your knowledge, have any Town service areas made improvements to deal with similar events in the future? Click or tap here to enter text.

8. What climate-related challenges do you or your service area expect to observe in the near and long-term? Please check all that might apply.
   ☐ Infrastructure damages
   ☐ Health challenges
   ☐ Water security and quality
   ☐ Temporary or long-term energy disruption
   ☐ Other: Click or tap here to enter text.

9. Is your department facing any non-climate related challenges now, or in the future? Please check all that may apply.
    - ☐ Policy
    - ☐ Capital (budgetary constraints)
    - ☐ Resources (staff)
    - ☐ Awareness and education
    - ☐ Other: Click or tap here to enter text.

10. Are you familiar with public health impacts of climate change?
    - ☐ Yes / ☐ No

**Part Three: The Quispamsis Climate Change Adaptation Plan**

11. Can you identify any sensitive natural areas that you think might be vulnerable to environmental change? Click or tap here to enter text.

12. Are there any physical assets or infrastructure that you think is vulnerable, or may become vulnerable as the climate changes? Click or tap here to enter text.

13. What sections would you like to see in the Quispamsis Climate Change Adaptation Plan? Please check all that apply.

    - ☐ Drinking water
    - ☐ Community
    - ☐ Flooding
    - ☐ Public health
    - ☐ Changing temperatures
    - ☐ Extreme weather (Heavy rainfall, ice storms, wind)
    - ☐ Power outages
    - ☐ Forest fires
    - ☐ Food security
    - ☐ Drought
    - ☐ Tick populations
    - ☐ Erosion
    - ☐ Accessibility and isolation

14. From the sections listed in Q.13, which five topics do you think are most significant for Quispamsis? Please rank 1-5, where 1 is most significant and 5 is least significant.
    1. Click or tap here to enter text.
    2. Click or tap here to enter text.
    3. Click or tap here to enter text.
    4. Click or tap here to enter text.
    5. Click or tap here to enter text.

15. What level of education around climate change impacts would you give to the community? Please select a ranking where:

| ☐ | ☐ | ☐ | ☐ | ☐ |
|---|---|---|---|---|
| 1 is no knowledge | 2 is 'heard of climate change' | 3 is recognizes flooding as a climate change impact | 4 is aware of all community impacts | 5 is very knowledgeable: understands the impacts and actions to reduce vulnerability |

16. Do you think the community would be interested to attend virtual or in-person workshops on? Please select a rank for the topics below, where 1 is most interested and 5 is least interested.
    - Select -Climate change projections and impacts
    - Select -Green infrastructure for homeowners
    - Select -Flood prevention
    - Select -Climate change and community health
    - Select -Eco-anxiety: focusing on the mental health impacts of flooding
    - Other workshop ideas: Click or tap here to enter text.

17. In your opinion, what are some of the planning decisions or activities that the Town of Quispamsis can take to reduce the impacts associated with climate change? Click or tap here to enter text.

18. Are there any topics listed in this questionnaire you want to learn more about for your community? Click or tap here to enter text.


*Figure 16: Community input results from the Kingston Farmers Market, October 2020.*

# Appendix D: Vulnerability and Risk Assessment

*Table 8: Consequence Rating Scheme. *Loss of service refers to loss of power, water or public services (i.e., administration).*

| Rating | Community Impacts | | | | |
|---|---|---|---|---|---|
| | **Health & Safety** | **Public Services** | **Community Lifestyle** | **Natural Environment** | **Infrastructure** |
| **1. Insignificant** | No injury, negligible concerns for physical and mental health. | Minor disruption for a small portion of customers. No disruption to public administration. | Temporary with no loss of function. "Annoyances" | No impacts to the natural environment. | No damage and little costs associated. Routine activities to resolve issues. Short recovery within 24hrs. |
| | **1** | **1** | **1** | **1** | **1** |
| **2. Minor** | Minor physical injuries. Small mental impact for few residents. | Significant disruption for small portion of customers. Public administration under severe pressure in localized instances. | Temporary disruption results in noticeable loss of function. Short-term impacts to daily routines. | Minor impacts to the natural environment to be reversed within three (3) months. | Minor damages and small costs involved for repair effort. No insurance claims placed. Short recovery time, within days to one week. |
| | **2** | **2** | **2** | **2** | **2** |
| **3. Severe** | Serious injury, non-life threatening but requiring medical services. Noticeable mental health impacts. | Extended periods without service in localized areas. Public administration under severe pressure. | Notable disruption to the well-being of residents. Routine can be re-established within up to six (6) weeks. | Major impacts to the natural environment to be reversed within one (1) year. | Moderate damage and a small number of insurance claims. Major costs involved for repair efforts. Moderate recovery time, weeks up to two (2) months. |
| | **3** | **3** | **3** | **3** | **3** |

| | | | | | |
|---|---|---|---|---|---|
| **4. Major** | Life-threatening injuries leading to loss of life.<br>Long-term mental health impacts. | Long-term localized disruption or loss of service* altogether.<br>Residents rely on back-up generators for an extended period.<br>Public administration struggling to remain effective, danger of failure. | Serious impacts create a long-term (months) disruption to the daily routine and well-being of residents. | Severe impact to the natural environment could be reserved within five (5) years.<br>Danger of continuing environmental damage. | Major damage and numerous insurance claims.<br>High costs involved for repairs and relocation.<br>Long-term recovery, several months up to two (2) years.<br>External aid requested to assist in recovery. |
| | **4** | **4** | **4** | **4** | **4** |
| **5. Catastrophic** | Multiple lives lost and city-wide injury.<br>Severe mental health impacts. | Long-term city-wide disruption for an unknown period.<br>Public administration in decay, failure to be effective. | Permanent disruption of daily routines and well-being of residents.<br>"Life-changing". | Disastrous impacts on the natural environment are irreversible. | Extensive structural damage and copious insurance claims.<br>Financial aid required to balance the cost of repairs.<br>Long-term recovery, years to decades.<br>External aid required to assist in 'state of emergency. |
| | **5** | **5** | **5** | **5** | **5** |

*Table 9: Climate Change vulnerability assessment for the Town of Quispamsis, NB.*

## Town of Quispamsis Climate Change Vulnerability Assessment

| | | IMPACT STATEMENT | Drinking Water System | Sanitary System | Storm System | Transportation | Buildings (Municipal) | Parks and Recreation | Economic Development and Tourism | Communications | Environment | Planning & Zoning | Emergency Services | Public Health | Energy Management | Buildings (Private) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHANGE IN PRECIPITATION | Higher Riverine Flooding | Contamination of lakes and streams due to increased pollutant/sediment runoff, combined sewer overflow, etc. | S3 AC4<br>V2 | | | | | | | | S2 AC3<br>V2 | | | S2 AC4<br>V2 | | |
| | | Isolation, accessibility and mental health challenges due to flooding | | | | | | | | | | | S1 AC4<br>V1 | S2 AC4<br>V2 | | |
| | | Damages to infrastructure/ properties due to flooding and/or erosion | S4 AC3<br>V4 | S4 AC1<br>V5 | S4 AC2<br>V4 | S4 AC1<br>V5 | S4 AC2<br>V4 | S4 AC4<br>V3 | | | | | | | S4 AC4<br>V3 | S4 AC1<br>V5 |
| | Localized flooding due to heavy rainfall | Contamination of lakes and streams due to increased pollutant/sediment runoff, combined sewer overflow, etc. | | | | | | | | | S2 AC3<br>V2 | | | S2 AC4<br>V2 | | |
| | | Isolation, accessibility and mental health challenges due to flooding | | | | | | | | | | | S1 AC4<br>V1 | S2 AC5<br>V1 | | |
| | | Damages to infrastructure/ properties due to flooding and/or erosion | S4 AC3<br>V4 | S4 AC1<br>V5 | S4 AC2<br>V4 | S4 AC1<br>V5 | S4 AC2<br>V4 | S4 AC4<br>V3 | | | | | | | S4 AC4<br>V3 | S4 AC1<br>V5 |
| | Winter rain | Flooding due to clogged catch basins (rain on snow event) | | | S3 AC3<br>V3 | S4 AC4<br>V3 | S4 AC1<br>V5 | S4 AC4<br>V3 | | S1 AC5<br>V1 | | | | | | S4 AC1<br>V5 |
| | | Ice accumulation due to freezing rain storms/flash freezing | | | S3 AC3<br>V3 | S3 AC4<br>V2 | | | | | S2 AC5<br>V1 | | | | S4 AC2<br>V4 | |
| | Increased snowfall | Increase in snow removal services around critical infratrsucture | | | S3 AC4<br>V2 | S3 AC4<br>V2 | | S1 AC4<br>V1 | | | | | | | | |
| | | Concern regarding isolation and accessibility of power, food and water during periods of extreme cold and ice conditions | | | | | | | | S1 AC5<br>V1 | | | S2 AC3<br>V2 | S2 AC4<br>V2 | S3 AC3<br>V3 | |
| | | Infrastructure damage due to increased snow loading on buildings | | | | | S4 AC2<br>V4 | | | | | | | | | S4 AC2<br>V4 |
| | Drought | Increased depletion of water supply for property owners with private wells | S4 AC1<br>V5 | | | | | | | | | | | | | S3 AC1<br>V4 |
| | | Increased forest fire potential | | | | S3 AC3<br>V3 | S4 AC1<br>V5 | S4 AC2<br>V4 | | | S4 AC3<br>V4 | | S2 AC3<br>V2 | S4 AC4<br>V3 | S3 AC3<br>V3 | S5 AC1<br>V5 |
| INCREASED TEMPERATURE | Increased number and duration of summer heat waves | Increased risk of heat stress on vulnerable populations due to extreme heat | | | | | | | | S1 AC4<br>V1 | | | | S2 AC3<br>V2 | | |
| | | Increased energy demand for cooling needs in the summer | | | | | | | | | | | | | S2 AC5<br>V1 | |
| | | Loss of work for seasonal outdoor employees due to extreme heat | | | | | | | S3 AC4<br>V2 | | | | | | | |
| | | Stress on habitat for cold water species due to loss of cool streams for refuge | | | | | | | | | S4 AC3<br>V4 | | | | | |
| | | Reduced health quality due to a reduction in air quality | | | | | | | | | S2 AC5<br>V1 | | | S2 AC4<br>V2 | | |
| | | Contaminated recreational water sources due to an increase in toxic cyanobacteria cultures | | | | | | S3 AC3<br>V3 | | | | | | S2 AC4<br>V2 | | |
| | Increasing average winter temperature | Increase in infrastructure damage due to increase in annual freeze-thaw cycles | | | | S3 AC2<br>V3 | | S2 AC3<br>V2 | | | | | | | | |
| | | Higher risks of vector borne disease due to increased tick and mosquito populations | | | | | | | | | | | | S2 AC4<br>V2 | | |
| | | Invasive species migration due to warmer winters | | | | | | S4 AC2<br>V4 | | | S3 AC5<br>V2 | | | | | |
| | | Increasing winter temperature limiting QPlex ice making | | | | | | S2 AC4<br>V2 | | | | | | | S2 AC5<br>V1 | |
| | Increase in severe weather events | Infrastructure damages due to increased storms | | | S3 AC4<br>V2 | | S3 AC2<br>V3 | S2 AC2<br>V2 | | | | | S2 AC3<br>V2 | | | S3 AC2<br>V3 |
| | | Food shortage due to power outage at grocery stores | | | | | | | | | | | | S3 AC3<br>V3 | | |
| | | Communications and power outages due to increased storms | S3 AC3<br>V3 | S3 AC3<br>V3 | | S2 AC5<br>V1 | | | S2 AC5<br>V1 | S3 AC4<br>V2 | | | S3 AC3<br>V3 | | S3 AC2<br>V3 | |
| | | Loss of trees and damage to green spaces | | | | | | S2 AC2<br>V2 | | | S1 AC3<br>V2 | | | | | |

Medium-high Vulnerability
High Vulnerability

Sensitivity Scale

| If the impact occurs, will it affect the functionality of the service area? | | | | |
|---|---|---|---|---|
| No – Functionality will stay the same (S1) | Unlikely – Functionality will likely stay the same (S2) | Yes – Functionality is likely to get worse (S3) | Yes – Functionality will get worse (S4) | Yes – Functionality will become unmanageable (S5) |

Adaptive Capacity Scale

| Can the service area adjust to the projected impact with minimal cost and disruption? | | | | |
|---|---|---|---|---|
| No – Will require substantial costs ($$$$$) and staff intervention (AC1) | No – Will require significant costs ($$$$) and staff intervention (AC2) | Maybe – Will require some costs ($$$) and staff interven-tions (AC3) | Yes – But will require some slight costs ($$) and staff intervention (AC4) | Yes – No to little costs ($) and staff intervention are necessary (AC5) |

*Table 10: Climate Change risk assessment for the Town of Quispamsis, NB.*

## Town of Quispamsis Climate Change Risk Assessment

| | | IMPACT STATEMENT | CONSEQUENCE | | | | | | LIKELIHOOD | RISK RATING |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Health & Safety | Loss of Service | Community & Lifestyle | Natural Environment | Damage & Recovery | TOTAL | | |
| CHANGE IN PRECIPITATION | Riverine Flooding | Contamination of lakes and streams due to increased pollutant/sediment runoff, sewer overflow | 1 | 2 | 2 | 4 | 2 | 11 | 3 | 33 |
| | | Isolation, accessibility and mental health challenges due to flooding | 3 | 3 | 4 | 2 | 4 | 16 | 4 | 64 |
| | | Damages to infrastructure/ properties due to flooding and/or erosion | 3 | 3 | 4 | 3 | 4 | 17 | 4 | 68 |
| | Flooding: heavy rainfall | Contamination of lakes and streams due to increased pollutant/sediment runoff, sewer overflow | 1 | 2 | 2 | 4 | 2 | 11 | 5 | 55 |
| | | Isolation, accessibility and mental health challenges due to flooding | 3 | 3 | 2 | 2 | 3 | 13 | 5 | 65 |
| | | Damages to infrastructure/ properties due to localized flooding | 3 | 2 | 4 | 1 | 3 | 13 | 5 | 65 |
| | Winter Rain | Flooding due to clogged catch basins (rain on snow event) | 3 | 2 | 2 | 2 | 3 | 12 | 5 | 60 |
| | | Ice accumulation due to freezing rain storms | 3 | 2 | 2 | 2 | 2 | 11 | 5 | 55 |
| | Increased Snowfall | Increase in snow removal services around critical infrastructure | 2 | 1 | 1 | 1 | 1 | 6 | 5 | 30 |
| | | Concern regarding isolation and accessibility of power, food and water for residents during periods of extreme cold and ice conditions. | 2 | 2 | 2 | 1 | 2 | 9 | 5 | 45 |
| | | Infrastructure damage due to increased snow loading on buildings/structures. | 3 | 3 | 3 | 1 | 3 | 13 | 5 | 65 |
| | Drought | Increased depletion of water supply for property owners with private wells. | 2 | 3 | 4 | 1 | 3 | 13 | 5 | 65 |
| | | Increased forest fire potential. | 3 | 2 | 3 | 5 | 3 | 16 | 2 | 32 |
| INCREASED TEMPERATURE | Increased summer heat waves | Increased risk of heat stress on vulnerable populations due to extreme heat | 4 | 2 | 2 | 2 | 1 | 11 | 5 | 55 |
| | | Increased energy demand for cooling needs in the summer | 2 | 2 | 2 | 1 | 2 | 9 | 4 | 36 |
| | | Loss of work for seasonal outdoor employees due to extreme heat | 2 | 1 | 2 | 1 | 1 | 7 | 5 | 35 |
| | | Stress on habitat for cold water species due to loss of cool streams for refuge | 2 | 1 | 2 | 5 | 3 | 13 | 5 | 65 |
| | | Reduced health quality due to a reduction in air quality | 3 | 1 | 2 | 4 | 2 | 12 | 2 | 24 |
| | | Contaminated recreational water sources due to an increase in toxic cyanobacteria cultures | 4 | 3 | 2 | 3 | 3 | 15 | 4 | 60 |
| | Increasing winter temps | Increase in infrastructure damage due to increase in annual freeze-thaw cycles | 2 | 2 | 2 | 4 | 3 | 13 | 5 | 65 |
| | | Invasive species migration due to warmer winters | 3 | 2 | 3 | 2 | 2 | 12 | 4 | 48 |
| | | Higher risks of vector borne disease due to increased in tick and mosquito population | 3 | 2 | 2 | 4 | 2 | 13 | 4 | 52 |
| | | Increasing winter temperature limiting QPlex ice making | 1 | 1 | 1 | 1 | 1 | 5 | 5 | 25 |
| | Increased Storm Events | Road and building infrastructure damages due to increased storms | 3 | 4 | 3 | 2 | 3 | 15 | 5 | 75 |
| | | Food Shortage due to power outages at grocery stores. | 3 | 2 | 3 | 1 | 2 | 11 | 3 | 33 |
| | | Communications and power outages due to increased storms | 2 | 3 | 3 | 2 | 3 | 13 | 4 | 52 |
| | | Loss of trees and damage to green spaces | 1 | 1 | 1 | 4 | 3 | 10 | 4 | 40 |

| 5-20 Very-Low | 21-35 Low | 36-50 Medium-Low | 51-65 Medium | 66-80 Medium-High | 81-95 High | 96-110 Very-High | 111-125 Extreme |
|---|---|---|---|---|---|---|---|

Medium-High Risk (66-80)
Medium (51-65)

# Appendix E: Flood Hazard Assessment

Disclaimer: The flood levels in this mapping were determined by elevation data, and may not accurately reflect actual events. This mapping is to be used for planning purposes only.

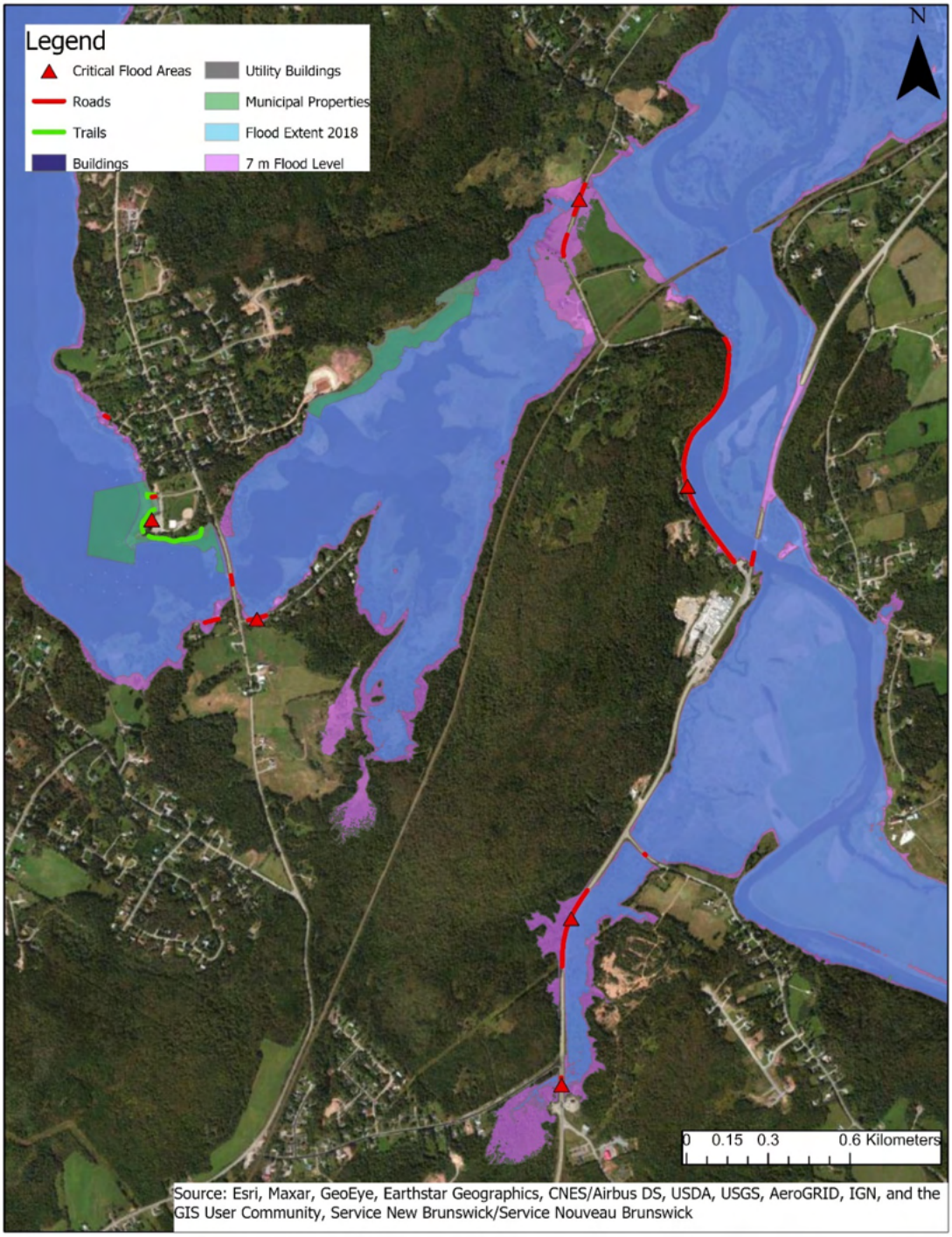


*Figure 17: Critical riverine flood locations displaying historical flooding (5.73m) and projected flooding for 2100 (7m) in Meenan's Cove and Hammond River, Quispamsis, NB (Daigle, 2020).*

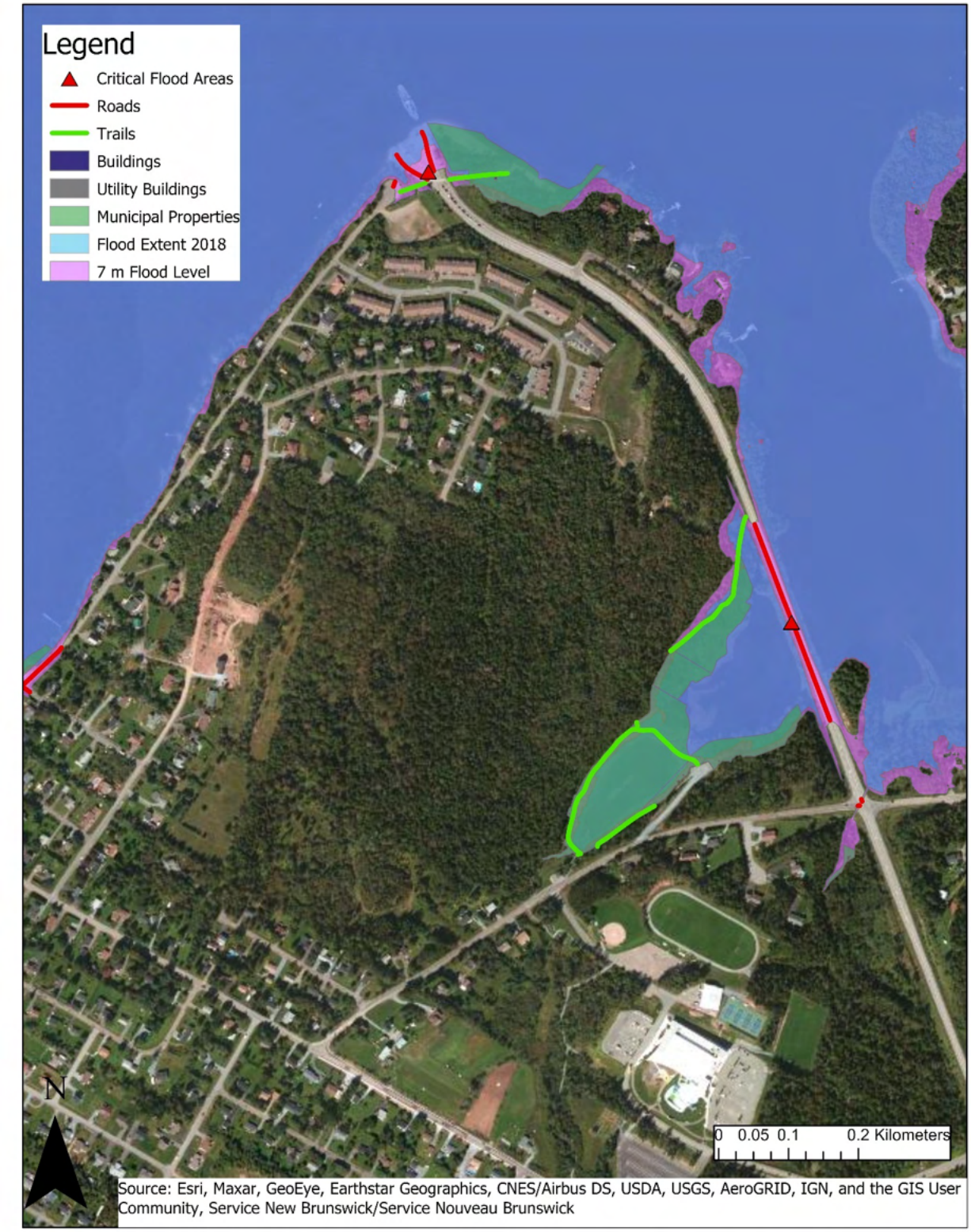


*Figure 18: Critical flood locations displaying historical flooding (5.73m) and projected flooding for 2100 (7m) at Gondola Point, Quispamsis, NB (2018) (Daigle, 2020).*


*Figure 19: Critical flood locations displaying historical flooding (5.73m) and projected flooding for 2100 (7m) on Gondola Point Road from 623 Gondola Point Road to 565 Gondola Point Road (Daigle, 2020).*


*Figure 20: Critical Flood locations displaying historical flooding (5.73m) and projected flooding for 2100 (7m) from Sherwood Drive to 495 Gondola Point Road (Daigle, 2020).*

*Table 11: Roads impacted by Kennebecasis River flooding in 2018 (5.73m) and by a projected 7m flood in 2100.*

| Street Name | Owned By | Length of road impacted historical flooding (2018) (m) | Sections Impacted by Projected Sea Level Rise (2100) (m) | Length of road Impacted by Projected Sea Level Rise (2100) (m) |
|---|---|---|---|---|
| **Beach** | Municipal | | 1 | 12 |
| **Douglas** | Municipal | | 1 | 68 |
| **Forrester's** | Municipal | | 1 | 15 |
| **Gondola Point Arterial (Route 119)*** | Provincial | 49 | **3** | 419 |
| **Gondola Point** | Municipal | | **9** | 1034 |
| **Goosedown** | Private | 28 | 1 | 51 |
| **Hammond River** | Municipal | | 1 | 1104 |
| **Harrison Hill** | Municipal | | 1 | 19 |
| **Prince** | Municipal | | 1 | 14 |
| **Saunders** | Municipal | | 1 | 1 |
| **Sherwood** | Municipal | | 1 | 14 |
| **Total** | | **77** | **211** | **2751** |
| **Total (km)** | | **0.077** | | **2.75** |
| *Impacted in 3 sections by the 2018 flood | | | | |

*Table 12: Additional roadways that may be impacted by flooding in the event of a blockage at a culvert. Culverts will require monitoring to prevent roadway flooding.*

| Street Name | Culvert Asset ID | Sections Impacted by Projected Sea Level Rise (2100) (m) | Length of road Impacted by Projected Sea Level Rise (2100) (m) |
|---|---|---|---|
| **George** | 4948 | Cliff Street to Roby's Road | 2 |
| **Meenan's Cove** | 5078 | Jameg Court to Gondola Point Arterial | 3 |
| **Palmer Brook** | 5080 | Elliot Road to Hampton Road | 3 |
| **Stock Farm** | 789 | Hampton Road to Motivation Avenue | 5 |
| **Total** | | | **13** |

*Table 13: Recreational trails impacted by Kennebecasis River flooding in 2018 (5.73m) and by a projected 7m flood in 2100.*

| Location | Impacted by Historical Flooding (2018) (m) | Impacted by Projected Sea Level Rise (2100) (m) |
|---|---|---|
| **Gondola Point Beach** | 60 | 122 |
| **Hammond River Park** | 473 | 719 |
| **Matthews Cove Park** | 232 | 677 |
| **Meenan's Cove Park** | 182 | 360 |
| **Total** | **947** | **1878** |

*Table 14: Municipally owned buildings impacted by Kennebecasis River flooding in 2018 (5.73m) and by a projected 7m flood in 2100.*

| Location | Building |
|---|---|
| **623 Gondola Point Road** | Sewage lift station |
| **565 Gondola Point Road** | Sewage lift station |
| **507 Gondola Point Road** | Sewage lift station |
| **282 Gondola Point Arterial** | Gondola Point Beach Building |
| **199 Model Farm Road** | Meenan's Cove Beach House |

# Appendix F: Action Register

The action register recommends actions that can work to achieve adaptation objectives for the Town of Quispamsis. These actions are a result from a comprehensive vulnerability and risk assessment, staff surveys and public input. The table below describes each action including the departments and partnerships involved, the completion target, costs, and current policies and initiatives that support the action. The Town of Quispamsis should incorporate the Climate Change Adaptation Plan into the next iteration of the Municipal Plan or during the next comprehensive review. The partnerships, completion targets and costs identified in this register are suggestions to help initiate implementation and are subject to change as implementation progresses.

## Table of Contents



## Completion Targets

Ongoing: refers to an action that is already being completed and should continue to be implemented.
Short-term: 2021-2025
Medium-term: 2026-2030
Long-term: 2031-2040

## Cost Categories

Low: < $20,0000
Medium: $20,000 - $100,000
High: $100,000 - $1,000,000+

## Risk Rating

The risk rating category describes the result from the vulnerability and risk assessment. Risks in this scheme are rated from very low to extreme. The vulnerability and risk assessment for the Town of Quispamsis revealed risks from very-low to medium-high. The level of risk represents the priority with which each action should be addressed:

- **Medium-High** risks are the most severe in the Town and should be addressed first.
- **Medium** risks can be incorporated into routine maintenance and operations or when the urgency of the climate impact increases.
- **Low** risks will continue to be monitored but it is expected that existing actions will be sufficient to address these risks. These risks can be re-evaluated as the urgency of the climate impact increases.

## List of Acronyms

**DELG:** Department of Environment and Local Government

**DTI:** Department of Transportation and Infrastructure

**GIS:** Geographic Information System

**HRAA:** Hammond River Angling Association

**KRFD:** Kennebecasis Regional Police Force

**KVFD:** Kennebecasis Valley Fire Department

**NB EMO:** New Brunswick Emergency Measures Organization

**PAC:** Planning and Advisory Committee

**QEMO:** Quispamsis Emergency Measures Organization

**CSA:** Canadian Standards Association

**HARS:** Heat Alert and Response System

| Strategy 1: Modifying policies, plans and procedures | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 1. Set development standards and zoning to restrict development near flood prone areas. Account for 7m flood elevation and 1 in 100-year storm (+20%) events. | Planning, Engineering, GIS, Consultants, PAC, DELG | Ongoing | Low/Med | Medium-High | *Zoning By-Law #38*<br>*Subdivision By-Law 053* |
| 2. Refer to the Quispamsis Municipal Emergency Measures Plan to respond to extreme climatic events (i.e., extreme wind, heat, ice storm, severe weather). Review plan on an annual basis. | Quispamsis EMO, NB EMO Neighbouring communities | Ongoing | Variable | Medium-High | *Quispamsis Emergency Measures Plan (2018)* |
| 3. Identify municipally owned natural assets (i.e., wetlands, forests, LPP) and the ecosystem services that they provide to the Town. | DELG, Planning, Engineering, Community Services, DFO, Consultants, HRAA | Ongoing | Medium | Medium-High | *Subdivision By-Law 053*<br>*Municipal Development Plan By-law 054* |
| 4. Integrate municipally owned natural assets into the asset management plan. | Planning, Engineering | Long | High | Medium-High | *Asset Management Strategy.* |
| 5. Apply a climate lens when developing to new regulations. | Planning, Climate Change Committee, Council, PAC | Ongoing | Low | Medium-High | *Municipal Development Plan By-law 054*<br>*NBCCAP – Objective 72* |
| 6. Develop a Watershed and Stormwater Management Plan. | Planning, Consultants, Council | Ongoing | Medium | Medium | *Municipal Development Plan By-law 054* |
| 7. Develop design standards to manage stormwater on commercial developments that includes low impact development designs. | Planning, Engineering | Ongoing | Medium | Medium | *Municipal Development Plan By-law 054* |
| 8. Consider future climate change impacts (drought) when completing the upcoming water supply and distribution study. | Planning, Engineering, Consultants, DELG | Long | High | Medium | *Municipal Development Plan By-law 054* |
| 9. Develop compact neighbourhoods that encourage multi-modes of active transport. | Planning, Engineering, PAC, Council | Medium | Medium | Medium | *Municipal Development Plan By-law 054.*<br>*Community GHG Inventory & Action Plan*<br>*Town of Quispamsis Active Transportation Plan* |
| 10. Expand the landscaping and sediment control practices laid out in the Millennium Drive Development Scheme to all new commercial developments. | Planning, Engineering, PAC, Council | Medium | Medium | Medium | *Millennium Drive Development Scheme* |

| Strategy 1: Modifying policies, plans and procedures | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 11. Clear debris from commonly blocked catch basins. | Public Works, Parks | Ongoing | Low | Medium | |
| 12. Work with NB Power to identify and trim trees in proximity to power lines. | NB Power, Communications | Ongoing | Low | Medium | *Subdivision By-Law 053*<br>*Public Utility Easement*<br>*Standard Operating Procedures* |
| 13. Monitor snow and ice accumulation on municipal buildings when necessary during the winter months. | Works, Parks | Short | Low | Low | *2019 Comprehensive Asset Management Plan* |

| Strategy 2: Building or infrastructure upgrades | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 14. Incorporate considerations for climate change impacts into design and development of infrastructure. | Engineering, Public Works & Utilities, Planning | Ongoing | Low | Medium-High | *Municipal Development Plan By-law 054* |
| 15. Raise roadways/reinforce banks in areas impacted spring freshet and stormwater flooding (Appendix E: Tables 11-12). | Engineering, Public Works, Consulting, Provincial Government | Ongoing | High | Medium-High | *Geotechnical Inspection & Rehabilitation Design 2018 Quispamsis Flood Damage* |
| 16. Upgrade wastewater pump stations along Gondola Point Road (Appendix E: Table 14). | Engineering, Utilities, Consulting, Federal Government | Ongoing/Long-term | High | Medium-High | *2019 Comprehensive Asset Management Plan Geotechnical Inspection & Rehabilitation Design 2018 Quispamsis Flood Damage* |
| 17. Adapt nationally recognized standards (CSA) and designs for flood resilience and stormwater management. | Engineering, Utilities, Planning, Building Inspection, PAC, Council | Medium | Medium | Medium-High | National Building Code of Canada (2015)<br>Subdivision By-Law 053<br>*Zoning By-Law #38* |
| 18. Upsize stormwater management infrastructure during end-of-life replacements to handle larger stormwater flows. | Engineering, Works, Parks, Council | Long | High | Medium | *Asset Management Policy* |
| 19. Integrate green infrastructure that will manage increased precipitation into infrastructure renewals. | Engineering, Planning | Long | High | Medium | |
| 20. Identify areas where a new municipal water system will be most effective. Determine resident interest in connecting to the new system as recommended by CBCL. | Engineering, Planning, Council, Public Works & Utilities | Long | High | Medium | *Water Supply and Distribution Study (2019)* |
| 21. Encourage installing backwater valves in existing buildings. | Building Inspector, Public Works & Utilities, Planning | Medium | Low | Medium | Building By-Law No. 055<br>Sewerage Utility By-Law No. 005<br>National Building Code of Canada (2015)<br>National Plumbing Code of Canada (2015) |
| 22. Educate contractors on changes in buildings codes that shift toward net zero runoff requirements. | Planning, Engineering, Building Inspection | Medium | Low | Medium | Building By-Law No. 055<br>Subdivision By-Law 053<br>*Zoning By-Law #38*<br>*Municipal Development Plan By-law 054* |
| 23. Increase insulation & air sealing at arenas to reduce heat gain during warmer periods. | Parks, Community Services | Medium | Medium | Low | *2019 Comprehensive Asset Management Plan* |

| Strategy 2: Building or infrastructure upgrades | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 24. Acquire a backup power source for the Q Plex. | Community Services, Utilities | Short | High | Low | |

| Strategy 3: Improving community awareness and public education | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 25. Increase the awareness and availability of flood mapping and forecasting in Quispamsis (i.e., libraries, social media). | Planning, GIS, Communications | Short | Low | Medium-High | |
| 26. Provide guidance for flood preparedness, recovery and restoration to property owners on the Kennebecasis River. | Quispamsis EMO, NB EMO, DELG, Communications, ACAP Saint John, Standing for Water, HRAA, River Watch NB | Ongoing | Low | Medium-High | *Quispamsis Emergency Measures Plan (2018)* |
| 27. Appoint the Climate Change Committee to monitor and implement the Climate Change Adaptation Plan | Climate Change Committee, Communications, Standing for Water, HRAA, ACAP Saint John | Short | Low | Medium-High | *Benchmarking Tool (QUEST)*<br>*Community Energy Plan (Corporate & Community)* |
| 28. Collaborate with the DELG and community groups to host a speaker series on flood preparedness and adaptation | Climate Change Committee, DELG, Communications, ACAP Saint John, Standing for Water, HRAA, Local Schools, NB Power | Ongoing | Low | Medium-High | *NBCCAP – Objective 95* |
| 29. Educate real estate agents and developers about new municipal climate adaptation regulations | Planning, Engineering, PAC | Medium | Low | Medium-High | *Zoning By-Law #38*<br>Subdivision By-Law 053<br>*Municipal Development Plan By-law 054* |
| 30. Engage community members when developing the Watershed and Stormwater Management Plan. | Planning, Engineering, PAC | Medium | Medium | Medium | *Municipal Development Plan By-law 054* |
| 31. Develop demonstration sites to illustrate ecosystem services provided by green infrastructure. | Planning, Engineering, PAC, Consultants, ACAP Saint John | Short | Low/ Medium | Medium | *Municipal Development Plan By-law 054* |
| 32. Educate community about reducing water usage during periods of drought. | Communications, DELG, Standing for Water | Ongoing | Low | Medium | *Municipal Development Plan By-law 054*<br>*Water By-Law* |
| 33. Educate the community on the health hazards of ticks and Lyme disease. | Communications, Public Health, Ministers of Health | Ongoing | Low | Medium | |
| 34. Alert the public to extreme temperatures (HARS Levels) and highlight methods to stay safe. | Communications, QEMO, NB EMO | Ongoing | Low | Medium | *NBCCAP – Objective 101* |
| 35. Communicate locations of heating/cooling shelters during power outages or extreme temperatures. | Communications, QEMO, NB EMO | Ongoing | Low | Medium | |

| Strategy 3: Improving community awareness and public education | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 36. Educate municipal staff and residents on identification and awareness of cyanobacteria in recreational water sources. | Community Services, Parks, Communications | Ongoing | Low | Medium | |
| 37. Educate the community on identifying and removing invasive species. | Planning, Engineering, Community Services, Parks, DELG | Ongoing | Low | Medium-Low | *Subdivision By-Law 053*<br>*Municipal Development Plan By-law 054* |
| 38. Educate residents about risks of well water contamination. | Communications, Climate Change Committee, Utilities, DTI, Public Health | Ongoing | Low | Low | *NB Public Health Act (1998)* |
| 39. Promote preparing 72-hour kits, evacuation plan for extended power outages. | QEMO, NB EMO, Red Cross, KRPF, KVFD | Ongoing | Low | Low | |

| Strategy 4: Building resilience to climate impacts | | | | | |
|---|---|---|---|---|---|
| **Action** | **Lead Department & Partners** | **Completion Target** | **Cost** | **Risk Rating** | **Supporting Initiatives and Policies** |
| 40. Participate in Emergency Preparedness Week. Update website with emergency preparedness information. | Quispamsis EMO, NB EMO, Federal Department of Public Safety, Communications, Red Cross | Ongoing | Low | Medium- High | |
| 41. Create a voluntary signup for vulnerable residents requiring electricity to run healthcare equipment or assisted evacuation. | Horizon, NB Power, Nursing homes, KRPF, KVFD | Short | Low | Medium | |
| 42. Promote rain barrels, rain gardens, and increasing groundwater infiltration. | Community Services, Parks, Communications, Council | Medium | Low | Medium | |
| 43. Use Wet Areas Mapping layer to protect natural buffers around unmapped rivers, lakes and wetlands. | Planning, Engineering, PAC, Developers | Long | High | Medium | *Zoning By-Law #38*<br>*Subdivision By-Law 053*<br>*Municipal Development Plan By-law 054*<br>New Brunswick Clean Water Act |
| 44. Identify alternate routes for transportation when emergency routes are flooded. | QEMO, NB EMO, KRPF, KVFD | Ongoing | Low | Medium | |
| 45. Identify and monitor critical habitats experiencing stress from increasing temperatures. | ACAP Saint John, HRAA, Parks, DELG | Long | Medium | Medium | |
| 46. Diversify energy supply to reduce energy usage and integrate green energy into backup power systems. | Utilities, Council, NB Power | Medium | High | Medium-Low | Community GHG Inventory & Action Plan |
| 47. Avoid planting Ash tree species. | Parks, PAC | Low | Low | Medium- Low | |
| 48. Promote and maintain community gardens as a food source for the community. | Parks, Communications | Ongoing | Low | Low | |

# Notes

ACAP SAINT JOHN

Founded in 1992, ACAP Saint John is a community-based, non-profit organization that encourages communication, partnership and active involvement from all sectors of the community in managing the environment.

At its heart, ACAP has always been an environmental incubator, one that transforms and evolves our region's landscapes with the help of governments, companies and community collaborators. Our work is designed to be seen, felt and experienced throughout the environment – from our wetlands and coastlines to our streets and public spaces.

ACAP Saint John
office@acapsj.org
1-506-652-2227