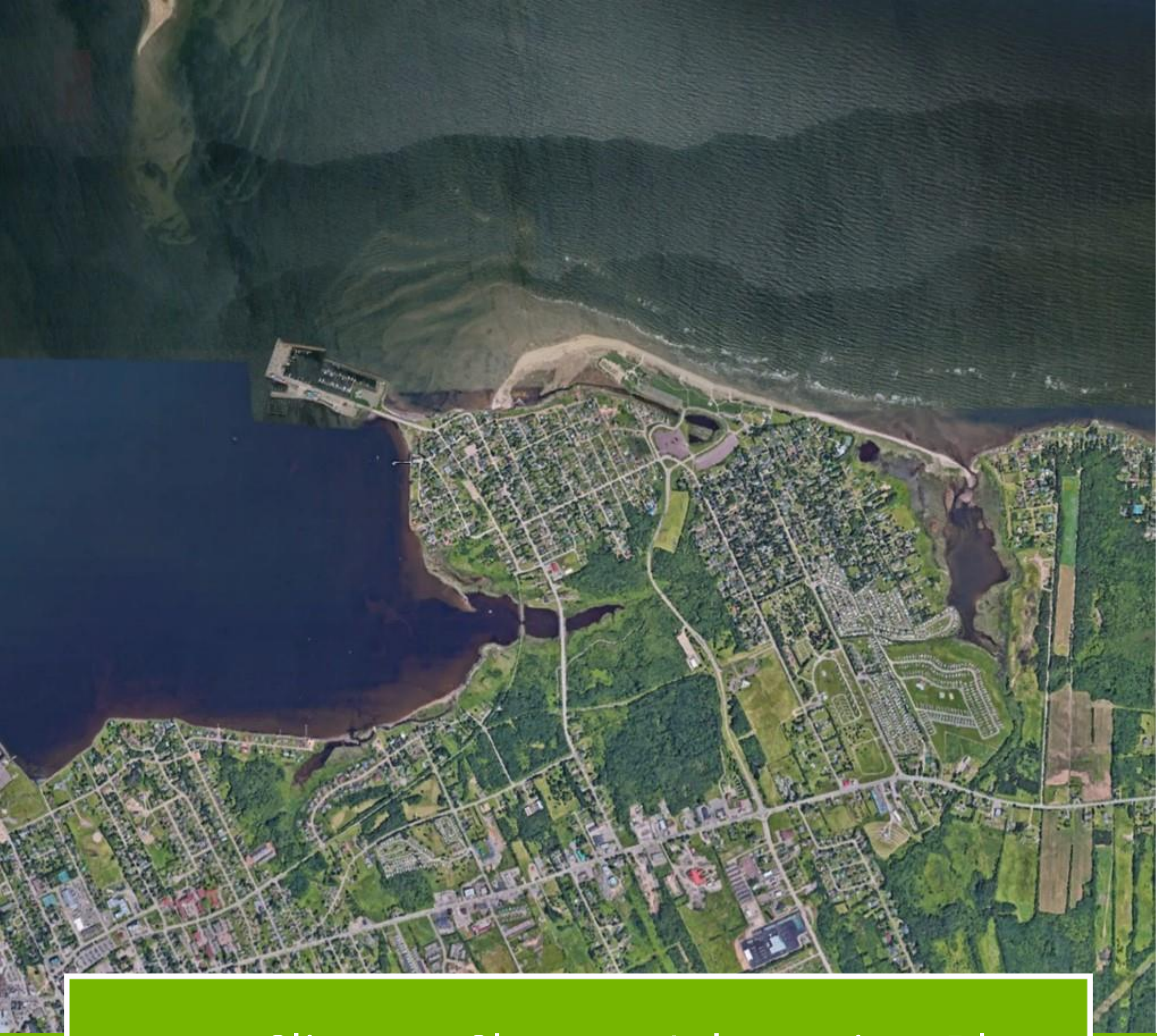


Climate Change Adaptation Plan

Pointe-du-Chêne, New Brunswick

Final Report

231113.00 • March 2024

CBCL

Executive Summary

Climate throughout New Brunswick has notably changed over the past several decades, including warmer, wetter, and stormier conditions. In recent years, Pointe-du-Chêne has shown increased vulnerability to climate change, with extreme events such as Hurricane Fiona wreaking havoc on the community. These types of events have caused widespread flooding and infrastructure damage throughout the community resulting in extended power outages and forced evacuation. Transportation infrastructure has been significantly damaged including asphalt and pavement uplift and deterioration, potholes, and ponded water that has created issues for vehicle access. Sanitary infrastructure has been experiencing unprecedented levels of inflow and infiltration which, combined with aging infrastructure, has required significant financial resources to manage.

The community of Pointe-du-Chêne has long recognized its vulnerability to climate change and has obtained funding from the Environmental Trust Fund (ETF) to complete a Climate Change Adaptation Plan (CCAP) with the ultimate objective of improving climate resilience within the community. The CCAP is being developed in accordance with the NB Department of Environment and Local Government guidance document for climate change adaptation planning developed in 2023, along with overarching objectives of the province's 2022-2027 Climate Change Action Plan (NB Department of Environment and Local Government, 2023).

Development of the CCAP involved a thorough risk and vulnerability assessment to identify key climate hazards and associated impacts to the community. The risk assessment was informed by review of relevant studies and background documents, consultation with the public, and discussions with community organizations such as the Shediac Bay Watershed Association and Greater Shediac Sewerage Commission.

High and extreme risk items identified were prioritized for adaptation planning by developing a set of actionable adaptation options aimed at reducing risk associated with the potential climate impacts. The adaptation actions developed were grouped into the following categories that cover the highest risk items identified:

- Emergency Management
- Coastal Flooding
- Transportation Asset Management
- Extreme Rainfall and Stormwater Management
- Tidal Creek Drainage and Surface Water Quality
- Municipal Wastewater Management
- Pointe-du-Chêne Wharf Upgrades

Adaptation actions are accompanied by a recommended lead party and possible supporting organizations, timelines for implementation, and estimated level of effort.

Contents

Appendices

1 Introduction

Source: NB Department of Environment and Local Government

Climate throughout New Brunswick has notably changed over the past several decades, including warmer, wetter, and stormier conditions. Increasing frequency and intensity of events such as storm surge, hurricanes, and flooding have led to significant impacts on Pointe-du-Chêne including widespread infrastructure damage, increased demand on emergency response organizations, and associated socio-economic implications.

The community of Pointe-du-Chêne has long recognized its vulnerability to climate change and has received funding from the Environmental Trust Fund (ETF) to complete a Climate Change Adaptation Plan (CCAP) with the ultimate objective of improving climate resilience within the community.

1.1 Climate Change Adaptation Objectives

Climate Change Adaptation serves a crucial purpose in proactively addressing and mitigating the impacts of climate change on various aspects of the local environment, economy, and resident well-being.

The primary objective of a CCAP is to safeguard critical infrastructure, natural resources, and economic sectors that may be particularly susceptible to the adverse impacts of climate change (New Brunswick Climate Change Secretariat, 2023). By identifying these vulnerabilities, communities can develop and implement effective strategies to enhance resilience and adapt to the changing climate conditions.

Engaging various stakeholders, including local government, businesses, residents, and environmental organizations, among others, is a key component of developing a CCAP that prioritizes a holistic, community-based approach to tackling climate resilience. This collaborative approach ensures a comprehensive and inclusive strategy that reflects the diverse interests and concerns of the community.

Along with protecting critical infrastructure assets, other key objectives of the Pointe-du-Chêne CCAP include prioritizing the health and safety of residents and visitors, educating residents on potential climate impacts and strategies for mitigating risks, and leveraging existing relationships within the community to further advance adaptation actions.

In essence, the purpose of the climate change adaptation plan is to create a resilient and sustainable future for Pointe-du-Chêne by addressing the challenges posed by climate change through prioritized actionable items.

1.2 CCAP Scope and Methodology

The CCAP is being developed in accordance with the NB Department of Environment and Local Government guidance document for climate change adaptation planning developed in 2023, along with overarching objectives of the province's 2022-2027 Climate Change Action Plan (NB Department of Environment and Local Government, 2023).

The scope associated with development of the CCAP includes conducting a thorough risk and vulnerability assessment to identify key climate hazards and associated impacts to the community. The risk assessment was conducted using The Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol, developed by Engineers Canada, which is a standardized process for assessing infrastructure vulnerabilities to climate change and extreme weather.

This PIEVC Protocol applies a bottom-up approach to climate vulnerability assessment that starts with a preliminary assessment of municipal assets and climate-related risks to the community. Once a key list of municipal assets is established, relevant climate parameters are identified that have significantly impacted these assets in the past, or are thought to potentially impact the assets in the future with climate change. The best available historical climate data and future projections are used to evaluate how the relevant climate parameters are likely to change over multiple time horizons in the future, and how these changes could impact the community. The PIEVC methodology is scalable to accommodate the relative size and scope of the assessment, which in this case includes a high-level assessment of all municipal assets and services.

Following completion of the risk assessment, high and extreme risk items identified are prioritized for adaptation planning by developing a set of actionable adaptation options aimed at reducing risk associated with the potential climate impacts. Adaptation actions typically involve, but are not limited to, recommendations for upgrading infrastructure, increasing public awareness, improving or expanding on existing municipal services, or initiating additional studies to further inform climate risk or develop adaptation programming.

1.3 Steering Committee

Development of the CCAP is being spearheaded by the Red Dot Association of Shediac Bay, with support from the Shediac Town Council, the Provincial Government, and other community organizations. A steering committee has been established to oversee the management of the CCAP development and implementation, as outlined in **Table 1-1**.

Table 1-1: Pointe-du-Chêne CCAP Steering Committee Members

Category and Entities		Representatives
Provincial Government Departments	DELG	Danielle Leger
	DELG	Jenna Miller
	DTI	Vincent Roussel
	Dept of Natural Resources and Energy Development	Dominique Berube
Town of Shediac	Mayor	Roger Caissie
	Citizen	Cathy Gallant
	Citizen	Chris Dixon
	Citizen	Andre Veniot
	RCMP	Mario Maillet
	Fire Dept	Captain Julien Boudreau
	Ambulance	Mark Hicks
	Infrastructure maintenance	Robert McEwen
Community Groups	Anglican Church	Julie Lawrence
	Ducks Unlimited	Jodie Hambrook
	SBWA	Helen Wedge
	GSSC	Joey Frenette
	Shediac Chamber of Commerce	Anne McGraw
Red Dot Association of Shediac Bay		Tim Borlase
		Arthur Melanson
		Roger Whittaker
		Helen Wedge
		Bill Ross

2 Background

2.1 Overview of Pointe-du-Chêne and Jurisdictional Considerations

Pointe-du-Chêne is a low-lying coastal community located in southeastern New Brunswick along the Northumberland Strait. Historically, the community operated as a Local Service District until it was amalgamated with the Town of Shediac in January 2023.

Pointe-du-Chêne is characterized by its pristine natural environment that includes tourism hubs including Parlee Beach Provincial Park and the Pointe-du-Chêne Wharf, along with the adjacent Belliveau Beach. The majority of the town's coastal-adjacent property is situated within the boundaries of provincially significant wetlands.

Demographically, Pointe-du-Chêne is characterized by a population of over 750 people with modest growth in recent years. **Table 2-1** outlines the key demographics for Pointe-du-Chêne obtained from the 2021 Statistics Canada Census.

Table 2-1: Demographic statistics for Pointe-du-Chêne (Stats Canada, 2021)

Demographic Characteristics	Total
Population, 2021	767
Population, 2016	716
Population percentage change, 2016 to 2021	7.1%
Total private dwellings	896
Private dwellings occupied by usual residents	442
Land area in square kilometers	2.30

In recent years, Pointe-du-Chêne has shown increased vulnerability to climate change, with extreme events such as Hurricane Fiona wreaking havoc on the community. These types of events cause widespread flooding and infrastructure damage throughout the community resulting in extended power outages and forced evacuation. Infrastructure damages have impacted critical tourism infrastructure in the community including the Pointe-du-Chêne Wharf, which has incurred millions of dollars in damage during recent storms and significantly impacted tourism operations within the community. Furthermore, transportation infrastructure has been significantly damaged including asphalt and pavement uplift and deterioration, potholes, and ponded water that has created issues for vehicle access. Sanitary infrastructure has been experiencing unprecedented levels of inflow and infiltration which, combined with aging infrastructure, has required significant financial resources to manage.

Extreme rainfall events, combined with the gently sloped topography and minimal stormwater maintenance infrastructure, has led to ongoing problems with overland flow and surface water contamination, as well as additional property damage and localized flooding of roads.

These events, combined with other climate parameters such as extreme temperatures, winter storms, and ice storms, can lead to increasing demands on emergency services and other municipal resources.

As climate change continues to progress, the majority of these events will become more frequent and/or intense, which with further exacerbate impacts to the community in years to come.

Pointe-du-Chêne is a resilient community with a common vision shared by residents – to preserve the natural environment and promote sustainable development and economic growth through continued community action and proactive planning against climate change. This climate change adaptation plan will support the community's ongoing initiatives and goals for sustainable and resilient development.

2.2 Data Collection

To inform the risk assessment and development of adaptation actions, a number of resources were used to gather information about existing assets in Pointe-du-Chêne and their potential vulnerabilities to climate change. The following sections outline data sources used for the assessment including previously completed studies, municipal planning resources, and input from the public.

2.2.1 Literature Review

A number of reports, maps, policies, guidelines, and other previously completed studies were reviewed to collect information about the infrastructure, natural assets, services, and management practices that exist within Pointe-du-Chêne. Documents reviewed include the following:

- Pointe-du-Chêne Sanitary Sewer System Improvements EIA Registration Document (2017)
- Parlee Beach Water Quality: Review of Stormwater Results 2017-2018, Approaches to Stormwater Quality Management, Data Information Gaps (2019)
- Managing Natural Assets to Increase Coastal Resilience, Pointe-du-Chêne, New Brunswick (2021)

- Preliminary Findings: Preferences for Coastal Adaptation, Shediac, New Brunswick (2021)
- Environmental Background Study, Pointe-du-Chêne Bridge (2008)
- Pointe-du-Chêne Wharf Development Plan Update (2012)
- Wetland Delineations near Shediac, New Brunswick (2017)
- Water Minoti Rong Protocol for Provincial Park Beaches (2021)
- Records of communication between Red Dot Association and
- A Community Plan for Adaptation in Pointe-du-Chêne, New Brunswick (2006)
- Parlee Beach Provincial Park Tidal Inlet Dredging EIA Registration Document (2022)
- Parlee Beach Water Monitoring Protocol (2017)
- Greater Shediac Sewerage Commission Public Meeting Minutes related to Cap-Brulé Wastewater Treatment Facility Upgrades
- Pointe-du-Chêne Land Donation Presentation, Ducks Unlimited Canada (2022)
- Department of Environment and Local Government Source Surface Water Management, Wetland Guidelines
- Shediac Climate Change Adaptation Plan (2019)
- Flood Hazard Mapping available through Service New Brunswick
- Town of Shediac by-laws, policies, and guidlines related to various topics including emergency management, stormwater management, sanitary sewer systems, municipal development guidelines, residential property maintenance, zoning

The goal of the literature was to develop an asset list and gather information about each asset including, but not limited to, the following:

- Location of assets within the community
- Existing conditions of infrastructure assets
- Ownership and management details
- Relevant policies or guidelines that impact management of an asset or service
- Historical climate impacts to the assets
- Recently completed or planned projects to improve climate resilience of assets
- Any other information that could further contribute to understanding an asset's vulnerability to climate change parameters.

2.2.2 Public Engagement Survey

Knowledge and experiences of residents and frequent visitors to Pointe-du-Chêne is imperative to fully understanding potential climate impacts to the region, identifying vulnerable infrastructure and services, and evaluating the severity of climate impacts on the community. To facilitate collection of this information, an online Public Engagement Survey was developed and distributed to community members using the SurveyMonkey platform. The survey included questions about the respondents relationship to the community (e.g., permanent residents, seasonal resident, frequent visitor), and asked specific questions about climate parameters and extreme events that have historically impacted the community.

A copy of the public engagement survey questionnaire is included in Appendix A. In total, the survey received 94 completed responses, and an additional 25 partially complete responses. Figure 2-1 summarizes key results from the survey, including the percentage of respondents who have experienced climate related impacts from the listed events in the past.

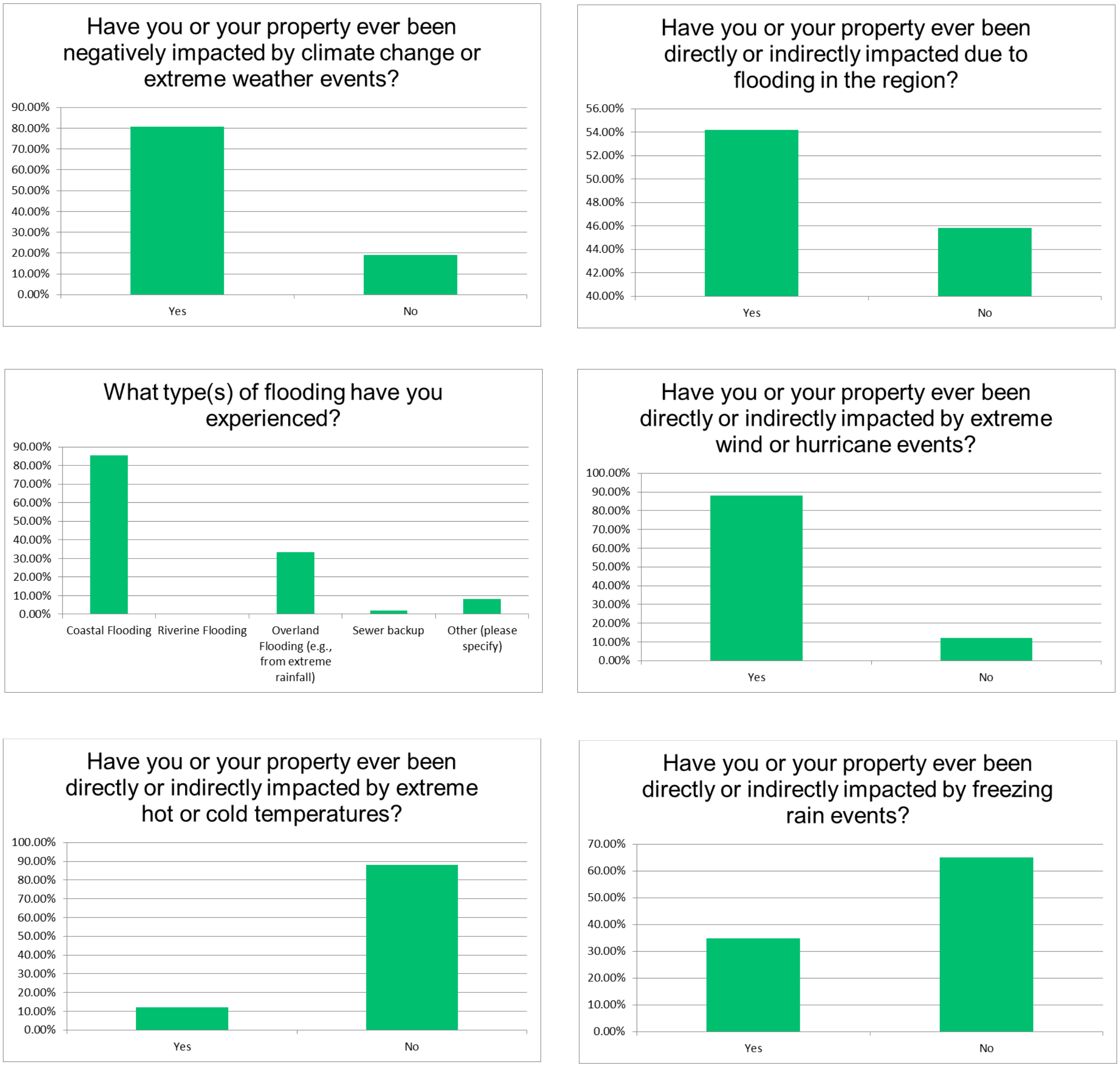


Figure 2-1: Summary of responses from the Public Engagement Survey

Results of the survey were used to further define the list of municipal assets and climate parameters that were to be included in the assessment, as outlined in the following sections.

2.3 Key Assets and Infrastructure

Based on the detailed literature review conducted and feedback from the public engagement survey, the project team defined a set of municipal assets for which climate change vulnerabilities will be assessed and prioritized. It is important to note that in the context of the CCAP, 'assets' does not only refer to built infrastructure, but also includes programs and services within the community that are critical to its function and could be impacted by climate change, such as emergency management planning or land use policies. Where appropriate, assets are grouped into categories representing the overarching theme in order to facilitate discussion and assessment of risk. The assets included in the assessment are summarized in **Table 2-2**.

Table 2-2: Overview of assets included in the risk assessment.

Category	Asset(s)
Coastal Environment	Beaches and Dunes ▶ Parlee Beach and Dunes ▶ Belliveau Beach and Dunes
	Tidal Creek ▶ Inlet, channel, and lagoon
	Coastal Wetlands ▶ Including associated development restrictions
Residential and Private Community Infrastructure	Residences
	Potable Water Wells
	Coastal Protection Infrastructure (armour stone)
	Pointe-du-Chêne Wharf
Transportation	Community Road Network
	Critical Community Access Points ▶ Pointe-du-Chêne Road Bridge ▶ Parlee Beach Road ▶ Gould Beach Road ▶ Belliveau Beach Road
Sanitary and Stormwater Management	Sanitary System ▶ Lift stations ▶ Underground piping ▶ Manholes
	Stormwater System ▶ Ditches and culverts
Emergency Services and Public Safety	Emergency Preparedness Plan
	Electrical Infrastructure
Land Use and Policies	Existing Municipal Development Practices

It is noted that this list was further presented and discussed with the Public during an in-person engagement session held at the Pointe-du-Chêne Community Centre on December 5th, 2023 (detailed in Section 4.1.1).

2.4 Key Assets Climate Parameters and Impacts

Based on the literature review conducted and public feedback received, a list of relevant climate parameters and indices was developed to be evaluated throughout the assessment. The climate parameters developed include coastal and atmospheric parameters that were identified to have impacted the community in the past, as well as climate events that have had minimal impacts to date but could present new challenges for the community as climate change progresses.

For each climate parameter, specific climate indicators were identified for which climate projections and PIEVC likelihood scoring was conducted. These climate indicators represent specific events, climate conditions, or thresholds that correspond to associated vulnerabilities in infrastructure design or management or services within the community. **Table 2-3**, below, outlines the climate parameters and indicators selected for the assessment, along with commentary on the associated potential impacts to the community that are further evaluated in the risk assessment.

Table 2-3: Climate indicators included in the assessment and associated potential impacts.

Climate Parameter	Climate Indicators	Potential Impacts from Climate Change
Extreme Water Levels	Threshold 1 (1.3 m CGVD2013) Threshold 2 (1.7 m CGVD2013) Threshold 3 (2.0 m CGVD2013)	▶ The elevation thresholds selected correspond to the 1 in 5-year flood event, the 1 in 25-year flooding event, and the 1 in 100-year flooding event, respectively. Each of these flooding events will have different impacts on the community based on the relative elevation of infrastructure and services. ▶ Impacts associated with extreme water levels evaluated in the risk assessment include widespread coastal flooding and associated damage to residences, sanitary systems, potable water supplies, and transportation assets. Changing coastal flood levels also presents challenges for emergency preparedness and long-term land use planning.
Extreme Waves and Wind (Hurricanes)	Severe wave overtopping and potential for erosion (100-year waves)	▶ Similar to coastal flooding, extreme waves and wind driven by events such as hurricanes present significant challenges for communities in relation to public health and safety and emergency management. ▶ These events also have the potential to significant damage costal infrastructure including residents, roads, wharves, and the natural assets in Pointe-du-Chêne such as beaches and dunes.

Extreme Rainfall	Annual Maximum 1-Day Rainfall (1 in 10 year); Maximum 1-Day Rainfall (1 in 100 year).	▸ Extreme rainfall presents a variety of challenges for Pointe-du-Chêne including. While smaller events such as the 1 in 10-year storm present challenges with sanitary system capacity, larger events have the potentially to flood larger areas, potentially blocking off access routes and damaging infrastructure. ▸ Due to limited stormwater management in the community these events also contribute to significant runoff into the surrounding environment which can impact surface water quality.
Heat Extremes	Number of Days T_{max} > 30°C in the Summer.	▸ Heat extremes present an increased risk to public health and safety due to an associated increase in emergency services required to treat illness such as heat stroke. ▸ Extreme temperatures can also contribute to poor water quality by promoting an ideal environment for growth and spread of some bacteria.
Freeze-Thaw Cycles	Number of Days with Max. Temp > 0°C and Min. Temp < 0°C	▸ Freeze-thaw cycles tend to impact infrastructure over longer periods of time by contributing to their wear and tear. This occurs when water gets into existing cracks, which then freeze and expands, thereby worsening deterioration.
Ice Accretion Thickness	Ice Accretion Thickness (1 in 20 year)	▸ Ice accretion can present health and safety challenges associated with falling ice and slippery roads, structural damage associated with heavy loading, and also contrite to damaged electrical infrastructure and extended power outages. ▸ Ice accretion also contributes to wear and tear of infrastructure due to abrasion and deterioration from snow clearing practices.
Snow Days	Number of Days with Snowfall Approximation > 10 cm.	▸ Snowfall in the range of 10cm or more often created significant transportation disruptions which can hinder emergency services. ▸ Furthermore, snowfall can damage residential and municipal infrastructure through excessive roof loading, as well as require more frequent maintenance to clear snow drifting and blocked access routes.
Winter Storms	Blowing and/or falling snow accompanied by sustained winds.	▸ In addition to the impacts caused by snowfall, winter storms carry strong winds which can worsen snow drifting and access issues, as well as caused widespread infrastructure damage such as downed utility poles which can lead to extended power outages.
Wildfire	Intensity and frequency of Wildfires.	▸ Areas of Pointe-du-Chêne sit in proximity to densely forested areas (i.e., 2.4km or less), meaning wildfire is a possible risk to the community (Kumar et al, 2022). ▸ Wildfires can cause significant impacts to a community including, widespread infrastructure damage, evacuation requirements, and public health and safety issues.
Drought	Drought Frequency and Intensity.	▸ Drought was considered in the assessment due to the high number of potable water wells in the community, and the potential for water supply to be temporarily impacts during periods of extended dry weather.
Lightning	Average number of days with lightning (within 25 km)	▸ Lightning presents a fire risk to municipal infrastructure including home and municipal buildings.

3 Climate Change Analysis

Southeastern New Brunswick has been subjected to many climate changes over the last several decades including average rising temperatures, high intensity precipitation events, sea level rise, and more frequent coastal erosion and flooding. Overall, Canadian climate scientists predict that Atlantic Canada will experience increasingly wetter, warmer, and stormier weather in the future as compared to today (Canon et al., 2020). Many of the climate conditions and extreme weather being experienced today are unprecedented, such as the effects of Hurricane Fiona in 2022, which presents new challenges for municipalities when planning for climate change adaptation.

Measurements of local weather and water trends have historically been used to predict the probability of extreme weather occurring in the future using return period statistics (the probability of a certain magnitude event occurring in each year). However, historical data has proven to no longer be a sufficient representation of future weather due to climate change. For this reason, modeling software such as global circulation model (GCM) projections are used in conjunction with dynamic and statistical downscaling to determine region and site-specific climate predictions. Climate projection science has progressed in recent years and sophisticated tools for predicting future temperature trends have evolved. Climate model predictions for precipitation and wind are still evolving, and as the science advances, the models will improve accordingly, although the ability of models to project changes remains limited by the large inherent natural variability of the atmospheric phenomena responsible for wind and precipitation changes.

The following chapter outlines projections for the various climate indicators applicable to Pointe-du-Chêne from now to the end of the Century (2100). Preliminary discussions on impacts to Pointe-du-Chêne are also presented. The climate projections developed were used to assign likelihood scores for the PIEVC risk assessment in order to evaluate overall risk and prioritize items for adaptation action, which are summarized at the end of the Chapter.

A stand-alone, detailed report on climate projections and scoring is included in Appendix C, which includes additional detail on methodology, data sources, and assumptions used in conducting the climate projections.

3.1.1 Extreme Water Levels

Index	Extreme water levels including 1:100 storm surge, tides, and sea level rise.
Importance	Extreme water levels can cause coastal flooding and damage infrastructure. This is the main driver for damage at the project site.
Climate Change Processes	Extreme water level increases are primarily driven by sea level rise. Sea level rise is predominantly caused by melting ice glaciers and icesheets because of an upwards shift of average temperatures.
Sources of Climate Information	DFO-CHS Tide Gauges – Tidal characteristics, such as Higher High Water Large Tide (HHWLT), and extreme water levels are based on the long-term tide records of the tide gauge located in the Shediac Bay and provided by the Canadian Hydrographic Service from Fisheries and Oceans Canada (DFO-CHS). NRCan Relative Sea-Level Rise (SLR) – Projected relative sea level change data, developed by Natural Resources Canada (NRCan), is available for 2006 and for every decade from 2010-2100, relative to 1986-2005 conditions for the three Representative Concentration Pathways (RCP) emissions scenarios (RCP 2.6, RCP 4.5, RCP 8.5) and an enhanced scenario based on melting of the West Antarctic Ice Sheet. This dataset is a combined measure of both changes to ocean levels due to climate change and vertical land movements.
Projection Summary	Sea Level Rise: Sea levels have been rising in the Maritimes since the end of last ice age 10,000 years ago. The trend is expected to accelerate with climate change. Future SLR projections vary depending on climate change scenarios and local factors, such as land subsidence. Extreme Water Levels are projected to increase significantly at the site, primarily as a result of sea level rise estimates in the magnitude of 0.7 m in the long term (Figure 3-1).

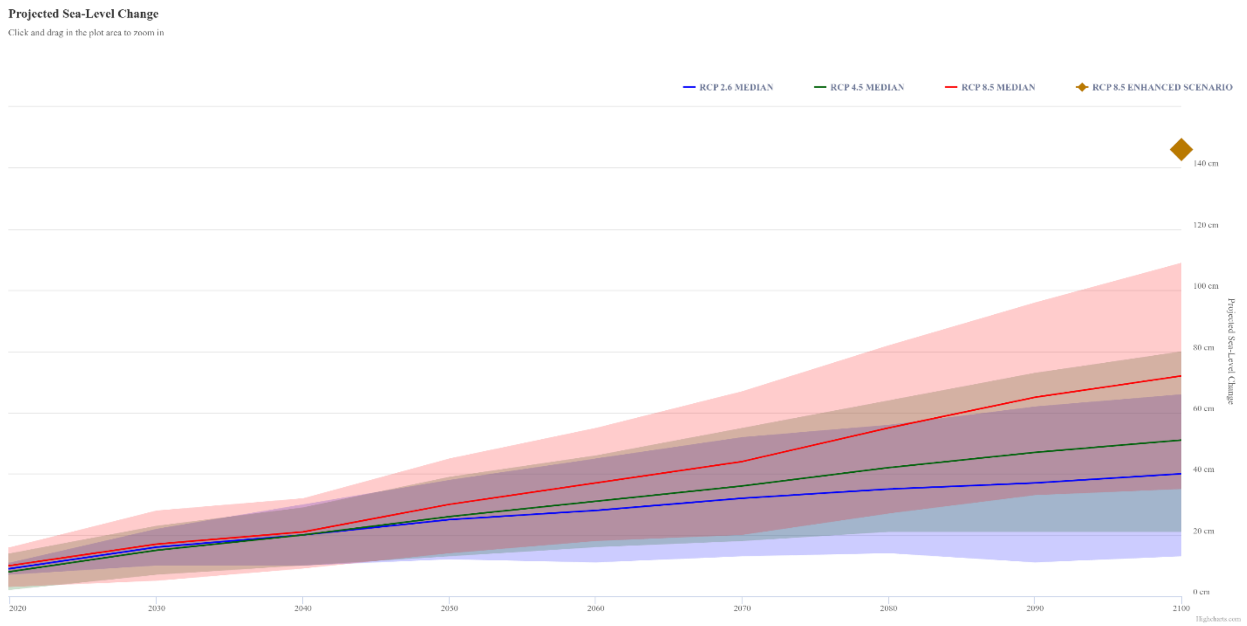


Figure 3-1: Relative Sea Level Rise Projections at Shediac Bay (climatedata.ca).

3.1.2 Hurricanes and Extreme Waves

Index	▶ Extreme: Severe wave overtopping and potential for erosion (100yr waves)
Importance	▶ Extreme waves driven by hurricane-type events pose a threat to the existing dune and beach system, and other coastal infrastructure. These can cause significant damage with direct wave impact, and also with the wave induced erosion.
Climate Change Processes	▶ Inside Shediac Bay, waves are primarily generated by wind rather than ocean swell, therefore extreme waves are projected to increase with time as a result of potential wind increases in the region. The north shore of Pointe-du-Chêne is exposed to larger waves which are also projected to increase due to potential changes in wind, and the reduction of ice cover during winter months, allowing waves to impact existing shorelines. ▶ There is a projected increase in wind due to localized convection caused by heating of the ground surface. ▶ There is a projected reduction of ice cover.
Sources of Climate Information	▶ ECCC MSC50 Hindcast - offshore wind and wave model hindcast from January 1954 to December 2018 containing hourly time series of wind and wave parameters at a location offshore of the project area.
Projection Summary	▶ In Pointe-du-Chêne, waves are primarily generated by wind rather than ocean swell, therefore seasonal and extreme

waves are projected to increase with time as a result of potential wind increases in the region (Figure 3-2 and Figure 3-3).

- Extreme winds are very difficult to model due to the general inability of coarse resolution climate models to resolve many of the physical processes involved. Overall, small changes in future design wind pressures are projected across Canada with high internal variability and uncertainty (Figure 3-3), which leads to a low signal-to-noise ratio. The IPCC (2013) states that winds are modelled with “low confidence”. In the Atlantic Canadian region, hourly wind pressures with a 50-year return period are projected to increase over the 21st century (Cannon et al, 2020).

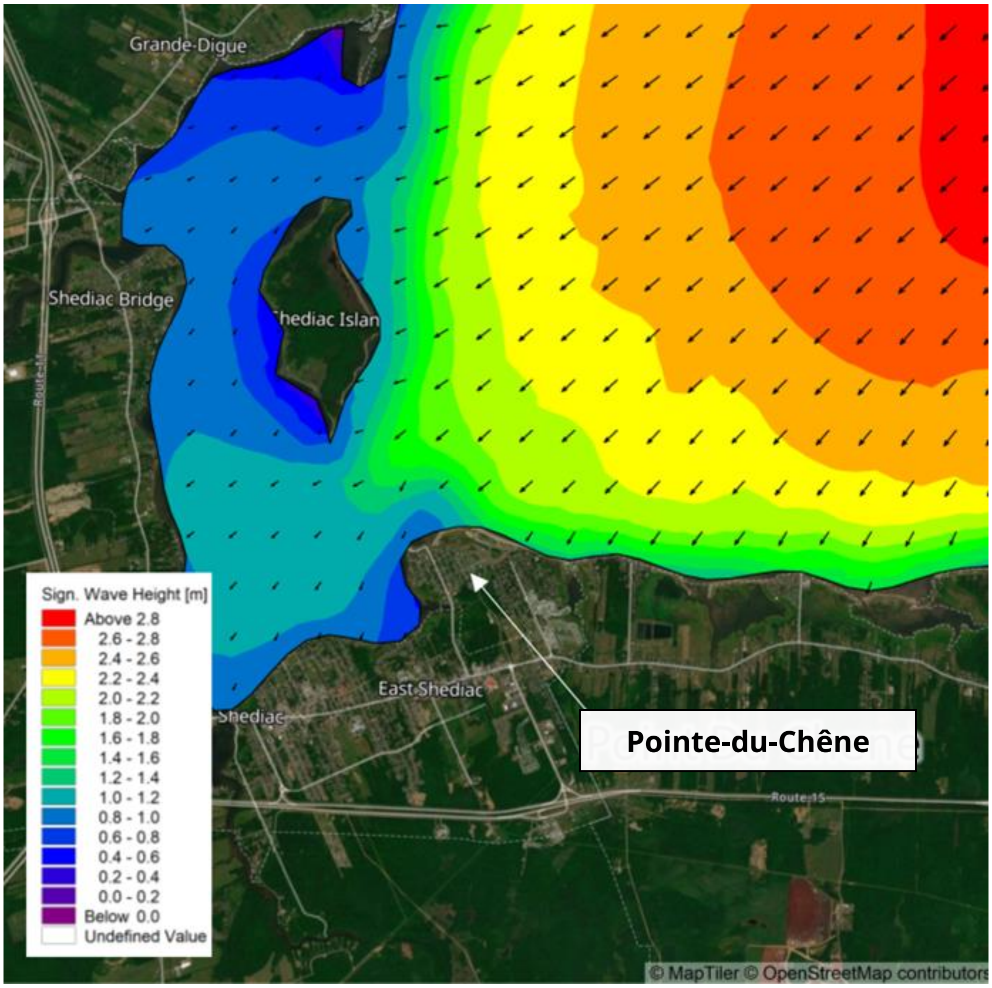


Figure 3-2: Modelled extreme waves, 20yr return period (CBCL, 2024)

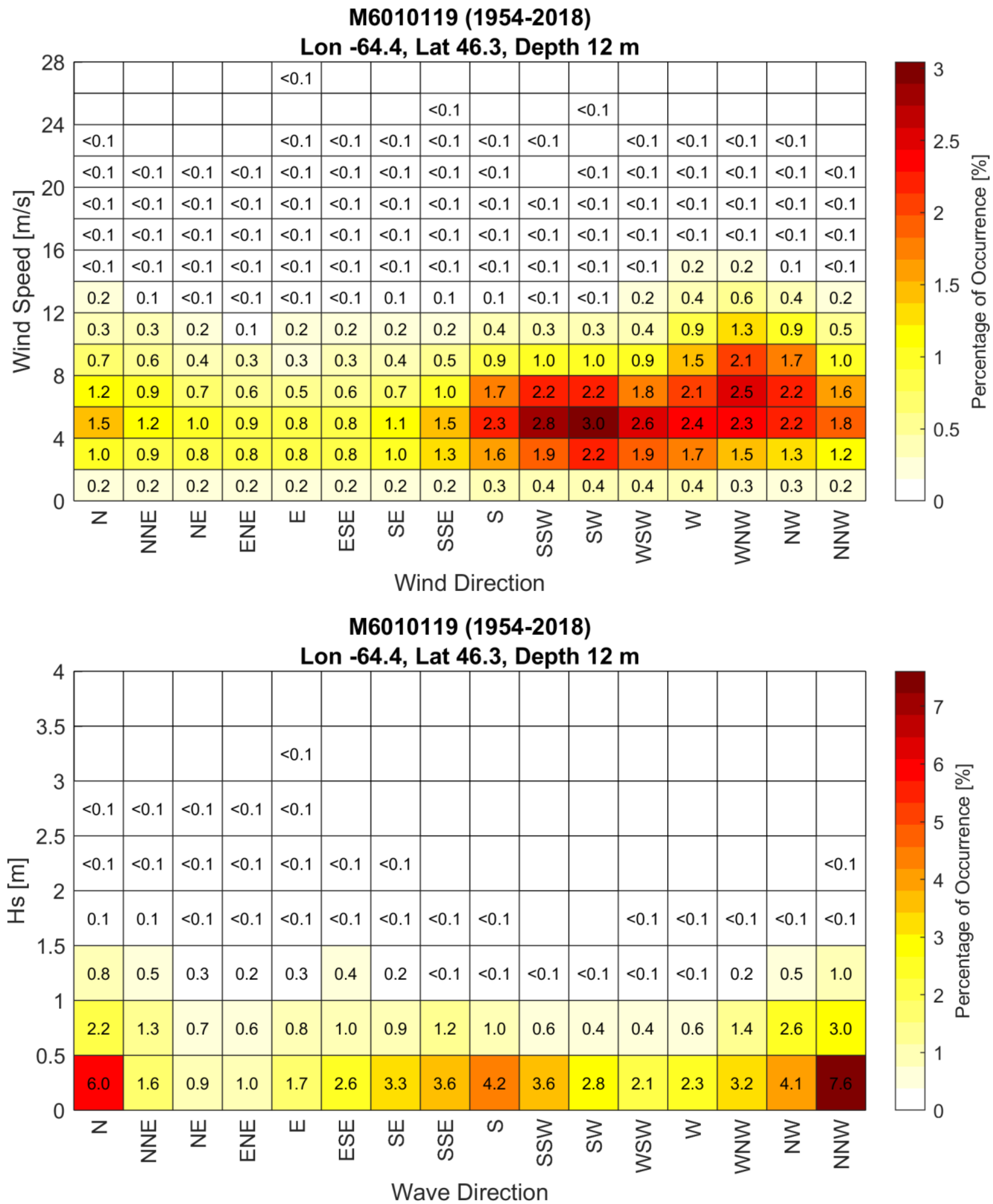


Figure 3-3: Analysis of offshore waves (bottom) and winds (top) (MSC50)

3.1.3 Extreme Rainfall

Index	Extreme Rainfall Events: 1 in 10 year and 1 in 100 year.
Climate Change Processes	A warmer atmosphere can hold more moisture, which leads to more precipitation (accelerated water cycle). Anticipated changes to atmospheric circulation and synoptic (large-scale weather patterns may affect the locations of storm tracks that influence extreme precipitation.
Sources of Climate Information	Environment Canada Historical IDF curves used for baseline characterization (Bouctouche CDA CS Station ID#8100593). Westra et al., 2014, Cannon et al., 2020, CSA PLUS 4013:19, used for selection of CC scaling rates. Statistically downscaled and bias-corrected CMIP6 data for temperature projections obtained from Climatedata.ca. Clausius-Clapeyron, Cannon et al. (2020), Westra et al. (2014) used for projections and scoring.
Projection Summary	A "temperature scaling" approach based on the Clausius-Clapeyron Equation, where each degree of warming results in an increase in precipitation intensity (Westra et al. 2014) was used to project a Climate Change Rate (CC Rate) to assess increases in the intensity of extreme rainfall. With this "temperature scaling approach, each degree of warming is taken to result in an approximately 7% increase in precipitation intensity (Westra et al,. 2014). This method is considered scientifically defensible by authoritative sources such as CSA PLUS 4013:19 and Cannon et al. (2020). Climate models project an increase in precipitation intensity of approximately 40-45% for the Pointe-du-Chêne region (Figure 3-4). This estimate is based on the median of the CMIP6 model ensemble for mean temperature obtained from Climatedata.ca. Projections depict a decrease in the return period of extreme storms is anticipated, and therefore extreme storms will likely occur more often. Through applying the CC Rate it is projected that the current 1 in 100 year event will become an approximate 1 in 10 year event and the current 1 in 10 year event will become an approximate 1 in 2 year to 1 in 5 year event in the long term (2080s). A greater projected increase is expected for higher return periods (1 in 100 year compared to 1 in 10 year). This is consistent with the IPCC (2021) statement that "heavy precipitation will generally become more frequent and more intense with additional global warming."

	▶ It is noted that high uncertainty is present in the far-term CC Rate projections.

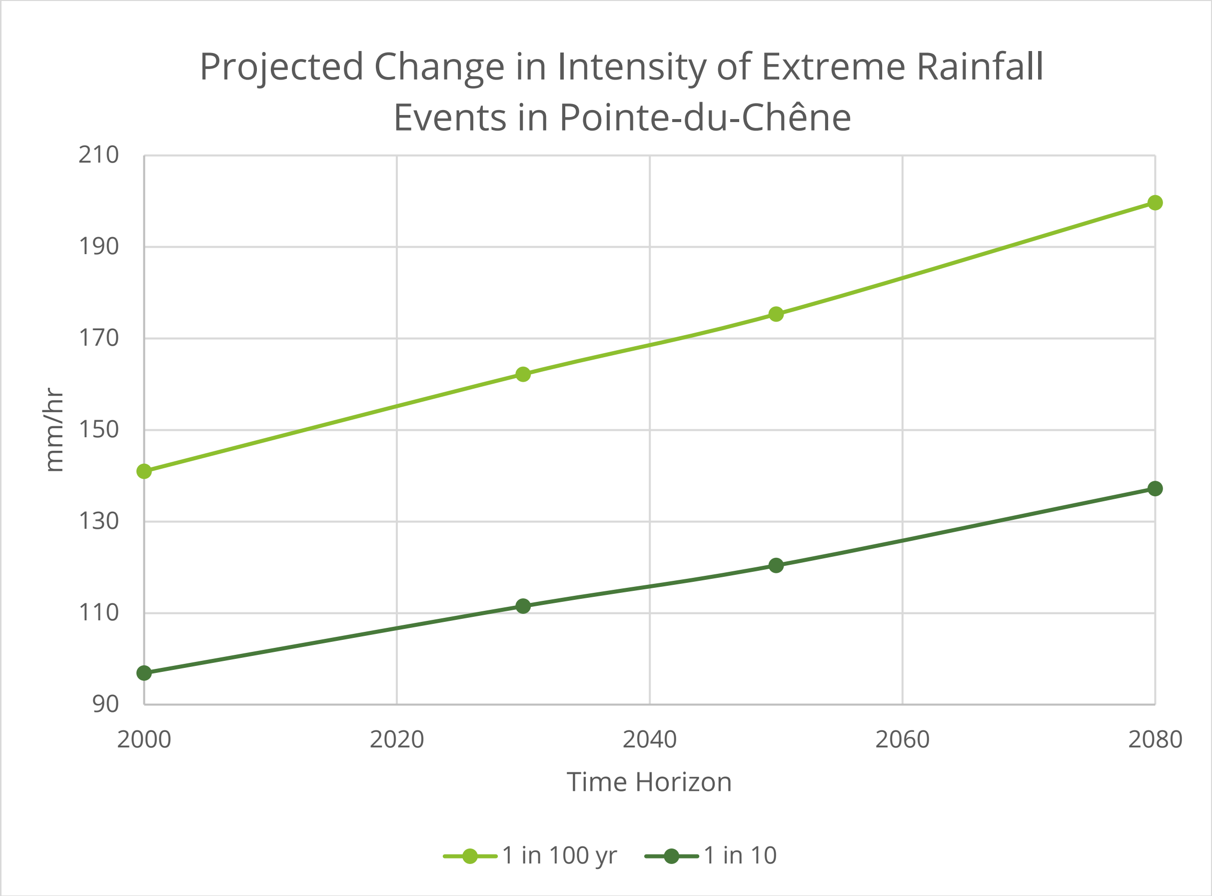


Figure 3-4: Projected Change in Intensity of Extreme Rainfall Events.

3.1.4 Heat Extremes

Index	▶ Number of Days Tmax > 30°C in the Summer.
Climate Change Processes	▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth.
Sources of Climate Information	▶ Environment Canada Climate Normals (Bouctouche CDA CS Station ID#8100593). ▶ Statistically downscaled and bias-corrected CMIP6 data obtained from Climatedata.ca.
Projection Summary	▶ For baseline characterization, ECCC climate normals report approximately 6 days with T_{max} > 30°C while Climatedata.ca indicates a frequency of approximately 4 days. ▶ Projections indicate significant increases over time in the number of days with T_{max} > 30°C in the summer with the largest increases occurring in the long-term.

	▶ Projections show increases of approximately 10, 25 and 50 days by the 2030s, the 2050s, and the 2080s, respectively (Figure 3-5).

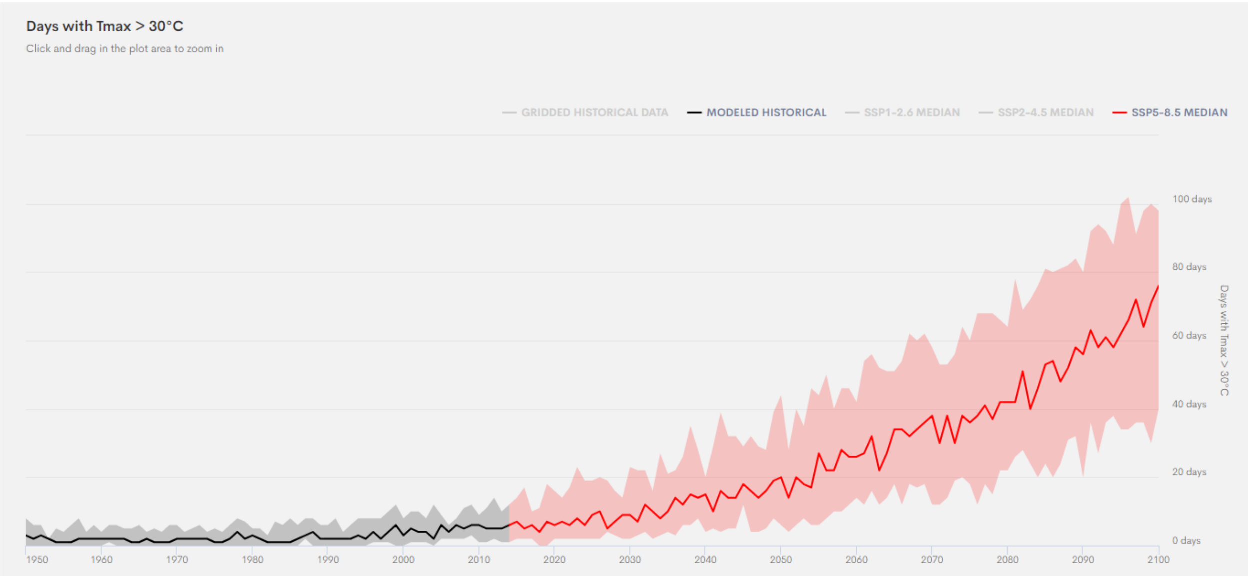


Figure 3-5: Projections for the number of days with Tmax greater than 30°C in the Summer (ClimateData.ca, 2023).

3.1.5 Freeze-Thaw Cycles

Index	▶ Number of Days with Max. Temp > 0°C and Min. Temp < 0°C. ▶ Index does not account for fluctuations that could occur on a longer timescale (e.g., over several days).
Climate Change Processes	▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth. ▶ As average temperatures shift upwards, either or both daytime and nighttime temperatures may shift from below to above freezing, which impacts daily freeze-thaw cycles.
Sources of Climate Information	▶ ClimateData.Ca used for baseline characterization, projections, and scoring.
Projection Summary	▶ In the baseline period (1981-2010), the number of daily freeze-thaw cycles is approximately 75-80. ▶ An overall decrease in the number of annual freeze-thaw cycles is expected, decreasing to approximately 60 by the 2080s due to warming temperatures (Figure 3-6). ▶ However, it is noted that annual projected decreases may obscure potential increases in the shoulder seasons (e.g., increases in winter).

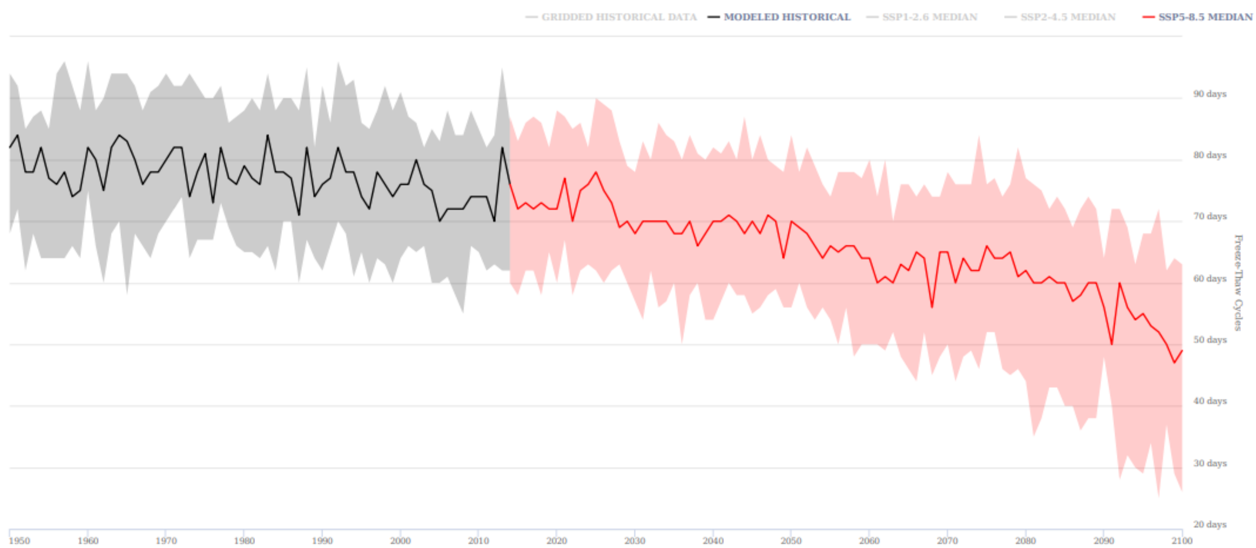


Figure 3-6: Projected Change in Freeze-thaw Cycles Over Time (Climatedata.ca

3.1.6 Ice Accretion Thickness

Index	▶ Ice Accretion Thickness (1 in 20 year) – thickness of ice that accumulates on exposed surfaces from freezing precipitation.
Climate Change Processes	▶ Freezing precipitation requires cold air near the earth's surface and warmer air higher in the atmosphere; the vertical temperature profile is affected by climate change. ▶ Ice accretion thickness is affected by other variables including surface wind speed and surface air temperature.
Sources of Climate Information	▶ Cannon et al. (2020) and other literature used for projections. ▶ Cannon et al. (2020) used for scoring.
Projection Summary	▶ The historical period has experienced increases in the frequency of freezing precipitation over northern parts of North America (Groisman et al. 2016). ▶ A decrease in the existing 1 in 20-year ice thickness is projected at the site and over northern parts of North America (Jeong et al. 2018, Cannon et al. 2020), due to a poleward shift of future freezing precipitation with climate change (Lambert and Hansen 2011, Klima and Morgan 2015) (Figure 3-7.

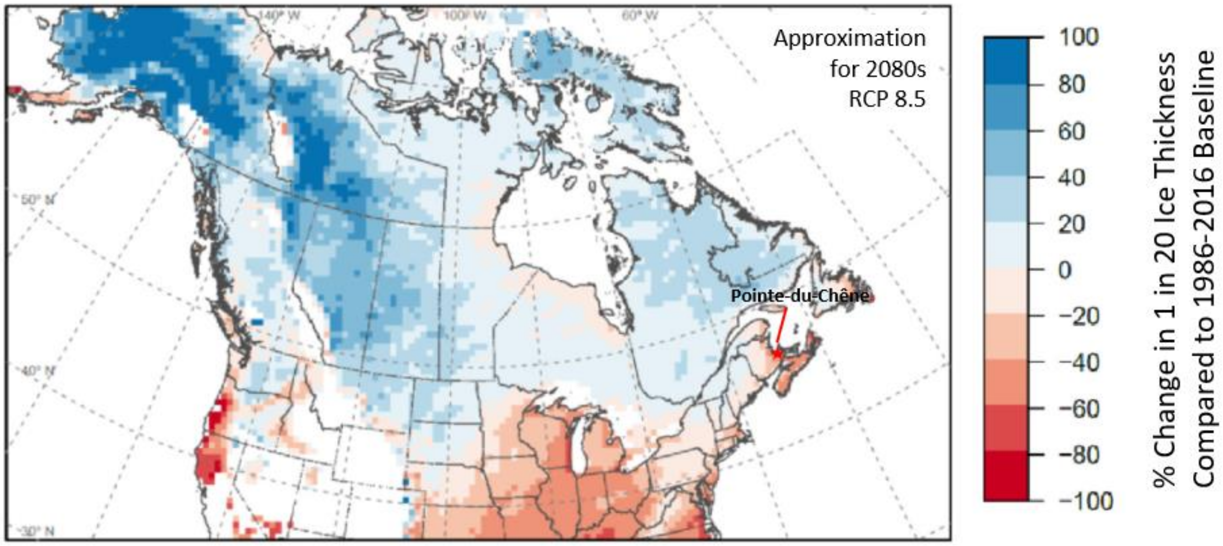


Figure 3-7: Projections for Ice Thickness (Cannon et al. 2020).

3.1.7 Snow Days

The investigation for snow days is summarized as follows:

Index	▶ Number of Days with Snowfall Approximation > 10 cm.
Climate Change Processes	▶ More snow is projected to fall as rain due to warming annual/ seasonal temperatures.
Sources of Climate Information	▶ Environment Canada Climate Normals (Bouctouche Station ID#8100590). ▶ Statistically downscaled and bias-corrected CMIP6 data obtained through Cliamtedata.ca
Projection Summary	▶ ECCC climate normals indicate there are approximately 9 days per year with snowfall > 10 cm. ▶ As temperatures rise, mean annual snowfall is projected to decrease across most of eastern North America (Bush and Lemmen., 2019). This aligns with the statement from the IPCC that it is “very likely that snow cover will reduce as temperature rises over the next century”. ▶ Scores reflect that the number of days with large snowfall amounts is expected to remain relatively consistent until the late century where decreases in frequency are anticipated.

3.1.8 Winter Storms

Index	▶ Blowing and/or falling snow accompanied by sustained winds.
Climate Change Processes	▶ A warmer atmosphere can hold more moisture, which drives heavier precipitation, including heavier snowfall if the conditions are right. Therefore, climate change could theoretically result in higher snowfall extremes.
Sources of Climate Information	▶ McCray et al. (2023), and Bush and Lemmen (2019) used for trends and process-based projections of winter storm activity.
Projection Summary	▶ Historically, the region has experienced several large winter storm events such as those occurring in the years 2018, 2015, 1990, and 1984 where significant snowfall combined with winds resulted in power outages, tree damage from snow, accidents on roads, and service disruptions. ▶ Although mean annual snowfall is projected to decrease across most of eastern North America, intense high-impact snowfall events that are experienced in the current climate can be expected to continue to occur with warming surface temperatures (McCray et al., 2023). ▶ Models generally project a decrease in average snowfall, but high year-to-year variability makes it difficult to project changes in snow extremes and combination events (e.g., blowing snow). ▶ However, the theoretical increase in snowfall from increased atmospheric moisture will likely be moderated by rising surface temperatures at the site location, which would cause more snow to fall as rain. ▶ Projections for winter storms have high uncertainty and can be anticipated to continue to occur throughout late century.

3.1.9 Wildfire

Index	▶ Intensity and frequency of Wildfires.
Climate Change Processes	▶ Climate change drivers that influence fires include changes to temperature, precipitation, snowmelt, wind, and groundwater (Littell *et al*. 2016). ▶ Climate change also impacts vegetation assemblages (affecting the amount of fuel available to burn), flammability (moisture state of the soil and vegetation), and disturbances (insect outbreaks and trees uprooted or broken by wind).
Sources of Climate Information	▶ Natural Resources Canada Fire Behavior Normals and Canadian National Fire Database (CBFDB) for baseline characterization.

	- Literature was used for baseline characterization, projections and scoring.
Projection Summary	- It is predicted that the fire season will lengthen and that the number and extent of wildfires will increase, especially in boreal forest types (Wotton et al. 2010; Flannigan et al. 2013; Sankey 2018). - Fires will be more intense including more fires that are difficult to suppress (Gaur et al. 2021). - The proportion of days in fire seasons with the potential for unmanageable fire will increase (Wotton et al. 2017). - Other projected trends include increases in fire size, area burned, and spread days (Coogan et al. 2019).

3.1.10 Drought

Index	- Drought Frequency and Intensity. - Drought/ Moisture indices (e.g., Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Climate Moisture index (CMI)).
Climate Change Processes	- Water availability and scarcity is driven by rainfall, snowmelt, and temperature (evapotranspiration), among other things. - Precipitation amount and intensity are projected to change. - More snow will fall as rain due to warming. Change to the timing and rate of snow melt will also change due to warming. - Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth. - An upwards shift of average temperatures means an increase in heat extremes and change in evapotranspiration.
Sources of Climate Information	- Literature was used for baseline characterization, projections, and scoring.
Projection Summary	- Overall, the exposure to drought in the Maritimes is low. Historically, the project region has typically experienced climate conditions classified as "wet" to "near normal" in terms of two drought indices: the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI) (El-Jabi and Caissie, 2019). - The frequency of droughts could vary under climate change due to regional changes in precipitation and temperature. Within New Brunswick, there seems to be an increase in precipitation through winter and spring, while a moisture deficit may be experienced during the summer and autumn (Tam et al., 2018). Conversely, projections presented in Zhao et al., (2020) show a decreasing potential in future droughts due to projected increases in precipitation.

3.1.11 Lightning

Index	▶ Average number of days with lightning (within 25 km)
Climate Change Processes	▶ Important factors include the moisture content of the air, changes in global circulation that may alter the location and frequency of large-scale storms, occurrence and characteristics of thunderstorms, and cloud ice particles.
Sources of Climate Information	▶ Baseline characterization based on ECCC ("Lightning activity in Canadian cities"). ▶ Literature was used for baseline characterization, projections, and scoring.
Projection Summary	▶ ECCC reports that cloud to ground lightning flashes occurring within a 25 km radius of Moncton, NB (closest record to Pointe-du-Chêne) occur on average approximately 17 days per year (~5% annual occurrence). ▶ The ECCC historical data (Figure 3-8) indicates Moncton may present less favorable conditions for lightning formation than most other major cities in Canada such as those located in southern Ontario and western Canada. ▶ The frequency of lightning strikes could increase under climate change due to an increase in the conditions favourable to lightning occurrence, such as an increase in Convective Available Potential Energy (Brooks, 2013; Huryn et al., 2016) and a larger potential vertical dimension of clouds (Agard and Emanuel, 2017). ▶ Presently, there is little scientific consensus on precisely how the frequency and intensity of lightning storms will be impacted by climate change, but consecutive building design should consider potential increases.

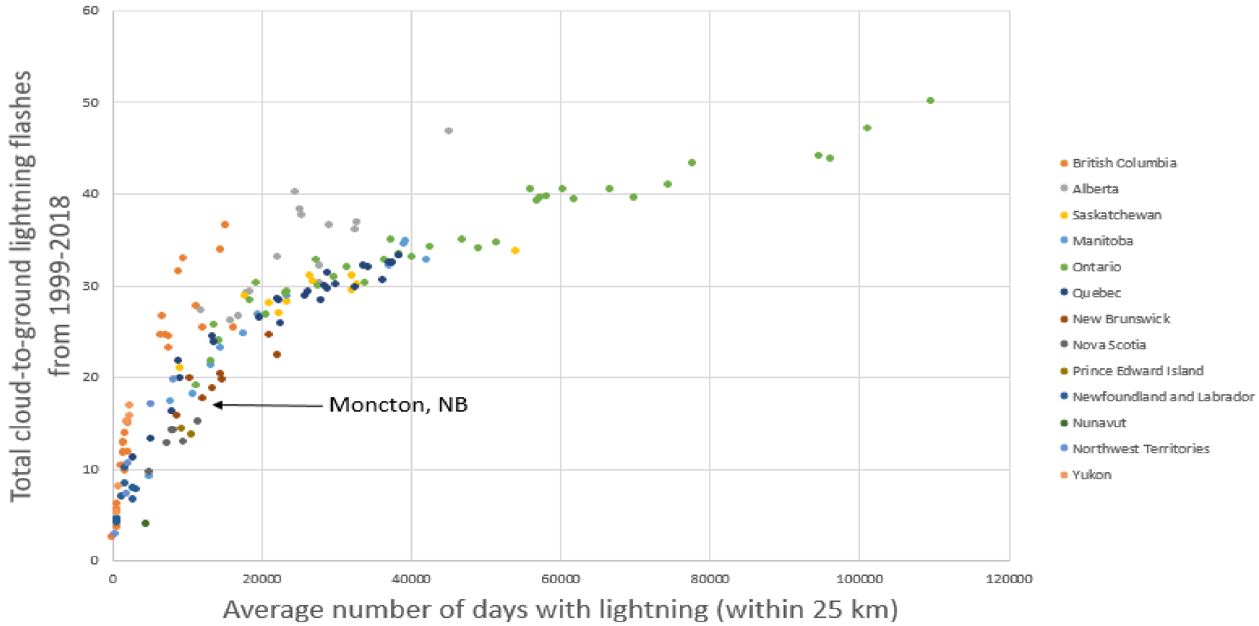


Figure 3-8: Baseline reference for Lightning (ECCC: Lightning activity in Canadian Cities). In comparison to other major Canadian cities.

3.2 PIEVC Likelihood Scoring and Risk Assessment Input

The PIEVC scoring system is designed to emphasize relative risk among different possible climate-infrastructure interactions. Different approaches (or scales) were used for different types of climate parameters (**Table 3-1**)

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

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

The PIEVC scores assigned that are used in the quantification of risk are summarized in **Table 3-2**, below.

Table 3-2: Summary of PIEVC Scoring used in Risk Assessment

Climate Parameter	Climate Indices	PIEVC Scoring Scale	Likelihood Scores			
			Baseline	2030s	2050s	2080s
Extreme Water Levels	Threshold 1 (1.3 m CGVD2013)	Thresholds of extreme water level elevation	4	4	4	5
	Threshold 2 (1.7 m CGVD2013)		3	3	4	4
	Threshold 3 (2.0 m CGVD2013)		1	1	2	3
Extreme Waves and Wind (Hurricanes)	Severe wave overtopping and potential for erosion (100-year waves)	Extreme return periods of wind speed (Qualitative)	1	1	2	2
Extreme Rainfall	Annual Maximum 1-Day Rainfall (1 in 10 year);	#1 (Return Period)	4	4	4	4
	Maximum 1-Day Rainfall (1 in 100 year).	#1 (Return Period)	1	2	3	4
Heat Extremes	Number of Days Tmax > 30°C in the Summer.	#2 (Percent Days)	2	3	3	4
Freeze-Thaw Cycles	Number of Days with Max. Temp > 0°C and Min. Temp < 0°C	#2 (Percent Days)	3	3	3	3
Ice Accretion Thickness	Ice Accretion Thickness (1 in 20 year)	#1 (Return Period)	3	3	2	2
Snow Days	Number of Days with Snowfall Approximation > 10 cm.	#2 (Percent Days)	3	3	3	2
Winter Storms	Blowing and/or falling snow accompanied by sustained winds.	#3 (Qualitative)	3	3	3	3
Wildfire	Intensity and frequency of Wildfires.	#3 (Qualitative)	1	1	2	2
Drought	Drought Frequency and Intensity.	#3 (Qualitative)	1	1	2	3
Lightning	Average number of days with lightning (within 25 km)	#2 (Percent Days)	3	3	3	3

4 Risk and Vulnerability Assessment

Risk analysis is an asset management technique that identifies and ranks risks based on their likelihoods of occurrence and their severity of impacts. A risk assessment study is a key step in developing an adaptation plan that aims to improve the community's resilience against climate change.

The PIEVC defines risk as:

Where probability is the likelihood of an event occurring, as previously described in Section 3.2, and severity is the impact the climate change/event would have on the asset in question if it were to occur. The following sections further outline how severity and risk was evaluated and quantified for the Pointe-du-Chêne risk assessment, and how these results were prioritized to inform the development of the CCAP recommendations.

4.1 Impact Identification and Analysis

The first analytical step in conducting the risk assessment was determining if a relationship exists between the asset in question and the respective climate parameter. To facilitate this, all assets and climate parameters were tabulated in a risk matrix, with climate parameters along the top row, and assets along the first column. Next, each individual asset was screened against each climate parameter to determine whether the climate parameter could potentially impact the asset or environment in any way.

Preliminary impacts were identified using information collected during background document review, responses from the public engagement survey, and professional judgement of CBCL's risk assessment team. If a relationship was thought to exist between an asset and a climate parameter, the severity of those impacts was quantified on a 1-5 scale, referred to as a severity score.

Table 4-1 illustrates the severity scoring crtieria ranging from 1-5 that were used in this Pointe-du-Chêne risk assessment. As shown in the table, impacts were assessed from a number of perspectives including physical impacts to infrastructure, impacts to Health, Safety, and Environment (HSE), and Socio-economic impacts. It is noted that when assigning a severity score, not all factors under each category must apply.

Table 4-1: Severity Scoring Scale

Score	Description		
	Physical Impacts	HSE Impacts	Socio-economic Impacts
1 Very Low	• Some measurable change • No maintenance required	• Some measurable change in environmental conditions • No actions required • No additional impact to human health and safety beyond what already exists	• Little to no financial impact on municipality or residents
2 Low	• Minimal maintenance required • Maintenance/repairs can generally be conducted using readily available resources	• Some measurable change in environmental conditions • Monitoring or additional testing may be required • No additional impact to human health and safety beyond what already exists • Changes do not impact emergency services	• Damage/repairs up to $250k • No significant impact on municipal budgets • Little to no additional funding required to restore assets (e.g., provincial or federal) • Changes do not impact municipal services, recreational areas, etc.
3 Moderate	• Some maintenance required • Outside contractors or resources required to repair infrastructure or return operations to normal conditions	• Some impact to environment • Possible health and safety risk to residents and visitors though hospitalizations or medical emergencies are unlikely • Additional testing or intervention may be required to restore/maintain services	• Damage/repairs required between $250k - $500k • Outside funding resources may be required to restore assets (i.e. insufficient municipal resources)
4 High	• Major loss of function • Partial rebuild required	• Significant impact to environment • Possible risk of hospitalizations or medical emergencies (though infrequent) • Short term closure of services/municipal areas (e.g., hours up to one day)	• Damage/repairs required between $500k - $1M • Outside funding resources may be required to conduct repairs or re-establish services

Score	Description		
	Physical Impacts	HSE Impacts	Socio-economic Impacts
5 Extreme	• Complete loss of critical asset	• Catastrophic impact to environment • Major health and safety risk to residents and visitors • Closure of services/municipal areas for extended period of time (e.g., days) • Medical emergencies/ hospitalizations likely	• Damage/repairs required >$1M • Federal or provincial funding required to rebuild assets

4.1.1 Public Consultation

Following the preliminary identification of impacts and severity scoring, CBCL hosted an open public consultation session with members of the community to review the preliminary results and gather additional feedback to better inform the risk assessment using local perspectives and experiences. The session was held on December 5th at the Pointe-du-Chêne Community Centre, and also had a virtual attendance option for members of the community who could not attend in person. A representative of the Government of New Brunswick was also in attendance.

The purpose of the engagement session was to present the preliminary vulnerabilities and risks identified to the public for additional input on their experiences related to these events, with the intention to further inform the risk assessment and narrow down the highest priority areas to be addressed in the CCAP.

The engagement session generally followed the below agenda:

- **Part 1**: Review of climate projections for Pointe-du-Chêne
- **Part 2**: Review of risk assessment methodology
- **Part 3**: Targeted discussion on historical and potential impacts to each asset from each climate parameter
- **Part 4**: Open discussion on any other assets or environmental impacts that had not previously been discussed.

The PowerPoint presentation used to facilitate discussion during the public engagement session is included in Appendix B.

4.1.2 Targeted Stakeholder Consultation

In addition to the public consultation, CBCL conducted targeted calls with various relevant stakeholders to gather additional information about ongoing work that is being conducted in the community related to climate change adaptation. These calls were initiated to better understand relationships between community organizations and to identify opportunities for collaboration and advancement of adaptation planning recommendations. Targeted calls were conducted with the following organizations:

- Pointe-du-Chêne Wharf Management
- Shediac Bay Watershed Association
- Government of New Brunswick Natural Resources and Energy Development Department
- Greater Shediac Sewerage Commission
- Ongoing calls with the Red Dot Association throughout the project duration.

Information collected during these calls was used to further refine the risk assessment, for example by noting reduced vulnerability of infrastructure in scenarios where adaptation-related projects are already underway, such as the upgrades taking place at the Pointe-du-Chêne Wharf, or improvement projects being undertaken by the Greater Shediac Sewerage Commission to improve capacity of their systems.

Furthermore, by understanding the responsibilities of these organizations and relationships within the community, recommendations were tailored to key community groups that can support the implementation of the adaptation recommendations outlined in Chapter 5.

4.2 Risk Calculation and Prioritization

Following discussions with the public and other relevant stakeholders, the impact analysis and severity scoring was finalized, and overall risks were calculated for each climate-asset interaction included in the assessment.

The overall risk level for a climate-asset interaction is represented as the product of the likelihood and severity scores as outlined in the PIEVC Protocol. Since likelihood scores were assessed for respective time horizons, this resulted in risk scores for each time horizon, which provides an overview of the risk profile over the lifecycle of an asset.

Table 4-2 illustrates the resultant risk assessment matrix template used for denoting risk scores where likelihood scores are listed on the x-axis and the severity scores are listed on the y-axis. Resultant risk is color coded based on its risk score.

Table 4-2: Risk Matrix Used in the Study

Risk Assessment Matrix 5x5							
Severity (S) ***(consequence/impact)***	Very High	5	5	10	15	20	25
	High	4	4	8	12	16	20
	Moderate	3	3	6	9	12	15
	Low	2	2	4	6	8	10
	Very	1	1	2	3	4	5
			1	2	3	4	5
			Likelihood (L)				

Resultant Risk Overall Grading	
Very Low Risk/Negligible	1-2
Low Risk	3-4
Moderate Risk	6, 8, 9
High Risk	5, 10, 12, 15, 16
Extreme/Very High Risk	20, 25

The detailed risk matrix showing the climate-asset interactions evaluated, impacts and vulnerabilities considered, and risk scoring is included in Appendix D.

As previously discussed, assets identified as having a high or extreme risk profile throughout their lifecycle are considered priority for adaptation. An overview of the high and extreme risk items identified through the risk assessment process are included in Section 4.3. Adaptation recommendations to reduce risk associated with these items are included in Chapter 5.

4.3 Risk Assessment Results and Prioritization

The risk assessment considers the impact to people, the environment, infrastructure, and the economy in order to develop a holistic CCAP plan that promotes a community-based approach to adaptation. A summary of the risk assessment results is provided in **Table 4-3** on the following page, which outlines the highest risk level identified across any time horizon for each climate-asset interaction assessed.

The risk and vulnerability assessment resulted in the identification of numerous high- and extreme-risk climate interactions that form the basis of the Adaptation Plan. The highest risks identified are associated with coastal parameters, including extreme water levels and hurricanes, as well as heavy rainfall and other extreme events including winter storms and wildfire. The risks associated with each of these climate parameters are summarized below. Further discussion on impacts and recommendations for mitigating associated risks are included in the Adaptation Plan in Chapter 5.

Table 4-3: Summary of Risk Assessment Results.

		Coastal				Precipitation				Temperature		Other Hazards			
Asset Group	Asset Subcomponent	Extreme Water Levels: (1.3 m CGVD2013)	Extreme Water Levels: (1.7 m CGVD2013)	Extreme Water Levels: (2.0 m CGVD2013)	Hurricanes, Wind and Waves	Extreme Rainfall: 1 in 10 year 24 hour	Extreme Rainfall: 1 in 100 year 24 hour	Snowfall: Days with Snow > 10 cm	Ice Accretion: 1 in 20 year Ice Thickness	Extreme Heat: (Days > 30°C in Summer)	Annual Freeze-Thaw Events	Winter Storms	Lightning Strikes within 25km	Frequency and Intensity of Wildfire	Frequency and Intensity of Drought
Coastal Environment	Beaches and Dunes														
	Tidal Creek														
	Coastal Wetlands														
Residential and Private Community Infrastructure	Residences														
	Coastal Protection Features														
	Potable Water Wells														
	Pointe-du-Chêne Wharf														
Transportation	Road Network														
	Critical Community Access Points														
Sanitary and Stormwater Management	Municipal Sanitary Collection System														
	Stormwater Collection System														
Emergency Services and Public Safety	Emergency Preparedness														
	Electrical Infrastructure														
Land Use and Policies	Development Practices														

Extreme Water Levels and Hurricanes

Extreme Water Levels and Hurricanes are the most significant climate hazards faced by Pointe-du-Chêne. During extreme water levels, the combination of sea level rise, storm, surge, and high tides can lead to unprecedented flooding that have historically caused widespread infrastructure damage and displacement of residents. When combined with wind and wave action during hurricanes, these events have led to significant coastal erosion and deterioration of the beach and dune environments, and displacement of coastal protection infrastructure, making the community further vulnerable to subsequent events when repairs and maintenance are not promptly carried out.

Widespread infrastructure damage has been seen during past events, including damage to residences, businesses, and economically important community infrastructure such as the Pointe-du-Chêne Wharf and Parlee Beach Provincial Park, both of which are major tourism drivers in the region. Furthermore, the property damage from flood waters can place a significant financial burden on impacted residents and businesses, as well as the town itself, including costs to repair infrastructure, flush and disinfect potable water wells, and clear debris from properties. Lastly, flooding events can place undue stress on emergency response providers when faced with an increase in emergency response calls, combined with potentially blocked or flooded access routes.

Extreme Rainfall

Extreme rainfall poses a widespread flood risk to the community as a lack of available or properly maintained stormwater management infrastructure has led to significant flooding in the past, with resulting impacts including property damage, well water contamination, capacity exceedances in the municipal sanitary system, flooded and/or damaged roads and transportation routes, erosion of natural assets and recreation areas from overland flow, and surface water contamination. Many of these impacts have an associated public health and safety risk, such as reduced potable water quality, surface water contamination at public swimming and recreation areas, or hindered emergency access due to road infrastructure damage and flooding.

Winter Storms

Winter storms pose a risk to the community as heavy snowfall combined with winds are likely to result in extended power outages and possible property damage. While many residents in Pointe-du-Chêne are seasonal, several hundred residents do remain in the community year-round and are susceptible to this risk. Many of the year-round residents fall within the senior citizen demographic, which can be particularly vulnerable to winter storm events and require additional support to maintain their homes during this type of event, or in seeking emergency shelter.

Wildfire

Wildfire poses a widespread risk to the area as both Pointe-du-Chêne and the Town of Shediac are situated adjacent to a large, forested area. Pointe-du-Chêne is particularly vulnerable due to the lack of municipal water supply or dedicated water supply for firefighting services. In the event of a wildfire, the area would rely heavily on water tanks that would require transportation to the region, and fire fighting support from the provincial water bombers.

Additional moderate and low risk climate impacts were identified in the risk assessment, typically associated with parameters such as extreme heat, snowfall, freezing rain, and lightning, among others. While these impacts are a lower priority for adaptation relative to the high and extreme risk items outlined above, mitigation measures are incorporated into the Adaptation Plan recommendations presented in Chapter 0, where appropriate.

5 Adaptation Plan

This Chapter outlines a series of adaptation actions for the top priority risks determined though the risk assessment process. The purpose of each recommended action is to improve community resilience to climate change and provide direction towards implementing these actions. The preferred adaptation method(s) to address each risk were developed based on information received throughout the risk assessment process from background documents and consultation with the public and community organizations, as well as the professional judgment of the engineering and environmental science team involved in the risk assessment.

Where appropriate, risks have been grouped into categories such as "Coastal Flooding" with multiple recommendations provided in each category to address the impacts identified from various climate parameters. Recommendations fall within a number of categories including infrastructure upgrades or maintenance, planning initiatives, communication, education, and/or additional studies to support these actions.

Each action item is summarized in a table at the bottom of each recommendation section that includes information to support its implementation. The information in the table includes the following:

- **Action Item** Number and Title as listed in the report.
- **Lead**: Organization responsible for initiating the actionable item
- **Supporting organization(s):** Organizations who can potentially be leveraged for support in implementing actionable items.
- **Timeframe** for Implementation
    - Ongoing: Actions that are currently being taken and should be continued
    - Short Term: 1-2 years
    - Medium Term: 3-4 years
    - Long Term: 5 years
- **Estimated Level of Effort**
    - Low: Easy to implement/Low Cost
    - Moderate: Doable, but difficult/Moderate Cost
    - High: Very Difficult/High Cost

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

The following sections outline the recommended actions to address each of the high and extreme risks identified during the risk assessment. In general, each of the adaptation categories are prioritized and listed in terms of importance. When prioritizing adaptation efforts, the following considerations were applied:

- Public safety.
- The protection and continued delivery of public drinking water and other essential services such as sewage treatment and conveyance, transportation, and emergency response.
- The protection of key structures for emergency exits and detours, as well as infrastructure that supports the community and local economy.

5.1 Emergency Management

Pointe-du-Chêne is susceptible to a number of climate hazards that may require emergency management intervention, such as flooding and/or property damage from extreme events. Extreme events include extreme coastal water levels, hurricanes, extreme rainfall, or wildfire, all of which are projected to increase in intensity and/or frequency throughout the coming decades. Additionally, while events such as winter storms, freezing rain, or snowfall are projected to decrease or remain consistent in frequency with climate change, interannual variability means that these extreme events will continue to occur on occasion, and may potentially require similar emergency response interventions.

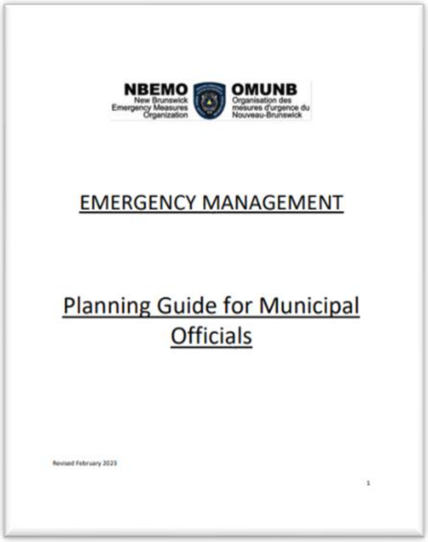
Under New Brunswick's Emergency Measures Act, all incorporated areas in New Brunswick are required to have an emergency preparedness plan and exercise the plan annually (NB Emergency Measures Organization, 2011). While the Town of Shediac does have an Emergency Preparedness Plan, it is understood that the plan does not officially incorporate Pointe-du-Chêne, since the former local service district was only recently incorporated into Shediac in 2023.

The following recommendations outline actions for updating the Town's Emergency Preparedness Plan and other relevant services to improve response to climate-related emergencies.

Action 5.1.1: Development and Testing of an Official Emergency Preparedness Plan for Pointe-du-Chêne

The Town of Shediac has historically supported Pointe-du-Chêne with emergency management services; however, to conform to the Emergency Measures Act and reduce the likelihood of public safety incidents during extreme weather events, the municipal emergency preparedness plan should be updated to officially incorporate all areas of

Pointe-du-Chêne. The plan should consider the extreme events that the region has previously faced (such as widespread hurricane damage) and challenges such as access during flood conditions or lack of water supply for firefighting. The Emergency Preparedness Plan should be developed in accordance with applicable provincial guidelines, including the *New Brunswick Emergency Measures Act* and the *Emergency Management Planning Guide for Municipal Officials* prepared by the New Brunswick Emergency Measures Organization (NB Emergency Measures Organization, 2023).


NBEMO New Brunswick Emergency Measures Organization
OMUNB Organisation des mesures d'urgence du Nouveau-Brunswick

EMERGENCY MANAGEMENT

Planning Guide for Municipal Officials

Revised February 2023

1

When officially incorporating Pointe-du-Chêne into the community Emergency Preparedness Plan, the following location-specific factors should be considered:

Maintenance of Critical Community Access Points During Emergency Events

- Pointe-du-Chêne has limited access points for emergency vehicles to respond during an emergency event. Primary access points include Pointe-du-Chêne Road and Parlee Beach Road (summer only), with additional points such as and Gould Beach Road and Belliveau Beach Road servicing areas in The Bluff. These access roads may become susceptible to flooding during extreme events, particularly as sea level rise continues to exacerbate flood conditions with climate change.
- Provisions should be included in the emergency preparedness plan to monitor accessibility of the access points during an extreme event and have flood risk mitigation plans in place (such as placing sandbags or other flood protection measures) in scenarios where anticipated flood levels during a storm threaten these access routes. Similarly, measures for removal of trees or other debris that can block access roads should be included in the plan. This may also include liaison with the provincial government to form an agreement on maintaining Parlee Beach Road during the winter months, as this is one of the main points of entry to the most vulnerable area of the community.
- In the longer term, raising or relocation of the critical assess points will likely be required if reactionary response measures (such as sandbagging) cannot efficiently manage the risk. Note that additional recommendations for raising transportation information are provided in Section 5.3.2.

Designation of the Pointe-du-Chêne Community Centre as an Official Emergency Warming Centre

- It is understood that the Pointe-du-Chêne Community Centre is currently used as an Emergency Warming Centre during extreme events where residents may be forced to leave their homes. The Emergency Warming Centre is equipped with 30 beds, wireless internet, a full kitchen, and enough fuel to operate for three (3) days.

- During public consultation, it was noted that there is currently no operational plan in place that outlines the conditions under which the emergency shelter should be opened, though it is understood that this plan is currently under development.
- It is recommended that this planning be continued and officially adopted into the municipal Emergency Preparedness Plan. The plan should outline a defined set of criteria that would warrant opening of the center, for example, the number of persons impacted, or the length of a power outage.
- The plan should also include an improved communication protocol for alerting the community when the center is open, for example through community bulletin boards, social media pages, or radio announcements. Furthermore, operators noted that signage is currently placed only on one side of the road to notify residents when the center is open. Going forward, signage should be displayed on both sides of the road to effectively inform residents.
- The center's current emergency generator is located at ground level, which may make it susceptible to flood damage during future extreme events.
- While current flood maps indicate that the center is outside the present-day flood for the 1 in 20 and 1 in 100-year flood zones, flood maps for the year 2100 show the center at risk in both flood zones (Appendix D). While this is not a short-term concern, the municipality should remain up to date on adjustments to provincial flood risk mapping, as the science is constantly evolving, and flood inundation extents may change. In the longer term, it will likely be necessary to relocate the warming center outside of the flood line.

Security Measures to Minimize Public Safety Incidents

- The plan should consider proactively implementing security measures before or during a storm event to block access to the Pointe-du-Chêne Wharf, Parlee Beach, Belliveau Beach, and other coastal areas that have been known to attract spectators during extreme events. During previous events, it has been noted that people will attempt to observe storm conditions, which can pose a threat to health and safety and also impede access routes for emergency vehicles due to increased traffic blocking the relatively narrow roads in the community.

Upon development of the updated Emergency Preparedness Plan, the plan should be exercised through an emergency response drill, as per requirements of the provincial Emergency Management Act.

Action 5.1.2: Public Awareness and Communication

Following development of the Emergency Preparedness Plan, it is recommended that critical information be communicated with Pointe-du-Chêne residents including, but not limited to, the following:

- Primary and backup evacuation routes.
- Location of healthcare facilities and Warming Centres.
- Contact information for emergency services.
- General education on the dangers of being outside or near hazardous areas during an emergency event.
- Communication protocols/information sources before, during, and after emergency events.

This information could be conveyed to the public in multiple ways, such as through a public meeting to provide an overview of the plan, and/or dissemination of brochures and information packages with maps and other images outlining the critical information.

Action 5.1.3: Expansion of Shediac's Senior Resident Registration Program

It is understood that the local Fire Department has implemented a successful program whereby seniors can register with the municipality by providing their name, address, phone number, emergency contact information, medical information, pets, and other details. By registering, seniors can be easily accounted for, contacted, and/or located during an emergency event, as necessary. While this program is voluntary, public perception has been very positive, and it was noted during the public consultation sessions that residents would like to see this programming extended to incorporate senior residents in Pointe-du-Chêne.

To account for as many vulnerable residents as possible, is it recommended that this program be expanded to Pointe-du-Chêne, and that the program objectives be communicated to the public to ensure all eligible residents are aware of its existence and purpose. This could be facilities through radio announcements, publication in local papers, newsletters, or bulletin boards, or a door-to-door program facilitated by volunteers. Consideration could also be given to expanding this program to other vulnerable demographics such as persons with disabilities, if not already implemented.

When collecting resident information in Pointe-du-Chêne, it should be kept in mind that many residents are seasonal cottage owners who would likely not be impacted during extreme events occurring in the winter, such as blizzards or freezing rainstorms. This factor should be considered when expanding the program into Pointe-du-Chêne by recording which property owners live in/maintain their residence in the winter, and the approximate dates that seasonal residents open and close their properties each year.

Table 5-1: Summary of Adaptation Options/Actions for Improved Emergency Management

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.1.1	**Update and testing of Municipal Emergency Preparedness Plan to officially incorporate Pointe-du-Chêne**	Town of Shediac	Community emergency management organizations (EMOs) NB Emergency Measures Organization	Short Term	Low
5.1.2	**Communication of Emergency Preparedness Details to Public**	Town of Shediac	Community EMOs	Short-term	Low
5.1.3	**Expansion of Shediac's Senior Resident Registration Program**	Shediac Fire Department	Town of Shediac	Ongoing	Low

5.2 Coastal Flooding

Coastal flooding from extreme water levels and combined wind and wave events, such as those seen during hurricanes, are among the primary climate hazards faced by Pointe-du-Chêne. Extreme water levels have caused widespread flooding throughout the community in previous years, while wave action driven by wind and storms has led to extensive damage to roads, coastal infrastructure, and the natural environment. Climate change projections suggest that these events will become more frequent and intense as the atmosphere continues to warm, and sea levels rise. Flood maps for Pointe-du-Chêne obtained through the Service New Brunswick online mapping application are included in Appendix D, and include the following scenarios:

- **Present Day, 1 in 20-year Flood:** Water Surface Elevation: 1.8 m CGVD2013 (2.4 m CGVD28)
- **Present Day, 100-year Flood**: Water Surface Elevation: 2.3 m CGVD2013 (2.9 m CGVD28)
- **2100, 1 in 20-year Flood with Climate Change**: Water Surface Elevation: 2.6 m CGVD2013 (3.2 m CGVD28)
- **2100, 1 in 100-year Flood with Climate Change:** Water Surface Elevation: 3.0 m CGVD2013 (3.6 m CGVD28)

- **2100 Higher High Water Large Tide**: Water Surface Elevation: 1.4 m CGVD2013

As indicted in the flood maps, a significant portion of the community is vulnerable to flooding during present day events (Figure 5-1 top), while by the year 2100, nearly the entire community is projected to be flooded during these events (Figure 5-1 bottom). Similarly, regularly occurring events such as the Higher High Water Large Tide (HHWLT) are projected to inundate a significant portion of Pointe-du-Chêne in the future.

Figure 5-1: Project flood extents during Present-Day, 1 in 100-year event (Top, blue shaded area) and 2100, 1 in 100-year event (bottom, pink shaded area) (Source: Service New Brunswick, 2022)

Flooding in the community is exacerbated by low sloping topography and minimal stormwater management infrastructure that has historically not been well maintained.

Issues related to stormwater management and drainage are further discussed in Section 5.4.

Given the extreme flooding conditions anticipated both at present day and in the future, it is imperative that action is taken to protect residents from these extreme events. The following subsections provide a series of action items that focus on both short-term engineered and natural solutions, guidance for private property owners to improve their individual resilience to flooding impacts, and planning for long-term implementation of coastal development policies as tides encroach on homes and businesses.

Action 5.2.1: Community-Wide Coastal Assessment to Investigate Options for Flood Mitigation

Numerous studies have been completed in past years to examine the flooding scenarios that face Pointe-du-Chêne; however, the community has expressed that there is an urgent need to better understand and evaluate the adaptation options available in order to implement solutions. It is therefore recommended that a comprehensive community-wide investigation into the engineering feasibility, environmental feasibility, and financial feasibility of various adaptation solutions be completed.

The assessment should have the following objectives:

- **Evaluate Engineering Solutions to Mitigate Flooding**: The study should investigate the effectiveness of numerous engineered options to mitigate flooding from sea level rise and extreme events including hurricanes and storm surge. Options studied should include a strengths and weaknesses analysis of engineered solutions such as retreat, raise, and protect, with a comparison of the social, economic, environmental, and cost implications. Engineered solutions studied could include a combination of tidal gates and berms in the wetland areas, raising, reinforcing, and potentially extending the dune systems to the north, and seawalls to protect infrastructure adjacent to the coast in other areas (e.g., western portion of the community). Along with coastal infrastructure to mitigate flooding, future systems would likely have to include a pumping system for drainage and stormwater management.
- **Evaluate Environmental Impacts**: Investigate the possible environmental impacts of the preferred coastal adaption solutions including impacts to wetlands, coastal environment, aquatic and terrestrial species, and vegetation, among others.
- **Evaluate Socio-Economic Impacts**: The study should include a detailed cost-benefit analysis that evaluates the feasibility of implementing the identified engineered solution(s) against alternate options including localized adaptation (e.g., floodproofing homes) and coastal retreat (relocation of infrastructure within flood zones). The cost benefit analysis must include not only the financial resources required, but the costs associated with environmental and social impacts that the engineered solutions would have on the community (e.g., impacts to tourism).
- **Identify Regulatory Requirements**: Identify the regulatory approvals and anticipated timelines required in order to execute the preferred option.

- **Identify Possible Funding Sources**: Studies of this magnitude can be costly to execute and are often eligible for funding through federal and provincial programs such as the Government of Canada's Disaster Mitigation and Adaptation Fund (DMAF).
- **Stakeholder Engagement and Public Consultation**: Identify relevant stakeholders that would be impacted by the identified solution(s) and conduct wide-scale public consultation to disseminate information and collect feedback.

This type of investigation should result in a comprehensive plan that outlines the flood mitigation solution(s) to be implemented, resources required to implement the solution(s), clear steps and responsibilities of associated parties, timeline for conducting each step, and the anticipated outcomes once the project is executed.

Action 5.2.1: Maintaining Parlee Beach and Dune System

Parlee Beach and its adjacent dune system act as a natural flood barrier by providing some protection to the infrastructure along the northern portion of the community from the direct forces of wave action and storm surge. A recent pilot study conducted by the David Suzuki Foundation found that protection of these assets including shoreline planting, beach nourishment, and dune improvement can provide significant benefits to the coastal environments including reduced coastal erosion and reduced local water levels during extreme events (MNAI, 2021).

The existing beach nourishment program that is undertaken by the province each year was designed several decades ago, before climate change considerations were widely considered in asset management. Furthermore, the beach environment itself has changed, along with advancements in science and understanding of coastal based processes, meaning the program could likely be updated to more effectively replenish the beach each year.

Based on discussions with representatives from the NB Department of Natural Resources and Energy who were directly involved with development of the existing beach nourishment program, it is understood that in recent years, the provincial government had initiated a project to re-evaluate the beach nourishment program using updated coastal modeling. Despite initiation of this project several years ago, it is understood that the project lost momentum and was never started.

It is recommended that this investigation into the effectiveness of the current beach nourishment program and potential upgrades be reintroduced and executed by the relevant provincial government departments. The assessment should consider the existing beach environment and coastal dynamics along with projections for climate change, including sea level rise, storm surge, wave action, and wind. Furthermore, the study should consider impacts that the upgraded beach nourishment program would have on the downstream environment, such as the Tidal Creek inlet directly to the southwest of the beach.

Along with the beach nourishment, the study should investigate strategies for dune improvement that should be undertaken to improve the resilience of the existing dunes. Given that the beach and dunes are a key tourism draw for the community, the focus of this investigation should be on natural engineering solutions that will not only strengthen the dune and beach environment, but also preserve its natural aesthetic.

To help streamline the investigation, the Town of Shediac should be direct in encouraging the province to reinitiate the study.

Action 5.2.3: Preserving Belliveau Beach and Dune System

While the adjacent Belliveau Beach and dune system provides similar flood protection for the northeastern portion of the community, the beach is privately owned and historically has not had the same level of intervention to preserve the beach and dunes as seen at Parlee Beach. Residents noted that in recent years, Belliveau Beach has seen an increase in visitors, primarily due to overflow from Parlee Beach, which has exacerbated deterioration of beach and dune conditions.

While the same resources are not available for beach nourishment and dune protection program at Belliveau Beach compared to Parlee Beach, numerous initiatives have been undertaken by the Shediac Bay Watershed Association (SBWA) and volunteer groups to advance projects aimed at replenishing the beach and dunes. Most recently, the SBWA organized a group of volunteers to plant marram grass plugs at the beach which is known for its durable root systems that can help stabilize dunes and provide erosion protection (Shediac Bay, Watershed Association, 2023).

In lieu of a formal beach and dune nourishment program, which would be very costly and beyond the capacity of the private property owners, it is recommended that the resources and expertise of the SBWA continue to be leveraged to promote beach and dune restoration projects at Belliveau Beach. This should include active restoration projects such as the previously mentioned marram grass planting and dune improvement, as well as education-based projects including posting and maintenance of signage that informs visitors about the sensitive dune and beach environment.

This programming should be encouraged and supported by the Town of the Shediac in order to achieve a community-wide approach to Belliveau Beach maintenance.

Action 5.2.4: Improve Public Awareness and Preparedness to Minimize Impacts to Private Property

Climate change projections for extreme flooding events indicate that residents and private property owners in Pointe-du-Chêne are highly vulnerable to coastal flooding both at the present day and in future time horizons.

At the individual level, residents should be aware of possible flood scenarios facing their properties, and prepare for these events should they occur. While it is clear that residents in Pointe-du-Chêne are aware of the existing flooding hazards that face the community, more could be done to inform the community on the full scale of possible flooding scenarios and strategies for reducing impacts to individuals and their properties.

To support this initiative, the municipality should work with community partners, including the Southeast Regional Service Commissions (SRSC), to prepare a public education strategy that includes the following information, at a minimum:

- Information on potential flooding scenarios, including maps and projected flood elevations intended to inform residents of risk at their properties.
- A summary of potential impacts to individual properties including flooding, debris buildup, and water quality issues.
- Strategies for improving the resilience of properties including maintaining coastal erosion protection at their properties (e.g., amour stone), floodproofing basements, having an emergency preparedness kit, and protection of water supply wells.
- Information on local contractors, consultants, and other resources who can support residents in improving the resilience of their properties or help restore properties following a flooding event.
- Information on insurance providers who provide protection against flood damage, if available.
- Resources for further education and planning such as the ClimAtlantic Coastal Adaptation Toolkit.

This information can be communicated to residents through information packages or in-person public engagement sessions. Education sessions on community flood risk would highlight methods, benefits, and costs of floodproofing mechanisms.

Action 5.2.5: Enforcement of Development Restrictions and Long-Term Land Use Planning

A significant portion of coastal adjacent infrastructure in Pointe-du-Chêne sits within a provincially significant wetland. In this area, development restrictions have been implemented that place restrictions on new development within 30 meters of the wetlands, along with strict conditions for existing property development. In recent years, there have been instances where these development restrictions have not been followed by residents, with little to no follow up or reprimand by provincial entities. It is recommended that since amalgamation with the Town of Shediac, the town take an active role in ensuring these development regulations are not infringed upon through reporting and follow up with the province where applicable. Furthermore, the town should promote education around development within wetland areas, highlighting to residents how development can impact the sensitive downstream environment.

In addition to the wetland development restrictions, the Town of Shediac and the Southeastern Regional Service Commission (SERSC) have developed a by-law that restricts construction of new buildings at an elevation below 4.3 m CGVS23 (3.7 m CVGD2013).

In the long-term, as sea level continues to rise, these development restrictions should be revisited to ensure appropriate development boundaries are maintained around the wetlands and with respect to project flood elevations. This includes reevaluating the restrictions if coastal flood mitigation infrastructure is constructed in the community that is effective in preventing widespread flooding.

Table 5-2: Adaptation Options/Actions for Reducing Coastal Flooding Impacts

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.2.1	**Community-Wide Coastal Assessment to Investigate Options for Flood Mitigation**	Town of Shediac	NB Provincial Government Departments Red Dot Association of Shediac Bay	Short Term	High Order of Magnitude Cost Estimate: • $1Million CAD
5.2.2	**Preserving Parlee Beach and Dune System**	NB Department of Tourism and Environment	Town of Shediac	Short Term	Moderate
5.2.3	**Preserving Belliveau Beach and Dune System**	Various Organizations could lead/support, including: • Town of Shediac • Property Owners • Shediac Bay Watershed Association • Volunteer Groups • New Brunswick Department of Tourism and Environment		Short Term	High

5.2.4	**Resident Education and Preparedness**	Town of Shediac	SERSC	Ongoing	Low
5.2.5	**Enforcement of Development Restrictions Long-term Land Use Planning**	Town of Shediac	N/A	Ongoing	Low

5.3 Transportation Asset Maintenance

From an upkeep and maintenance perspective, transportation infrastructure in Pointe-du-Chêne is a complex asset due to variable ownership conditions between private residents, community organizations such as the Anglican Parrish, and the Province of New Brunswick. Historically, roads throughout the community have not always been well maintained due to lack of guidance and enforcement. In extreme cases, this lack of road maintenance can be a risk to public health and safety as ambulances and other emergency vehicles could become stuck in emergency scenarios. Additionally, a general lack of road maintenance can contribute to poor perception of the community by tourists and visitors.

Further to road maintenance issues, many roads within the community are relatively low in elevation, making them highly susceptible to flooding from extreme water levels and associated erosion and deterioration. Not only does this exacerbate the need for frequent and proactive road maintenance, but flooded roads can be of particular concern when critical access points to the community are flooded that are used for evacuation routes and emergency response.

The following recommendations outline actions for prioritizing infrastructure upgrades and regular maintenance of roads to ultimately improve the climate resilience of transportation infrastructure in the community.

Action 5.3.1: Establish Clear Road Maintenance Responsibilities

It is understood that the Shediac Town Council recently adopted a motion (at the meeting on February 5, 2024) to review the topic of private roads maintenance in Pointe-du-Chêne. The motion states “that Council authorize the Mayor and staff of the Town of Shediac to investigate, evaluate, and report back to Council on financial and other related issues associated with having the provision of basic private road maintenance in Pointe-du-Chêne assumed by the Town of Shediac”.

It is recommended that this investigation continue as planned and be used to establish clear responsibilities for road maintenance in Pointe-du-Chêne. In situations where the Town of Shediac does not agree to assume responsibility for road maintenance of private roads in Pointe-du-Chêne, residents must be made aware of their individual responsibilities with respect to road maintenance. This can be achieved through establishing a minimum road maintenance standard and/or by-law that can be easily communicated and enforced by the Town of Shediac (see Action 5.3.2).

Action 5.3.2: Develop a Minimum Maintenance Standard for Private Road Owners

Climate events including extreme rainfall, extreme heat, and flooding from extreme water levels and hurricanes will continue to damage road infrastructure in the community, particularly as these events intensify with climate change in the future. Furthermore, regularly occurring climate conditions such as freeze-thaw, snow, and ice, while projected to reduce in frequency with climate change, will continue to contribute to road deterioration to some degree.

Where residents will be responsible for maintaining private road infrastructure, a minimum road maintenance standard should be promoted throughout the community that includes best practices for regular road maintenance such as regularly repairing cracks and potholes and ensuring proper drainage. Residents should be regularly reminded of these road standards, for example on an annual basis, to promote regular care and maintenance of transportation infrastructure. Enforcement of proper road maintenance could be facilitated through development of a municipal by-law, similar to existing Town of Shediac by-laws for Respecting Residential Properties Maintenance and Occupancy.

It is noted that this recommendation should be implemented pending the outcome of Action 5.3.1 - Establish Clear Road Maintenance Responsibilities. If the Town of Shediac agrees to assume all responsibilities for road maintenance in the community, this recommendation may no longer be applicable.

Action 5.3.3: Proactive Infrastructure Upgrades to Incorporate Climate Change Projections

As previously mentioned, Pointe-du-Chêne has limited key access points to the community for vehicles and emergency services. Main access points to lower-lying areas of the community include the bridge on Pointe-du-Chêne Road and Parlee Beach Road (summer only), with The Bluff area being accessible via a number of roads including Gould Beach Road and Belliveau Beach Road.

Following a community climate change adaptation plan developed in 2006 (Chouinard and Martin, 2006), the Pointe-du-Chêne Road Bridge was upgraded in 2008-2009 to provide the community with a new structure that would have improved resilience to climate and extreme weather events. The new structure consists of a 10.5 m long, three barrel buried structure with a finished grade of 3.6 meters above sea level. The structure also includes three, 2400 mm culverts that enable water to flow into and out of the adjacent wetland during high tide and storm events (Jacques Whitford, 2008).

The other main access point to the low-lying, vulnerable areas, of Pointe-du-Chêne is Parlee Beach Road, which is owned and maintained by the Provincial Government during the tourism season only (approximately May-September). According to the province's digital elevation model (DEM), this road sits between 1.0 m at its lowest points within the community, and 2.6 m or more above sea level at its highest points.

Provincial flood mapping indicates that at the present day, the Pointe-du-Chêne Road Bridge is the only access point at a suitable elevation to withstand a 1 in 20-year and 1 in 100-year flood event (Figure 5-2). While this is positive in that there is a reliable access point to the community during these extreme events, any critical access points identified as part of the Emergency Preparedness Plan (Action 5.1.1) should be evaluated to determine whether or not their elevation is suitable for providing access during extreme weather events. In cases where the infrastructure would be flooded, consideration should be given to raising this infrastructure in order to maintain critical access points.

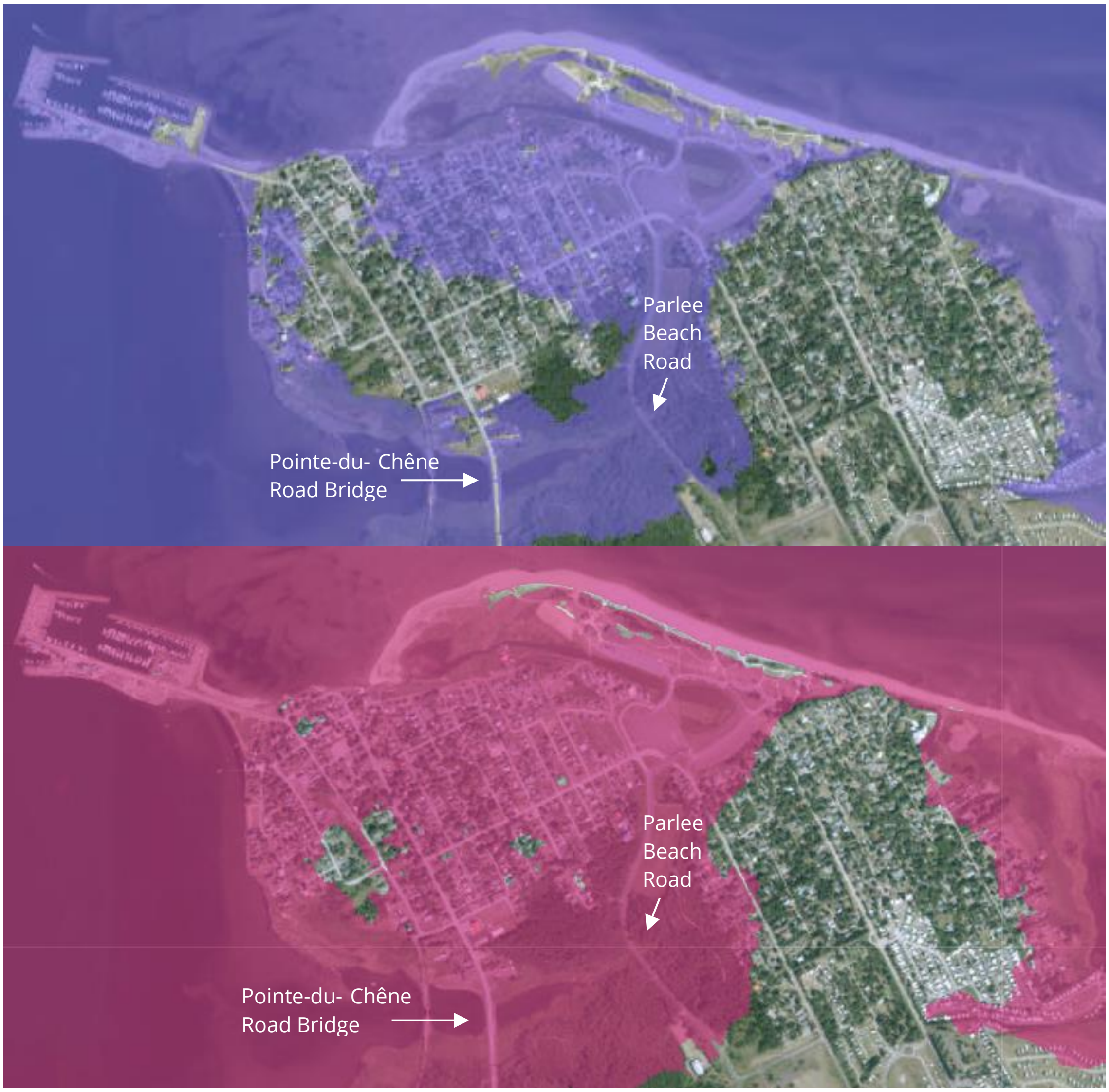


Figure 5-2: Flood extends during a present day, 1 in 100-year event (top) and 2100, 1 in-100 year event (bottom) (Source: Service New Brunswick, 2022)

In order to minimize costs associated with raising the elevation of transportation infrastructure, it is recommended that these upgrades take place during planned road upgrade projects, including when infrastructure has reached its end of useful life and requires significant rehabilitation. In other words, climate change and extreme events should be considered in all future road rehabilitation projects in Pointe-du-Chêne, particularly in those areas that are considered critical access points to the community for emergency planning.

Projections for 2100 indicate that while the current elevation of the Pointe-du-Chêne Road Bridge will be able to withstand the projected 1 in 20-year flooding event, it will not be above the elevation of the 1 in 100-year flooding event. While this is not of primary concern in the near term, the municipality and relevant stakeholders should remain up to date on potential flooding zones with climate change and prioritize upgrading the elevation of this infrastructure as necessary. Costs associated with these upgrades can be minimized by incorporating climate change projections for extreme events into future design and upgrade projects for the bridge as it nears its end of useful life.

Table 5-3: Adaptation Options/Actions for Reducing Impacts to Transportation Infrastructure

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.3.1	**Establish Clear Road Maintenance Responsibilities**	Town of Shediac	N/A	Short Term	Moderate
5.3.2	**Develop a Minimum Maintenance Standard for Private Road Maintenance**	Town of Shediac	Landowners NB Department of Transportation and Infrastructure	Medium Term	Moderate
5.3.3	**Proactive Infrastructure Upgrades to Incorporate Climate Change Projections**	Town of Shediac NB Department of Transportation and Infrastructure Landowners*		Ongoing	Moderate

*Note: Lead party will depend on ownership/responsibilities

5.4 Extreme Rainfall and Storm Water Management

Given Pointe-du-Chêne's relatively dense population and flat topography, the community faces a complex range of challenges both during and following extreme rainfall events. In particular, a lack of stormwater management infrastructure means low lying areas of the community are prone to pooling water, which can have secondary impacts such as increased surface water contamination from overland flow. These impacts are exacerbated by the gently sloping topography throughout the community that does not facilitate effective drainage to nearby waterbodies. It is noted that these drainage issues have also created problems for the community during coastal flooding events as flood waters are unable to retreat effectively.

During spring runoff periods, standing water on the community's dirt roads often leads to muddy conditions. This can be problematic for accessibility and could create a public health and safety issues if ambulances and other emergency vehicles were to become stuck.

As extreme rainfall events continue to increase in intensity and frequency with climate change, these impacts will continue to worsen. The following recommendations outline adaptation strategies that should be considered for improving the conveyance of stormwater following an extreme rainfall event, thus minimizing the associated impacts.

Action 5.4.1: Develop a Community-Wide Stormwater Management Plan

The majority of roads in Pointe-du-Chêne are privately owned, either by residents or community groups such as the Anglican Parish, meaning that there is no widespread community stormwater management system that collects and conveys stormwater. Stormwater management infrastructure typically consists of intermittently spaced drainage ditches located along private roads. The ditches are not well connected or maintained and have limited capacity to convey stormwater.

In order to effectively tackle the drainage issues that impact Pointe-du-Chêne, it is recommended that a community-wide stormwater management plan be developed with the overall objective of developing a clear and actionable plan for enhancing stormwater management in the community.

The stormwater management plan should incorporate the following steps:

- Analyze the current drainage system to identify existing infrastructure includes drainage ditches and culverts. This should include conducting a full survey of the system for mapping purposes.

- Determine the general condition of the existing infrastructure and its capacity to inform asset management planning.
- Build a stormwater model to evaluate system capacity in extreme events both for present day and future conditions with climate change (i.e., performance of the system in future time horizons). The system design should consider a combination of additional drainage ditches and culverts, as well as underground piping infrastructure in areas where space is limited, and surface drainage features cannot safety be accommodated.
- The model will be used to recommend the upgrades that would be required to convey stormwater in line with industry standards.
- Considerations for natural or nature-based approaches with Low Impact Development (LID) techniques should be explored. Exploration of incentive programs for projects such as rain garden implementation would be beneficial for the community.
- Opinions of probable cost for recommended upgrades are required for capital planning.

It is noted that many of the stormwater issues in Pointe-du-Chêne are exacerbated by lack of clear ownership and maintenance responsibilities. To implement a full stormwater management system, it is imperative that ownership and management requirements for the system be established to properly maintain the infrastructure over the long-term.

Action 5.4.2: Maintenance of Existing Stormwater Management Infrastructure

As previously mentioned, the majority of roads in Pointe-du-Chêne are privately owned which has created complexities around maintenance of existing stormwater management features. The ditches are often poorly maintained by their owners, with many having been filled with sediment that has built up over years of repeated runoff. Furthermore, there are numerous reported cases of property owners intentionally filling ditches to extend their property frontage. There has been little to no repercussions in these scenarios since historically, there has been no formal authority assigned to oversee the condition of ditches or other stormwater management features on privately owned roads.

It is recommended that the municipality provide residents with information on the importance of maintaining this infrastructure and enforce and/or promote a minimum standard of maintenance for existing stormwater infrastructure to prevent further deteoriation. This standard of maintenance could include guidance on removing sediment and other debris that blocks ditches and culverts, as well as implementing repercussions for those who intentionally fill these features on their property. Enforcement could be facilitated through an amendment to existing by-laws related to stormwater management in the Town of Shediac, which already includes restrictions against filling drainage ditches or altering conveyance structures without prior written approval.

Enforcing these maintenance standards will be increasingly important going forward if an enhanced stormwater management system is implemented in the Town (as per Action 5.4.1).

Action 5.4.3: Property Owner Education and Awareness

Where new programs or by-laws are introduced, such as minimum standards of care for private infrastructure, the municipality, with support of other community organizations such as the Shediac Bay Watershed Association, should host information sessions to inform the public of the programs or standards. Information session should focus on building climate resilience and the positive impacts to private property owners, resources for implementation, such as contractors or community organizations who can support private property owners with implementation of these programs, and relevant costs and funding resources available.

Table 5-4: Adaptation Options/Actions for Reducing Extreme Rainfall Impacts and Improving Stormwater Management

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.4.1	**Develop a Community-Wide Stormwater Management Plan**	Town of Shediac	SBWA SERSC	Short Term	Moderate
5.4.2	**Maintenance of existing stormwater management infrastructure**	Town of Shediac	Landowners NB Department of Transportation and Infrastructure	Short Term	Moderate
5.4.3	**Property Owner Education and Awareness**	Red Dot Association of Shediac Bay	Town of Shediac SBWA SERSC	Medium Term	Low

5.5 Tidal Creek Drainage and Surface Water Quality

Pointe-du-Chêne is home to a Tidal Creek and Lagoon situated towards the north of the community between Parlee Beach and the residential area along St. John's Street, Beach Street, and Sand Dune Lane. The Tidal Creek and surrounding land are owned by the NB

Department of Tourism, Heritage, and Recreation, and is designated as a Provincially Significant Wetland.

Historically, the Tidal Creek has been a key recreational fixture in the community where residents were known to swim and fish. In recent decades, sediment has migrated into the channel creating a stagnant environment where water is unable to effectively drain from the area during regular tidal cycles following significant rainfall events (Englobe, 2022).

Additionally, declining water quality has plagued the lagoon due to excessive overland flow that is unable to effectively drain, combined with deteriorating sanitary infrastructure in Parlee Beach Provincial Park, which was believed to have been leaking contaminants into the Tidal Creek and surrounding environment both through underground infrastructure and lift station overflows. Amid growing concerns about water quality in the area, the Government of New Brunswick recently underwent a sanitary system upgrade project which saw a full rehabilitation of the system and removal of the overflow pipe to reduce contaminant infiltration into the creek.

Subsequent projects are proposed for the area that aim to further improve water quality and support floodwater drainage in the community. It was noted in community consultation that a lack of community engagement around the status of the project has created frustration and raised concerns about drainage and water quality.

The following recommendations outline the planned projects and their relation to climate adaptation within the community.

Action 5.5.1: Dredging and Future Maintenance of the Tidal Creek to Improve Surface Water Drainage

In addition to the sanitary upgrades, a Tidal Creek Dredging project is currently proposed in order to further improve surface water quality in the creek and reduce flooding of adjacent land from stormwater runoff that is unable to effectively drain following extreme rainfall events. An Environmental Impact Assessment (EIA) detailing the project specifications is currently under review, with an anticipated approval date in 2024.

The EIA details the province's plans to dredge the inlet and Channel of the Tidal Creek to restore flow within the channel and reduce the associated water quality concerns and flooding risks. Development of the proposed Tidal Inlet Dredging program was conducted by Englobe and based on a number of detailed studies such as hydrodynamic evaluation to predict sediment transport in the creek, a bathymetric survey, sediment sampling programs, and a species at risk assessment, among others. Based on these assessments, the associated EIA document specifies that during the first year of the program, the tidal creek inlet and channel will be dredged, while in subsequent years it is anticipated that only the inlet of the channel will require dredging. It is proposed that the annual dredging of the inlet be added to the regular beach nourishment program that sees sediment taken from an area west of Parlee Beach on a regular basis to replenish sand that has migrated westward from the beach (Englobe, 2022).

As extreme rainfall events are projected to intensify with climate change, it is likely that flooding in areas surrounding the Tidal Creek could become more persistent and widespread without an intervention program such as the proposed dredging program. For this reason, and assuming that the project is released from EIA, it is recommended that the dredging program move forward and be closely monitored in the coming years to evaluate its effectiveness in reducing flooding and improving water quality. To that effect, the EIA document outlines a simplified monitoring program consisting of piezometers and sediment sampling, among other factors.

In addition to monitoring the effectiveness of the program in relation to water quality and surface water drainage, it is also recommended that the community monitor whether dredging of the creek impacts coastal flood dynamics, including size of the flooded area surrounding the creek during extreme water level events and storm conditions. Resulting changes in flood dynamics should be considered in future planning related to management of coastal flood water.

Table 5-5: Adaptation Options/Actions for Improving Water Quality at Parlee Beach and Tidal Creek

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.5.1	**Dredging and Maintenance of Tidal Creek and associated Monitoring**	NB Department of Tourism, Heritage, and Culture	N/A	Ongoing	Moderate

5.6 Municipal Wastewater Management

Wastewater from the majority of Pointe-du-Chêne is directed to a municipal sanitary system that is managed by the Greater Shediac Sewerage Commission (GSSC). As infrastructure has reached its end of useful life and shown signs of deterioration, the GSSC has undertaken significant upgrading and maintenance programs to improve the function of the system and its capacity by reducing inflow and infiltration (I&I).

I&I can enter a sanitary system through holes, cracks, joint failures, and faulty pipe connections throughout the system. The infrastructure in Pointe-du-Chêne is particularly susceptible to these effects because of its relatively low elevation which results in a portion of the sanitary infrastructure being at or below sea level. As climate change leads to increased sea levels, tidal ranges, and extreme precipitation events, I&I will become increasingly important to manage to ensure the sanitary system does not become overwhelmed, which can lead to overflows and environmental contamination.

Furthermore, there are five lift stations in Pointe-du-Chêne, some of which have been susceptible to flooding in the past. If lift stations are impacted by flooding, critical electrical and electronic equipment can be damaged meaning that the infrastructure may not function as intended, potentially resulting in overflows to the environment. As climate change projections show increases in extreme water levels and flooding in the future, the lift stations will remain vulnerable if measures are not taken to ensure critical equipment is raised above projected flood elevations.

It is noted that these issues are being actively addressed through GSSC's annual infrastructure upgrade programs and long-term planning, as well as through construction of the new wastewater treatment plant in adjacent Cap-Brulé which will allow for significant capacity increases in the system.

The following recommendation includes action items that build upon the work currently being done by GSSC to improve the climate resilience of sanitary infrastructure in the community.

Action 5.6.1: Continued Improvement Projects to Reduce Inflow and Infiltration and Improve System Capacity

Based on discussions with GSSC, it is understood that recent upgrades to the municipal sanitary system have included sealing manhole covers and lining underground pipes to reduce I&I, as well as raising lift station equipment in flood prone areas. GSSC has also added emergency generators to several lift stations to reduce the chance of overflow events during widespread power outages, and have also acquired a portable generator that can be used as needed at sites where there is no fixed generator.

The following list provides a summary of key upgrades that have recently been undertaken or are currently ongoing at the lift stations within Pointe-du-Chêne:

- Lift Station #9 (Hunter Lane) was refurbished in May 2023, including new pumps, a flow meter, new piping, new electrical/electronic components, and an on-site generator.
- GSSC is currently completing the evaluation of raising electric/electronic components at Lift Station #7 (Jarvis Street) to protect the infrastructure from flooding. Work is anticipated to be completed in summer 2024.
- GSSC is currently completing the evaluation of raising electric/electronic components at Lift Station #10 (Mackenzie Avenue) to protect the infrastructure from flooding. Work is anticipated to be completed in summer 2024.
- GSSC is currently completing the evaluation of raising electric/electronic components at Lift Station #18 (Pointe-du-Chêne Wharf) to protect the infrastructure from flooding. Work is anticipated to be completed in summer 2024.

- Lift Station #8 received an on-site generator in May 2018.

In summary, four out of five lift stations in Pointe-du-Chêne have recently undergone or are currently undergoing improvement to enhance the flood resilience of the infrastructure. Lift Station #8 is the only remaining Lift Station that does not have this type of assessment planned.

Given the criticality of the sanitary infrastructure, it is recommended that all currently planned assessments into raising lift station equipment consider extreme water level projections over the design life of the infrastructure, rather than being based on historical flooding events. In other words, mechanical and electrical system components should be raised to an appropriate height so that projected storm events will not impact the function of the equipment in the future. The target elevation should be the 1 in 100-year extreme water levels including projections for climate change. The climate change projections incorporated should be dependent on the design-life of the infrastructure (i.e., If design life of equipment is 20 years, ensure climate projections for the next 20 years are included, at a minimum). Flood projections for future time horizons (e.g., mid and late century) can be incorporated into future upgrade projects once the infrastructure nears its end of useful life.

The GCCS releases a five year plan each year that prioritizes infrastructure for upgrades and replacement. In addition to the current ongoing assessments, it is recommended that plans to evaluate the elevation of Lift Station #8 should be introduced into the next planning cycle, and upgrades take place as necessary.

As the five-year plan is developed in subsequent years, the plan should proactively prioritize infrastructure that is particularly susceptible to the impacts of climate change, including sections piping that have not yet been lined, or manholes that have not been appropriately sealed. Future designs for upgraded lift stations or other infrastructure should continue to incorporate projections for extreme water levels and flooding over the design life of the infrastructure.

Action 5.6.2: Identification of Illegal System Connections

Despite the infrastructure upgrades to reduce I&I in recent years, the GSSC still sees substantial increases in flow through the system during extreme rainfall events. It is believed that this is due to illegal connections to the system from private property such as from foundation drain tiles, sump pumps, or rain gutters/ roof leaders.

As previously mentioned, maximizing capacity in the system will be particularly important in the coming decades as climate change continues to exacerbate I&I. The population of Pointe-du-Chêne is also anticipated to grow, which will lead to additional flows in the system.

Over the coming years, it is recommended that the GSSC prioritize identifying illegal connections and removing them from the system in order to reduce unnecessary flows. This can be done through targeted flow metering and smoke testing investigations, among others.

While identifying these connections is important for GSSC to be aware of vulnerabilities to their system, it is noted that there are not always alternative options for these connections due to the lack of stormwater infrastructure throughout the community. Typically, residential drainage features such as drain tile and sump pumps would be directed to above ground or to a municipal storm sewer system. Until an appropriate stormwater management plan is developed and implemented (see Action 5.4.1), illegal connections cannot be easily rectified. In the future, as stormwater management features are developed, residential drainage stormwater features should directed towards the stormwater infrastructure, rather than the sanitary infrastructure.

Action 5.6.3: Public Education and Awareness

It is likely that many of the stormwater connections to the sanitary system are in place without knowledge of the homeowner. For example, it is possible that properties may have been purchased from previous owners who did not disclose these connections, or plumbers who have conducted work on the property failed to disclosure connections that they made to the system.

To further disseminate the message surrounding stormwater connections and the negative impacts on sanitary systems and neighborhood flood risk, public education on the topic should be prioritized. Education on this topic should aim to inform residents of the negative impacts of these illegal connections to the system itself, as well as the broader community, and should educate property owners on how to identify stormwater connections and report them to the GSSC. This information can be provided to residents in several forms, including through handouts and brochures, information published on the GSSC website, or through in-person presentations to the public.

To further facilitate identification of these connections, it is recommended that as part of educating residents, the GSSC designated a contact person, email, and/or phone number that residents can use to discuss options for disconnection. Residents should be informed on exactly what information to provide to the GSSC when reporting, including address and location of the connection within the property. Cost sharing the expense of disconnecting would incentivize residents to report connections. Unfortunately, if there is no storm sewer or ditch system available, residents may have no alternative connection point. This further emphasizes the importance of implementing recommendations associated with a Town-wide stormwater management plan.

Table 5-6: Adaptation Options/Actions for Improving Water Quality at Parlee Beach and Tidal Creek

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.6.1	**Continued Upgrades to Sanitary Infrastructure that Incorporate Climate Change Projections**	GSSC	N/A	Ongoing	Moderate
5.6.2	**Identification of Illegal Stormwater Connections**	GSSC	N/A	Medium Term to Long Term	High
5.6.3	**Public Education on Negative Impacts of Stormwater Connections**	GSSC	Town of Shediac	Medium Term	Low

5.7 Pointe-du-Chêne Wharf Upgrades

Action 5.7.1: Incorporate of Climate Change Projections into Future Upgrades

The Pointe-du-Chêne wharf is a critical tourism and recreation hub for the community with many shops, restaurants, and tourism activity operators. The wharf is also home to important municipal recreational organizations such as the Pointe-du-Chêne Yacht Club that supports outdoor recreation within the community.

In recent years, mostly notably during Hurricane Fiona, the wharf has experienced significant impacts resulting in closures of businesses, extensive infrastructure damage and costly repairs, as well as environmental near-misses including dislodgement of fuel tanks.

Since hurricane Fiona, the wharf has been undergoing a significant upgrade project that has included installation of a new seawall and armour stone, replacement of dislodged gas and diesel tanks, and enhancements to the footings and decks of buildings (Lapointe, 2023). In the coming years, additional work will take place that will include dredging the harbour and upgrades to the breakwater infrastructure in order to better prepare the site for future storm surge and hurricane events. Based on discussion with wharf management, it is understood that projections for climate change and extreme events are being incorporated into the infrasture planning and design.

While no additional adaptation actions are recommended at this time, given the substantial investment into repairing and replacing the infrastructure, it is recommended that the ongoing work continue to consider climate change projections for extreme water levels, wind, waves, and hurricanes over the planned design life of the infrastructure in order to improve the facility's climate resilience and minimize impacts from future extreme events.

Table 5-7: Adaptation Options/Actions for Improving Climate Resilience of Wharf Infrastructure

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult
5.7.1	**Incorporate climate change projections into future upgrades**	Pointe-du-Chêne Wharf Management	N/A	Ongoing	Low

5.8 Monitoring and Implementation

Many of the recommendations presented in the CCAP will require a collaborate approach between the Town of Shediac and supporting groups within the community. For this reason, it is important that the recommendations of the CCAP be reviewed by the Steering Committee and/or other community stakeholders on a regular basis to monitor the progress towards implementation. To support this monitoring, a complete table summarizing the information provided in **Table 5-1** to **Table 5-7** is included in Appendix F that can be used to track progress towards initiating and completing each action item. As action items are initiated or completed, the corresponding checkboxes can be filled in to track progress towards full implementation of the CCAP.

6 Conclusions

The recommendations for adaptation provided in the Pointe-du-Chêne Climate Change Adaptation plan (CCAP) were developed based on an understanding of municipal infrastructure and services, historic climate impacts, and input from community organizations and members of the public. To identify key risks and prioritize areas for adaptation, a PIEVC risk assessment was completed that involved identification of key climate parameters and their interactions with municipal assets, quantification of climate changes and severity of impacts on relevant assets and the environment, and calculation of overall risk using associated likelihood and severity scoring.

The recommendations provided in the CCAP build upon existing programming in the community and leverage relationships between the Town of Shediac, community organizations such as the Shediac Bay Watershed Association and Greater Shediac Sewerage Commission, and relevant provincial government departments.

To implement the adaptation plan, the document should first be accepted and adopted by the Town of Shediac who will support the listed organizations in executing the recommendations adaptation actions. The CCAP should be reviewed by the Town and the Steering Committee on an annual basis to verify that the recommended measures remain applicable in the community context, to make changes and updates where necessary, and to ensure that progress is being made.

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APPENDIX A

Public Engagement Survey Questionnaire

POINTE-DU-CHÊNE CLIMATE CHANTE ADAPTATION PLAN

Community Engagement Survey

PROJECT BACKGROUND

The Red Dot Association is currently undertaking a project to develop a Climate Change Adaptation Plan (CCAP) for the Pointe-du-Chêne region. The CCAP will aim to target key climate-related risks to the community by developing measures to adapt to a changing climate.

WE WANT TO HEAR FROM YOU!

Please fill out the following brief survey regarding your experiences with climate change and extreme weather in the Pointe-du-Chêne region only.

SECTION 1 – GENERAL QUESTION

Question 1. Do you live or own a property in Pointe-du-Chêne?

A) Yes
B) No

Question 2. Have you or your property ever been negatively impacted by climate change or extreme weather events? (Examples of this could include flooding, wind damage, extended power outages, extreme heat, drought, etc.).

Note that by selecting "Yes", you will be prompted to provide additional details regarding the type of climate event(s) and impacts faced.?

A) Yes
B) No *(In Survey Money, if the user selects "No", they will skip Section 2 about climate impacts, and skip directly to Section 3 (on page 7).*

SECTION 2 – EVENT/IMPACT SPECIFIC QUESTIONS

Question 3. Have you or your property ever been directly or indirectly impacted by flooding in the region?

A) Yes *(In Survey Monkey, if they user selects "Yes", they will be directed to fill info into the following text boxes)*
B) No *(If the user selects "No" they won't see the below text boxes and will skip directly to Question 3)*

Type of Flooding:

- ☑ **Coastal**
- ☑ **Riverine**
- ☑ **Overland (e.g., from rainfall)**
- ☑ **Sewer backup**
- ☑ **Other: ____________**

General location (e.g., address, location within municipality, business):

Approximate date(s), if known:

Impacts (e.g., property damage, health and safety incident, loss of livelihood)

Financial losses, if applicable (e.g., cost for repairs, insurance claims)

Measures required to restore property and/or resume normal activities following the event (e.g., major repairs)

Question 4. Have you or your property ever been directly or indirectly impacted by extreme wind and/or hurricane events?

A) Yes *(In Survey Monkey, if they user selects "Yes", they will be directed to fill info into the following text boxes)*
C) No *(If the user selects "No" they won't see the below text boxes and will skip directly to Question 4)*

General location (e.g., address, location withing municipality, business):

Approximate date(s), if known:

Impacts (e.g., property damage, health and safety incident, loss of livelihood)

Financial losses, if applicable (e.g., cost for repairs, insurance claims)

Measures required to restore property and/or resume normal activities following the event (e.g., major repairs)

Question_5. Have you or your property ever been directly or indirectly impacted by extreme hot or cold temperatures?

A) Yes *(In Survey Monkey, if they user selects "Yes", they will be directed to fill info into the following text boxes)*
B) No *(If the user selects "No" they won't see the below text boxes and will skip directly to Question 5)*

Location (e.g., address, location withing municipality, business):

Approximate date(s), if known:

Impacts (e.g., property damage, health and safety incident, loss of livelihood)

Financial losses, if applicable (e.g., cost for repairs, insurance claims)

Measures required to restore property and/or resume normal activities following the event (e.g., major repairs)

Question 6. Have you or your property ever been directly or indirectly impacted by freezing rain events?

A) Yes *(In Survey Monkey, if they user selects "Yes", they will be directed to fill info into the following text boxes)*
B) No *(If the user selects "No" they won't see the below text boxes and will skip directly to Question 6)*

Location (e.g., address, location withing municipality, business):

Approximate date(s), if known:

Impacts (e.g., property damage, health and safety incident, loss of livelihood)

Financial losses, if applicable (e.g., cost for repairs, insurance claims)

Measures required to restore property and/or resume normal activities following the event (e.g., major repairs)

Question 7. Are there any other climate conditions or events that have historically impacted you or your property in Pointe-du-Chêne?

A) Yes *(In Survey Monkey, if they user selects "Yes", they will be directed to fill info into the following text boxes)*
B) No *(If the user selects "No" they won't see the below text boxes and will skip directly to the next section)*

Type of climate conditions/event:

Location (e.g., address, location withing municipality, business):

Approximate date(s), if known:

Impacts (e.g., property damage, health and safety incident, loss of livelihood)

Financial losses, if applicable (e.g., cost for repairs, insurance claims)

Measures required to restore property and/or resume normal activities following the event (e.g., major repairs)

SECTION 3 – FINAL REMARKS

Question 8. Please indicate which climate change and extreme weather events you are most concerned about in PDC in the future.

- ☐ Sea Level Rise and Coastal Flooding
- ☐ Coastal Erosion
- ☐ Riverine Flooding
- ☐ Overland Flooding
- ☐ Extreme Rainfall
- ☐ Extreme Wind
- ☐ Hurricanes
- ☐ Extreme Hot Temperatures
- ☐ Extreme Cold Temperatures
- ☐ Drought
- ☐ Freezing Rain
- ☐ Snow Accumualation
- ☐ Quality of potable (drinking) water
- ☐ Surface Water Quality Issues (e.g.., in rivers, lakes, ocean)
- ☐ Power Outages
- ☐ Other

Question 9. Is there any additional information you would like to provide regarding climate change in Pointe-du-Chêne, and/or development of the Climate Change Adaptation Plan?

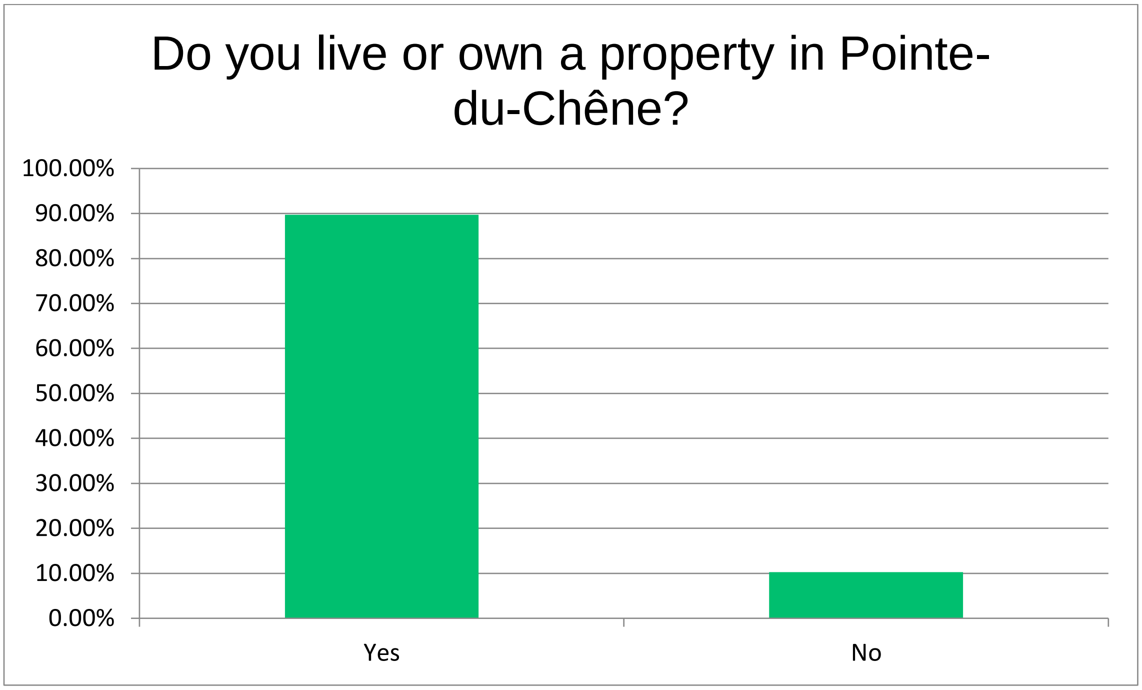
Question 10 (OPTIONAL). If you would like to leave your contact information in case we would like to further discuss the information you provided, please fill out the following information:

Full name:

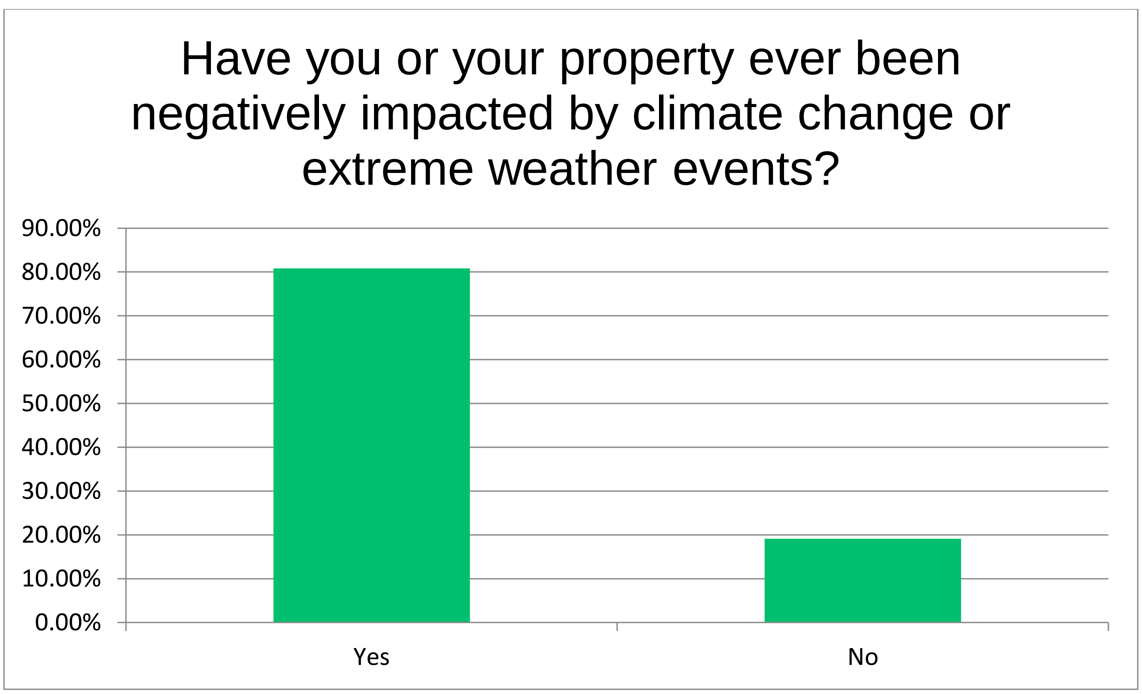
Relationship to community (e.g., resident, seasonal property owner, business owner, tourist, etc.)

Email address:

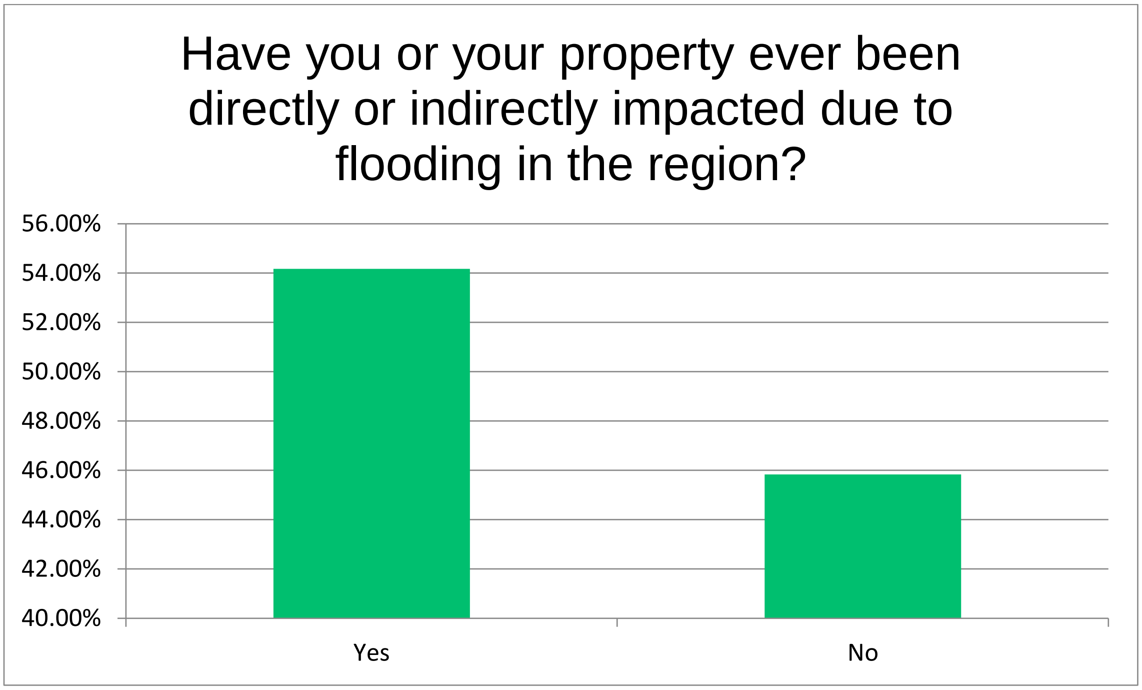
Phone number:

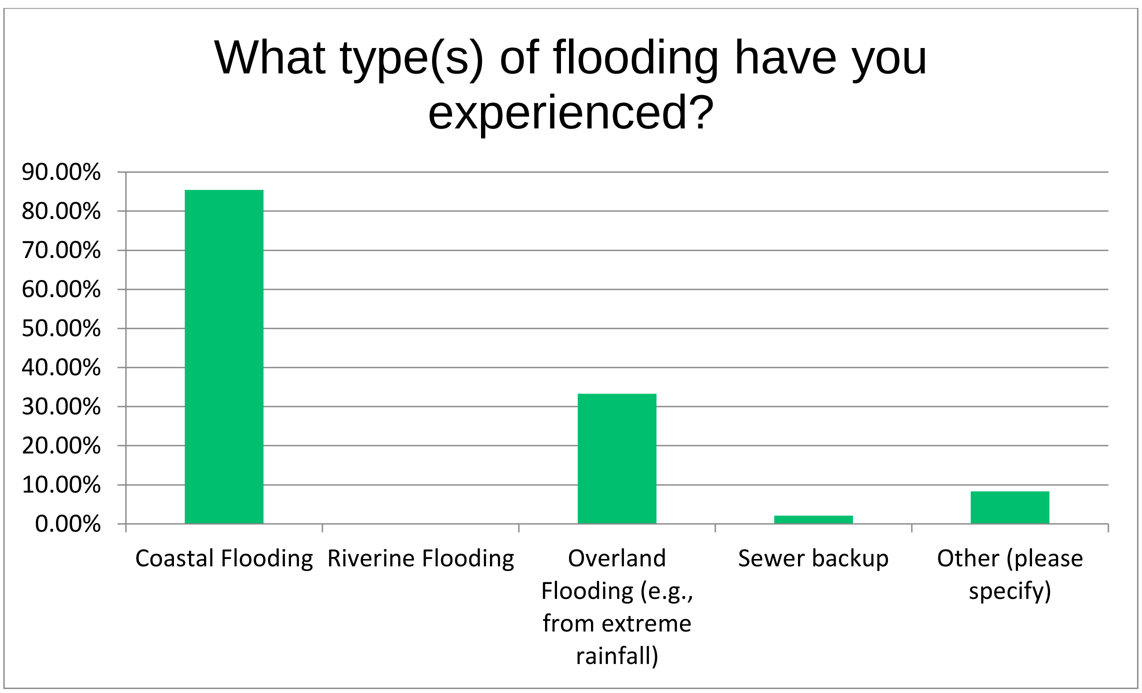


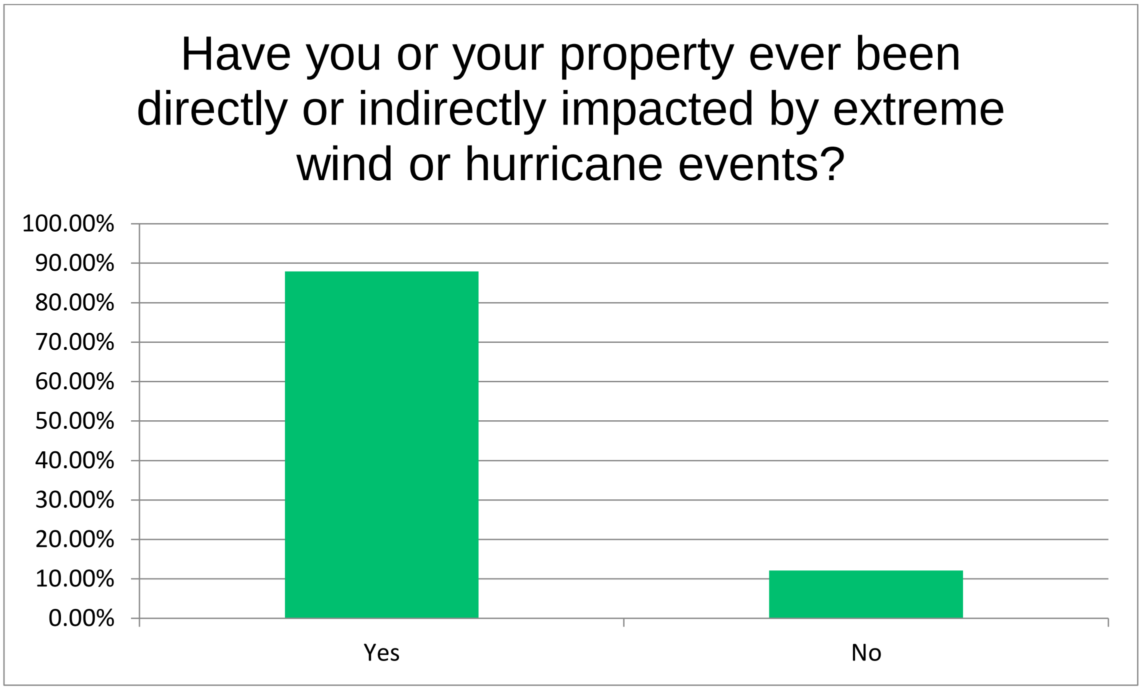
Do you live or own a property in Pointe-du-Chêne?
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Yes
No

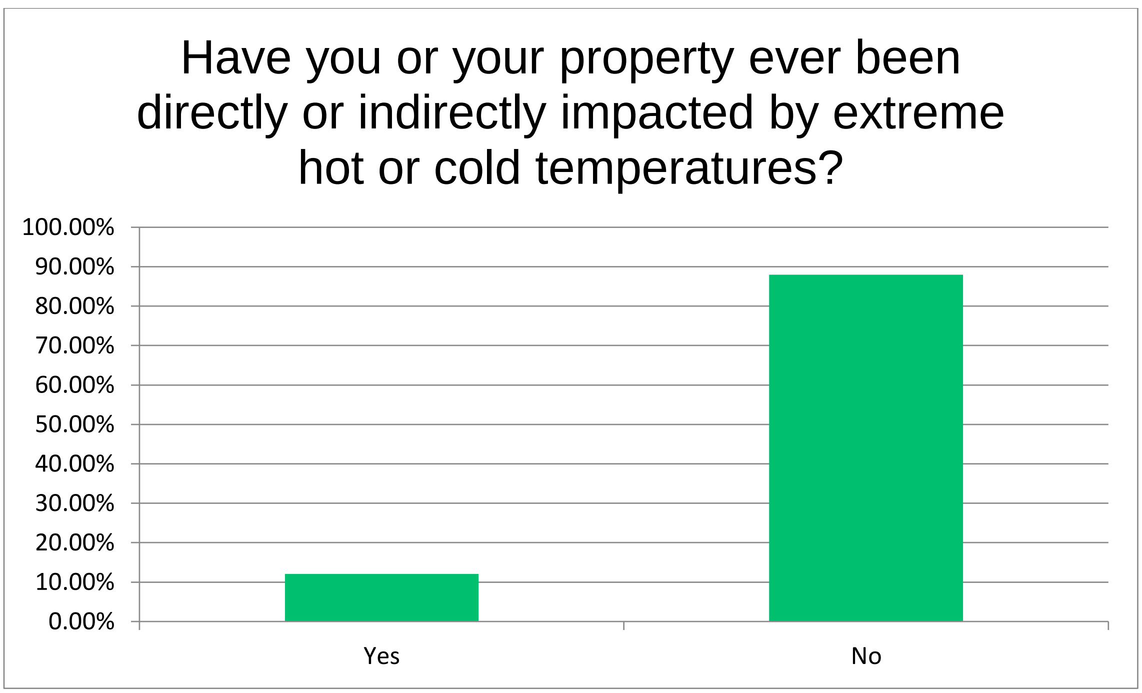


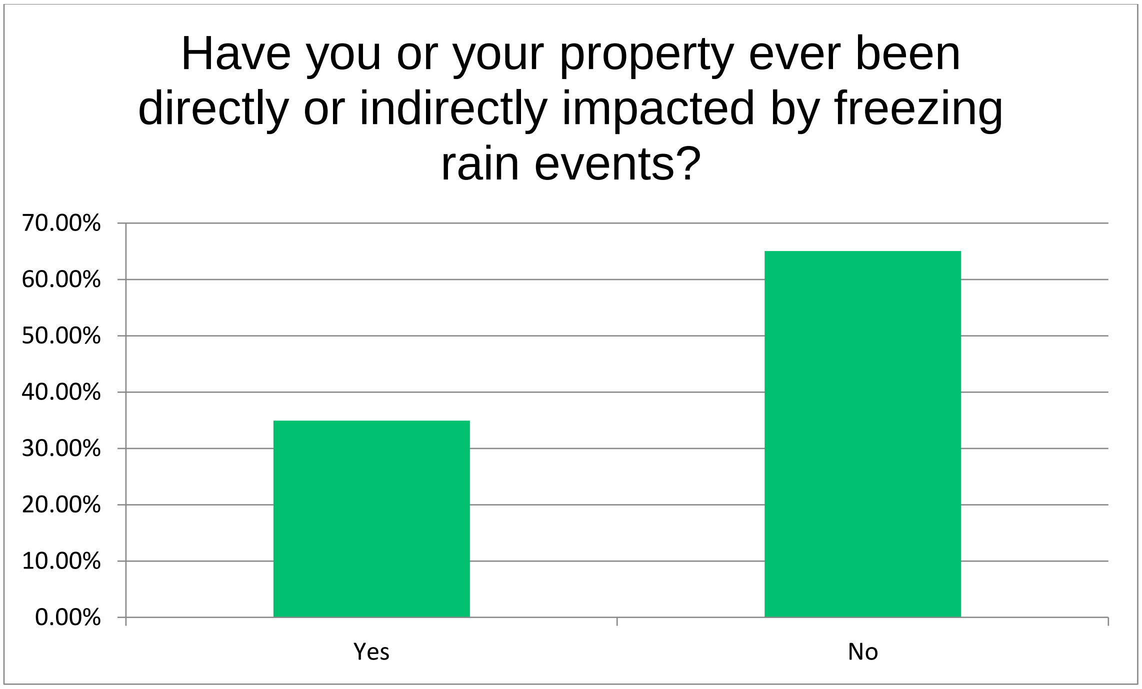
Have you or your property ever been negatively impacted by climate change or extreme weather events?
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Yes
No


Have you or your property ever been directly or indirectly impacted due to flooding in the region?
56.00%
54.00%
52.00%
50.00%
48.00%
46.00%
44.00%
42.00%
40.00%
Yes
No


What type(s) of flooding have you experienced?
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Coastal Flooding
Riverine Flooding
Overland Flooding (e.g., from extreme rainfall)
Sewer backup
Other (please specify)


Have you or your property ever been directly or indirectly impacted by extreme wind or hurricane events?
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Yes
No


Have you or your property ever been directly or indirectly impacted by extreme hot or cold temperatures?
100.00%
90.00%
80.00%
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Yes
No



Have you or your property ever been directly or indirectly impacted by freezing rain events?
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Yes
No

APPENDIX B

Public Consultation PowerPoint

Development of a Climate Change Adaptation Plan for Pointe-du-Chêne, New Brunswick

Public Engagement Session

CBCL

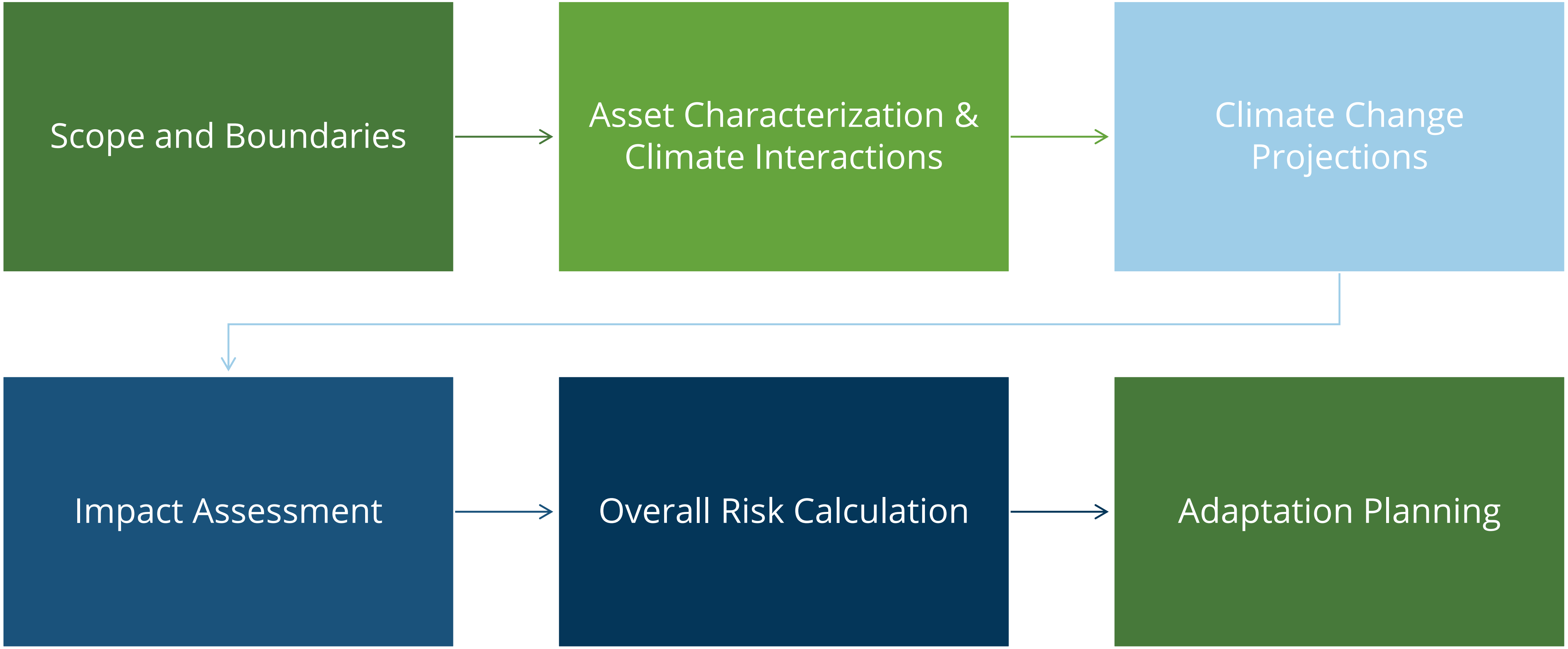
Agenda

- Project Background & Methodology
- Climate Projections
- Discussion on Interactions and Impacts
- Next Steps

Project Overview

- Overview of CCAP
  - A climate change adaptation plan considers potential future climate changes along with existing infrastructure and community programs to identify areas at high risk of being impacted by climate change.
- Objectives of CCAP
  - To develop a plan that Pointe-du-Chêne can follow to begin implementing climate change adaptation strategies throughout the community.
- We want your input!
  - CBCL has conducted a preliminary risk assessment of climate impacts in Pointe-du-Chêne
  - The goal of this public consultation session is to ground truth findings and gather additional information to support assessment and development of recommendations

CCAP Development Process



Risk Assessment Methodology

$$\textbf{Risk} = \textbf{\textit{Likelihood of Occurrence}} \times \textbf{\textit{Consequences of Impacts}}$$

Likelihood

Consequence	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

High Risk	
Moderate-High Risk	
Moderate-Low Risk	
Low Risk	
Negligible Risk	

Assets

Asset Group	Asset
Coastal Environment	Parlee and Belliveau Beach Environment (and associated flood risk)
	Tidal Creek
	Coastal Wetlands
Coastal Infrastructure	Pointe-du-Chêne Wharf
	Coastal Protection Features (Armour Stone)
Private Property and Development Practices	Residences
	Groundwater Wells (Water Supply)

Assets

Asset Group	Asset
Transportation	Road Network
	Pointe-du-Chêne Road Bridge
	Municipal Trails (recreational)
Sanitary and Stormwater Systems	Sanitary Collection Stormwater Collection System
Energy Services	Electrical Infrastructure
Emergency Services	Fire Protection Police Services Emergency Health Services (Ambulance)

Agenda

- Project Background & Methodology
- Climate Projections
- Discussion on Interactions and Impacts
- Next Steps

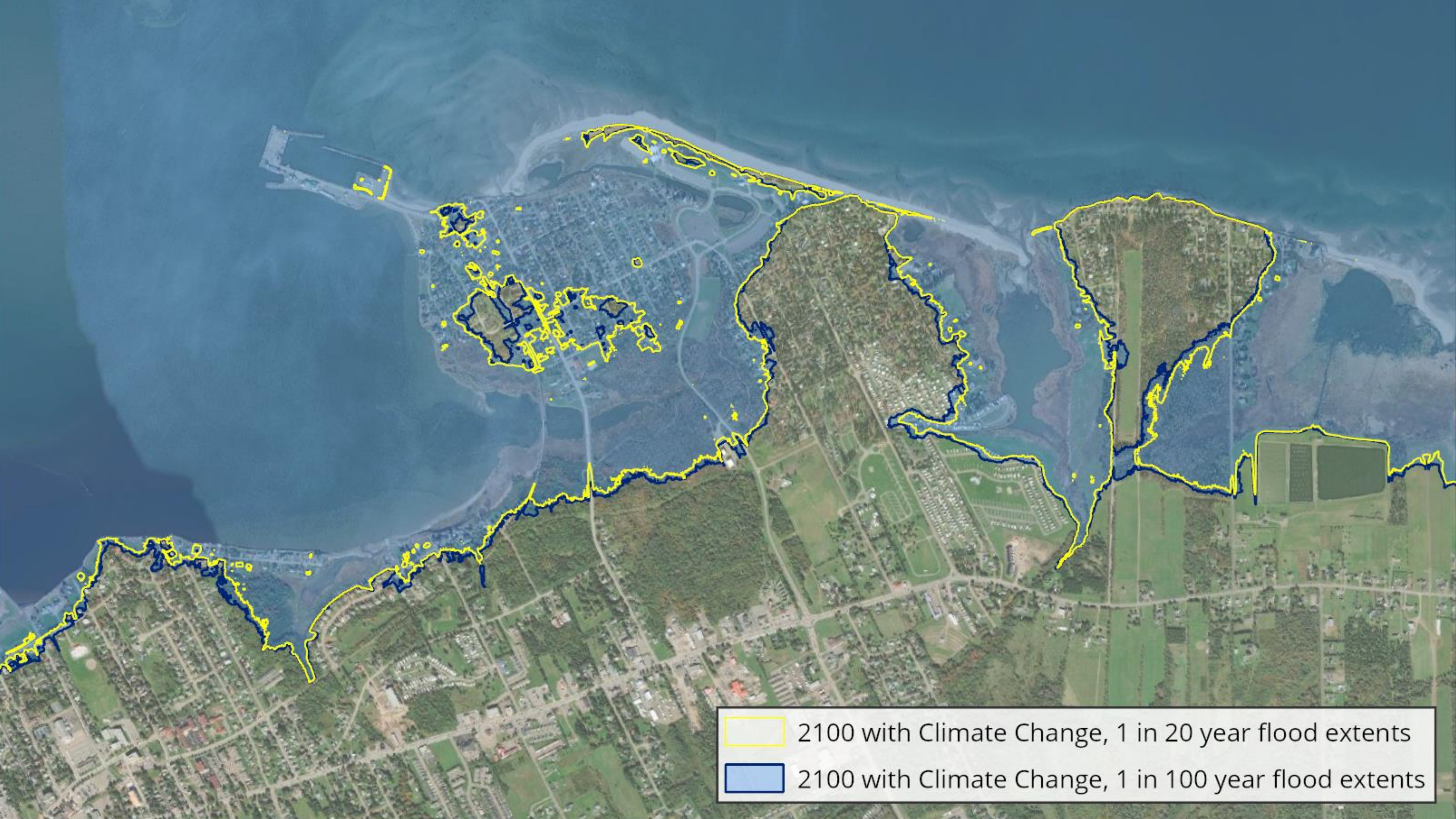
Climate Projections

Parameters	Climate Indices	Climate Trends (Present Day – 2100)	
Coastal	Extreme Water Levels* 1 in 5-year event	⬆	• Water level approximately 1.3m • Baseline: 5-year event • 2100: 1-year event
	Extreme Water Levels 1 in 25-year event	⬆	• Water level approximately 1.7m • Baseline: 25-year event • 2100: 5-year event
	Extreme Water Levels 1 in 100-year event	⬆	• Water level approximately 2.0m • Baseline: 100-year event • 2100: 15-year event
	Sea Ice Thickness	⬇	• Sea ice thickness and duration will decrease
	Hurricanes (Extreme Water Levels + Wind +Waves)	⬆	• Frequency of hurricanes increasing • Intensity will increase, exacerbated by lack of ice cover in future

*Extreme Water Levels = Sea Level Rise + Storm Surge + Tides

CBCL


Present Day, 1 in 20 year flood extents
Present Day 1 in 100 year flood extents


2100 with Climate Change, 1 in 20 year flood extents
2100 with Climate Change, 1 in 100 year flood extents

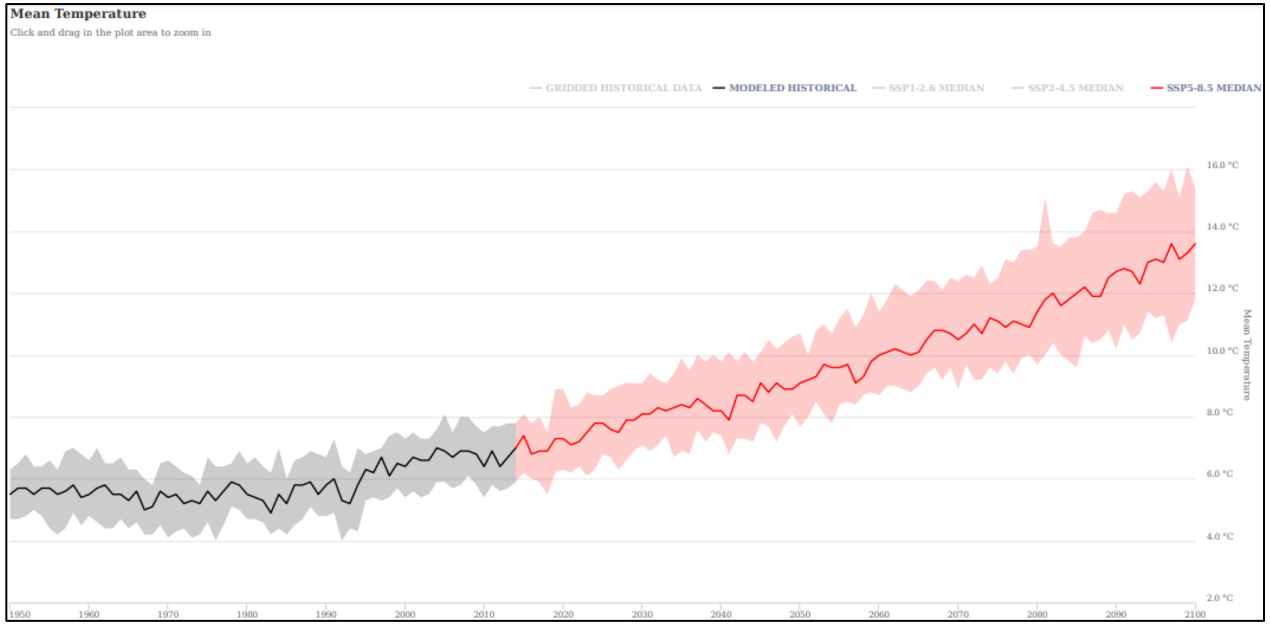

2100 Higher High Water Large Tide

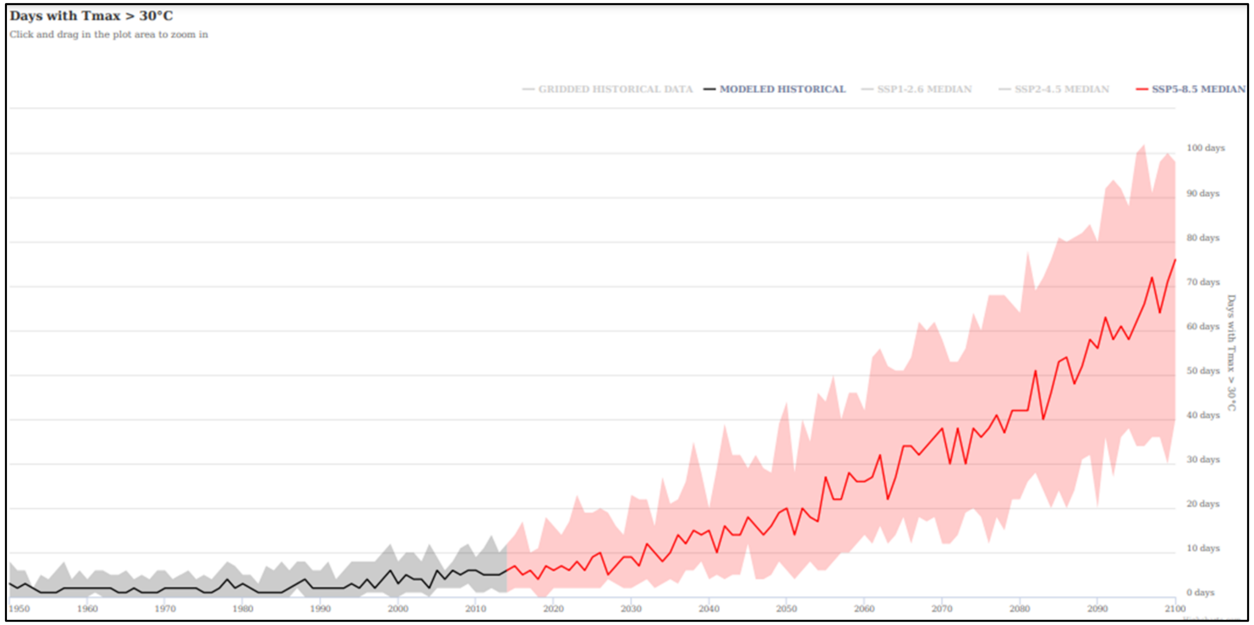
Climate Projections

Parameters	Climate Indices	Climate Trends	
Precipitation	1 in 10 year event (24 hour)	↑	• 96.9 mm • Increasing to approx. 1 /2 yr – 1/5 yr event
	1 in 100 year event (24 hour)	↑	• 141 mm • Increasing to approx.1/10 yr – 1/25 yr event
	Snowfall (days with snow > 10cm)	↓	• Approx. 9-10 days/winter season (10% of days) • Trend remains relatively consistent • Decreases expected by 2100
	Ice Accretion (1 in 20 year freezing rain event)	↓	• Decreasing by up to 50% by 2100

Climate Projections

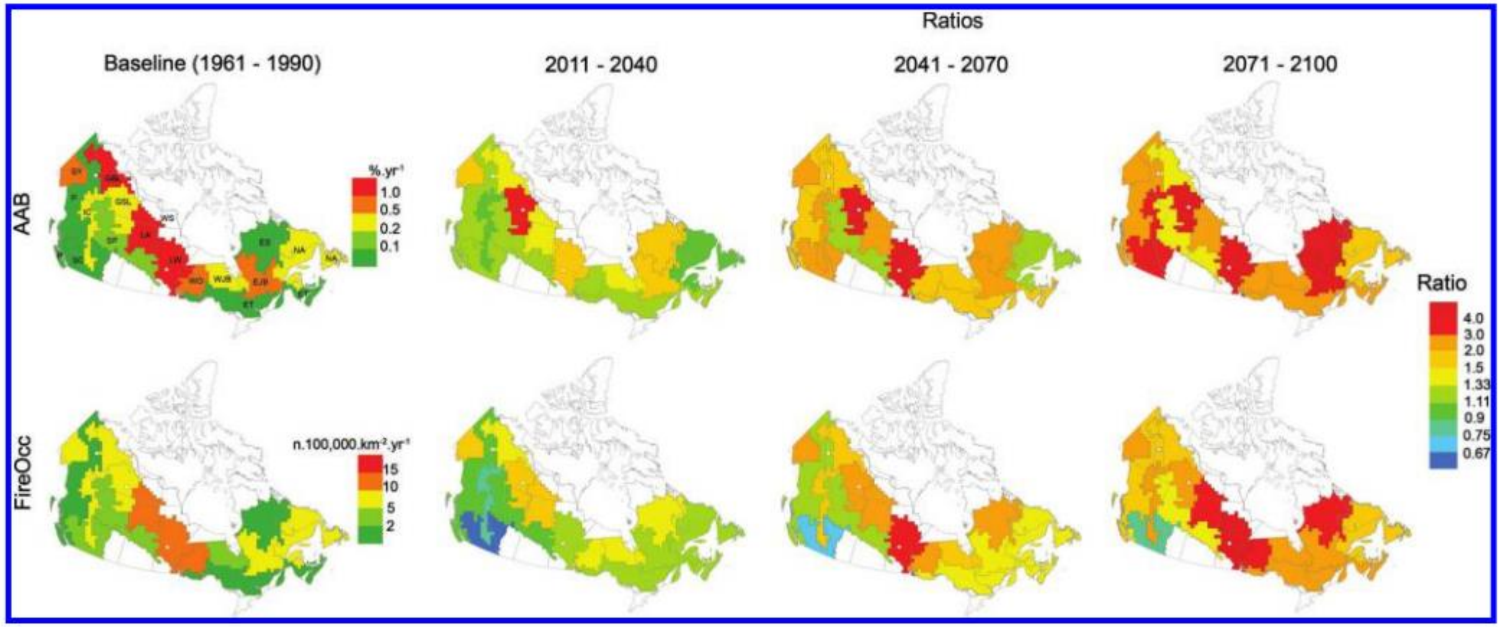
Parameters	Climate Indices	Climate Trends	
Temperature	Extreme Heat (Days 30 deg Celsius)		• Baseline: 4 days per summer • 2100: 48 days per summer
	Annual Freeze-Thaw Cycles		• Baseline: 21% of days (76 days/yr) • 2100: Minor decreases, 16% of days (60 days/yr) • More freeze thaw in winter due to shifting seasons, less annually





Climate Projections

Parameters	Climate Indices	Trend	
Extreme Events	Wildfire	↑	• Likely to see increased frequency of wildfires (dryer conditions, high temps)
	Lightning	—	• Baseline: 4.8% of days (annually) strikes within 25km • Projections indicate minimal change • High degree of uncertainty
	Drought	↑	• Baseline: Likely to occur once between 51-100 years • 2100: Likely to occur once between 11 and 30 years



Agenda

- Project Background & Methodology
- Climate Projections
- Discussion on Interactions and Impacts
- Next Steps

Consequence Scoring

Score	Impact Assessment Categories		
	Physical Impacts	HSE Impacts	Socio-Economic Impacts
1	Very Low		
2	Low		
3	Moderate		
4	High		
5	Very High		

Risk Assessment Review

HIGH RISK INTERACTIONS		
Emergency Services	Extreme Water Levels	• Drainage • Access issues
Private Property and Development Practices (Residences & Water Supply)	Extreme Water Levels	• Flooding • Property Damage • Water Contamination (Saltwater intrusion)
Coastal Infrastructure	Extreme Water Levels	• Coastal erosion • Undermining Infrastructure • Wharf Damage/operational disruptions
Coastal Environment	Extreme Water Levels	• Shoreline and dune erosion • Flooding and debris
Sanitary System	Extreme Water Levels	• Capacity issues • Overflow of system (lift stations) • Surface water quality issues • Basement backups

Each interaction will be discussed in detail on the following slides
We want to hear how these climate events have impacted the community as a whole

Risk Assessment Review

MODERATE RISK INTERACTIONS (climate events less likely)		
Coastal Environment	Extreme Rainfall	• Water quality impacts, increased contamination
Transportation	Extreme Water Levels	• Flood risk impacting mobility throughout the town. • Erosion and damage to roadways and trails
Private Property (residences and wells)	Extreme Rainfall	• Property damage • Potential overland flooding leading to well contamination
Sanitary system	Extreme Rainfall	• Capacity issues • Exacerbated I&I issue from rainfall • Overflowing lift station, basement backup
Stormwater System	Extreme Water Levels Extreme Rainfall	• Flooding causing the system to become overwhelmed • Storm sewer backup • Debris blocking catch basins
Energy System	Extreme Water Levels Extreme Rainfall	• Infrastructure damage and extended power outages
Emergency Services	Wildfire Winter Storms	• Access issues, infrastructure damage, power outages, etc.

Each interaction will be discussed in detail on the following slides
We want to hear how these climate events have impacted the community as a whole

Emergency Services and Response

Asset Description: Fire, RCMP, and Ambulance

Climate Interaction	Impact	Discussion Points
Extreme Water Levels **Hurricanes** **Extreme Rainfall Events** **Winter Storms** **Wildfire**	• Reduced mobility throughout the community • Potential for isolation of residential areas • Increased requests for emergency services • Unsafe working/driving conditions during event • Possible extended power outages • Potential for fire and infrastructure damage	1. Is there is a documented emergency response plan for Pointe-du-Chêne? 2. Are there any gaps in emergency response services? 3. Is there a designated emergency shelter/muster location in the community? Is there any critical community infrastructure that has backup power? 4. Who is responsible for communication to residences/businesses during emergency? How is communication executed? 5. Where does current firefighting water supply come from? Has a fixed supply been considered?

Private Infrastructure

Asset Description: Residential Structures, Groundwater Wells		
Climate Interaction	**Impact**	**Discussion Points**
Extreme Water Levels **Extreme Rainfall** **Freezing Rain**	**Residences**: • Widespread flooding • Damage to homes/property • Erosion around foundation • Deposited debris (sediment, seaweed, etc.) **Water Supply:** • Saltwater intrusion from sea level rise over time (not individual flooding events) • Temporary contamination during flood events (extreme events)	1. Describe impacts to private infrastructure from extreme water level and/or extreme rainfall events 2. Describe the cleanup efforts required to return homes to normal (financial resources, times, etc.) 3. Is damage manageable for individuals? Typically covered by insurance? 4. Has there been consideration for a municipal system longer term? 5. How is well water use restored? (E.g., Testing? Standard time period to wait?) 6. Is there another water supply that can be used when there are issues with residential wells? (E.g., municipal emergency station?) 7. Are residents pleased with measures implemented regarding land use policies? (E.g., wetland rezoning, buffer area?)

- Note that residential services (stormwater & sewer) and transportation infrastructure will be discussed on a different slide

Coastal Environment

Asset Description: Parlee and Belliveau Beach Environment (Shorelines, Dunes), Tidal Creek, Coastal Wetlands		
Climate Interaction	**Impact**	**Discussion Points**
Extreme Water Levels **Hurricanes** **Extreme Rainfall**	**<u>Beach</u>**: • Shoreline and dune erosion • Deposited debris • Possible sand contamination • Associated health risks **<u>Tidal Creek</u>**: • Flooding of tidal creek and surrounding areas (sedimentation) • Possible contamination **<u>Wetlands</u>**: • No major impact to wetland itself identified	1. Describe impacts to coastal environment (beach, tidal creek, wetlands) from these events. 2. Describe issues with contaminant transport. 3. Is a regular beach cleaning program necessary following this type of event? Who is responsible? Cost? 4. How does tidal creek impact residents? What are residents hoping to see/achieve with potential dredging program? 5. How do impacts from hurricane events differ from extreme water level events? (E.g., cumulative impacts from wind, rainfall, etc.)

- Note that impacts to transportation infrastructure (roads, bridges, etc.) will be discussed on a different slide

Coastal Infrastructure

Asset Description: Residential Structures, Pointe-du-Chêne Wharf, Armour Stone/Erosion Protection		
Climate Interaction	**Impact**	**Discussion Points**
Extreme Water Levels **Hurricanes**	**Wharf**: • Infrastructure damage • Problems with berthing • Wharf closure and impacts to businesses/tourism **Armour Stone**: • Damage and undermining • Homes and other infrastructure become more susceptible to flooding	1. Describe any impacts that wharf closures/damages have had on residents, businesses owners, etc. 2. Have residents noticed damage to coastal protection features? 3. Is coastal protection infrastructure (armour stone) regularly monitored and repaired? How frequently? By whom? What repairs or upgrades were done to the Wharf following Fiona? 4. Is there any security to keep people off wharf/away from coast during storms? Has this historically been a problem?

Sanitary and Stormwater Systems

Asset Description: Municipal collection system, residential septic tanks

Climate Interaction	Impact	Discussion Points
Extreme Water Levels **Extreme Rainfall** **Hurricanes**	**<u>Sanitary System:</u>** • Capacity issues (water infiltration into sanitary system during flood) • Overflow of system (environmental release) • Basement backup **<u>Stormwater System</u>:** • Overwhelmed system during flooding • System backup • Localized ponding of water • Debris blocking catch basins • Basement flooding if drains are connected to storm sewer	1. Describe impacts to sanitary and storm systems from these events 2. How many residents are connected to municipal system? 3. How many residents are on individual septic systems? 4. Has basement backup occurred?

- Note that emergency services will be discussed on a different slide

Transportation Infrastructure

Asset Description: Roads, Pointe-du-Chêne Bridge, Recreational Trails

Climate Interaction	Impact	Discussion Points
Extreme Water Levels **Hurricanes** **Freezing Rain**	**Road and Trails:** • Flooding • Uplift/damage to asphalt or concrete surfaces • Erosion of gravel roads/trailways • Undermining of roadways • Extensive and costly repairs required • Ice buildup (health and safety concern) **Bridge:** • Erosion of embankments and abutments • Blocked culverts (from debris)	1. Describe impacts to transportation infrastructure associated with these events. 2. Is damage to road infrastructure and trails a regular occurrence? 3. Who is responsible for maintaining roads? 4. Who is responsible for maintaining trails? 5. Is road/trail maintenance prompt in extreme deterioration conditions? 6. Have there been any impacts to the bridge since it has been rebuilt?

Energy Services

Asset Description: Roads, Pointe-du-Chêne Bridge		
Climate Interaction	**Impact**	**Questions**
Extreme Water Levels **Hurricanes**	• Possible infrastructure damage • Extended power outages	1. How reliable is power supply during extreme weather events? 2. Is there any backup power in the municipality? 3. Do residents typically have backup generators at their properties? 4. Are repairs generally prompt?

Agenda

- Project Background & Methodology
- Climate Projections
- Discussion on Interactions and Impacts
- Next Steps

Next Steps

~~Scope and Boundaries~~ → ~~Asset Characterization & Climate Interactions~~ → ~~Climate Change Projections~~ → ~~Impact Assessment~~ → Overall Risk Calculation → Adaptation Planning

Overall Risk Calculation

- Adjust scoring based on public feedback
- Prioritize high/med/low risks

Adaptation Planning

- Targeted studies
- Infrastructure upgrades
- Policies and Communication
- Emergency Planning

Thank You!

APPENDIX C

Climate Change Assessment

Contents

1 Introduction

This appendix report presents the historical (i.e., baseline) characterization, future climate projections, and associated PIEVC likelihood scores for the Pointe-du-Chêne LSD Climate Change Adaptation Plan. The list of climate indices considered in this study was developed by the risk assessment and change analysis teams based on extensive literature review and consultation with the public and relevant project stakeholders. Selection of these parameters was based primarily on climate and extreme weather phenomena which are anticipated to impact the Pointe-du-Chêne, as well as the municipal infrastructure identified within scope of the project.

The coastal and atmospheric climate parameters included in the project are listed as follows:

- **Extreme Water Levels:** Sea Level Rise + Storm Surge + Tides
- **Sea Ice:** Ice cover and thickness
- **Extreme Wind and Waves:** Severe wave overtopping and potential for erosion (100-year waves)
- **Extreme Rainfall:** Extreme Rainfall Events: 1 in 10 year and 1 in 100 year.
- **Heat Extremes:** Number of Days Max. Temperature greater than 30°C.
- **Freeze-Thaw Cycles:** Number of Days with Max. Temp Greater than 0°C and Min. Temp Less than 0°C in the Winter Season.
- **Ice Accretion:** Ice Accretion Thickness (1 in 20 year).
- **Snow Days:** Number of Days with Snowfall > 10 cm.
- **Winter Storms:** Frequency and Intensity of Winter Storms (combined index including falling or blowing snow and strong winds).
- **Wildfire:** Frequency and Intensity of Wildfire.
- **Drought:** Frequency and Intensity of Drought Conditions.
- **Lightning:** Lightning Strikes within 25km of the site.

2 Methodology

The methodology consists of obtaining historical climate data and climate change projections from various data sources (Section 2.1), for a given future emission scenario (Section 2.2), over selected projection horizons (Section 2.3). The analysis of historical climate and climate change projections for each index are then converted to a PIEVC likelihood score (Section 2.4). See Section 2.5 for a discussion of uncertainties and assumptions.

2.1 Data Sources

The following primary sources of climate information were used:

1. **Climate Normals:** Collected from Environment and Climate Change Canada (ECCC) Climate Data Normals Bouctouche CDA CS (Station ID#8100593). Climate data from the National Building Code of Canada was also used for baseline characterization based on the Moncton region of New Brunswick.
2. **Observation Data:** Collected from Environment and Climate Change Canada (ECCC) for Station ID: 8100593.
3. **IDF Curves:** Collected from Environment and Climate Change Canada (ECCC) Bouctouche CDA CS (Station ID#8100593) for characterization of baseline climate conditions.
4. **Cannon *et al.* (2020):** A report to support the future update of the building and bridge design codes, entitled "Climate-Resilient Buildings and Core Public Infrastructure: an assessment of the impact of climate change on climatic design data in Canada".
5. **CMIP6 Data:** Statistically downscaled and bias-corrected Coupled Model Inter-comparison Project Phase 6 (CMIP6) data available through Climatedata.ca.
6. **Clausius-Clapeyron Equation:** A "temperature scaling" approach based on the Clausius-Clapeyron Equation, where each degree of warming results in an approximately 7% increase in precipitation intensity for daily precipitation events (Westra et al. 2014). This method is considered scientifically defensible by authoritative sources such as CSA PLUS 4013:19 and Cannon et al. (2020), Temperature projections for this approach were obtained from ClimateData.Ca.
7. **Literature:** In addition, for the parameters that are not readily available in global or regional climate model outputs, information was obtained from the literature (e.g., process-based understanding from measurement or modelling study conducted elsewhere).

2.2 Emission Scenarios

Climate models are driven by different emissions scenarios. The CMIP project uses "Representative Concentration Pathways" (RCPs) in Phase 5 (CMIP5) and "Shared Socioeconomic Pathways" (SSP) in Phase 6 (CMIP6) to represent different emissions scenarios. For this study, we used the higher emission scenario (RCMP 8.5 & SSP5-8.5) for climate projections. The higher emissions scenarios represent conditions when the level of radiative forcing reaches 8.5 W/m^2 by 2100. RCP 8.5 accounts for radiative forcing only through anthropogenic sources, while SSP5-8.5 integrates socioeconomic factors in the emission scenario.

2.3 Projection Horizons

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

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

When projections for a given parameter were not available for these exact time frames, adjustments were made so that projections could be standardized for the PIEVC risk matrix.

2.4 PIEVC Scoring

The PIEVC scoring system is designed to emphasize relative risk among different possible climate-infrastructure interactions. Different approaches (or scales) were used for different types of climate parameters (**Table 2-1**)

Table 2-1: Scoring Scales (#1-#3) for Likelihood Scores, Based on PIEVC Template

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

4	Likely to occur once per decade	35 – 75% of the days	Somewhat likely
5	Likely to occur once or more annually	>75% of the days	Likely

2.5 Key Methodological Considerations

Several factors were considered when choosing sources of climate information:

1. **Spatial Resolution:** Global climate models (**GCMs**) have grid cells that are typically one to several hundred km wide. Available regional climate models (**RCMs**) have grid cells that range between 10 and 50 km wide. Some parameters can only be predicted at a higher resolution (for example convective storms which cause high-intensity precipitation). Therefore, these parameters would be better obtained from regional climate models, downscaling tools such as **PCIC**, or analyses of historical measurements.
2. **Stationarity Assumption:** Both statistical downscaling and extrapolation of trends based on historical measurements have the advantage of capturing local effects, which is key. However, they rely on the "stationarity assumption" (assumption that past processes will continue unchanged into the future) because they ignore known changes in processes and non-linearity.
3. **Need to Characterize Uncertainty:** There are several major sources of uncertainty in climate modelling, including natural variability, emission scenarios, and inter-model variability. For this reason, the Intergovernmental Panel on Climate Change (**IPCC**) recommends in their most recent Sixth Assessment Report (**AR6**) that an ensemble or range of models be considered, because individual models may be less accurate on their own. There are more than 30 internationally accepted Global Climate Models in the Coupled Model Inter-comparison Project (**CMIP6)**, which is many more than the number of available RCMs. Therefore, the GCMs were used to provide a range of predictions. To further characterize model uncertainty, historical measurements were compared with GCM outputs for baseline values.
4. **Availability of Parameters:** GCMs provide a limited set of parameters as output, while RCMs generally provide more parameters as output. The RCMs were therefore selected for particular parameters that are not available from global climate models.
5. **Process-based Understanding:** For the parameters that are not readily available in global or regional climate model outputs, information was obtained from literature (e.g., process-based understanding from measurement or modelling study conducted elsewhere, including previous CBCL assessments of the area).

These considerations result in several trade-offs for sources of climate information. Since no one approach is ideal for all parameters, time horizons, locations, or purpose, best practice is to vary the sources of climate information depending on the quality of available data and characteristics of the climate parameter. It is also best practice to use several sources of climate information (and several models) when at all possible.

3 Projections

This chapter summarizes, for each climate parameter, relevant climate change processes, sources of information used, baseline characterization and projections (main findings only), and PIEVC likelihood scores.

3.1 Extreme Water Levels

The investigation for extreme water levels is summarized as follows:

Index	▸ Extreme water levels including 1:100 storm surge, tides, and sea level rise (RCP 8.5)
Importance	▸ Extreme water levels can cause coastal flooding and damage infrastructure. This is the main driver for damage at the project site.
Climate Change Processes	▸ Extreme water level increases are primarily driven by sea level rise. ▸ Sea level rise is predominantly caused by melting ice glaciers and icesheets as a result of an upwards shift of average temperatures.
Sources of Climate Information	▸ DFO-CHS Tide Gauges – Tidal characteristics, such as Higher High Water Large Tide (HHWLT), and extreme water levels are based on the long-term tide records of the tide gauge located in the Shediac Bay and provided by the Canadian Hydrographic Service from Fisheries and Oceans Canada (DFO-CHS). ▸ NRCan Relative Sea-Level Rise (SLR) – Projected relative sea level change data, developed by Natural Resources Canada (NRCan), is available for 2006 and for every decade from 2010-2100, relative to 1986-2005 conditions for the three Representative Concentration Pathways (RCP) emissions scenarios (RCP 2.6, RCP 4.5, RCP 8.5) and an enhanced scenario based on melting of the West Antarctic Ice Sheet. This dataset is a combined measure of both changes to ocean levels due to climate change and vertical land movements.
Projection Summary	▸ Sea Level Rise: Sea levels have been rising in the Maritimes since the end of last ice age 10,000 years ago. The trend is expected to accelerate with climate change. Future SLR

	projections vary depending on climate change scenarios and local factors, such as land subsidence. ▶ Extreme Water Levels are projected to increase significantly at the site, primarily as a result of sea level rise estimates in the magnitude of 0.7 m in the long term.			
Scoring Scale	▶ Thresholds of extreme water level elevation			
Likelihood Scores		Threshold 1 (1.3 m CGVD2013)	Threshold 2 (1.7 m CGVD2013)	Threshold 3 (2.0 m CGVD2013)
	Baseline	4	3	1
	2030s	4	3	1
	2050s	4	4	2
	2080s	5	4	3

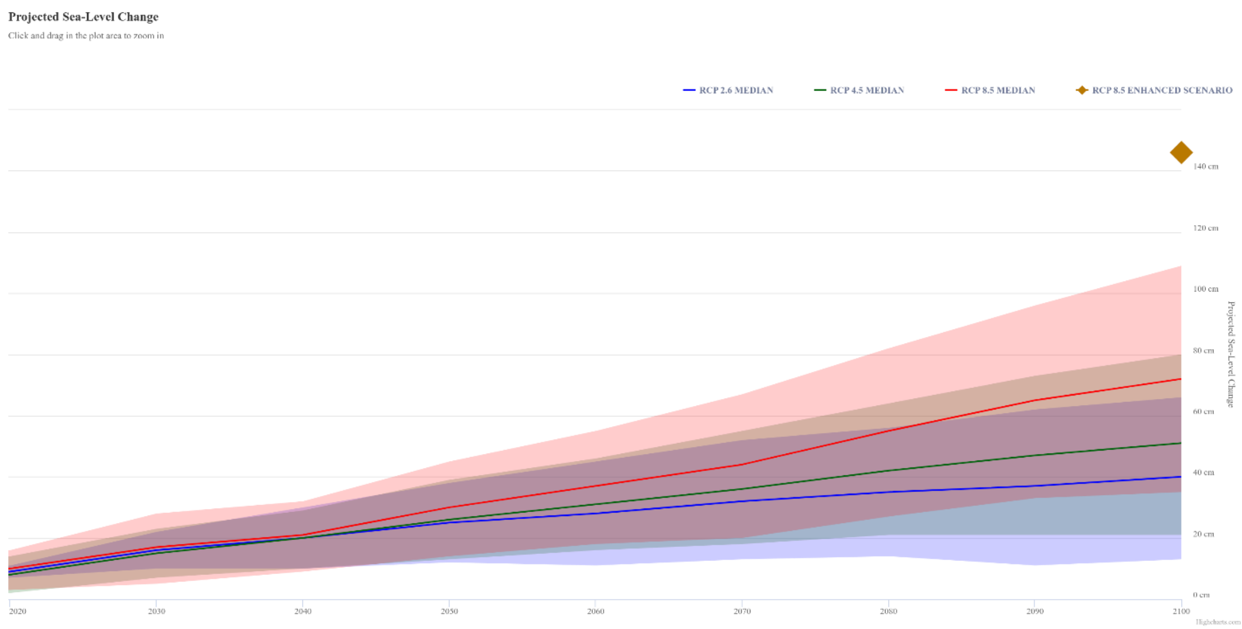


Figure 3-1: Relative Sea Level Rise Projections at Shediac Bay (climatedata.ca).

3.2 Extreme Waves

The investigation for extreme waves is summarized as follows:

Index	▶ Extreme: Severe wave overtopping and potential for erosion (100yr waves)
Importance	▶ Extreme waves pose a threat to the existing dune and beach system, and other coastal infrastructure. These can cause significant damage with direct wave impact, and also with the wave induced erosion.
Climate Change Processes	▶ Inside Shediac Bay, waves are primarily generated by wind rather than ocean swell, therefore extreme waves are projected to increase with time as a result of potential wind

	increases in the region. The north shore of Pointe-du-Chêne is exposed to larger waves which are also projected to increase due to potential changes in wind, and the reduction of ice cover during winter months, allowing waves to impact existing shorelines. - There is a projected increase in wind due to localized convection caused by heating of the ground surface. - There is a projected reduction of ice cover.
Sources of Climate Information	- **Sources of wave data:** - ECCC MSC50 Hindcast - offshore wind and wave model hindcast from January 1954 to December 2018 containing hourly time series of wind and wave parameters at a location offshore of the project area.
Projection Summary	- In Pointe-du-Chêne, waves are primarily generated by wind rather than ocean swell, therefore seasonal and extreme waves are projected to increase with time as a result of potential wind increases in the region. - Extreme winds are very difficult to model due to the general inability of coarse resolution climate models to resolve many of the physical processes involved. Overall, small changes in future design wind pressures are projected across Canada with high internal variability and uncertainty, which leads to a low signal-to-noise ratio. The IPCC (2013) states that winds are modelled with "low confidence". In the Atlantic Canadian region, hourly wind pressures with a 50-year return period are projected to increase over the 21st century (Cannon et al, 2020).
Scoring Scale	- Extreme return periods of wind speed (Qualitative)

Likelihood Scores		Extreme Waves
	Baseline	1
	2030s	1
	2050s	2
	2080s	2

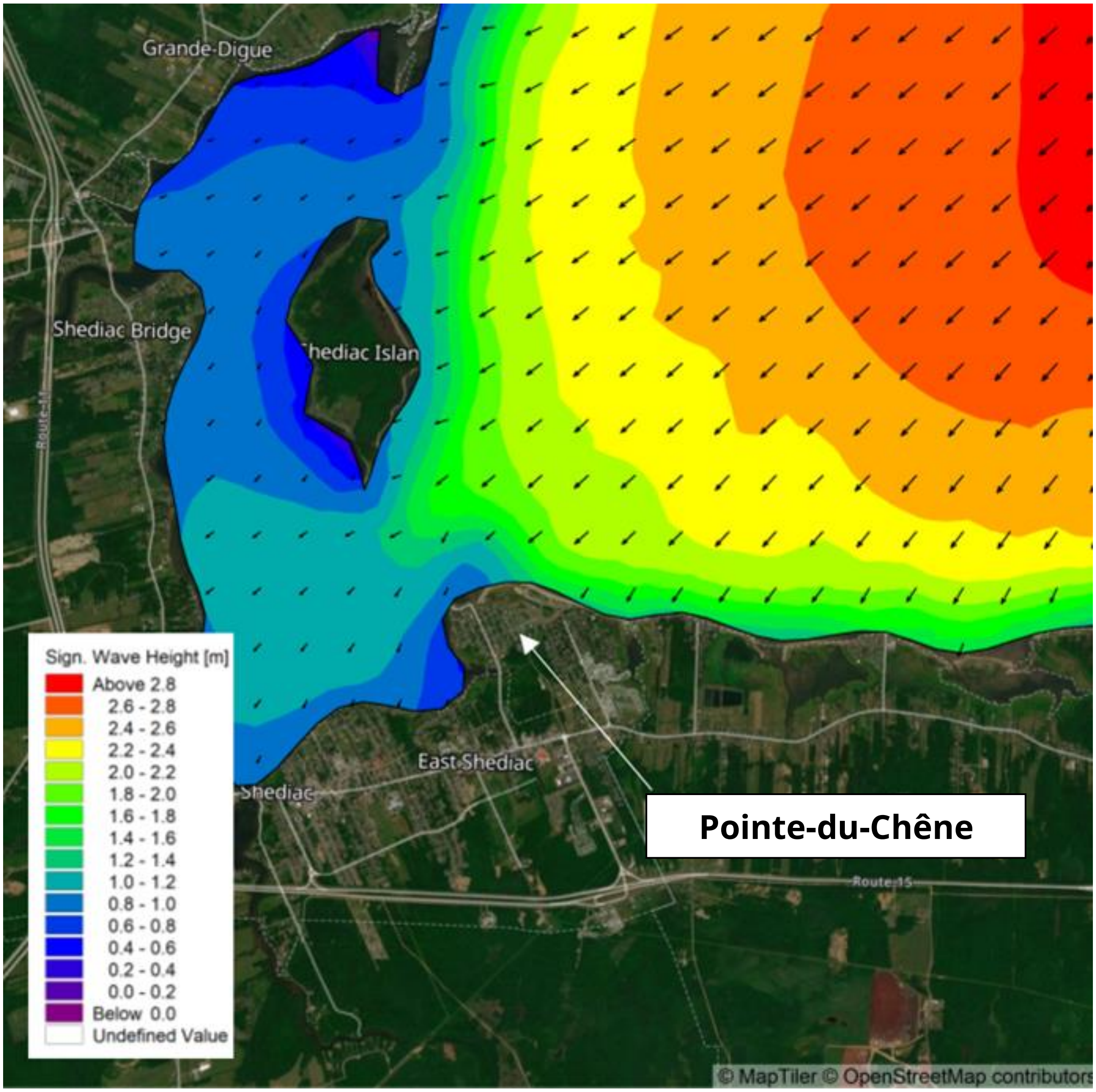
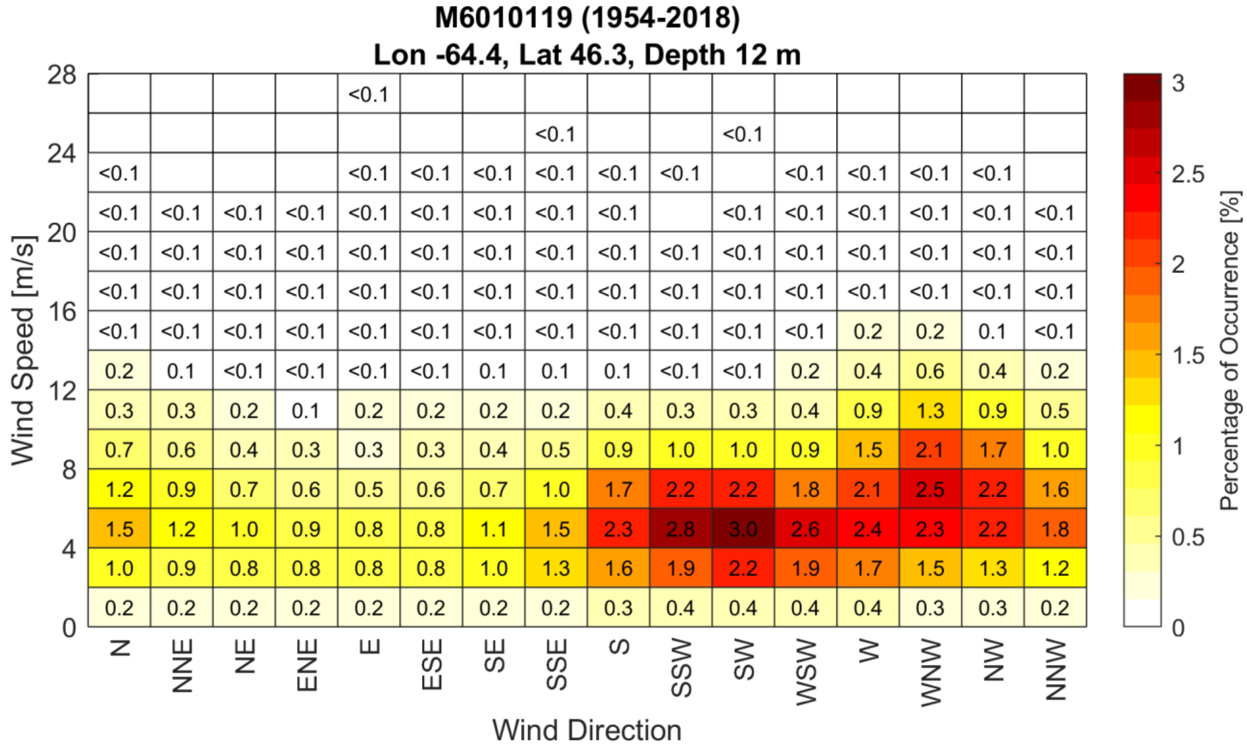


Figure 3-2 Modelled extreme waves, 20yr return period (CBCL 2024)



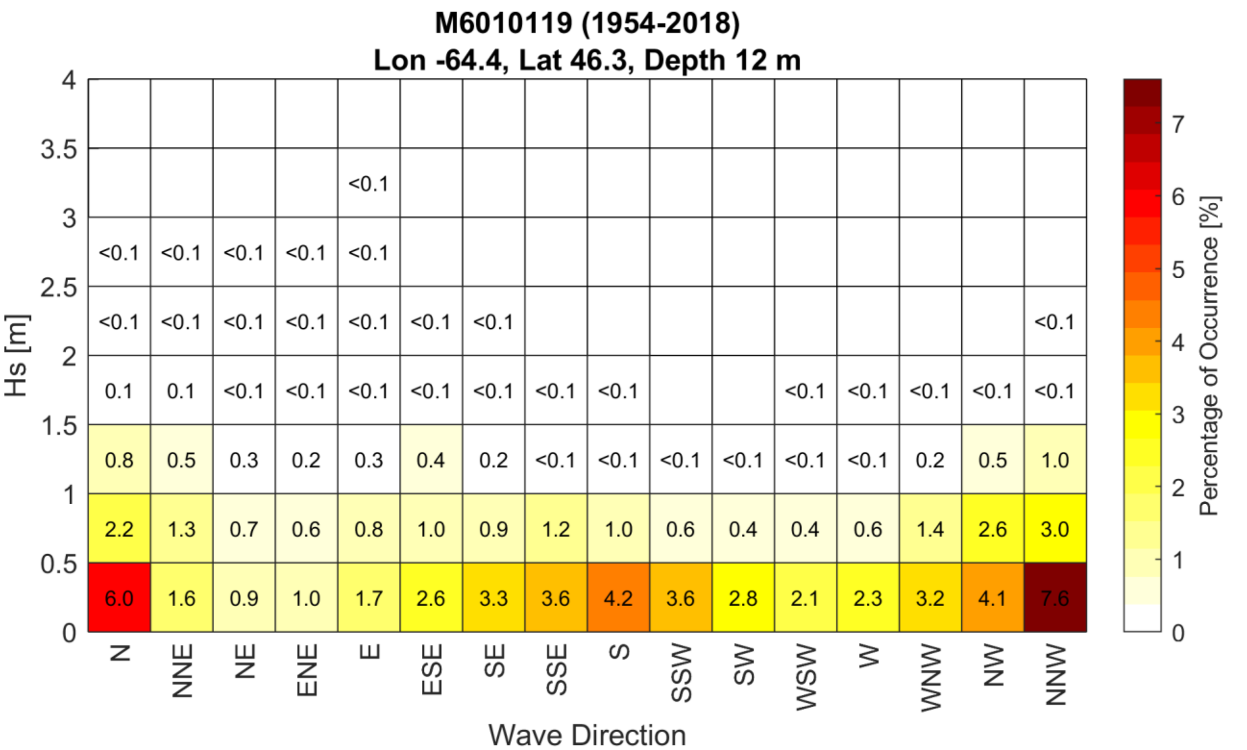


Figure 3-3 Analysis of offshore waves (bottom) and winds (top) (MSC50)

3.3 Sea Ice

The investigation for sea ice is summarized as follows:

Index	▶ Ice cover and thickness
Importance	▶ Protection of shoreline against extreme waves, direct ice forces damage to coastal infrastructure.
Climate Processes	▶ In Eastern Canada at large, the volume and extent of the sea ice is generally caused by cold air from the Canadian Arctic resulting in temperatures far below the freezing point (CIS 2013). ▶ On the other hand, migratory low-pressure centres from the Southeastern United States result in mild air and melting conditions lasting from a few hours to several weeks. Ice development in Eastern Canada therefore varies considerably in severity depending upon the relative frequency and the paths of these migratory storm systems (CIS 2013).
Climate Change Processes	▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth creating warmer average temperatures and reducing sea ice.
Sources of Climate Information	▶ Given the lack of ice extent and thickness records, local knowledge on ice presence and accumulation can allow for a better understanding of ice processes in the Shediac Bay. Additional Canadian Ice Charts were used for the general understanding of ice over and thickness over time.
Projection Summary	**Ice Formation in the Shediac Bay.** Compared to reference period (1986-2005), based on ensemble of models from the Coupled Model Intercomparison Project Phase 5 (CMIP5). Concentration is a unitless term that describes the relative amount of area that is covered by ice. Arctic Ocean are projected to experience decreases of sea ice concentration of up to 40% by 2061-2080. In contrast, sea ice concentration in Hudson's Bay, Baffin Bay, and the Labrador Sea is projected to decrease most during the winter and spring seasons (Source: Environment Canada).
Scoring Scale	▶ Days of Ice Cover (Qualitative).

Likelihood Scores

	Sea Ice Thickness
Baseline	3
2030s	2
2050s	1
2080s	1

3.4 Extreme Rainfall

The investigation for extreme rainfall is summarized as follows:

Index	▶ Extreme Rainfall Events: 1 in 10 year and 1 in 100 year.
Climate Change Processes	▶ A warmer atmosphere can hold more moisture, which leads to more precipitation (accelerated water cycle). ▶ Anticipated changes to atmospheric circulation and synoptic (large-scale weather patterns may affect the locations of storm tracks that influence extreme precipitation.
Sources of Climate Information	▶ Environment Canada Historical IDF curves used for baseline characterization (Bouctouche CDA CS Station ID#8100593). ▶ Westra et al., 2014, Cannon et al., 2020, CSA PLUS 4013:19, used for selection of CC scaling rates. ▶ Statistically downscaled and bias-corrected CMIP6 data for temperature projections obtained from Climatedata.ca. ▶ Clausius-Clapeyron, Cannon et al. (2020), Westra et al. (2014) used for projections and scoring.
Projection Summary	▶ A "temperature scaling" approach based on the Clausius-Clapeyron Equation, where each degree of warming results in an increase in precipitation intensity (Westra et al. 2014) was used to project a Climate Change Rate (CC Rate) to assess increases in the intensity of extreme rainfall. ▶ With this "temperature scaling approach, each degree of warming is taken to result in an approximately 7% increase in precipitation intensity (Westra et al,. 2014). This method is considered scientifically defensible by authoritative sources such as CSA PLUS 4013:19 and Cannon et al. (2020). ▶ Climate models project an increase in precipitation intensity of approximately 40-45% for the Pointe-du-Chêne region. This estimate is based on the median of the CMIP6 model ensemble for mean temperature obtained from Climatedata.ca. ▶ Projections depict a decrease in the return period of extreme storms is anticipated, and therefore extreme storms will likely occur more often. ▶ Through applying the CC Rate it is projected that the current 1 in 100 year event will become an approximate 1 in 10 year event and the current 1 in 10 year event will become an approximate 1 in 2 year to 1 in 5 year event in the long term (2080s). ▶ A greater projected increase is expected for higher return periods (1 in 100 year compared to 1 in 10 year).

	▶ This is consistent with the IPCC (2021) statement that "heavy precipitation will generally become more frequent and more intense with additional global warming." ▶ It is noted that high uncertainty is present in the far-term CC Rate projections.
Scoring Scale	▶ Scale #1: Return Period.

PIEVC Likelihood Scores

	Extreme Daily Rainfall Events	
	1 in 10 year	1 in 100 year
Baseline	4	1
2030s	4	2
2050s	4	3
2080s	4	4

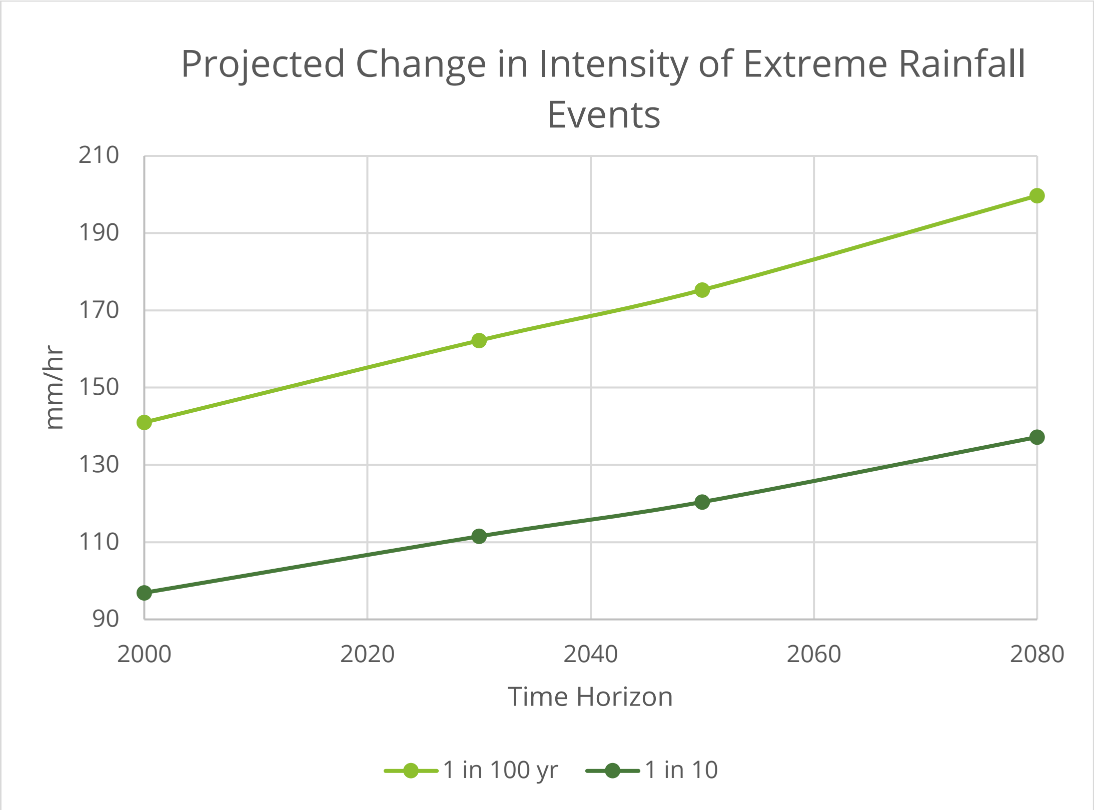


Figure 3-4: Projected Change in Intensity of Extreme Rainfall Events.

3.5 Heat Extremes

The investigation for heat extremes is summarized as follows:

Index	▶ Number of Days Tmax > 30°C in the Summer.
Climate Change Processes	▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth.

Sources of Climate Information	- Environment Canada Climate Normals (Bouctouche CDA CS Station ID#8100593). - Statistically downscaled and bias-corrected CMIP6 data obtained from Climatedata.ca.	
Projection Summary	- For baseline characterization, ECCC climate normals report approximately 6 days with T_{max} > 30°C while Climatedata.ca indicates a frequency of approximately 4 days. - Projections indicate significant increases over time in the number of days with T_{max} > 30°C in the summer with the largest increases occurring in the long-term. - Projections show increases of approximately 10, 25 and 50 days by the 2030s, the 2050s, and the 2080s, respectively (Figure 3-5).	
Scoring Scale	- Scale #2: Percent Days.	
	Number of Days T_{max} > 30°C in the Summer.	
PIEVC Likelihood Scores	Baseline	2
	2030s	3
	2050s	3
	2080s	4

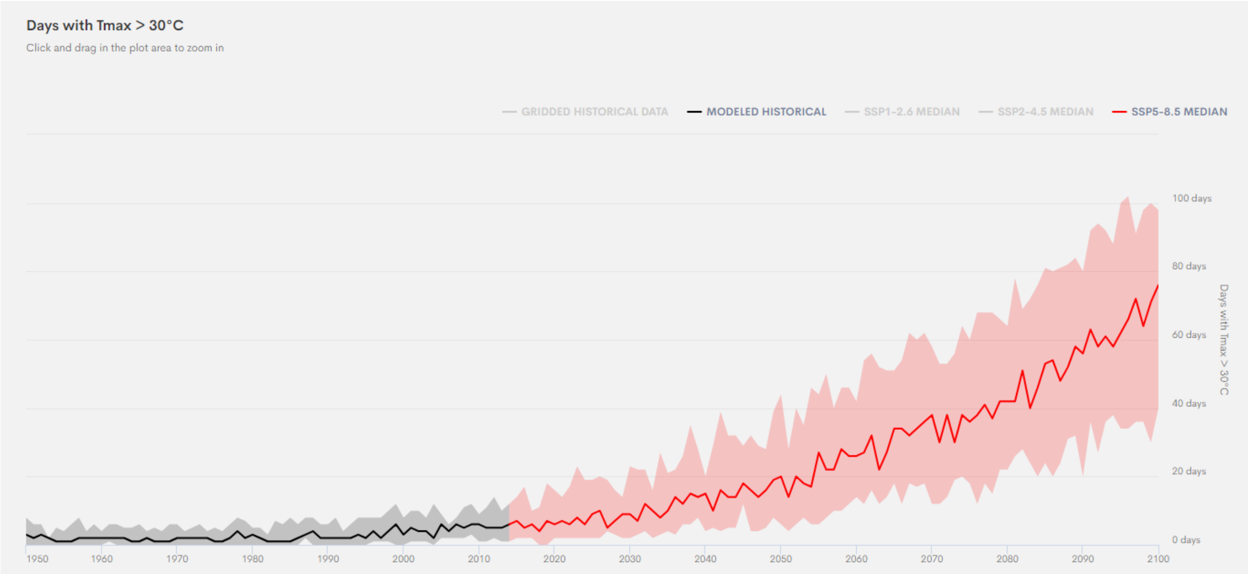


Figure 3-5: Projections for the number of days with Tmax greater than 30°C in the Summer (ClimateData.ca, 2023).

3.6 Freeze-Thaw Cycles

The investigation for freeze-thaw cycles is summarized as follows:

Index	▶ Number of Days with Max. Temp > 0°C and Min. Temp < 0°C. ▶ Index does not account for fluctuations that could occur on a longer timescale (e.g., over several days).	
Climate Change Processes	▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth. ▶ As average temperatures shift upwards, either or both daytime and nighttime temperatures may shift from below to above freezing, which impacts daily freeze-thaw cycles.	
Sources of Climate Information	▶ ClimateData.Ca used for baseline characterization, projections, and scoring.	
Projection Summary	▶ In the baseline period (1981-2010), the number of daily freeze-thaw cycles is approximately 75-80. ▶ An overall decrease in the number of annual freeze-thaw cycles is expected, decreasing to approximately 60 by the 2080s due to warming temperatures. ▶ However, it is noted that annual projected decreases may obscure potential increases in the shoulder seasons (e.g., increases in winter).	
Scoring Scale	▶ Scale #2: Percent Days.	
PIEVC Likelihood Scores	Baseline	3
	2030s	3
	2050s	3
	2080s	3

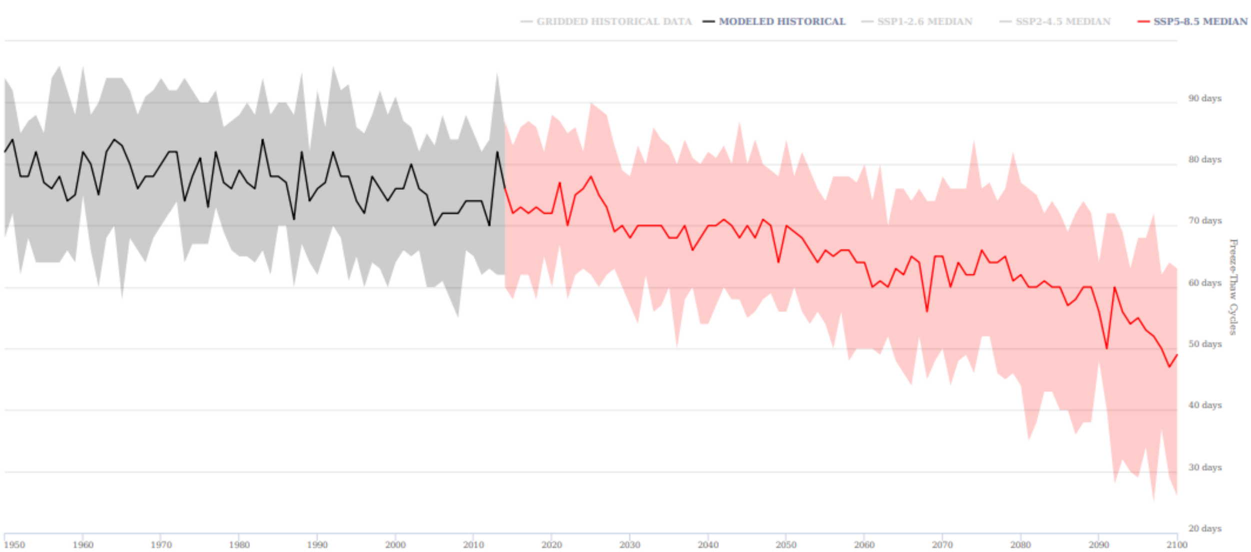


Figure 3-6: Projected Change in Freeze-thaw Cycles Over Time (Climatedata.ca

3.7 Ice Accretion Thickness

The investigation for ice accretion is summarized as follows:

Index	▶ Ice Accretion Thickness (1 in 20 year) – thickness of ice that accumulates on exposed surfaces from freezing precipitation.	
Climate Change Processes	▶ Freezing precipitation requires cold air near the earth's surface and warmer air higher in the atmosphere; the vertical temperature profile is affected by climate change. ▶ Ice accretion thickness is affected by other variables including surface wind speed and surface air temperature.	
Sources of Climate Information	▶ Cannon et al. (2020) and other literature used for projections. ▶ Cannon et al. (2020) used for scoring.	
Projection Summary	▶ The historical period has experienced increases in the frequency of freezing precipitation over northern parts of North America (Groisman et al. 2016). ▶ A decrease in the existing 1 in 20-year ice thickness is projected at the site and over northern parts of North America (Jeong et al. 2018, Cannon et al. 2020), due to a poleward shift of future freezing precipitation with climate change (Lambert and Hansen 2011, Klima and Morgan 2015).	
Scoring Scale	▶ Scale #1: Return Period.	
PIEVC Likelihood Scores	Baseline	3
	2030s	3
	2050s	2
	2080s	2

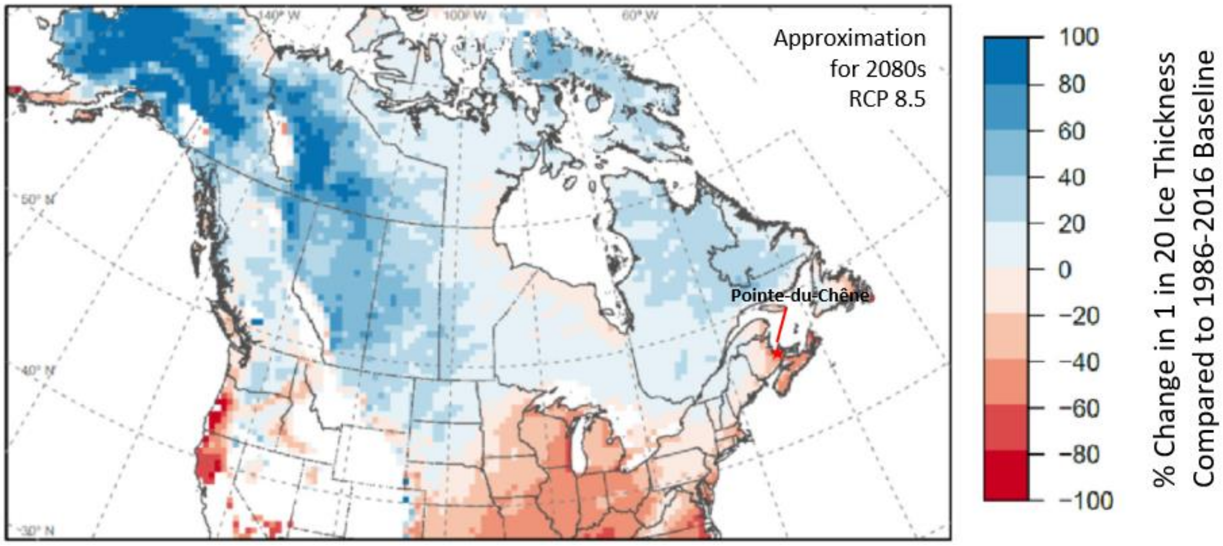


Figure 3-7: Projections for Ice Thickness (Cannon et al. 2020).

3.8 Snow Days

The investigation for snow days is summarized as follows:

Index	Number of Days with Snowfall Approximation > 10 cm.	
Climate Change Processes	More snow is projected to fall as rain due to warming annual/ seasonal temperatures.	
Sources of Climate Information	Environment Canada Climate Normals (Bouctouche Station ID#8100590). Statistically downscaled and bias-corrected CMIP6 data obtained through Cliamtedata.ca	
Projection Summary	ECCC climate normals indicate there are approximately 9 days per year with snowfall > 10 cm. As temperatures rise, mean annual snowfall is projected to decrease across most of eastern North America (Bush and Lemmen., 2019). This aligns with the statement from the IPCC that it is "very likely that snow cover will reduce as temperature rises over the next century". Scores reflect that the number of days with large snowfall amounts is expected to remain relatively consistent until the late century where decreases in frequency are anticipated.	
Scoring Scale	Scale #2: Percent Days.	
PIEVC Likelihood Scores	Baseline	3
	2030s	3
	2050s	3
	2080s	2

3.9 Winter Storms

The investigation for winter storms is summarized as follows:

Index	▶ Blowing and/or falling snow accompanied by sustained winds.
Climate Change Processes	▶ A warmer atmosphere can hold more moisture, which drives heavier precipitation, including heavier snowfall if the conditions are right. Therefore, climate change could theoretically result in higher snowfall extremes.
Sources of Climate Information	▶ McCray et al. (2023), and Bush and Lemmen (2019) used for trends and process-based projections of winter storm activity.
Projection Summary	▶ Historically, the region has experienced several large winter storm events such as those occurring in the years 2018, 2015, 1990, and 1984 where significant snowfall combined with winds resulted in power outages, tree damage from snow, accidents on roads, and service disruptions. ▶ Although mean annual snowfall is projected to decrease across most of eastern North America, intense high-impact snowfall events that are experienced in the current climate can be expected to continue to occur with warming surface temperatures (McCray et al., 2023). ▶ Models generally project a decrease in average snowfall, but high year-to-year variability makes it difficult to project changes in snow extremes and combination events (e.g., blowing snow). ▶ However, the theoretical increase in snowfall from increased atmospheric moisture will likely be moderated by rising surface temperatures at the site location, which would cause more snow to fall as rain. ▶ Projections for winter storms have high uncertainty and can be anticipated to continue to occur throughout late century.
Scoring Scale	▶ Scale #3: Qualitative.

PIEVC Likelihood Scores	Baseline	3
	2030s	3
	2050s	3
	2080s	3

3.10 Wildfire

The investigation for wildfire is summarized as follows:

Index	▶ Intensity and frequency of Wildfires.	
Climate Change Processes	▶ Climate change drivers that influence fires include changes to temperature, precipitation, snowmelt, wind, and groundwater (Littell *et al*. 2016). ▶ Climate change also impacts vegetation assemblages (affecting the amount of fuel available to burn), flammability (moisture state of the soil and vegetation), and disturbances (insect outbreaks and trees uprooted or broken by wind).	
Sources of Climate Information	▶ Natural Resources Canada Fire Behavior Normals and Canadian National Fire Database (CBFDB) for baseline characterization. ▶ Literature was used for baseline characterization, projections and scoring.	
Projection Summary	▶ Wildfires have historically rarely occurred in the project region according to the documented forest fire perimeters (1980-2021) published by Natural Resources Canada. ▶ It is predicted that the fire season will lengthen and that the number and extent of wildfires will increase, especially in boreal forest types (Wotton et al. 2010; Flannigan et al. 2013; Sankey 2018). ▶ Fires will be more intense including more fires that are difficult to suppress (Gaur et al. 2021). ▶ The proportion of days in fire seasons with the potential for unmanageable fire will increase (Wotton et al. 2017). ▶ Other projected trends include increases in fire size, area burned, and spread days (Coogan et al. 2019).	
Scoring Scale	▶ Scale #3: Qualitative.	
PIEVC Likelihood Scores	Baseline	1
	2030s	1
	2050s	2
	2080s	2

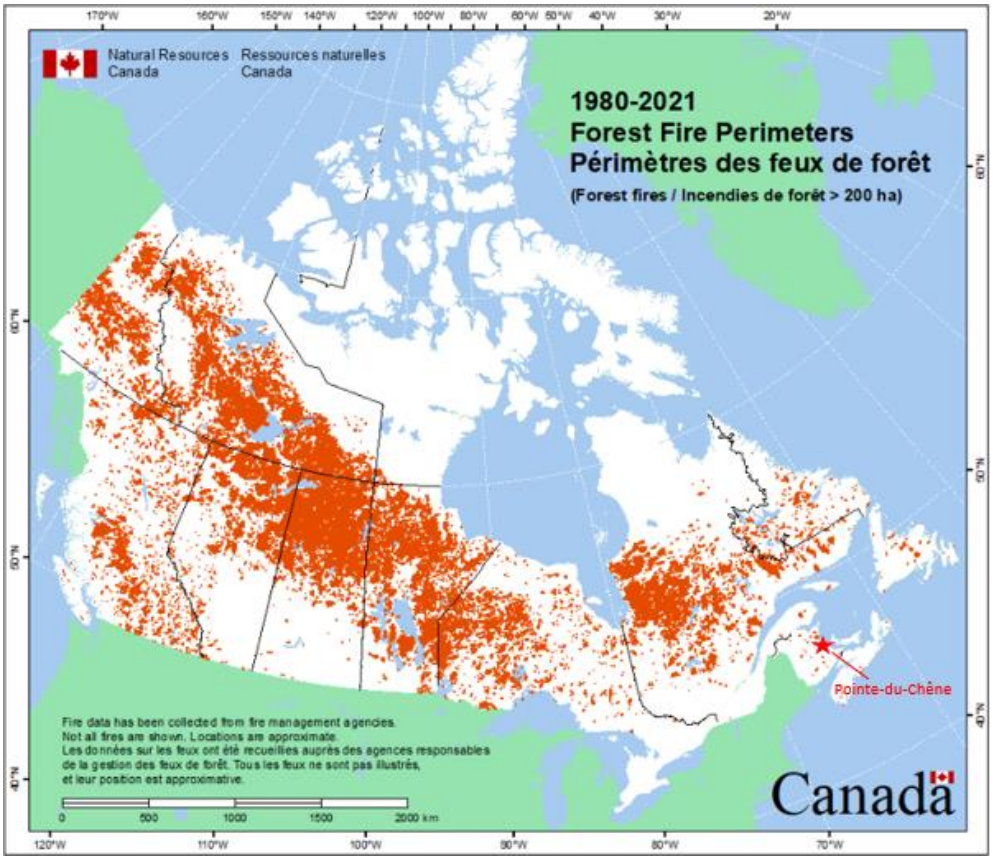


Figure 3-8: Historical Fire Perimeters (1980-2021) (Natural Resources Canada, 2022)

3.11 Drought

The investigation for drought is summarized as follows:

Index	▶ Drought Frequency and Intensity. ▶ Drought/ Moisture indices (e.g., Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI), Climate Moisture index (CMI)).
Climate Change Processes	▶ Water availability and scarcity is driven by rainfall, snowmelt, and temperature (evapotranspiration), among other things. ▶ Precipitation amount and intensity are projected to change. ▶ More snow will fall as rain due to warming. Change to the timing and rate of snow melt will also change due to warming. ▶ Modification of Earth's energy balance as greenhouse gases reflect more shortwave radiation back to Earth. ▶ An upwards shift of average temperatures means an increase in heat extremes and change in evapotranspiration.
Sources of Climate Information	▶ Literature was used for baseline characterization, projections, and scoring.
Projection Summary	▶ Overall, the exposure to drought in the Maritimes is low. Historically, the project region has typically experienced

	climate conditions classified as "wet" to "near normal" in terms of two drought indices: the Standardized Precipitation Index (SPI), Standardized Precipitation Evapotranspiration Index (SPEI) (El-Jabi and Caissie, 2019). ▶ The frequency of droughts could vary under climate change due to regional changes in precipitation and temperature. Within New Brunswick, there seems to be an increase in precipitation through winter and spring, while a moisture deficit may be experienced during the summer and autumn (Tam et al., 2018). Conversely, projections presented in Zhao et al., (2020) show a decreasing potential in future droughts due to projected increases in precipitation. ▶ Scoring was assigned conservatively to reflect the uncertainty in site specific of impacts of drought in the project region.
Scoring Scale	▶ Scale #3: Qualitative.

PIEVC Likelihood Scores	Baseline	1
	2030s	1
	2050s	2
	2080s	3

3.12 Lightning

The investigation for lightning is summarized as follows:

Index	▶ Average number of days with lightning (within 25 km)
Climate Change Processes	▶ Important factors include the moisture content of the air, changes in global circulation that may alter the location and frequency of large-scale storms, occurrence and characteristics of thunderstorms, and cloud ice particles.
Sources of Climate Information	▶ Baseline characterization based on ECCC ("Lightning activity in Canadian cities"). ▶ Literature was used for baseline characterization, projections, and scoring.
Projection Summary	▶ ECCC reports that cloud to ground lightning flashes occurring within a 25 km radius of Moncton, NB (closest record to Pointe-du-Chêne) occur on average approximately 17 days per year (~5% annual occurrence). ▶ The ECCC historical data (Figure 3-9) indicates Moncton may present less favorable conditions for lightning formation than most other major cities in Canada such as those located in southern Ontario and western Canada. ▶ The frequency of lightning strikes could increase under climate change due to an increase in the conditions favourable to lightning occurrence, such as an increase in Convective

	Available Potential Energy (Brooks, 2013; Huryn et al., 2016) and a larger potential vertical dimension of clouds (Agard and Emanuel, 2017). ▶ Presently, there is little scientific consensus on precisely how the frequency and intensity of lightning storms will be impacted by climate change, but consecutive building design should consider potential increases.	
Scoring Scale	▶ Scale #2: Percent days.	
PIEVC Likelihood Scores	Baseline	3
	2030s	3
	2050s	3
	2080s	3

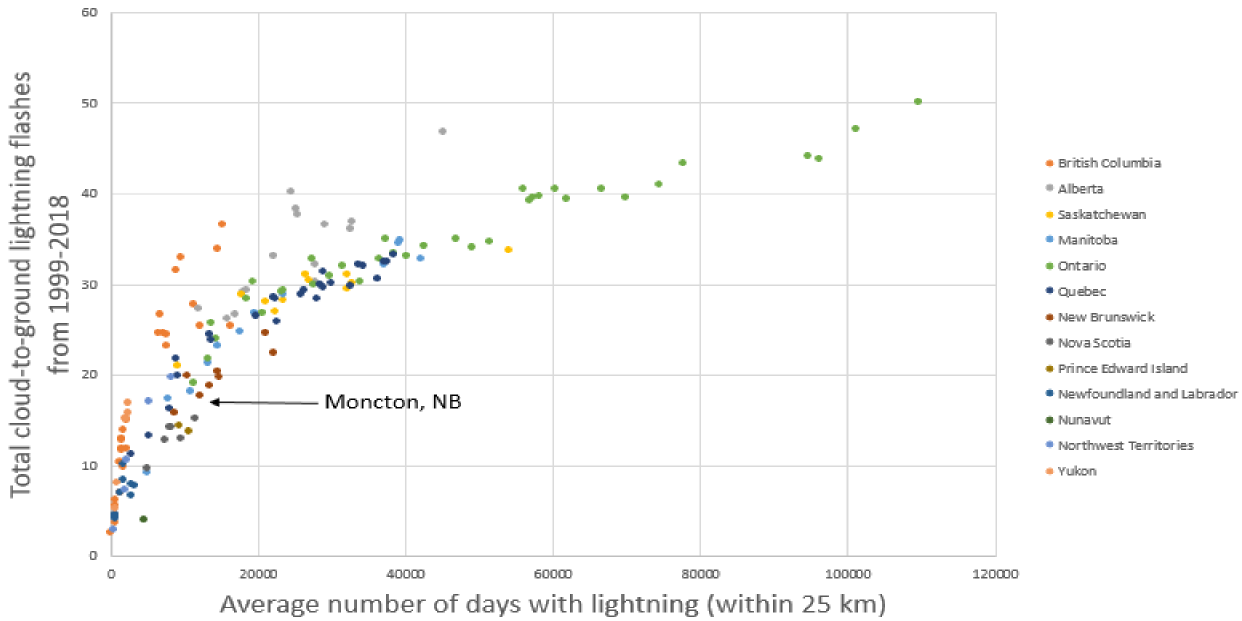


Figure 3-9: Baseline reference for Lightning (ECCC: Lightning activity in Canadian Cities). In comparison to other major Canadian cities.

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APPENDIX D

Risk Matrix

			Coastal																Precipitation															
Asset Group	Asset Subcomponent	Risk = L x C	Extreme Water Levels (SLR + Surge + Tides)												Hurricanes, Wind and Waves				Extreme Rainfall								Snowfall				Ice Accretion			
			Threshold 1 (1.3 m CGVD2013)				Threshold 2 (1.7 m CGVD2013)				Threshold 3 (2.0 m CGVD2013)								1 in 10 year 24 hour				1 in 100 year 24 hour				Days with Snow > 10 cm				1 in 20 year Ice Thickness			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
Coastal Environment	Parlee and Belliveau Beach Environment and Dunes	Interaction	Shoreline and dune erosion leading to reduced flood protection to the community. Possible additional beach nourishment and/or dune protection needed to return environment to its natural conditions. Aesthetic/reputational impacts that may impact tourism draw.												Dune/shoreline erosion leading to increased flood risk for community.				Overland flow that is unable to be captured by stormwater management infrastructure can contribute to water contamination.															
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	4				5				5				5				2				3											
		Risk	16	16	16	20	15	15	20	20	5	5	10	15	5	5	10	10	8	8	8	8	3	6	9	12	0	0	0	0	0	0	0	0
	Tidal Creek (inlet, channel, lagoon)	Interaction	Flooding of creek and surrounding area. Creek is protected from waves by the beach and dune system. Damage will be minimal. Siltation of tidal creek												Possible flooding of Tidal Creek and overflow into adjacent parking areas. Limited erosions as creek is protected from waves by the beach and dune system. Increased sedimentation leading to blocked channel, stagnant water, water quality implications, and possible increased dredging requirements.				Increased contamination of surface water from overland flow entering Tidal Creek area.															
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				3				3				4				4											
		Risk	8	8	8	10	6	6	8	8	3	3	6	9	3	3	6	6	16	16	16	16	4	8	12	16	0	0	0	0	0	0	0	0
	Coastal Wetlands	Interaction	Flooding of wetland area and any development or infrastructure within the wetland. Minimal damage to wetland environment itself which are flooded on a regular basis. Possible expansion of wetland area in the long term, which could have implications for development restrictions.												Minor erosion and sedimentation. Wetland areas are relatively well protected from wind and waves, minimizing potential damages.				Possible accelerated runoff and downstream erosion if wetlands are encroached on through development. Water quality impacts due to development in watershed															
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				2				2				3				3											
		Risk	8	8	8	10	6	6	8	8	2	2	4	6	2	2	4	4	12	12	12	12	3	6	9	12	0	0	0	0	0	0	0	0
Residential and Private Community Infrastructure	Residences	Interaction	Flooding of basement and damage to personal property. Damage to home exterior or displacement of exterior property elements due to overland flow and fast-moving debris. Debris deposited from adjacent properties requiring clean up. Homes located at a lower elevation are at a higher risk of impact.												Wind damage to exterior of property including roofing, siding, doors and windows. Possible damage from flying debris and downed trees.												Snow buildup on roof and property, potentially requiring removal to prevent structural damages.				Ice buildup on property. Removal required to avoid structural damage of health and safety incidents from falling ice.			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	3				4				4				5												2				2			
		Risk	12	12	12	15	12	12	16	16	4	4	8	12	5	5	10	10	0	0	0	0	0	0	0	0	6	6	6	4	6	6	4	4
	Coastal Protection Features (Armour Stone)	Interaction	Undermining of structure and displacement of materials. Water levels could exceed breakwater/riprap height reducing efficiency, and making infrastructure more susceptible to impacts from waves. . Areas where appropriate maintenance is not carried out are particularly vulnerable.												Wind driven waves could cause advanced deterioration and erosion to armour stone and breakwaters, reducing their ability to protect against adjacent property damage and flooding.				Increased extreme rainfall a consideration for stormwater outfalls				Increased extreme rainfall a consideration for stormwater outfalls											
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				3				4				1				2											
		Risk	8	8	8	10	6	6	8	8	3	3	6	9	4	4	8	8	4	4	4	4	2	4	6	8	0	0	0	0	0	0	0	0

			Coastal																Precipitation															
Asset Group	Asset Subcomponent	Risk = L x C	Extreme Water Levels (SLR + Surge + Tides)												Hurricanes, Wind and Waves				Extreme Rainfall								Snowfall				Ice Accretion			
			Threshold 1 (1.3 m CGVD2013)				Threshold 2 (1.7 m CGVD2013)				Threshold 3 (2.0 m CGVD2013)								1 in 10 year 24 hour				1 in 100 year 24 hour				Days with Snow > 10 cm				1 in 20 year Ice Thickness			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
Residential and Private Community Infrastructure	Potable Water Wells	Interaction	Temporary flooding of area surrounding well. Possible salt water infiltration into well causing temporary unsuitable water quality. Testing/intervention may be required to restore water supply.												Temporary flooding of area surrounding well. Possible salt water infiltration into well causing temporary unsuitable water quality. Testing/intervention may be required to restore water supply.				Possible flooding of area around well given existing stormwater managing and drainage issues in community.															
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	3				4				4				3				2				3											
		Risk	12	12	12	15	12	12	16	16	4	4	8	12	3	3	6	6	8	8	8	8	3	6	9	12	0	0	0	0	0	0	0	0
	Pointe du Chene Wharf	Interaction	Extreme water levels could impacts accessibility of the road (vehicle and pedestrian access point), potentially limiting operations.												Damage to erosion protection infrastructure. Differential water levels causing undermining of road structure. Extreme waves causing damage to marine infrastructure, problematic conditions for berthing and for passengers/crew accessing the pontoons and vessel. Operations could be temporarily stopped. Potential for significant repairs to be required. Note that severity scoring does not consider wharf upgrades that are currently in the planning phase.																			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				3				4				5																			
		Risk	8	8	8	10	9	9	12	12	4	4	8	12	5	5	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transportation	Road Network	Interaction	Flood risk impacting mobility throughout the town. Erosion and damage to roadways requiring repairs and debris cleanup.												Flood risk impacting mobility throughout the town. Erosion and damage to roadways requiring repairs and debris cleanup Increased maintenance to clear off wind-blown debris from surfaces and maintain transportation routes. Potential increased maintenance to clear localized flooding/ pooling of water from heavy rainfall. .				Localized ponding of water on roads. Noted to be a particular issue for dirt roads where extreme rainfall creates erosion issues and muddy conditions on roads, presenting challenges for vehicle access and emergency response.								Health and safety issues for car travel and pedestrians. Required snow removal operations. Wear and tear to asphalt and concrete surfaces from snow removal operations.				Health and safety issues for car travel and pedestrians. Required de-icing operations. Wear and tear to asphalt and concrete surfaces from de-icing operations.			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				3				4				3				2				3				2				2			
		Risk	8	8	8	10	9	9	12	12	4	4	8	12	3	3	6	6	8	8	8	8	3	6	9	12	6	6	6	4	6	6	4	4
	Critical Community Access Pointes (Pointe du Chene Road Bridge, Parlee Beach)	Interaction	Flooding or damage to critical access points for low-lying areas can restrict movement of emergency vehicles and hinder community evacuation. The Pointe-du-Chene Road Bridge is currently suitable for maintain access during most extreme water levels events, however limited other access routes exist creating a public health and safety concern.																Localized ponding of water on roads. Noted to be a particular issue for dirt roads where extreme rainfall creates erosion issues and muddy conditions on roads, presenting challenges for vehicle access and emergency response.								Health and safety issues for car travel and pedestrians. Required snow removal operations. Wear and tear to asphalt and concrete surfaces from snow removal operations.				Health and safety issues for car travel and pedestrians. Required de-icing operations. Wear and tear to asphalt and concrete surfaces from de-icing operations.			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				2				3				2				2				2				2			
		Risk	8	8	8	10	6	6	8	8	2	2	4	6	3	3	6	6	8	8	8	8	2	4	6	8	6	6	6	4	6	6	4	4

Asset Group	Asset Subcomponent	Risk = L x C	Coastal																Precipitation															
			Extreme Water Levels (SLR + Surge + Tides)												Hurricanes, Wind and Waves				Extreme Rainfall								Snowfall				Ice Accretion			
			Threshold 1 (1.3 m CGVD2013)				Threshold 2 (1.7 m CGVD2013)				Threshold 3 (2.0 m CGVD2013)								1 in 10 year 24 hour				1 in 100 year 24 hour				Days with Snow > 10 cm				1 in 20 year Ice Thickness			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
Sanitary and Stormwater Management	Municipal Sanitary Collection System (underground pipes, manholes, lift stations)	Interaction	Capacity issues related to water infiltration into sanitary system during flooded conditions. Overflow of systems from lift stations contributing to water quality issues. Possible flooding of low-lying lift stations and generators that could lead to additional overflows during power outages. Municipal system may back into peoples basement, particularly during high tide.																Capacity issues related to water infiltration into sanitary system during extreme rainfall events. Additional capacity issues resulting form illegal stormwater connections to the sanitary system at residences. Possible overflowing at lift stations which can contribute to water quality issues.												Ice buildup could damage SCADA system that is used for reporting and monitoring flows, resulting in possible overlooked capacity issues and overflows.			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	4				4				5				4				4				4								2			
		Risk	16	16	16	20	12	12	16	16	5	5	10	15	4	4	8	8	16	16	16	16	4	8	12	16	0	0	0	0	6	6	4	4
	Stormwater Collection System (ditches and culverts)	Interaction	Lack of municipal stormwater infrastructure limits drainage capabilities and leads to localised pooling of water in low-lying areas where water is unable to drain. Where stormwater management features such as drains and culverts do exist, flooding events can lead to increased sedimentation and debris blocking drainage pathways.																Increased overland flow due to lack of stormwater management infrastructure, possibly contributing to surface water contamination in the community. Localized pooling of water on properties.				Flooding causing the system to become overwhelmed. Debris blocking catch basins. Basement flooding if drains are connected to storm sewer											
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				3				2				3				4											
		Risk	8	8	8	10	6	6	8	8	3	3	6	9	2	2	4	4	12	12	12	12	4	8	12	16	0	0	0	0	0	0	0	0
Emergency Services and Public Safety	Emergency Preparedness and Management	Interaction	Potential flooding or erosion that could lead to reduced access to critical services and reduced mobility throughout the community for emergency and other critical services. Potential for isolation residential areas without access to essential services.												Potential infrastructure damage to essential services, e.g. hospital. Potential access issues due to debris. Unsafe working/driving conditions during event. Health and safety risk. Potential for increased request for services.				Potential localized flood, particularly homes/buildings in depression areas. Possible reduced access to critical services and reduced mobility throughout the community for emergency and other critical services.												Possible power outages lasting for extended period of time. Emergency warming centres could be required.			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	4				5				5				5				2				3								3			
		Risk	16	16	16	20	15	15	20	20	5	5	10	15	5	5	10	10	8	8	8	8	3	6	9	12	0	0	0	0	9	9	6	6
	Electrical Infrastructure	Interaction	Possible damage to infrastructure resulting in prolonged power outages												Possible damage to infrastructure resulting in prolonged power outages				Possible damage to infrastructure resulting in prolonged power outages												Possible damage to infrastructure resulting in prolonged power outages			
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	2				2				3				3				2				3								3			
		Risk	8	8	8	10	6	6	8	8	3	3	6	9	3	3	6	6	8	8	8	8	3	6	9	12	0	0	0	0	9	9	6	6
Land Use and Policies	Development practices	Interaction	Structures which are built in the flood plain are at risk of flooding and associated damages. Development in wetland would reduce efficiently of flood protection.												Structures which are built in the flood plain are at risk of flooding and associated damages. Coastal adjacent properties are at additional risk of damage from waves and storm surge.				Increased development in sensitive areas could lead to increased runoff, creating erosion and water quality issues for downstream environments. This is of particular concern in protected areas such as wetlands.															
		Likelihood	4	4	4	5	3	3	4	4	1	1	2	3	1	1	2	2	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
		Consequence	3				3				4				3				2				2											
		Risk	12	12	12	15	9	9	12	12	4	4	8	12	3	3	6	6	8	8	8	8	2	4	6	8	0	0	0	0	0	0	0	0

			Temperature								Other Hazards															
Asset Group	**Asset Subcomponent**	**Risk = L x C**	**Extreme Temperatures**				**Freeze-Thaw Cycles**				**Winter Storms**				**Lightning**				**Wildfire**				**Drought**			
			Days > 30C in Summer				**Annual Freeze-Thaw Events**				**wind and waves (not hurricane driven)**				**Lightning Strikes within 25km**				**Frequency and Intensity of Wildfire**				**Frequency and Intensity of Drought**			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	**2**	**3**	**3**	**4**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**2**	**2**	**1**	**1**	**2**	**3**
Coastal Environment	Parlee and Belliveau Beach Environment and Dunes	Interaction	Increased occurrences of public health and safety incidents such as heat stroke. Exacerbated water contamination issues. It is noted that numerous initiatives are underway by the Shediac Bay Watershed Association and the Provincial Government to improve water quality.																							
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence	2																							
		Risk	4	6	6	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tidal Creek (inlet, channel, lagoon)	Interaction																								
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence																								
		Risk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coastal Wetlands	Interaction																								
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence																								
		Risk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential and Private Community Infrastructure	Residences	Interaction									Wind damage to exterior of property including roofing, siding, doors and windows. Possible damage from flying debris and downed trees. Snow built-up on roof presenting possible structural implications. Snow drifting on property requiring cleanup and removal.				Possible fire risk in the event of a direct strike.				Widespread property damage from interaction with wildfire.							
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence									3				3				5							
		Risk	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	5	5	10	10	0	0	0	0
	Coastal Protection Features (Armour Stone)	Interaction					Wear and tear to concrete																			
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence					2																			
		Risk	0	0	0	0	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

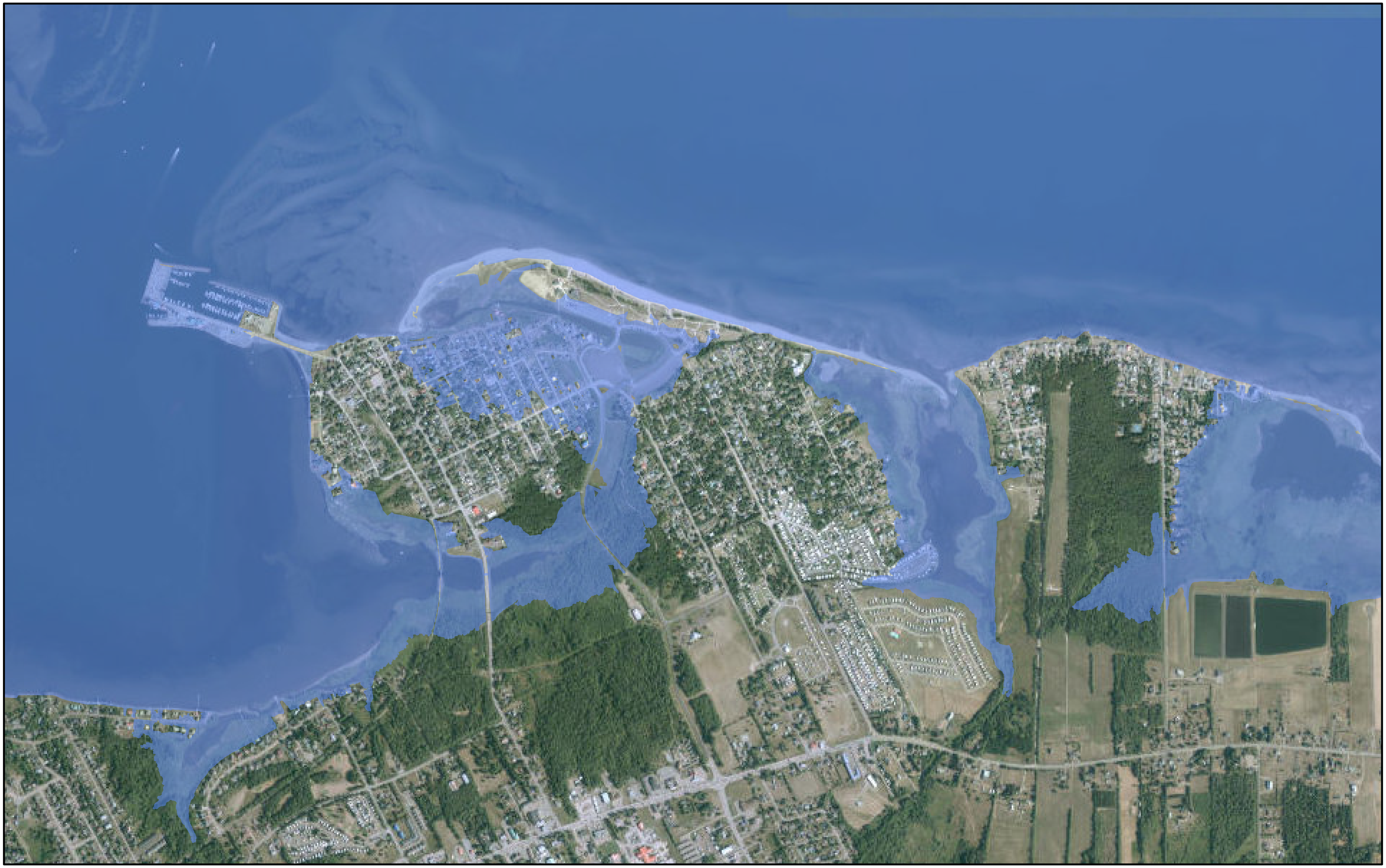
			Temperature								Other Hazards															
Asset Group	Asset Subcomponent	Risk = L x C	Extreme Temperatures				Freeze-Thaw Cycles				Winter Storms				Lightning				Wildfire				Drought			
			Days > 30C in Summer				Annual Freeze-Thaw Events				wind and waves (not hurricane driven)				Lightning Strikes within 25km				Frequency and Intensity of Wildfire				Frequency and Intensity of Drought			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
Residential and Private Community Infrastructure	Potable Water Wells	Interaction									Possible power outages that render pumps inoperable, temporarily restricting water supply.												Reduced/unreliable water supply during prolonged periods of drought.			
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence									3												2			
		Risk	0	0	0	0	0	0	0	0	9	9	9	9	0	0	0	0	0	0	0	0	2	2	4	6
	Pointe du Chene Wharf	Interaction													Possible infrastructure damage from lightning strike. Possible health and safety risk.											
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence													2											
		Risk	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6	0	0	0	0	0	0	0	0
Transportation	Road Network	Interaction					Melting and re-freezing of water in cracks causing expansion of cracks, frost heave, weathering, spalling, and deterioration of concrete or asphalt over time reducing it's service life and requiring increased maintenance over time.				Health and safety issues for car travel and pedestrians. Snow accumulation on roads, snow clearing necessary. Wear and tear to asphalt and concrete surfaces from snow clearing and de-icing operations.															
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence					2				2															
		Risk	0	0	0	0	6	6	6	6	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0
	Critical Community Access Pointes (Pointe du Chene Road Bridge, Parlee Beach)	Interaction					Melting and re-freezing of water in cracks causing expansion of cracks, frost heave, weathering, spalling, and deterioration of concrete or asphalt over time reducing it's service life and requiring increased maintenance over time.				Health and safety issues for car travel and pedestrians. Snow accumulation on roads, snow clearing necessary. Wear and tear to asphalt and concrete surfaces from snow clearing and de-icing operations.															
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence					2				2															
		Risk	0	0	0	0	6	6	6	6	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0

			Temperature								Other Hazards															
Asset Group	Asset Subcomponent	Risk = L x C	Extreme Temperatures				Freeze-Thaw Cycles				Winter Storms				Lightning				Wildfire				Drought			
			Days > 30C in Summer				Annual Freeze-Thaw Events				wind and waves (not hurricane driven)				Lightning Strikes within 25km				Frequency and Intensity of Wildfire				Frequency and Intensity of Drought			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
Sanitary and Stormwater Management	Municipal Sanitary Collection System (underground pipes, manholes, lift stations)	Interaction	Possible odour issues in extreme temperatures																							
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence	1																							
		Risk	2	3	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Stormwater Collection System (ditches and culverts)	Interaction																								
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence																								
		Risk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emergency Services and Public Safety	Emergency Preparedness and Management	Interaction	Increased occurrences of extreme hot temperatures can lead to heat related illness, such as dehydration, heat exhaustion, heat cramps, and heat stroke								Potential access issues due to debris and snow drifting. Unsafe working/driving conditions during event. Potential for increased request for services.				Possible lightning strike resulting in fire or infrastructure damage. Direct health and safety risk Note that there is no fire water supply in PDC.				Increased demand on emergency services. Access issues Note that there is no fire water supply in PDC							
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence	2								4				2				5							
		Risk	4	6	6	8	0	0	0	0	12	12	12	12	6	6	6	6	5	5	10	10	0	0	0	0
	Electrical Infrastructure	Interaction									Possible damage to infrastructure resulting in prolonged power outages				Possible damage to infrastructure resulting in prolonged power outages				Possible damage to infrastructure resulting in prolonged power outages							
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence									3				3				3							
		Risk	0	0	0	0	0	0	0	0	9	9	9	9	9	9	9	9	3	3	6	6	0	0	0	0
Land Use and Policies	Development practices	Interaction																								
		Likelihood	2	3	3	4	3	3	3	3	3	3	3	3	3	3	3	3	1	1	2	2	1	1	2	3
		Consequence																								
		Risk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX E

Government of New Brunswick Flood Mapping

Present Day Flood: 1 in 20-year (5% Annual Exceedance Probability)



2/7/2024, 11:18:48 AM

Current condition (5% AEP Flood Extent) - Pop Up	Climate change (5% AEP Flood Extent) - Pop Up	HHWLT 2100 - Pop Up
312.756	312.922	8.58613
2.00931	0.612371	1.4
Current condition (1% AEP Flood Extent) - Pop Up	**Climate change (1% AEP Flood Extent) - Pop Up**	**Digital Elevation Model (DEM)**
312.87	312.951	815.107
-1.93259	2.14335	-48.9933

1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Service New Brunswick / Service Nouveau-Brunswick

GeoNB

This map is a graphical representation which approximates the size, configuration and location of features. This map is not intended to be used for legal descriptions or to calculate exact dimensions or area.

Present Day Flood: 1 in 100-year (1% Annual Exceedance Probability)

2/7/2024, 11:18:09 AM

Current condition (5% AEP Flood Extent) - Pop Up	Climate change (5% AEP Flood Extent) - Pop Up	HHWLT 2100 - Pop Up
312.756	312.922	8.58613
2.00931	0.612371	1.4
Current condition (1% AEP Flood Extent) - Pop Up	**Climate change (1% AEP Flood Extent) - Pop Up**	**Digital Elevation Model (DEM)**
312.87	312.951	815.107
-1.93259	2.14335	-48.9933

1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Service New Brunswick / Service Nouveau-Brunswick

GeoNB

This map is a graphical representation which approximates the size, configuration and location of features. This map is not intended to be used for legal descriptions or to calculate exact dimensions or area.

2100 Flood with Climate Change: 1 in 20-year (5% Annual Exceedance Probability)

2/7/2024, 11:19:58 AM

Current condition (5% AEP Flood Extent) - Pop Up	Climate change (5% AEP Flood Extent) - Pop Up	HHWLT 2100 - Pop Up
312.756	312.922	8.58613
2.00931	0.612371	1.4
Current condition (1% AEP Flood Extent) - Pop Up	**Climate change (1% AEP Flood Extent) - Pop Up**	**Digital Elevation Model (DEM)**
312.87	312.951	815.107
-1.93259	2.14335	-48.9933

1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Service New Brunswick / Service Nouveau-Brunswick

GeoNB

This map is a graphical representation which approximates the size, configuration and location of features. This map is not intended to be used for legal descriptions or to calculate exact dimensions or area.

2100 Flood with Climate Change: 1 in 100-year (1% Annual Exceedance Probability)

2/7/2024, 11:21:27 AM

Current condition (5% AEP Flood Extent) - Pop Up	Climate change (5% AEP Flood Extent) - Pop Up	HHWLT 2100 - Pop Up
312.756	312.922	8.58613
2.00931	0.612371	1.4
Current condition (1% AEP Flood Extent) - Pop Up	**Climate change (1% AEP Flood Extent) - Pop Up**	**Digital Elevation Model (DEM)**
312.87	312.951	815.107
-1.93259	2.14335	-48.9933

1:18,056

0 0.15 0.3 0.6 mi

0 0.25 0.5 1 km

Service New Brunswick / Service Nouveau-Brunswick

GeoNB

This map is a graphical representation which approximates the size, configuration and location of features. This map is not intended to be used for legal descriptions or to calculate exact dimensions or area.

2100 Higher High Water Large Tide (HHWLT)

2/7/2024, 11:22:29 AM

Current condition (5% AEP Flood Extent) - Pop Up	Climate change (5% AEP Flood Extent) - Pop Up	HHWLT 2100 - Pop Up
312.756	312.922	8.58613
2.00931	0.612371	1.4

Current condition (1% AEP Flood Extent) - Pop Up	Climate change (1% AEP Flood Extent) - Pop Up	Digital Elevation Model (DEM)
312.87	312.951	815.107
-1.93259	2.14335	-48.9933

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APPENDIX F

Summary of Action Items

Action Item and Description		Lead	Supported By	Timeframe Ongoing: Underway Short Term: 1-2 years Medium Term: 3-4 years Long Term: 5 years	Level of Effort Low: Easy to implement Moderate: Doable, but difficult High: Very Difficult	Progress Tracking
Emergency Management						
5.1.1	**Update and testing of Municipal Emergency Preparedness Plan to officially incorporate Pointe-du-Chêne**	Town of Shediac	Community emergency management organizations (EMOs) NB Emergency Measures Organization	Short Term	Low	◯ In progress ◯ Completed
5.1.2	**Communication of Emergency Preparedness Details to Public**	Town of Shediac	Community EMOs	Short-term	Low	◯ In progress ◯ Completed
5.1.3	**Expansion of Shediac's Senior Resident Registration Program**	Shediac Fire Department	Town of Shediac	Ongoing	Low	◯ In progress ◯ Completed
Coastal Flooding						
5.2.1	**Community-Wide Coastal Assessment to Investigate Options for Flood Mitigation**	Town of Shediac	NB Provincial Government Departments Red Dot Association of Shediac Bay	Short Term	High	◯ In progress ◯ Completed
5.2.2	**Preserving Parlee Beach and Dune System**	NB Department of Tourism and Environment	Town of Shediac	Short Term	Moderate	◯ In progress ◯ Completed

5.2.3	**Preserving Belliveau Beach and Dune System**	Various Organizations: • Town of Shediac • Property Owners • Shediac Bay Watershed Association • Volunteer Groups • New Brunswick Department of Tourism and Environment		Short Term	High	◯ In progress ◯ Completed
5.2.4	**Resident Education and Preparedness**	Town of Shediac	SERSC	Ongoing	Low	◯ In progress ◯ Completed
5.2.5	**Enforcement of Development Restrictions Long-term Land Use Planning**	Town of Shediac	N/A	Ongoing	Low	◯ In progress ◯ Completed
			Transportation Asset Management			
5.3.1	**Establish Clear Road Maintenance Responsibilities**	Town of Shediac	N/A	Short Term	Moderate	◯ In progress ◯ Completed
5.3.2	**Develop a Minimum Maintenance Standard for Private Road Maintenance**	Town of Shediac	Landowners NB Department of Transportation and Infrastructure	Medium Term	Moderate	◯ In progress ◯ Completed
5.3.3	**Proactive Infrastructure Upgrades to Incorporate Climate Change Projections**	Town of Shediac NB Department of Transportation and Infrastructure Landowners		Ongoing	Moderate	◯ In progress ◯ Completed

Extreme Rainfall and Stormwater Management						
5.4.1	**Develop a Community-Wide Stormwater Management Plan**	Town of Shediac	SBWA SERSC	Short Term	Moderate	◯ In progress ◯ Completed
5.4.2	**Maintenance of existing stormwater management infrastructure**	Town of Shediac	Landowners NB Department of Transportation and Infrastructure	Short Term	Moderate	◯ In progress ◯ Completed
5.4.3	**Property Owner Education and Awareness**	Red Dot Association of Shediac Bay	Town of Shediac SBWA SERSC	Medium Term	Low	◯ In progress ◯ Completed
Tidal Creek Drainage and Surface Water Quality						
5.5.1	**Dredging and Maintenance of Tidal Creek and associated Monitoring**	NB Department of Tourism, Heritage, and Culture	N/A	Ongoing	Moderate	◯ In progress ◯ Completed
Municipal Wastewater Management						
5.6.1	**Continued Upgrades to Sanitary Infrastructure that Incorporate Climate Change Projections**	GSSC	N/A	Ongoing	Moderate	◯ In progress ◯ Completed
5.6.2	**Identification of Illegal Stormwater Connections**	GSSC	N/A	Medium Term to Long Term	High	◯ In progress ◯ Completed

5.6.3	**Public Education on Negative Impacts of Stormwater Connections**	GSSC	Town of Shediac	Medium Term	Low	◯ In progress ◯ Completed
Pointe-du- Chêne Wharf Upgrades						
5.7.1	**Incorporate climate change projections into future upgrades**	Pointe-du-Chêne Wharf Management	N/A	Ongoing	Low	◯ In progress ◯ Completed

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