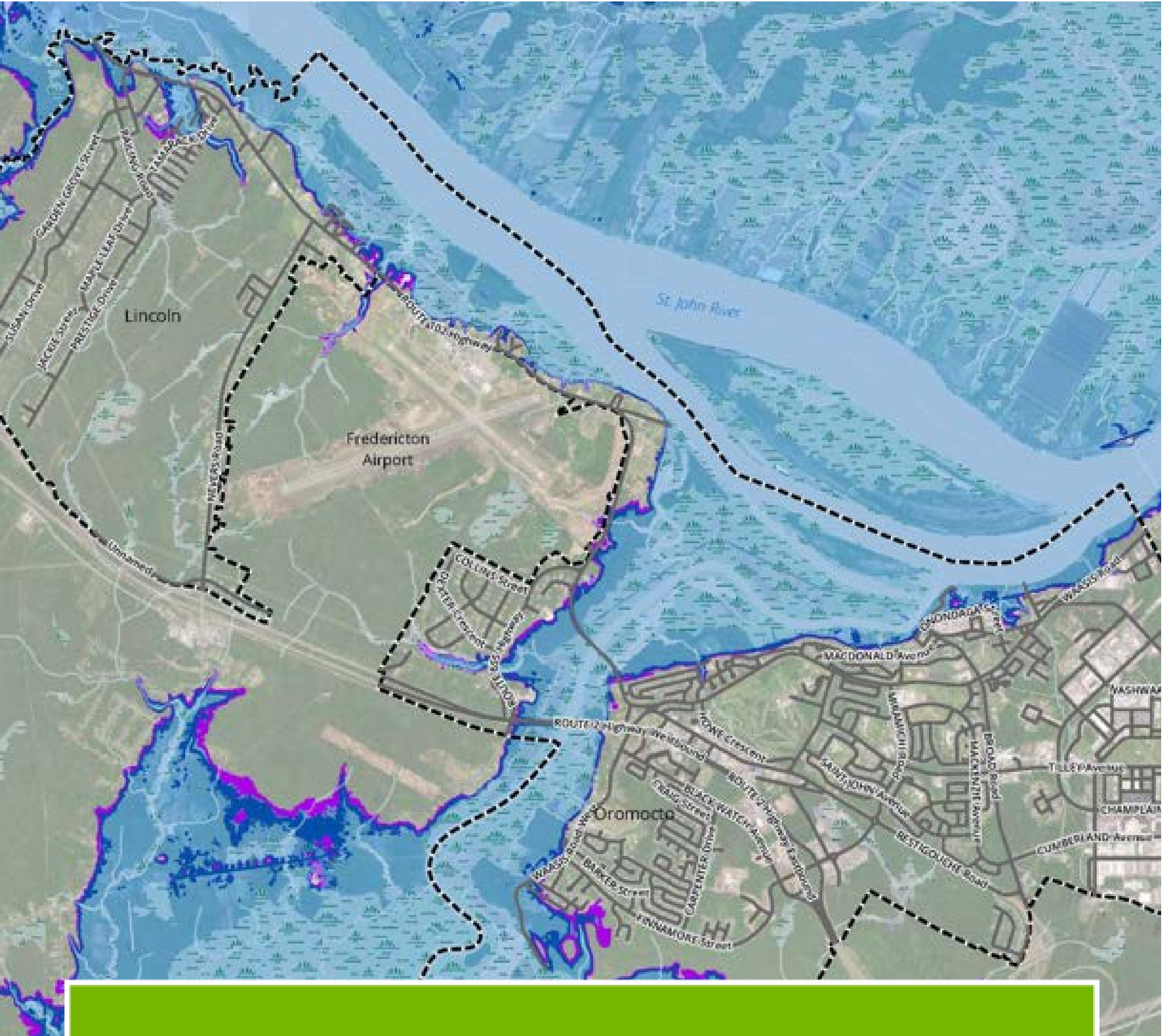

Municipal Climate Change Adaptation Plan
Oromocto, New Brunswick

Final Report

233287.00 • March 2024

CBCL

Canada's Model Town OROMOCTO

OROMOCTO Engineering & Public Works

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CBCL

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March 28, 2024

Dallas Gillis
Director of Planning & Compliance
Town of Oromocto
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Email: dgillis@oromocto.ca

Dear Dallas:

RE: Oromocto Climate Change Adaptation Plan

The Oromocto Climate Change Adaptation Plan includes an evaluation of climate change and extreme weather impacts on the Town's infrastructure, assets, and environment. The attached final report provides an adaptation plan for the highest ranked climate change and extreme weather-related vulnerabilities, including flooding, wildfire, extreme temperatures, and drought.

Yours very truly,

CBCL Limited

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Project No.: 233287.00

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Executive Summary

The Town of Oromocto has been awarded a grant from the New Brunswick Environmental Trust Fund for the development of a Climate Change Adaptation Plan (CCAP). The purpose of the CCAP is to provide a plan to support a resilient and sustainable future for Oromocto by addressing the risks posed by climate change through prioritized actionable items.

The Town of Oromocto engaged CBCL Limited to complete the CCAP to address climate change and extreme weather vulnerabilities for key areas of the Town. Areas of the Town studied in the assessment include municipal infrastructure (sanitary collection and treatment system, water distribution systems, transportation systems, and natural environment (trails, parks), municipal buildings, emergency services and development and planning practices.

A risk assessment, following the Public Infrastructure Engineering Vulnerability Assessment (PIEVC) Protocol, was completed. An analysis of climate change parameters for riverine flooding, temperatures, wind, and precipitation among others are presented. The resulting impacts, identified as extreme or high risk through the assessment's time frames, and addressed in the adaptation plan are summarized below:

- Flooding impacts to transportation, sanitary and water systems.
- Wildfire impacts to the community and emergency services.
- Extreme temperatures and drought impacts to emergency services and water supply.

Adaptation options and actions are presented for Oromocto's at-risk infrastructure to prioritize future adaptation and resilience investments. The adaption plan aims to increase community resilience to climate change and inform future municipal planning by assigning adaptation actions with an estimated time frame for implementation, and high-level cost or level of effort estimation.

1 Introduction

Climate change is changing the way municipalities across Canada address and maintain their infrastructure. Climate throughout New Brunswick has notably changed over the past several decades to warmer, wetter, and stormier conditions, posing challenges for local communities. A Climate Change Adaptation Plan (CCAP) considers potential future climate changes along with existing infrastructure and community programs to identify areas at high risk of being impacted by climate change.

The Town of Oromocto (Oromocto) has been awarded a grant from the NB Environmental Trust Fund (ETF) for the development of a CCAP. The project is led by the Planning and Compliance office with involvement from the Town's Climate Action Committee and participation from Town Departments as part of a steering committee.

Figure 1.1: Flooding in Oromocto, 2008 (Town of Oromocto, 2008).

1.1 Climate Change Adaptation

Climate Change Adaptation in a municipality is crucial to proactively addressing and mitigating the impacts of climate change on various aspects of the local environment, economy, and community well-being. The primary objective of a CCAP is to provide a roadmap in order to safeguard critical infrastructure, natural resources, and economic sectors that may be particularly susceptible to the adverse impacts of climate change (New Brunswick Department of Environment and Local Government, 2023). By identifying these vulnerabilities, communities can develop and implement effective strategies to enhance resilience and adapt to the changing climate conditions.

The purpose of the CCAP is to provide a plan to support a resilient and sustainable future for Oromocto by addressing the risks posed by climate change through prioritized actionable items.

1.2 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 ((New Brunswick Department of Environment and Local Government, 2023). This direction includes conducting a risk and vulnerability assessment to identify key climate-asset interactions for the community.

For the risk and vulnerability assessment the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Protocol was applied. The PIEVC Protocol was developed by Engineers Canada and consists of a standardized process for assessing infrastructure vulnerabilities. The 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, interactions identified as high or extreme risks are prioritized for adaptation planning by developing a set of actionable options aimed at reducing risk associated with the potential climate impacts. Adaptation actions typically involve, but are not limited to:

- Recommendations for upgrading or investing in infrastructure;
- Increasing public awareness;
- Improving or expanding on existing municipal services;
- Adjustment or enactment of municipal bylaws of policy; and/or
- Initiating additional studies to further inform climate risk or to develop adaptation measures.

2 Background

2.1 Overview of Oromocto

Oromocto is situated along the Saint John River at the mouth of the Oromocto River, in Sunbury County, New Brunswick. Located adjacent to the Canadian Forces Base Gagetown (the Base), Oromocto shares or is serviced by some essential Base owned and operated infrastructure, including the water treatment plant, and one wastewater treatment plant. Much of the electrical service within the Town is located underground. This attention to aesthetic is part of why the Town became known as “Canada’s Model Town” as it quickly developed to accommodate the influx of military personnel in the 1950s.

Today, Oromocto is characterized by its expansive natural environment, including community parks, trails, and significant wetlands. With the inclusion of Lincoln, the Town of Oromocto has a population of 11,486 (Statistics Canada , 2021). Recently conducted Province of New Brunswick governance reform in 2021, saw the Town of Oromocto and the previous Local Service District of Lincoln merged into one local municipal government. Figure 2, on the following page, provides an overview of the former boundaries of Lincoln and Oromocto, with the Oromocto First Nation and federal lands identified.

Historically, the Oromocto area has been vulnerable to flooding from the adjacent Saint John River. The Oromocto area also has a significant forest-urban interface that poses risks of wildfire. This CCAP will address these key climate vulnerabilities and support the community’s ongoing initiatives and goals for sustainable and resilient development.

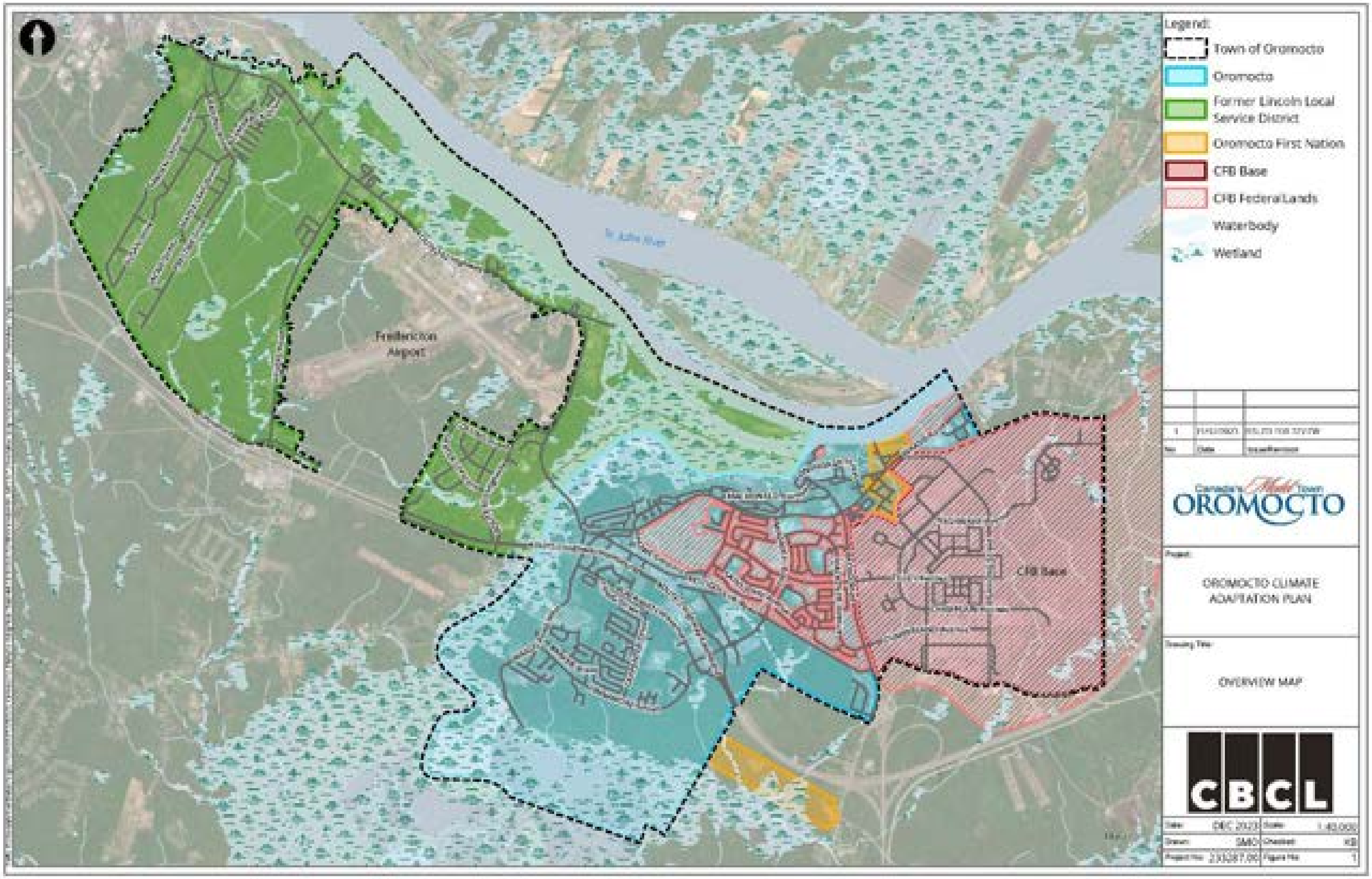

Figure 2.1: Overview Map of Oromocto

2.2 Data Collection

To inform the risk assessment and development of adaptation actions, several resources were used to gather information on existing assets in Oromocto and their potential vulnerabilities to climate change. Information was gathered from the background data, discussions with municipal representatives, and the professional judgment of the risk assessment team.

The following documents and data were used to formulate the basis of knowledge for this assessment:

- **Asset Management Plan Town of Oromocto (2018)**: Completed by CBCL Limited in 2018, the report meets the requirements for a Phase I Asset Management Plan. Provided context for Town infrastructure and potential concerns.
- **Town of Oromocto Municipal Plan (2016)** and associated documents including the following;
    - 510-a-municipal-plan;
    - 510-c-municipal-plan;
    - Proposed municipal plan by-law 510-d; and
    - Future Land Use Map – Schedule "B".
- **GIS Data (2023):** CBCL reviewed a variety of GIS Data provided by the Town. This included:
    - Water system infrastructure including; water mains, fire hydrants, valves, wells and tanks.
    - Administration boundaries including; including federal lands, CFB Base, First Nations, Oromocto Boundary, Lincon Boundary.
    - Building footprints.
    - Road network including; road centerline, road extents, and curb and gutter;
    - Provincial hydrology layers including, wetlands, 30m wetland buffers, watercourses, and water bodies.
    - Land Use in Oromocto.
    - Zoning in Lincon.
- **Sanitary Sewer Collection System Model and Data (2023):** CBCL is in the process of developing a sanitary sewer collection system model for Oromocto. The model provided insight into sewer system capacity restrictions and limitations now as well as with climate change and proposed development.
- **Storm Water Management System Data (2023**): Oromocto is currently in the process of updating the GIS system with detailed information on the storm water management system (i.e. piped system, culverts, ditches, etc.) as well as natural stormwater features (i.e. wetlands).
- **Oromocto West WWTP Capacity Assessment (2023):** In 2023, CBCL assessed the capacity of the Oromocto West wastewater treatment plant (WWTP).

- **Relevant New Brunswick Provincial Flood Data (2022):** Downloaded from Province of New Brunswick (GeoNB online source).
- **Oromocto Fire Service Review, Transitional Solutions (2023).**
- **Preliminary Groundwater Supply Investigation – Town of Oromocto, NB, Hydrostrata (2024).**

The goal of the data collection and review phase of the project was to inform and develop a relevant asset list and to gather historical information concerning the assets. The following was taken into consideration for the identified assets:

- 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.

2.3 Limitations

The findings and recommendations are based on information collected to date at the time of writing. Some information was available for the former LSD of Lincoln; however, the area lacks a comprehensive GIS dataset comparable to the one available for the Town of Oromocto. It is noted that in the future, when such data is available that this assessment may be revisited to update the infrastructure specific risks and better capture the risks specific to Lincoln assets.

2.4 Key Assets and Infrastructure

Based on the detailed literature review conducted and feedback received from Town representatives, 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 to facilitate discussion and assessment of risk. The assets included in the assessment are summarized in the following **Table 2.1** on the following page, detailed maps of key asset categories can be in Appendix A.

Table 2.1: Overview of Assets Included in Risk Assessment.

Category	Asset(s)
Emergency Services and Public Safety Fire Protection, Police Services, & Emergency Health Services	Response and Operations Building Structure • Two (2) Fire Stations • Townhall • Community Centre by Library
Transportation	Road Network Active Transportation Routes • Roads, Sidewalks, Bike Lanes
Water System	Water Supply to the Town • Base Owned Water Treatment Plant Water Storage and Distribution • Underground Distribution System • Water Tower • Fire Hydrants Wells
Sanitary System	Operation and Treatment Three (3) Wastewater Treatments Plants (WWTP) owned by Town; • (1) Waasis Rd. West servicing approx. 3000 residents • (2) Robert St. servicing approx. 20 residents • (3) Waasis Rd. servicing Industrial Park One WWTP owned by the Base: • (4) servicing 6000 residents Sanitary Building Structure Sanitary Collection • Underground System • Lift Stations
Storm System	Stormwater Management • Major and Minor Systems
Energy Services	Energy Supply and Services Electricity • N.B Power services Town via above-ground transmission lines and powerlines both above and underground • Substation • Town owns and maintains some power assets (streetlights, poles) Natural Gas

Category	Asset(s)
	• Enbridge provides natural gas services to parts of the Town via underground pipelines
Community Services (Public Works Dept., Kings Arrow Arena, Hazen Park Centre, Library, Community Arts and Learning Centre, Marina, Leroy Washburn Turf)	Service and Operation Building Structure Natural Environment • Trails, Parks, and Wetlands
Land Use and Policies	Development Practices

3 Climate Analysis

The following chapter outlines projections for the various climate indicators applicable to Oromocto from now to the end of the Century (2100). The climate projections developed were used to assign likelihood scores for the PIEVC risk assessment to evaluate overall risk and prioritize items for adaptation action, which are summarized at the end of the Chapter.

3.1 Climate Parameters

The list of climate parameters considered for this project was developed with internal CBCL subject matter experts in each major asset engineering discipline (e.g., planning, water & wastewater, civil, structural, mechanical, and electrical engineers). Selection of these parameters was based primarily on climate and extreme weather phenomena that are known to impact municipal assets and the climate-asset interactions described in the Town of Oromocto Asset Management Plan (CBCL, 2016). **Table 3.1** below lists the climate parameters considered in the development of the CCAP including a brief description of the reasoning for inclusion.

It should be noted that the potential impacts of each climate-asset interaction described in **Table 3.1** may not be fully encompassing and the Risk Matrix in the Appendix B should be referred to for all identified climate-asset interactions and resulting impacts.

Table 3.1 Climate Parameters included in Scope of the Project

Climate Parameter	Index	Reason for Inclusion in the Project
Riverine Flooding and Erosion	1 in 20 year Riverine Flood Extent and Elevation	Wide ranging community impacts to buildings, wastewater treatment plants/sewage lift stations, roads, Stormwater infrastructure, and recreational trails/areas from overland flooding and washout. Impacts could affect areas of development for the Town.
	1 in 100 year Riverine Flood Extent and Elevation	
Ice Accretion	Ice Accretion Thickness (1 in 20 year)	Potential impacts to electrical transmission and power distribution within the Town. Potential ice damming on roofs, and hazards due to falling ice.

Climate Parameter	Index	Reason for Inclusion in the Project
Wind Load	Hourly Wind Pressures (1 in 50 year)	Impacts to structures and natural elements (e.g., trees, parks, vegetation)
Storms	Frequency and Intensity of Tropical Storms/Hurricanes & Winter Storms	Impacts to structures, roads/ transportation, natural elements (e.g., trees, parks, vegetation), electrical transmission and power distribution, source water quality, exterior electrical/ mechanical equipment.
Lightning	Average number of days with lightning (within 25 km)	Impacts to buildings or exterior electrical/ mechanical equipment that is not grounded.
Extreme Rainfall	1 in 10-year sub-daily rainfall event	Impacts to storm sewer system capacity. Potential for sewer backup.
	1 in 100-year sub-daily rainfall event	Impacts to buildings, wastewater treatment plants/sewage lift stations, water quality, roads, and recreational trails/ areas from overland flooding.
Snowfall	Days with Snowfall > 10 cm	Impacts to roads/ transportation and maintenance operations.
Warm Temperatures	Cooling Degree Days Above 18°C	Impacts to HVAC system performance and sizing.
Heat Extremes	Number of Days with Max. Temp Greater than 30°C	Impacts to vulnerable populations due to heat stress, recreational activities, water usage patterns and water quality, HVAC system performance and size, natural elements (trees, vegetation, parks, etc.)
Freeze-Thaw Cycles	Number of Days with Max. Temp Greater than 0°C and Min. Temp Less than 0°C in the winter season (Dec - Feb)	Impacts to road network, hard standing surfaces such as parking lots and walkways, structures which are not frost protected, underground infrastructure not located below the frost line.
Wildfire	Intensity and Frequency of Wildfires	Potential impacts to the Town as a whole (including all municipal assets), emergency response procedures and operations of emergency centers, and water quality.
Low Flows	Low river flows such as Environmental Maintenance Flows or Summer Flows	Impacts to the extractable quantity and quality of water from the Saint John River. Additional potential impacts to the timing of extraction.

Climate Parameter	Index	Reason for Inclusion in the Project
Drought	Intensity and Frequency of Drought	Impacts to source (groundwater wells) water quantity, and natural elements (trees, vegetation, parks, etc.).

A broader list of climate change parameters was initially considered for the climate change analysis portion of the project; however, parameters were prioritized based on their anticipated interaction with the municipal assets identified. The list of parameters included in **Table 3.2**, below, were excluded from the scope of the project as they were determined to have less significant and/or negligible impacts on the identified municipal assets. Some parameters are less applicable to the project region and scope, and in some cases, the interactions/impacts of the climate parameters are already considered in the assessment through parameters in **Table 3.1** (see details in **Table 3.2**).

Table 3.2: Climate Parameters Not Included in the Project

Climate Change Parameter	Reason for Exclusion from Climate Change Analysis
Total Rainfall: Annual Total Rainfall	Impacts to assets are indirect. Mechanical systems and drainage features are impacted by storm events which will be assessed based on analysis of Extreme Rainfall (included in the assessment).
Total Precipitation: Annual Total Precipitation	Impacts to assets are indirect. Mechanical systems and drainage features are impacted by storm events which will be assessed based on analysis of Extreme Rainfall.
Snow Load (1 in 50 -Year Snow Water Equivalent)	Although snow at this latitude is expected to become wetter and denser, climate models project a decrease in extreme snow accumulations. As a result, design snow loads are generally projected to decrease (though interannual variability will continue to occur and extreme events will continue for some time).
Rain and Freeze: Rain (1 in 50 year) with Freeze (Min. Daily Temperature < 0°C)	Relevant impacts of rain and freeze on assets, such as mechanical assets, will be assessed based on analysis of Extreme Rain, Freeze-Thaw Cycles, and Ice Accretion.
Annual Mean Relative Humidity	Increases in humidity are projected to be small, within a couple percentage points. As a result, the impacts of humidity, which are in conjunction of extreme heat, will be covered in the extreme heat category.
Cold Temperatures (Heating Degree Days Below 18°C)	There is high confidence of projected increasing temperatures over time, therefore, there are no anticipated impacts from decreases in heating degree days to infrastructure assets.
Ice Days (Number of Days with Max. Temp Less than 0°C)	There is high confidence of projected increasing temperatures over time, therefore, there are no

Climate Change Parameter	Reason for Exclusion from Climate Change Analysis
	anticipated impacts from decreases in the number of ice days occurring.

3.2 Climate Data Sources

The following primary sources of climate information were used for the climate analysis.

1. **Climate Normals.** Collected from Environment and Climate Change Canada (ECCC) Climate Data Normals Fredericton CDA CS (Station ID# 8101605). The National Building Code of Canada data for Halifax was also used for baseline characterization (based on the same measurement stations as the ECCC data normals).
2. **IDF Curves.** Obtained from Environment and Climate Change Canada (ECCC) Fredericton CDA CS (Station ID# 8101605) for characterization of baseline climate conditions.
3. **ClimateData.Ca.** A data portal from Environment and Climate Change Canada, based on an ensemble of 24 statistically downscaled GCMs. Indices available from this website are annual rather than return-period extremes.
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. **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 (Westra et al. 2014) for daily precipitation events. An approximately 7% increase in precipitation intensity for temperatures below 12°C and 14% for temperatures above 12°C (Westra et al. 2014) was applied for sub-daily rainfall events. This method is considered scientifically defensible by authoritative sources such as CSA PLUS 4013:19 and Cannon et al. (2020).
6. **Ouranos (2016).** Ouranos updated 29 climate indices for the Fifth Assessment Report (AR5) from the IPCC for the Government of New Brunswick (Roy and Huard, 2016) using three Representative Concentration Pathway (RCP) scenarios, and three study timeframes: the 2020s, 2050s, and 2080s. Simulations from the CMIP5 ensemble were statistically adjusted using “change factors” based on the observed record from meteorological stations.
7. **Literature.** In addition, for the climate 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).

As a best practice, several sources of information were used and compared prior to likelihood scoring. The projections available through the *Future Climate Scenarios Province of New Brunswick* (Ouranos, 2016), although not directly applied in the climate analysis, were compared to those available through, for example, ClimateData.ca for additional context.

Climate information sources used in this assessment were adjusted to align with updated information and best practices where possible. In this assessment, ClimateData.ca and *An Assessment of the Impact of Climate Change on Climatic Design Data In Canada* (Cannon et. al, 2020) were used as the primary data sources for baseline and projections scoring. ClimateData.Ca has been updated to include the GCM projections from the latest publication of the IPCC CMIP6 project (superseding the IPCC CMIP iteration applied in Ouranos (2016)) and the BCCAQv2 method for downscaling and bias-adjustment used in the ClimateData.Ca dataset is more advanced than the change factors applied by Ouranos (2016). Cannon et al. (2020) was developed by ECCC for future building code updates and was therefore used to characterize baseline and projections for several indices including ice accretion and wind loads.

Several factors were considered when choosing sources of climate information, such as:

1. **Spatial Resolution** – Global climate models (**GCMs**) have grid cells that are typically one to several hundred 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 downscaling tools, 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 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 with model data from the latest phases of the Coupled Model Inter-comparison Project (**CMIP6**). To further characterize model uncertainty, historical measurements were compared with GCM outputs for baseline values.
4. **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 possible.

3.3 Emission Scenarios

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

3.4 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

3.5 Climate Projections

Table 3.3, below, presents the general future projected trend for each climate parameter considered in the project scope (refer to **Table 3.1**). More detailed climate information and projection data, including associated likelihood scores, is presented in the following **Table 3.4**.

Table 3.3: Future Projected Climate Trends in the Project Region

Climate Parameter	General Future Projected Climate Trend
Riverine Flooding	Elevation and extent of riverine flood events are projected to increase overtime in the project region.
Ice Accretion Thickness	Minor changes in ice accretion thickness may occur by the near term, overall, a decrease is expected by the end of century.
Wind Load	In the project region, hourly wind pressures with a 50-year return period are projected to increase over the 21st century.
Storms	The dominant scientific consensus is that tropical cyclones, hurricanes, and general storm activity (winter storms) are likely to increase.
Lightning	The frequency of lightning strikes could increase under climate change due to an increase in the conditions favourable to

Climate Parameter	General Future Projected Climate Trend
	lightning occurrence (e.g., increases in Convective Available Potential Energy).
Extreme Rainfall	The intensity and frequency of extreme rainfall events are projected to increase for all indices investigated. There is a greater projected increase for higher return periods (1 in 100 compared to 1 in 10) and smaller timescales (sub-daily compared to daily).
Snowfall	As temperatures rise, mean annual snowfall is projected to decrease across most of eastern North America including in the project region.
Warm Temperatures and Heat Extremes	The frequency and duration of warm temperatures and heat extremes are projected to increase over the 21^{st} century.
Freeze Thaw Cycles	Projections depict decreases in annual freeze-thaw cycles. This annual trend may be obscuring seasonal variations (e.g., increase in winter and decrease in shoulder seasons).
Wildfire	It is expected that the fire season will lengthen and that the number, extent, and intensities of wildfires will increase over time due to the impacts of climate change.
Low Flows	Low Flows in the Saint John River may occur more frequently over time due to the impacts of climate change.
Drought	The conditions for drought may worsen overtime in the project region due to the impacts of climate change.

Table 3.4: Climate Projection Likelihood Scores.

Climate Category	Climate Parameter	Description	Baseline	Near-Term	Mid-Term	Long-Term	Overall Trend	
Riverine Flooding	Riverine Flooding	2100., 1 in 100	1	2	3	4	↑	Elevation and extent of riverine flood events are projected to increase overtime in the project region.
Temperature	Warm Temperatures	Cooling Degree Days	3	4	5	5	↑	Baseline: approximately 170 cooling degree days annually Projections: Increasing significantly over time, approximately 4 times by the long-term
	Extreme Heat	Days T_{max} > 30°C	2	3	4	4	↑	Baseline: 9 days per summer 2100: 62 days per summer
	Freeze-Thaw Cycles	Annual Freeze Thaw Cycles	3	3	3	3	—	Baseline: 22% of days (80 days/year) 2100: Minor decreases, approx. 20% of days Expected increase freeze thaw cycles in winter due to shifting seasons, overall, less annually.
Precipitation	Extreme Rainfall	1 in 10-year 24 hour	4	4	4	4	—	Increasing to approx. 1 in 2 year event by 2080's.
		1 in 100-year 24 hour	1	2	3	4	↑	Increasing to approx. 1 in 10 year event by 2080's.
	Snowfall	Days with Snowfall > 10cm	3	3	3	2	↓	Approx. 7 days/winter season. Trend remains relatively consistent until 2080's where decreases are expected.
	Ice Accretion	1 in 20-year Ice Thickness	3	3	2	2	↓	Trend remains relatively consistent until 2080's where decreases up to 30% are expected.
Wind & Extreme Events	Wind Load	1 in 50-year Wind Load	2	2	2	3	↑	Projections for extreme design wind pressures indicate increases of approx. 10% may be experienced in the long-term.

Climate Category	Climate Parameter	Description	Baseline	Near-Term	Mid-Term	Long-Term	Overall Trend	
								Projected changes may be underestimated given the high internal variability of the climate system and limitations of modelling systems.
	Winter Storms		3	3	3	3	—	Models generally project a decrease in average snowfall, but high year-to-year variability makes it difficult to project changes in snow extremes. Therefore, the likelihood of Winter storm events are expected to remain relatively consistent over time.
	Hurricanes and Tropical Storms		1	1	1	2	↑	Hurricane force event do not occur frequently in the region. Hurricanes and tropical storms are expected to increase in intensity and frequency with climate change. However, there is high uncertainty in projections.
Other Hazards	Lightning	Lightning Strikes within 25km	3	3	3	3	—	Baseline: 5% of days (annually) strikes within 25km. Projections indicate minimal change High degree of uncertainty.
	Wildfire	Frequency and Intensity of Wildfire (incl. Air Quality)	2	2	3	3	↑	Likely to see increased frequency and intensity of wildfires (dryer conditions, high temperatures).
	Low Flows		1	2	2	3	↑	The conditions for the occurrence of drought are expected to increase in frequently and intensity over time (low precipitation, high temperatures).
	Drought	Frequency and Intensity of Drought	1	2	2	3	↑	Occurrence of Low Flows may increase over time. More detailed assessment is required.

4 Risk and Vulnerability Assessment

Risk assessment is a key management technique that identifies and ranks risks based on their likelihood of occurrence and their severity of impact. Although it is difficult to predict the future with certainty, the techniques used for this risk assessment, as described in the following subsections, apply simple and streamlined processes to quantify uncertainties and identify risks. This risk assessment study is the first step in developing a risk management adaptation plan that aims to improve the community's resilience against climate change.

4.1 Climate-Asset Interactions

The first analytical step in conducting the risk assessment was determining if a relationship exists between the asset component in question and the respective climate parameter. First, all asset components and all climate parameters were tabulated in a risk matrix, with climate parameters along the top row, and infrastructure components along the first column. Next, each individual component was screened against each climate parameter to determine if the climate parameter might impact the component in any way. If no relationship was found, the relationship was simply not assessed. If a relationship was established, then the assessment moved on to identifying the potential impacts of the interaction and assigning an associated consequence score relative to the findings.

Asset-climate interactions were evaluated based on background information provided by the Town, literature review conducted by CBCL, and professional engineering judgement. Climate-asset interactions are detailed in the Risk Matrix (Appendix B).

4.2 Consequence Scoring

For each climate-asset interaction identified, a vulnerability assessment was conducted to quantify the potential impacts that might occur from each interaction. This impact is quantitatively represented through an assigned consequence score. Infrastructure components may exhibit vulnerability to risk in several ways. How risks manifest and affects the performance/function of an asset can be represented by performance response factors (PRFs).

To complete the vulnerability analysis, PRFs were used to evaluate impacts associated with each climate-asset interaction and influenced the resulting assigned consequence score.

The PRFs considered in this assessment include structural integrity, operation and maintenance, health and safety, financial, and access. Consequence scores include considerations for existing condition/performance of the asset, operations/operator experience, professional judgement, owner history, and input from Town staff/representatives during the projects risk assessment workshop (described in section 4.3).

Table 4.1 below illustrates the consequence scoring scale ranging from 1-5 that was applied in this assessment. The consequence scale was adapted from the PIEVC protocol.

Table 4.1: Consequence Scoring Scale

Score		Impact Description (PRFs)				
		Structural Integrity	Operation & Maintenance	Health & Safety	Financial	Access
1	Very Low	Typical wear and tear to infrastructure.	Very little or no change to operations and maintenance.	Very little to no impact to the health and safety of the community.	No financial loss or increase in operational expenses.	No impact to the accessibility within and to/from the Town.
2	Low	Minor impacts to infrastructure beyond typical wear and tear.	Minor changes to daily operations and maintenance.	Minor impact to the health and safety of the community.	Minor changes to operating costs or insignificant financial loss.	Minor impact to the accessibility within the Town.
3	Moderate	Moderate physical impacts requiring some level of maintenance or repair.	Moderate operational changes and/or maintenance increased.	Moderate impact to the health and safety of the community.	Moderate financial impacts. Does not require capital funding.	Moderate impact to the accessibility within and to/from the Town.
4	High	Major physical damage requiring increased maintenance, repair, or replacement of asset.	Major impact/disruption to operations and increased maintenance required.	Major impact to the health and safety of the community.	Major financial loss. Capital funding likely required.	Major impact to the accessibility within and to/from the Town.
5	Very High	Extreme damage or loss of asset requiring repairs or replacement.	Extreme damages beyond repair or maintenance abilities. Loss of operational capability.	Extreme impact to the health and safety of the community. No capacity to respond to emergencies.	Extreme financial loss. Significant capital funding required	Extreme impact to accessibility within and to/from the Town. Areas are isolated.

4.3 Workshop

To further support the risk assessment, a virtual workshop was held on December 13th, 2023. The objective of the workshop was to review the preliminary results of the risk assessment with relevant parties and gain feedback/input on the vulnerability analysis and resulting preliminary consequence scores assigned to each extreme/high risk item identified.

Participants included staff/representatives of the Town of Oromocto, the Province of New Brunswick Climate Change Secretariat, and members of CBCL's project team. A list of the participants is summarized in the **Table 4.2** below.

Table 4.2: Workshop Participants

Organization	Attendees
Town of Oromocto	Dallas Gillis, Peter Wong, Laurie Muise, David Goodfellow, Anna Kulesza
Province of New Brunswick, Climate Change Secretariat	Prativa Prahan
CBCL Limited	Lindsay Bolton, Emanuel Nicolescu, Sarah Ensslin, Lauren Fleet, Kendal Baker

During the workshop, CBCL facilitated a presentation on the background of the project including:

- High-level description of Town assets under consideration.
- High-level summary of projected changes for relevant climate indices.
- A brief overview of the risk assessment methodology.

After the presentation, discussion focused on the climate – asset interactions identified to have a high-extreme risk profile. A risk assessment is an iterative process; therefore, the workshop was used as an opportunity to present the vulnerability analysis and preliminary consequence scores to participants. Additional information/insight on vulnerabilities or impacts that can be used to refine the assigned scores, was gathered.

During and following the workshop, participants provided feedback on the preliminary consequence scores based on operational experience, Town histories, priorities, and professional judgement. Additional feedback was gained from the Climate Adaptation Plan steering committee and Oromocto Fire Department following the workshop. This feedback was used to establish the final risk scoring.

Following the completion of the workshop, the team had individual meetings/calls with the Oromocto First Nation as well as the Oromocto Fire Department. The Oromocto First Nation identified that there are ongoing flood resilient projects, including raising of the Oromocto First Nation Powwow grounds which is almost complete at the time of publishing this report. The Oromocto First Nation also operates an emergency center at the community center during extreme weather or significant power outages, which is reported to be well communicated throughout the community. The Oromocto Fire Department provided insights into historical wildfire management, training initiatives, and future community risks. Departmental representatives provided input on areas of highest risk potential based on historical responses.

4.4 Risk Calculation and Prioritization

The overall risk score for a climate-asset interaction is represented as the product of the likelihood and severity score (i.e., L x C = R) as outlined in the PIEVC Protocol. Since likelihood scores were assessed for respective time horizons, this resulted in obtaining risk scores for each time horizon as well. Based on the overall risk score, each risk is categorized from negligible to very high in order to prioritize the development and implementation of adaptation strategies.

Figure 4.1 illustrates the risk assessment scoring rubric used in this assessment for prioritizing risk scores. Likelihood scores are listed on the x-axis and the consequence scores are listed on the y-axis. Resultant risk is color coded based overall score.

Risk Assessment Matrix 5x5							
Consequence (C) *(severity/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	10, 12, 15, 16
Extreme/Very High Risk	20, 25
Special Case	5

Risk Score (R)	Risk Classification
Extreme	Controls required, develop options for risk reduction.
High	High priority for controls, develop options for risk reductions. These interactions are second priority.
Moderate	Some controls may be required, use professional judgement to determine if action is necessary.
Low	Consider on a case-by-case basis if controls are required.
Negligible	Controls are not required, no need to include in action plan.
Special Case	Consider on a case-by-case basis if controls are required.

Figure 4.1: Risk Matrix and Risk Classification.

The climate-asset interactions identified as having higher risk profiles are addressed in 4.5 Summary of Findings, and Chapter 5 Adaptation plan.

4.5 Summary of Findings

The risk assessment considered 117 total interactions which are summarized in **Table 4.3**. This depicts the number of climate-asset interactions assigned to each risk rating across all time horizons.

Table 4.3: Risk Assessment Results

Risk Rating	Baseline (1981-2010)	Near-Term (2021-2050)	Mid-Term (2041-2070)	Long-Term (2071-2100)
Special Case	5	0	0	0
Negligible	21	6	8	7
Low	69	74	61	42
Moderate	10	19	21	30
High	12	18	27	33
Extreme	0	0	0	5

Through the risk assessment, there are five interactions identified as "Extreme risks" in the long-term. All Extreme risks are related to riverine flooding. High risks to Oromocto include impacts resulting from wildfires and extreme rainfall, warm and extreme temperatures, and drought. High risks are shown to increase over time due to climate change, with 12 high risk items identified in the baseline increasing to 33 high risk items in the long-term. A full breakdown of risk assessment results and impacts is available in the Risk Matrix (Appendix B).

4.5.1 Riverine Flooding and Extreme Rainfall

As identified by the risk assessment, riverine flooding poses an extreme risk in the long-term to the structural integrity (e.g., infrastructure/equipment damages) and operation of several critical Town assets such as emergency services and response, transportation routes, sanitary treatment plants, and water supply.

Flood maps for the Town of Oromocto created with the Province of New Brunswick flood risk data are included in Appendix C and contain highlighted at-risk infrastructure that has been identified throughout the risk assessment.

Extreme rainfall may significantly impact the operation/performance of the sanitary treatment plants, collection system, and the stormwater management systems. Extreme rainfall can also result in localized flooding impacting access though the Town (e.g., impacts to emergency response, evacuation, and transportation) and affect the water quality of wells.

4.5.2 Wildfire

The risk assessment highlights that Wildfire presents a considerable, widespread threat to the Town, including substantial risks to health and safety. In a Wildfire emergency event, there will be increased demand for emergency services (e.g., fire fighting services), in addition to potential reduced/restricted access to and from areas of the Town. Currently, some key areas of the road network lack redundancies, such as alternative evacuation routes, which increases the risk profile. Discussions with the Oromocto Fire Department also suggest that certain areas of the community may be at a higher risk profile due to ageing and/or low pressures in the water distribution system for fire protection.

The risk to Town infrastructure and services during wildfire are severe and would potentially result in partial or complete loss of many assets, and significant operational impacts of most essential services.

4.5.3 Extreme Temperatures and Drought

The results of Extreme Temperature and Drought on the Town include potential for increased heat related illness, such as dehydration, heat exhaustion, heat cramps, and heat stroke. Concentration of these illnesses can lead to increased demand for emergency services and/or response and use of community centers (e.g., Town hall is equipped with A/C). Vulnerable populations such as elderly persons and children may be more at risk.

Additionally, these conditions impact the domestic water supply, through the distribution system (e.g., increase chlorine boosting demand) and the impacts to the water supply, the Saint John River, including increased potential for harmful algal blooms. Through impacts to supply and/or increased demand, there is potential for community-wide water use restrictions to be implemented. For well serviced residents, there are potential impacts to aquifer recharge and allowable extraction impacting water availability.

Similarly, for sanitary treatment systems, the extreme temperatures can lead to the potential loss of aeration capacity due to warmer water temperatures (from increased air temperatures) which may impact operations and treatment. If system capacity is impacted, then discharge requirements may be exceeded, and there is potential for odour issues.

5 Adaptation Plan

When faced with the variety of challenges associated with the top priority risks determined through the risk assessment process in Chapter 4, adaptation measures can be considered to minimize negative consequences and increase community resilience to climate change.

Each of the high and extreme risks identified during the risk assessment are addressed in the subsequent sections, with recommendations for adaptation aimed at reducing the impacts to an acceptable level. Where appropriate, risks are grouped into categories (i.e. Flooding, Wildfire / Emergency Response, Extreme Temperatures) with multiple adaptation measures provided to address similar impacts (i.e. riverine flooding and extreme rainfall).

Generally, recommendations for adaptation measures fall within the following categories; infrastructure upgrades or maintenance, planning initiatives, communication and education, and additional studies. Additionally, each adaptation measure is prioritized and listed in terms of importance. When prioritizing adaptation measures the following aspects were considered:

- Public safety;
- The protection and continued delivery of essential services; and
- The protection of important community buildings and infrastructure.

The adaptation measures presented in this plan contain a level of effort consideration. This most often refers to cost in a general scale where low, moderate, or high level of effort equate to a low, moderate, or high cost. This is in addition to relevant stakeholders and an estimation of timeline for implementation (e.g., short or long-term). Timelines for implementation of adaptation measures align with the time horizons used for the risk assessment. Meaning short-term adaptation measures address risks identified that currently pose a short-term risk to the community, whereas mid-term adaptation measures can address risk present by the 2030–2050-time horizons. Long-term timelines are associated with risks that are not expected to cause a significant impact until approximately 2070-2100.

The preferred adaptation methods, presented in the following sections, were developed based on information gathered throughout the risk assessment process and the professional judgment of the engineering team.

5.1 Flooding (Riverine and Extreme Rainfall)

Riverine flooding has historically posed a significant risk to the community of Oromocto. The following critical Town assets are the most affected by a flooding event:

- Emergency Services and Response
- Transportation Routes
- Sanitary Treatment Plants
- Water Supply

It should be noted that the regional flood hazard maps presented in this report (developed by the Province of New Brunswick) are intended to be used for educational purpose only, for the purpose of preliminary land use planning, hazard screening and prioritization, public awareness, emergency response planning, and high-level hazard assessment. Prior to any major infrastructure investment or use for legislative purposes, more detailed flood mapping may be required to determine appropriate flood limits.

5.1.1 Transportation and Planning

5.1.1.1 Transportation

Historical flooding affects several low-lying areas in Lincoln and Oromocto, multiple subdivision roads, the NB Trail (at Onondaga St.), as well as significant disruption west of Lincoln boundary. Please refer to the flood maps presented in Appendix C. In the future, potential overtopping of major road links may occur at several key locations (see **Figure 5.1**).

The three primary areas of concern on Lincoln Road (Route 102), located between the town boundary and Lower Lincoln Elementary School, will restrict access to Route 1. Potential overtopping of Lincoln Road continues west of the town boundary, within the jurisdiction of the City of Fredericton. This has implications for local evacuation routes and regional connectivity to Fredericton. Damage to roads may occur, including washout of supporting materials and erosion of slopes and revetments. Furthermore, potential overtopping of the road may occur at Wharf Road, restricting access to the Base Water Treatment Plant. Considering the implications of potential overtopping on Lincoln Road for emergency management, **Figure 5.1** identifies a conceptual routing of an emergency access road, providing secondary access to Highway 2.

Relevant flood mapping should be considered in all future road rehabilitation projects within Oromocto, particularly in areas that are considered critical access points to the community for emergency planning. The municipality, and relevant stakeholders, should remain up to date on potential flooding zones with climate change as provincial flood maps are updated. Prioritizing of road upgrades, including raising the elevation of critical transportation infrastructure, should be done through an asset management lens. Consideration for the current asset condition and remaining useful life, hydraulic capacity, cost, and criticality will form a decision on the timelines for investment. Following

Infrastructure Canada best practices, a cost-benefit analysis should be performed to justify the investment.

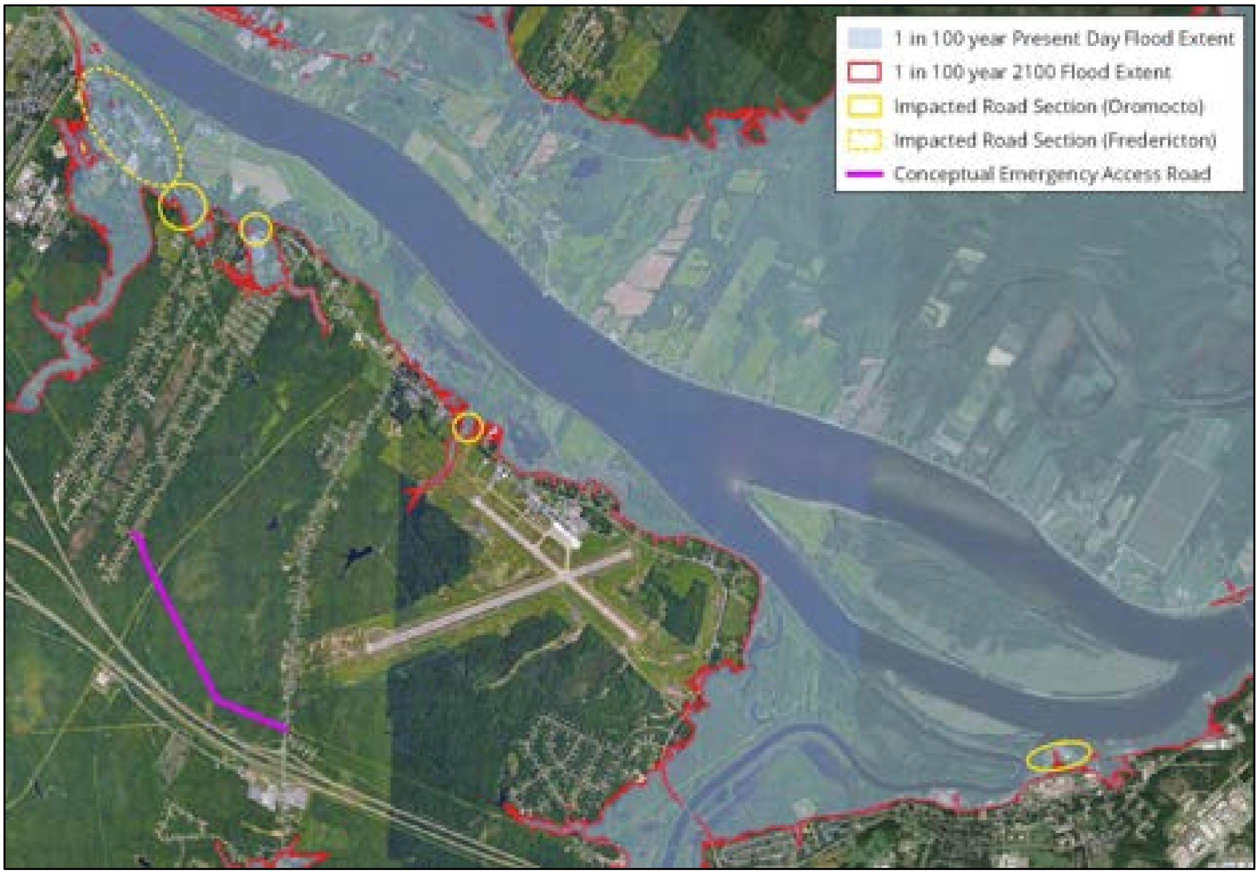

Figure 5.1: Potential Overtopping of Major Road Links

5.1.1.2 Land Use Planning

Oromocto's zoning by-laws provide the legal basis and organizational footing to formalize the Town's response to climate change risks and to implement appropriate adaptation measures, as proposed by the Municipal Plan. The current Plan includes policies to identify and protect areas of significant environmental and wildlife habitat and provide for the orderly and comprehensive management of shorelines, flood plains, and wetlands (policy P1.3.1), and to prohibit development within flood plains and environmentally sensitive areas in accordance with Provincial regulations (policy P2.4.2). However, the Municipal Plan does not currently directly acknowledge impacts of climate change on Oromocto's natural and built environment.

Oromocto's zoning by-law addresses flood risk to development by stating (in section 4.0.15) that "No development of any habitable space shall be permitted in any zone unless the minimum geodetic elevation of the top of any floor is at least 1 metre above recorded flood of record". However, the historical flood record is not specifically illustrated or defined within current zoning by-law. Furthermore, the historical flood record that informs this by-law is lower than the current and future 1 in 100-year flood extent and does not address recognized future flood risk. Section 1.2.11 states that “No building or structure may be erected on any site where it would otherwise be permitted under this Bylaw when, in the opinion of the Planning Advisory Committee, the site is marshy, a wetland, subject to flooding, excessively steep or otherwise unsuitable by virtue of its soil or topography.” This language can be revised to reflect the nuances inherent in both the designation of “subject to flooding” and the definition of “building or structure”. Several adaptability pathways are available to integrate climate adaptation strategies into zoning frameworks.

A first step in an effective flood management strategy is to identify and understand the flood risks facing the municipality. This entails an understanding of the floodplain now and in the future. The Province of New-Brunswick references a two-zone strategy with regards to floodplain: the floodway and the flood fringe. Floodway refers to the area serving the conveyance of watercourses and corresponds to a flood return of a 1:20 year event, meaning that the area has a 5% chance of flooding any given year. Flood Hazard Areas refer to areas outside of the floodway that will see a 1:100 year event or have a 1% chance of flooding any given year. The flood fringe consists of the Flood Hazard Area and includes the Flood Risk Area corresponding to historical flood levels.

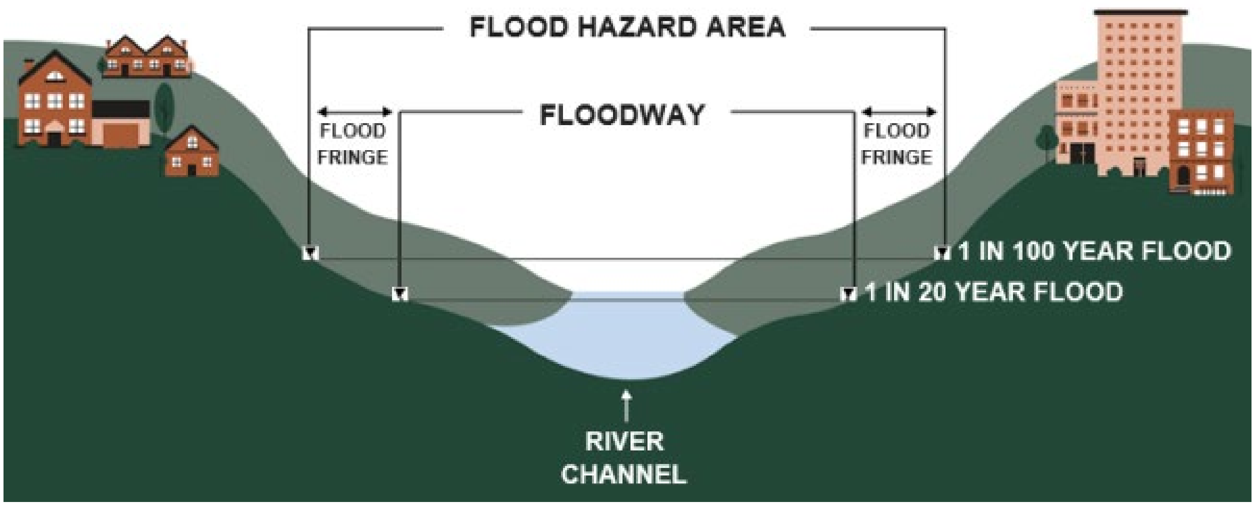

Figure 5.2: Depiction of Flood Hazard Area (Image source: New Brunswick Statements of Public Interest User Guide)

In terms of planning and building services, other Canadian jurisdictions have used floodplain definitions and flood level forecasts to develop adaptation policies and regulations framing development in the floodplain. Examples are summarized in **Table 5.1**.

Table 5.1: Jurisdictions with Policies for Development in Floodplain

Jurisdiction	Planning Based Floodplain Management
Dieppe	The City of Dieppe has also produced a Climate Change Adaptation Plan which recommends several policy initiatives to control and manage flood

Jurisdiction	Planning Based Floodplain Management
	risk. In response, the zoning by-law prescribes a (in section 3.19) minimum geodetic elevation for all new development, and the requirement that non-conforming development applications are to exempt the City of any liability. Development of habitable space or occupied floor space must have a minimum geodetic elevation of any floor of at least 10.5m, representing the projected flooding level for a storm with a 1:100 return period in 2100. Development of a residential care facility, daycare centre, educational use, a health services use, a hotel, a safety and emergency services may be permitted with floors at a minimum geodetic elevation of 9.25m, representing the projected flood levels for a storm with a 1:100 return period in 2014, if they have a site drainage plan demonstrating the elevation of the occupied floor space and a signed copy of the Climate Change Flood Risk disclaimer. It is worth noting that a 9.25m water level is anticipated annually in 2100 due to global warming and the sea level rise. Lastly, a parking garage may be permitted to have an occupied floor space below the geodetic elevation of 9.25 m, as long as the critical elevation (the lowest point on a foundation wall where surface water would first enter) is at least 9.25m and an engineering solution is provided.
Moncton	The City of Moncton has in place a Climate Change Adaptation and Flood Management Strategy that sets out several planning policies for ongoing monitoring and identification of flood risk, and puts in place a flood management strategy with several adaptation measures, including: • Completion of a major storm/hurricane/flood emergency response plan • Community engagement plan • Urban forest management plan • Heritage and civic property assessment in flood prone areas • Storm water and flood plain management strategy and plan • Reduce storm water run-off volumes • Minimum floor elevations for habitable space and structured parking associated with new development • Landscaping provisions to assist in containing storm-water run-off • Increased development setbacks from watercourses to 30m The strategy's recommendations are not incorporated into the zoning by-law, which at a minimum restrict (in section 1.3 11) buildings or structures on a site where it would otherwise be permitted under the by-law, when in the opinion of the Committee, the site is marshy or subject to flooding.
Shediac	Shediac has incorporated policies in its Municipal Plan requiring that development in flood-prone areas be adapted to mitigate the effects of

Jurisdiction	Planning Based Floodplain Management
	sea level rise. Consequently, the city's zoning by-law stipulates (in section 17.4) that, for new buildings, main buildings placed, erected or altered in an SLR zone shall have a minimum elevation for the habitable portion of the building and/or for a commercial building or 4.3 m, based on CGDV28. In the case of existing buildings in the SLR zone, extensions may only be permitted if they do not reduce the existing building elevation.
Truro	The Town of Truro Municipal Planning Strategy delineated the 1:20 and 1:100 flood risk elevations for the Salmon River as early as 1988. It defines a Flood Plain Zone below the 1:20 flood elevation, further demarcated between a Floodway Overlay and a Flood Fringe Overlay, and set outs several development control policies, governing the type of development allowed in each zone. The Town's zoning by-law clarifies both the land uses and development rights within each Flood Plain Overlay. Furthermore, the zoning by-law identifies specific Hydrologic Regions, according to their water retention capacities, and provides detailed flood proofing standards for each Overlay.
Toronto	The City of Toronto has established a number of Special Policy Areas (SPA) designed to address flood risks in flood-prone areas, primarily at the mouth of the Don River. While steps have been taken to protect existing development by improving the conveyance of the Don River mouth and by constructing landforms, areas in the south-east of the city remain flood prone. Development controls are in place limiting new development in this SPA unless flood adaptation is included in the development plan and the City is absolved of responsibility in the event of a flood event. Ongoing work is underway to identify additional flood risk reduction measures ranging from improved watercourse conveyance to flood protection structures and landforms. The Don River regulatory flood plain is based on the more severe of the Regional Storm (Hurricane Hazel) level, or the 100 year storm.

When developing adaptation plans to combat the effects of a changing climate, there are five strategies typically used: Avoid, Retreat, Accommodate, Protect, or Proceed (Leys, 2016). Determining the preferred strategy greatly depends on the infrastructure in question, the associated level of risk, as well as the cost-benefit of implementing said plan. These five flood mitigation options are outlined and discussed in greater detail below. Each approach has its characteristic advantages and disadvantages, which are summarized in **Table 5.2** and presented below:

- **Prevent/ Avoid the Risk** – Prevent building infrastructure in flood plains. Most directly affected by zoning is the avoidance of development within flood-prone areas or below applicable flood elevations. This may be refined as restricting all new development within the floodway, and restricting development in flood fringe to non-essential uses. Sports fields and parks are one potential use of land in flood risk areas that results in minimal consequence of flooding. Prescribing flood proofing measures.

- **Retreat** – Move existing infrastructure or assets to higher ground outside of the flood plain. Where possible, this measure entails moving buildings and essential infrastructure and services out of the floodplain. Example: relocate buildings outside of flood plain.
- **Accommodate/ Adapt Existing Infrastructure** – Modify construction to flood resilience builds. Where the risk of flooding is understood and accepted, the risk may be accommodating by adapting to its impacts. Development within the floodplain can be adapted to by locating essential systems and infrastructure off the ground floor, or by prescribing a minimum elevation, for example establishing a minimum freeboard above the 100-year flood line elevation. Example: Raise building on pilings above flood level.
- **Protect Existing Development** – Construct engineering solutions to prevent flooding. Exemplified by the City of Toronto, the more resource intensive measure to reduce the flood risk is protecting the flood-prone area from flooding. This may involve either the reduction of flood severity, or the physical management of flood water via the erection of flood protection structures like berms, walls or barriers, or the modification of the landscape with extensive landforms. Example: Construction of dykes and sea walls to protect buildings.
- **Proceed** – Accept inherent risks and potential infrastructure loss. Example: the adaptation measures are more costly than the asset itself.

Table 5.2: Approaches for Adapting to Riverine Flooding

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

In 2023, the Province of New Brunswick established the Statements of Public Interest (SPI) Regulation, enabled under the *Community Planning Act*. SPIs are implemented through municipal plans, zoning by-laws, and planning-related decisions, representing the minimum standards that must be met. Starting from October 1, 2023, all new municipal land use plans, by-laws, and amendments must align with the SPIs where applicable. The SPI Regulation comprises five statements with supportive policies, emphasizing the following themes in the public interest:

1. **Settlement Patterns** – Promote settlement patterns that contribute to the well-being of the residents of the province, minimize impacts on the environment, and support vibrant rural and urban economies.
2. **Agriculture** – Promote the agriculture, fishery and aquaculture sectors and the production of food in the Province.
3. **Climate Change** – Engage in processes of climate change mitigation and climate change adaptation.
4. **Flood and Natural Hazard Areas** – Manage development in these areas to increase health and safety and limit social, environmental and economic costs to the Province, local governments, and residents of the Province.
5. **Natural Resources** – Protect natural resource development areas and environmentally sensitive areas for present and future generations while fostering a more consistent and predictable regulatory environment.

Long-term land use planning will be essential for mitigating flood risk in the community. By integrating climate adaptation into land use planning policies, regulations, procedures, and operational decision-making, they become essential tools for mitigating climate risks. To align with the provincial SPIs, updates to zoning by-law should place focus on:

- Making roads and other critical infrastructure more resilient.
- Working with the Province to relocate existing development in areas most susceptible to flooding.
- Restricting new development, other than agricultural or recreation uses, in areas most susceptible to flooding.

It has been suggested that some "park zones" within the community could be designated as light agriculture uses (through the adjustment of permissible land uses) such as maple sugar tapping, in alignment with the provincial initiative to promote more maple syrup operations in New Brunswick.

It is recommended that Oromocto consider incorporating the following into the Municipal Plan, zoning by-laws, and regulations:

- Amend municipal plan to include the objective of ensuring safety from flooding, wildfires, and other climate risks.
- Establish Flood Hazard Zone to mitigate the risks of developing in flood hazard areas.
- Updating the referenced flooding layer to include the 2100, 1 in 100-year event provided by the Province of New Brunswick.
- The addition of development restrictions, particularly with respect to finished floor elevations, in flood prone areas; and
- Enforceable restrictions on developments within the wetlands surrounding Oromocto.

Emergency management considerations with respect to the likely flood scenarios, the resulting extent and impact of flooding, as well as the emergency response capacity to address these risks should be assessed. More detail is provided in Section 5.2 Emergency Response.

The University of Waterloo Intact Centre on Climate Adaptation released a report in January 2019 titled: "Weathering the Storm: Developing a Canadian Standard for Flood-Resilient Existing Communities" which provides recommendations for enhancing community resilience to flooding. This report largely focuses on adaptation measures for riverine, overland, and sewer flooding in existing residential communities. Some generic recommendations taken from the report for flood resilient design and construction include raising building openings, raising electrical and mechanical systems above the regulatory flood level, and the use of flood damage resistant materials in basements below the projected flood elevation (i.e. non-wicking materials). For example, flood proofing design requirements could include:

1. A minimum elevation for all new construction of 0.1m (4in) above elevation the 1:100 floodline (floodline elevation is changing across Oromocto and must reference the floodline map rather than one universal elevation).
2. A minimum building or parking garage opening elevation of 0.1m (4in) above the 1:100 floodline elevation (at the specific building lot location) for long term planning with confirmation from a professional surveyor.
3. A minimum elevation for non-flood resilient mechanical and electrical equipment of 0.1m (4in) above the 1:100 floodline (at the specific building lot location) for long term planning.
4. Development below the 100 year floodline (at the specific building location) (within SPA) to include flood resilient construction methodologies (such as non-wicking and moulding materials) to be presented in a design brief confirmed flood resilient by a profession engineer or architect.
5. Consideration of the expected life of an asset is critical when determining if the current or future (with climate change) 1:100 floodline is applicable.

Attempting to prescribe all possible flood resilient designs is inherently onerous given that this exercise is highly development/infrastructure specific. Private residential or lot-level improvements are outlined in CSA-Z800-18 which is a standard on basement flood protection and risk reduction measures (Weathering the Storm, 2019). The National Research Council of Canada (NRC) is currently researching flood resilient building designs under the "Climate-Resilient Building & Core Public Infrastructure Initiative" (CRBCPI) project and have announced updates to the 2025 National Building Code (NBC) which will include climate change.

The discussions presented in this report largely focus on the incorporation of riverine flood projections in the Town's Municipal Plan. The subsequent zoning by-laws must consider specific land uses based on risk, which are both infrastructure and site specific, as well as the expected life of the asset.

Table 5.3: Options for Reducing Flood Vulnerabilities

Action	Actionable By	Timeline	Cost/ Level of Effort	Notes
Enact a policy (within the Municipal Plan) based on designated flood elevations	Planning and Compliance	2-3 years	Moderate – High	Policy can include prevention or adaptation by stipulating a minimum slab elevation above freeboard. Policy should consider limiting the Town's exposure by waiving liability for development below the flood line.
Consider future flood elevations in the construction or upgrade of new infrastructure	Engineering	1 year	Low	Existing flood impacted infrastructure is presented in Appendix C of this report. Newly constructed infrastructure planned in flood risk areas should consider the feasibility of a flood resilient designs strategy. Updated flood lines may be required to support major infrastructure investment.

5.1.2 Water Supply

Oromocto's water supply, the Base owned and operated Water Treatment Plant (WTP) is currently at risk of flooding based on the provincial flood lines and is expected to worsen over time. Flooding of the WTP may result in significant impacts to operations (e.g., restricted access, damaged equipment, loss of treatment capacity) and disruption to the Oromocto's water supply may occur. The duration of disruption could vary from the amount of time required for the flood water to recede to allow operations staff to reach the WTP to several weeks/months if damaged equipment needs to be replaced. It is recommended that location of the WTP be considered in long term asset planning for the facility and future consideration of relocating the facility outside the projected flood line areas. Once it is determined that significant capital upgrades are required at the plant, there should be a cost-benefit analysis completed to determine if relocation outside of the flood zone or raising infrastructure is recommended.

For residents on privately owned and maintained wells, a flooding event has potential to transport pathogens and/or contaminants into the water supply. It is recommended that

Oromocto initiate public reminders to follow New Brunswick Public Health practices for maintaining well system after a flood. Well water should not be used while a well is under water, and dependent on the extent of flooding, this may require the opening of the local emergency center. The Department of Environment and Local Government produced a guide entitled Well Chlorination and Water Testing for Those Affected by Flooding that should be followed after a flooding event. In addition to an assessment of the infrastructure flood risk, it is recommended that Oromocto EMO review policies around the issuance and communication of Boil Water Advisories and the availability of water stations for residents impacted by flooding.

Oromocto does not currently maintain a backup water supply in the event of disruption of the operation of the treatment plant due to flooding, contamination in Saint John River or low flow in the river reducing the volume of water available to treat. A recently completed study for Oromocto concluded that well water is not a viable option for diversifying the water supply due to water quality (Hydrostrata, 2024). Without a viable well water source, there are no other source water options immediately available for the municipality. It is therefore recommended that the Town, in conjunction with the Base, create and maintain detailed emergency and contingency plans in the event of water supply disruptions.

During periods of high river water level and high tides, the current WTP experiences periods of high colour and high turbidity in the source water (referred to as the "Oromocto Effect"), which would be at or exceed the anticipated treatment capacity of the current process train and could result in process upsets (CBCL Limited, 2012). Increased risk of flooding due to riverine or extreme rainfall could increase the risk or frequency of the drastic change in source water quality. Forest fires can also impact water quality. Further studies should investigate the possibilities for providing treatment redundancy and resilience in the event of source water upsets in the Saint John River. This would likely require building resilience into the treatment process to handle upset conditions. This might involve the addition of treatment processes when developing a 10-year capital plan for the WTP and the timing of this work depends on the age and condition of the existing WTP. The first priority, however, is to protect the WTP equipment from immediate flood risk from the river.

As the WTP is owned and operated by the Base, the only immediate action for Oromocto is to work with the base to develop a detailed emergency/contingency plan, while continuing to advocate for analysis into potential options to build treatment redundancy and protect from critical equipment from flood risk.

5.1.3 Sanitary and Storm System

Risks of sewer system flooding include exceedance of system capacity, discharge of untreated wastewater resulting in exceedance of effluent regulations, and wear and tear or damage to sewage lift station (SLS) equipment.

In the sanitary collection and treatment system, there has been known historic flooding of the Waasis Rd. West Wastewater Treatment Plant (WWTP). The Waasis Road (Industrial Park) WWTP is also identified as at risk of flooding as a result of high river water levels. In the future, riverine flood risk is expected to increase. The following SLSs are in the provincial 1 in 100 year flood line at 2100: No. 4; No. 5; No. 9; and No. 14.

Within the WWTP specifically, high river water levels have caused/ may cause discharge of poorly treated or untreated wastewater, prevent Town staff from safely accessing the WWTP, and, in extreme scenarios, could cause significant damage to electrical equipment, leading to the WWTP being offline for weeks to months while repairs are completed.

To reduce the risk of flooding, it is recommended that the Town do a Feasibility Study focussed on relocation of the WWTP to a higher elevation where it is better protected from flooding. This Feasibility Study is currently underway with a completion date of summer 2024. If a viable location is selected for a new WWTP, funding mechanisms may be available to assist with capital expenses.

The SLSs located in areas of flood risk should be considered for flood-resilience measures or relocation, when it comes time to upgrade or replace aging equipment, to reduce the risk of untreated overflows and significant damage to electrical equipment.

In addition to riverine flooding, sewer systems can be susceptible to flooding as a result of extreme rainfall. As Oromocto has a separated storm and sanitary collection system, the only wet weather influence in the sanitary sewer is as a result of inflow and infiltration (I&I) sources. Based on the newly developed sewer model, which was calibrated to flow metering data collected in the sanitary system during wet weather, the system is not expected to have excessive wet weather influence. It is recommended that system capacity issues identified in the sewer system capacity assessment (CBCL, 2024) are addressed on a case-by-case basis, where system flooding and surcharging is addressed systematically through an asset management approach. Additional analysis of the downstream impacts associated with allowing development upstream of known capacity issues should be completed.

Riverine flooding is one major source of flooding in the Town; however, the storm sewer collection system is also susceptible to flooding during extreme rainfall events. A flooding event in the stormwater collection system is characterized by surcharge conditions, where the hydraulic grade line (HGL) or water level in the system is above the pipe capacity. Surcharging occurs when the flow entering the system is higher than the system is designed to convey. When surcharging occurs in the storm sewer system, there is a risk that basement flooding can occur in nearby residents where water backs up though the foundation lateral or property flooding from a ditch or culvert system that is overwhelmed.

Oromocto is in the process of developing a comprehensive GIS database of the municipal storm water collection system. It is recommended that this database be used as the basis for a community wide stormwater management model to determine the system's capacity to current and future rainfall events. If there is a significant gap between the expected and actual level of service in the system, strategic projects may be initiated to address system deficiencies. This can be summarized in an Oromocto Stormwater Management Plan.

Additionally, to support ongoing development applications, without creating unintended downstream consequences, a pre- and post- development storm water management strategy and policy is required. A policy of this nature would require new developments to store any increase in stormwater runoff leaving the property as a result of new development. This is a common policy in municipalities across Atlantic Canada and is becoming increasingly important with climate change.

Table 5.4: Adaptation Action Items Summarized to Reduce Flooding Impacts

Action Item and Description		Stakeholders	Timeline	Level of Effort
5.2.1 a	Model Sanitary Sewer System, Assess Capacity	Town of Oromocto	Ongoing	Moderate
5.2.1 b	Model Storm System, Stormwater Management Plan	Town of Oromocto	Near-Term	Moderate
5.2.2	Develop and Maintain Emergency and Contingency Plans in the Event of Water Supply Disruptions	Town of Oromocto CFB Gagetown	Near-Term	Moderate
5.2.3	Preserving Important Wetland Ecosystems through Municipal Planning	Town of Oromocto	Long-term	Low
5.2.4	Updating Town Flood Lines referenced in the Municipal Plan, Enforcement of Development Restrictions	Planning and Compliance Department	Near-term	Low
5.2.5	Continued Long-term Land Use Planning	Planning and Compliance Department	Mid-term	Low
5.2.6	Further Water Supply Treatment Redundancy and Resilience Studies	Town of Oromocto CFB Gagetown	Near-term	Moderate
5.2.7	Proactive Infrastructure Upgrades, Incorporating Climate Change Projections	Town of Oromocto	Long-term	High
5.2.8	Relocating of Waasis Rd. West WWTP, starting with Feasibility Study	Town of Oromocto	On-going	Low

Action Item and Description		Stakeholders	Timeline	Level of Effort
5.2.9	Sanitary Sewer Master Plan, complete with concept designs and costs for required upgrades	Town of Oromocto	Near-term	Moderate

5.2 Wildfire and Emergency Response

Due to the proximity of Oromocto to vast amounts of rural New Brunswick forest, the risk posed by Wildfire is high in all time frames assessed. Wildfire poses a significant wide-spread risk to the Town and a Municipal Emergency Preparedness Plan (MEPP) to manage the risk is essential. Due to the recent amalgamation of the municipality, there is a need for an update and further testing of a MEPP that includes all areas of the municipality.

In addition to wildfire response, the plan should consider the extreme events that the region has previously faced (such as historic riverine flooding damage) and challenges such as access during flood conditions. 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).

Within this Emergency Preparedness Plan, the following location specific factors should be considered:

- Maintenance of critical community access points during emergency events
- The future designation of the planned recreation centre as a warming centre
- Response times for the Oromocto Fire Department to the former areas of Lincoln

The University of Waterloo Intact Centre on Climate Adaptation released a report in December 2023 titled: "Wildfire-Ready: Practical Guidance to Strengthen the Resilience of Canadian Homes and Communities" which provides recommendations for enhancing community resilience to wildfires. This report largely focuses on best practices for communities to integrate wildfire-ready features into their wildfire risk management plans to limit damage and disruption due to wildfire events and strengthen emergency preparedness. The report highlights three features of a wildfire-ready community which includes wildfire-ready structures and infrastructure, wildfire-ready community design, and wildfire-ready emergency response. Practical actions to improve community wildfire resilience taken from the report are summarized in **Table 5.5** on the following page.

Table 5.5: Three Features of a Wildfire-Ready Community

Feature 1: Wildfire-Ready Structures & Infrastructure
▸ Complete regular maintenance of structures, infrastructure, and landscaping within 10 m to limit accumulation of flammable materials (e.g., leaves, brush piles, stored items, fuel tanks). ▸ Install/replace landscaping with fire resistant materials within 10m of structures and infrastructure. ▸ Build/update structures and infrastructure using fire resistant building materials (e.g., Class A roofing/metal roofs, non-combustible siding, metal, or concrete hydro poles). ▸ Design/update structures and infrastructure to be ignition resistant (e.g., 5m distance between vegetation and power lines, power supply lines below ground where feasible).
Feature 2: Wildfire-Ready Community Design
▸ Integrate minimum 30m wide zones (fire breaks) featuring ignition resistant materials (e.g., mowed grasses, ponds, roads) into community design to limit the spread of fire. Increase minimum to 50m on steep slopes. ▸ Provide greater spatial separation between structures in hazard areas to limit the spread of fire from one structure to another. ▸ Require minimum 10m setback from the crest of a hill to limit spread of fire to structures. ▸ Restrict development in hazard areas where mitigation measures cannot meet minimum standards for health, safety, and environmental protection.
Feature 3: Wildfire-Ready Emergency Response
▸ Complete annual emergency planning and cross-training exercises that include multiple agencies (e.g., wildland and structural firefighters). ▸ Designate at least one emergency shelter per community. ▸ Ensure minimum water supply for firefighting. ▸ Provide two or more suitably sized access and egress routes to accommodate the movement of emergency vehicles

In addition to wildfire response, the plan should consider the extreme events that the region has previously faced (such as historic riverine flooding damage) and challenges such as access during flood conditions. 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).

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

- Primary and backup evacuation routes.
- Location of healthcare facilities and warming/emergency 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. It is recommended that the Municipality considers the implemented of an EMO alert system for the wider community, and a vulnerable resident registration program for the most at-risk members of the community.

Consideration should be applied to adopting Canada's FireSmart initiative within the community to engage community members and property owners. Best management practices are available through the program to educate and engage residents, some examples include; reduced use of mulch on properties, appropriate spacing between trees to avoid chandelling, fire resistant construction methods, and best practices for maintenance of parks and deadfall management.

In consultation with project stakeholders, areas of the Town were noted as having insufficient fire flows, including within Oromocto First Nation and the east end industrial park. Water system upgrades may improve fire flows throughout the community; however, it is recognized that municipal water systems are not intended to provide adequate water suppression for forest fire management. Fire flow management will require a combination of water supply from the WTP as well as direct access to water from the river. Water distribution system analysis and modelling may be required to confirm the best available sources for gaining fire fighting capacity in the water system.

Lastly, consideration should be given to emergency service response times throughout the entire municipality, notably the former LSD of Lincoln, to determine an appropriate level of service.

It has been recommended by the steering committee that the Town could benefit from an assessment of wild fire risk. The assessment would identify high risk areas and recommend specific mitigation measures for risk management based on forest health. This assessment would provide input into the updated Municipal Emergency Preparedness Plan.

Table 5.6: Adaptation Action Items Summarized for Emergency Management

Action Item and Description		Stakeholders	Timeline	Level of Effort
5.1.1	Update and Testing of Municipal Emergency Preparedness Plan	Town of Oromocto New Brunswick Emergency Measures Organization	Near-term	Moderate
5.1.2	Communication of Emergency Preparedness Details to Public	Community EMOs Town of Oromocto	Near-term	Low
5.1.4	Consider EMO alert system for Community	Town of Oromocto	Near-term/Mid-term	Moderate
5.1.5	Consider Implementation of a Vulnerable Resident Registration Program	Town of Oromocto	Near-term/Mid-term	Moderate/High
5.1.6	Canada's FireSmart Communities	Community EMOs/Fire Department	Near-term	Moderate
5.1.7	Water System Upgrades (Fire Flows)	Town of Oromocto	Mid-term	High

5.3 Extreme Temperatures and Drought

Long periods of extremely hot temperatures can become a public safety concern, particularly for vulnerable populations such as elders and youth, who are more severely affected by extreme heat. Options for community adaption include:

- Investing in community centers with cooling capacity;
- As previously mentioned, implementing an emergency system and/or database to check on vulnerable populations;
- Encouraging residents to install systems such as heat pumps which offer a cooling mechanism; and
- Educating the community on the health risks of extreme temperature, and available community resources, such as cooling centers.

Extreme temperatures and drought can impact the quantity and quality of water supply systems. Water quality parameters during low flow events such as turbidity or organics may vary from normal operating conditions due to changes in river flow patterns or other disruptions in the watershed due to low quantity. Warm water temperatures above 20°C for extended periods of time can be favourable for a harmful algal bloom (HAB). The warmer water temperatures typically occur during periods of low precipitation or drought and can result in less mixing throughout the water column providing calmer water conditions for cyanobacteria/algae to grow. The three outcomes of concern that can result from a HAB event are; cyanotoxins, taste and odour compounds and increased in biomass due to prolific algae growth. The current WTP has capabilities for removing algal biomass but would have limited capacity to remove cyanotoxins and no ability to remove taste and odour compounds.

It is recommended to consider a HAB vulnerability assessment for the WTP as well as development of contingency plans should a HAB impact the Saint John River for an extended period of time. For well serviced residents, there are potential impacts to aquifer recharge and allowable extraction impacting water availability during drought events. Current practices is for the Town to provide water at community locations for pick up (i.e., usually a fire department station). It is recommended that the previously mentioned is acknowledged in the contingency plan.

In addition to changing water quality, the Town may recommend water use restrictions or programming that generally encourages behaviors that reduce peak water demand during periods of drought. The program may consider the viability of techniques such as the application of low water use appliances, rain barrels for rainfall capture, rain gardens and low impact development (LID) landscaping techniques, among others.

The steering committee noted that the Town could benefit from better knowledge of the water distribution system capacity with drought. This would include an assessment of potable water consumption (average and maximum day demands) and fire flows, under various water supply and development scenarios. The development of a water distribution system model will assist in identifying any required upgrades to meet minimum level of services expectations.

Table 5.7: Action Items for Extreme Heat and Drought

Action Item and Description		Stakeholders	Timeline	Level of Effort
5.3.1	Extreme Heat Community Education Efforts	Town of Oromocto Provincial Public Health Authorities	Near-term	Low
5.3.2	Assess the Cost of Including Emergency Shelter Capacity into the Newly Proposed Multiplex	Town of Oromocto	Short-term	Moderate

Action Item and Description		Stakeholders	Timeline	Level of Effort
5.3.3	Consider a HAB vulnerability assessment and contingency plan development for the WTP	Town of Oromocto CFB Gagetown	Near-term	Moderate
5.3.4	Development of a Water Distribution Model	Town of Oromocto	Near-term	Moderate

6 Next Steps

The recommendations for adaptation measures provided in this Town of Oromocto Climate Change Adaptation Plan (CCAP) were developed through study of municipal infrastructure, climate analysis, and input from Town Staff and project stakeholders. The contributions from municipal departments and relevant stakeholders were essential in completing a comprehensive assessment to best represent the community.

The PIEVC Protocol was used to identify key risks and prioritize areas for adaptation. This risk assessment involved the 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 consequence scoring.

The recommendations for adaptation planning included within the CCAP are intended to build upon existing programming and initiatives within the community. The CCAP should be reviewed by the Town on an annual basis 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 ongoing.

Although third party service providers, such as Liberty Gas, were not included as part of the Steering Committee for this risk assessment, the Town may reach out to these service providers to incorporate community risks into their individual adaptation plans or contingency plans. As community consultation is completed, the Town is encouraged to communicate key risks with businesses and residents. The Town may provide tools and resources to support the community in responding to risks and building community resilience.

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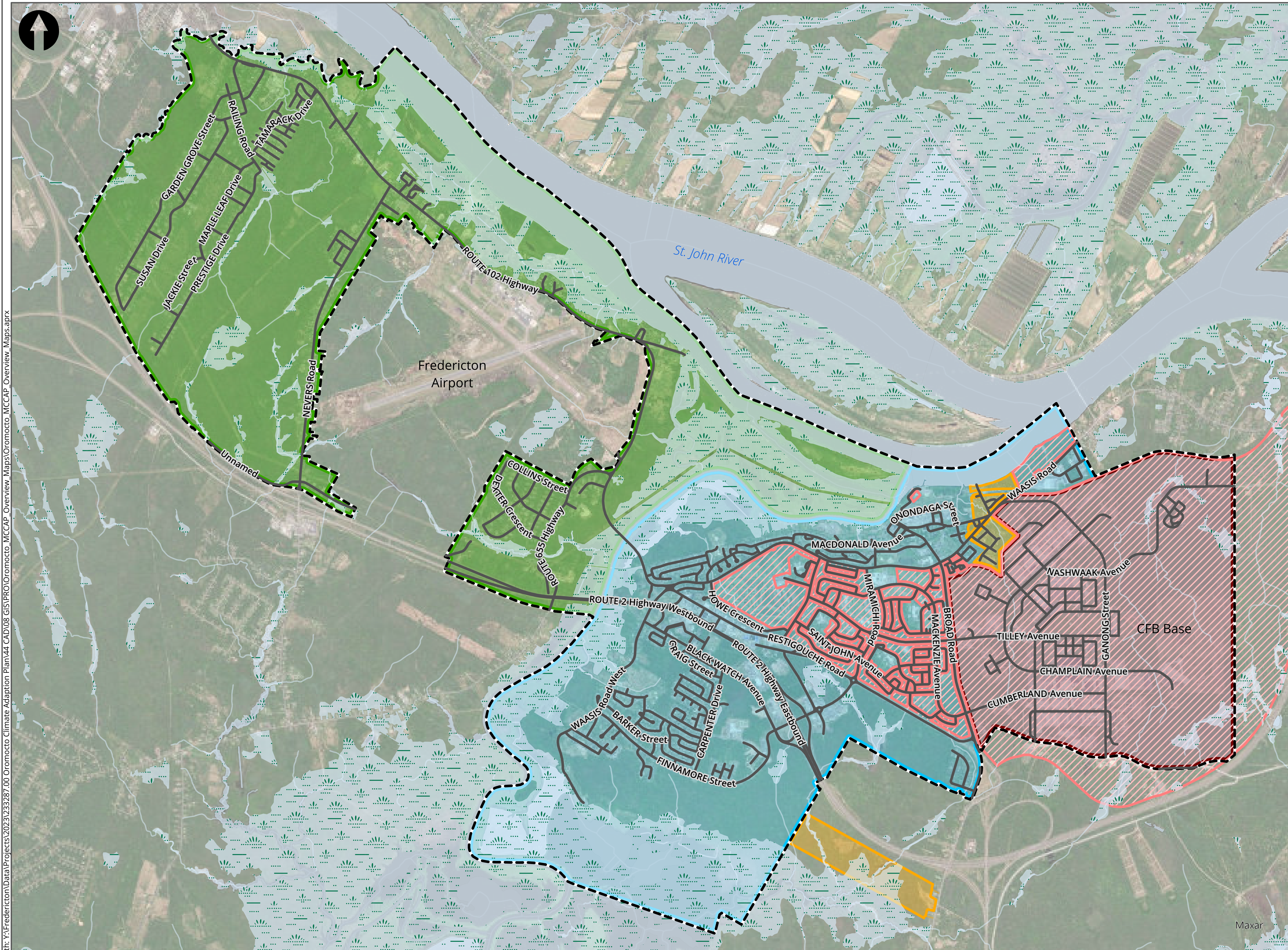
APPENDIX A

Key Asset Group Maps



Legend:

- Town of Oromocto
- Oromocto
- Former Lincoln Local Service District
- Oromocto First Nation
- CFB Base
- CFB FederalLands
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

OVERVIEW MAP

CBCL

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Project No:	233287.00	Figure No:	1

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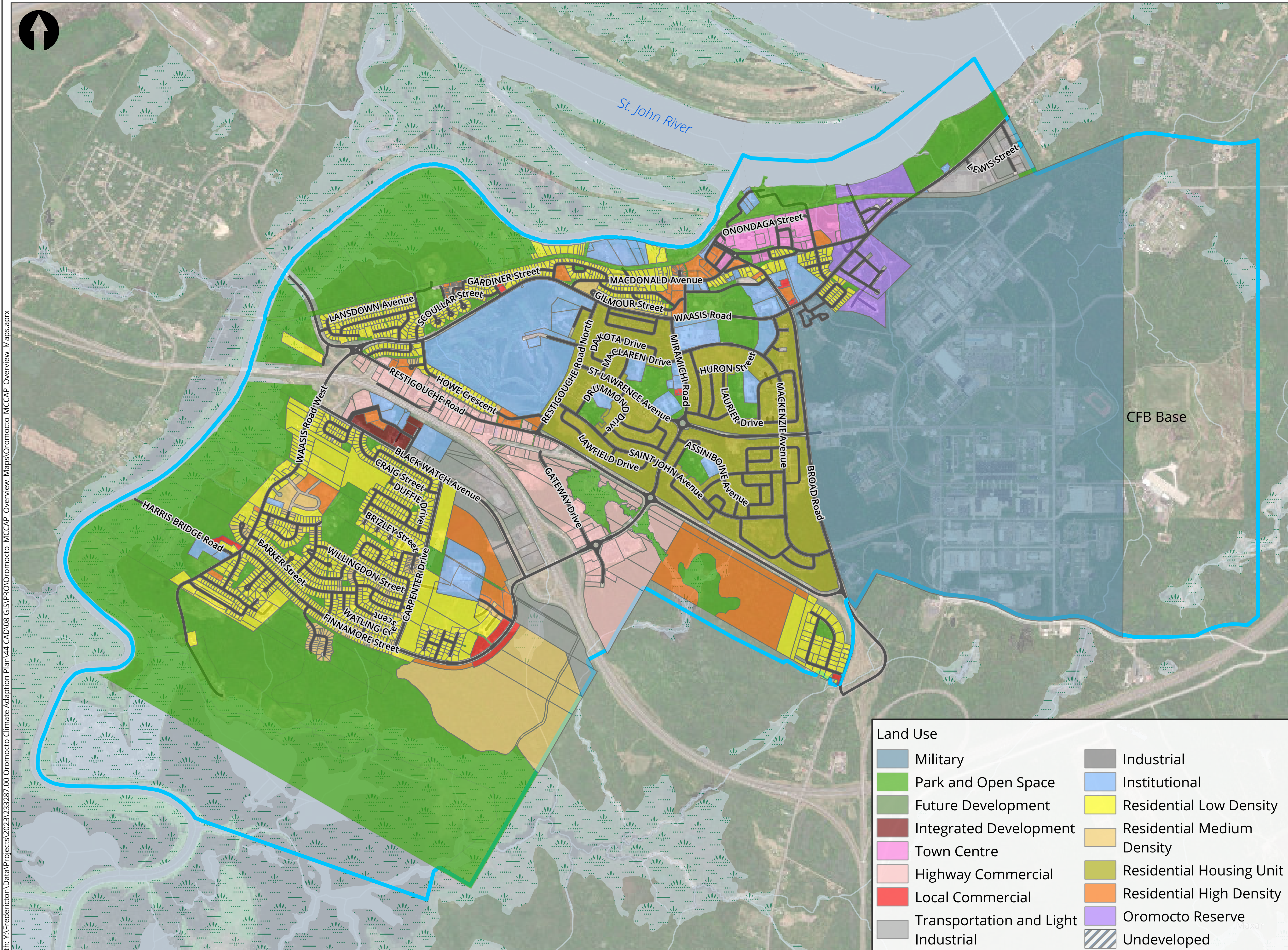

Legend:

- Oromocto
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project: OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title: LAND USE

CBCL

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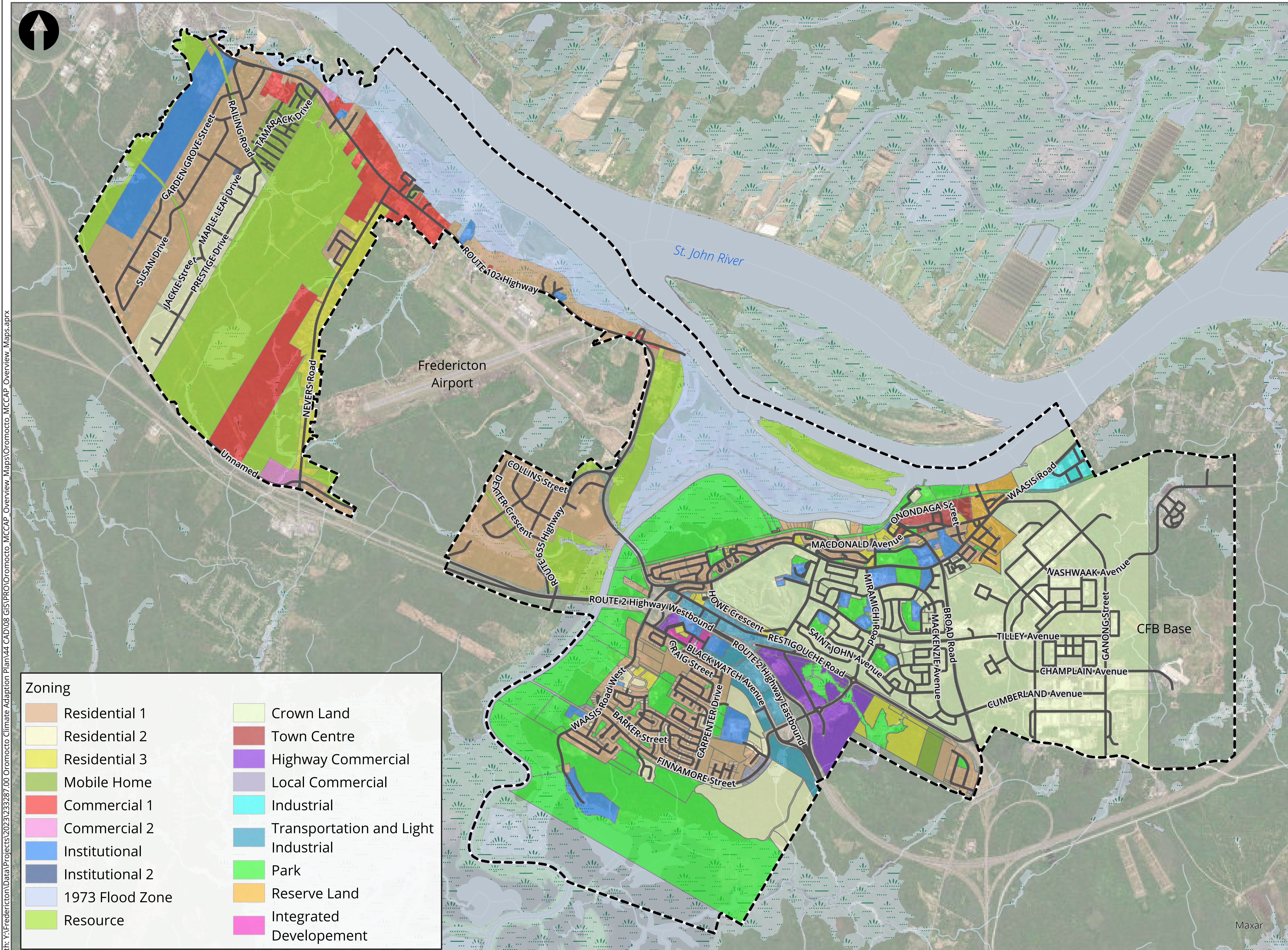

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

ZONING

CBCL

Date: DEC 2023 | Scale: 1:40,000
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Project No: 233287.00 | Figure No: 1

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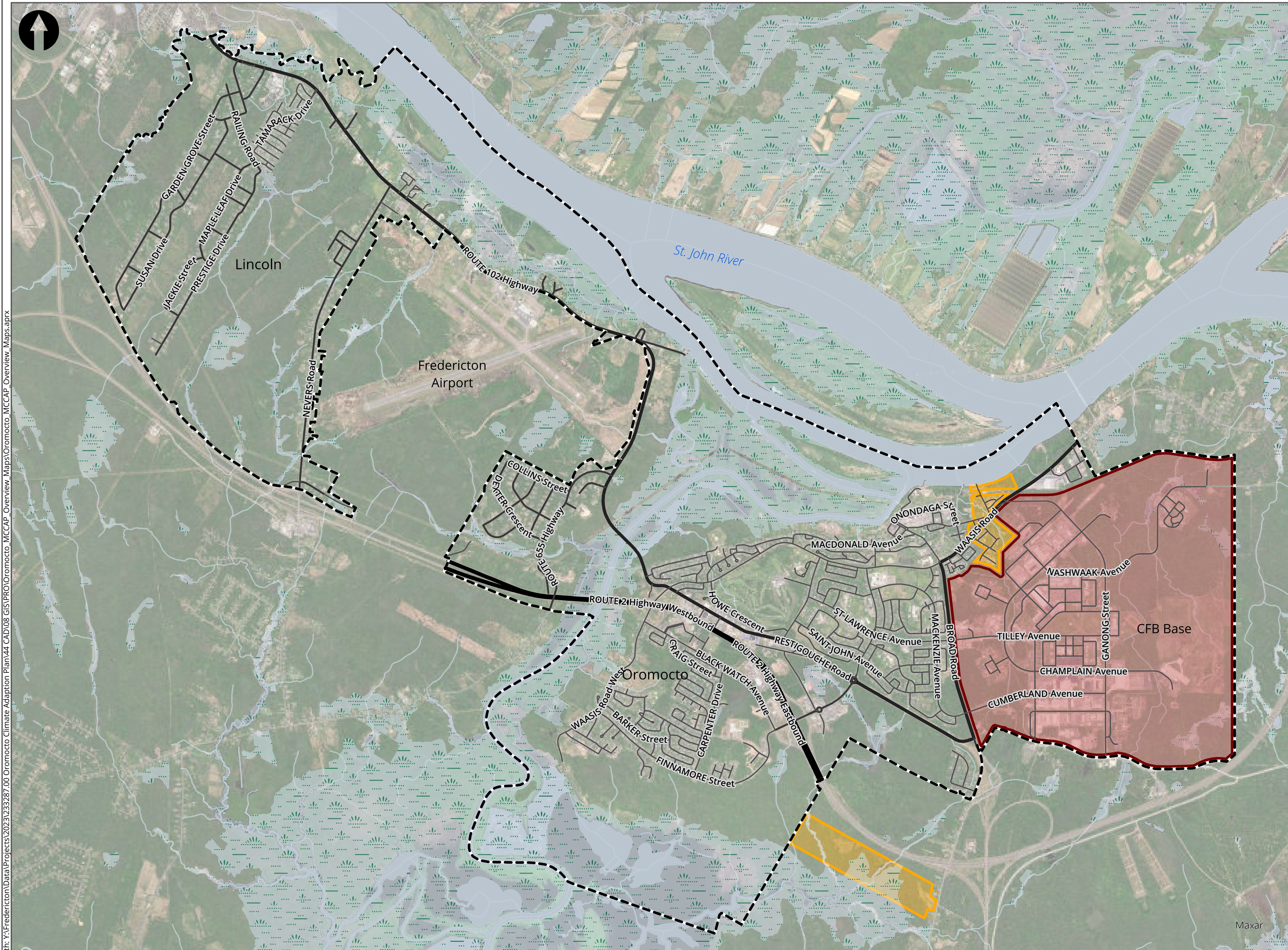

Legend:

- Freeway
- Collector
- NBDOT Local Named
- Local Street
- Resource
- Town of Oromocto
- Oromocto First Nation
- CFB Base
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

TRANSPORTAION SYSTEM

CBCL

Date:	DEC 2023	Scale:	1:40,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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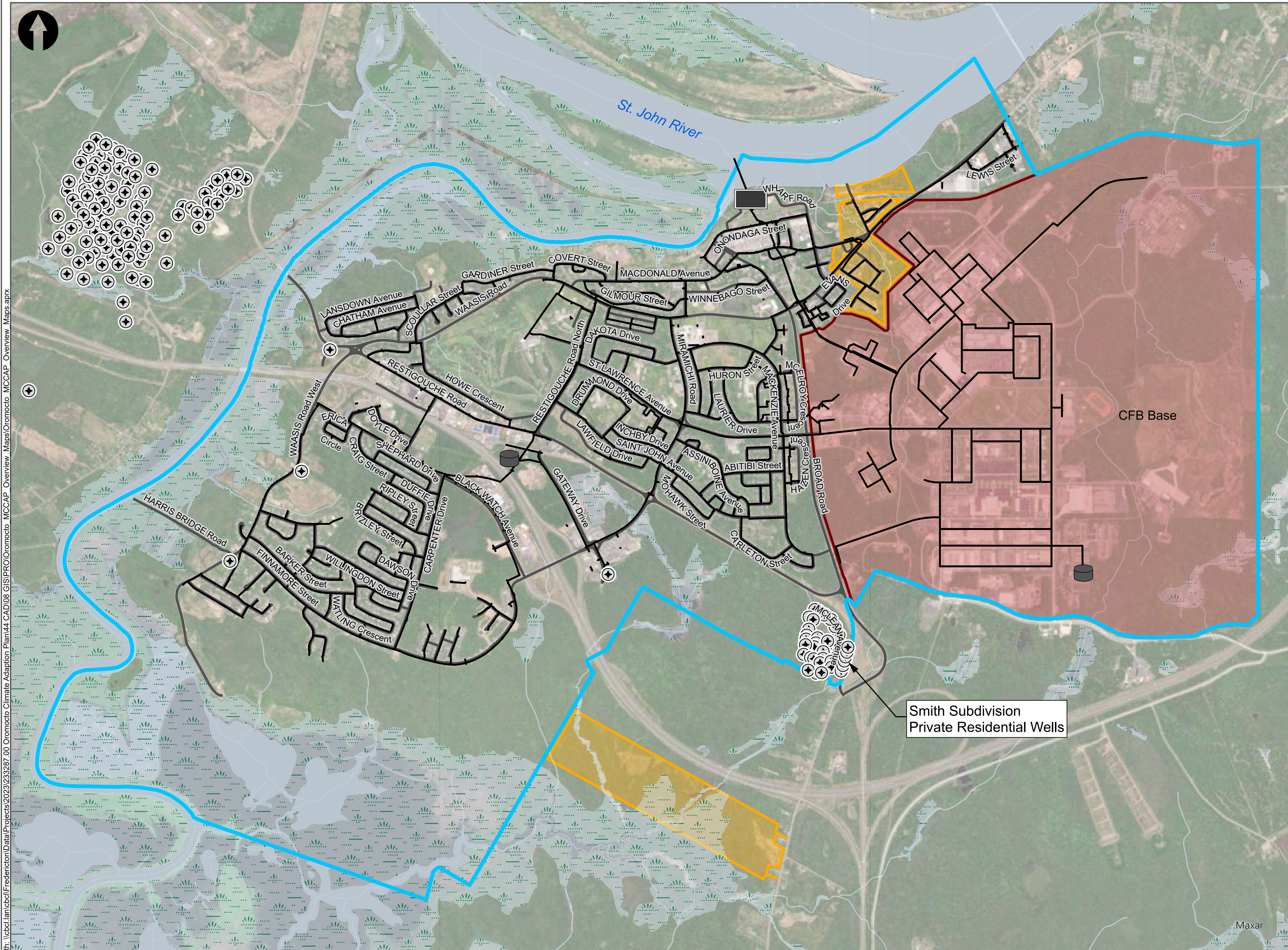


Legend:

- Water Tower
- Treatment Plant
- Well
- Water Main
- Oromocto
- Oromocto First Nation
- CFB Base
- Waterbody
- Wetland

No	Date	Issue/Revision
2	06/03/2024	ISSUED REVISIONS
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

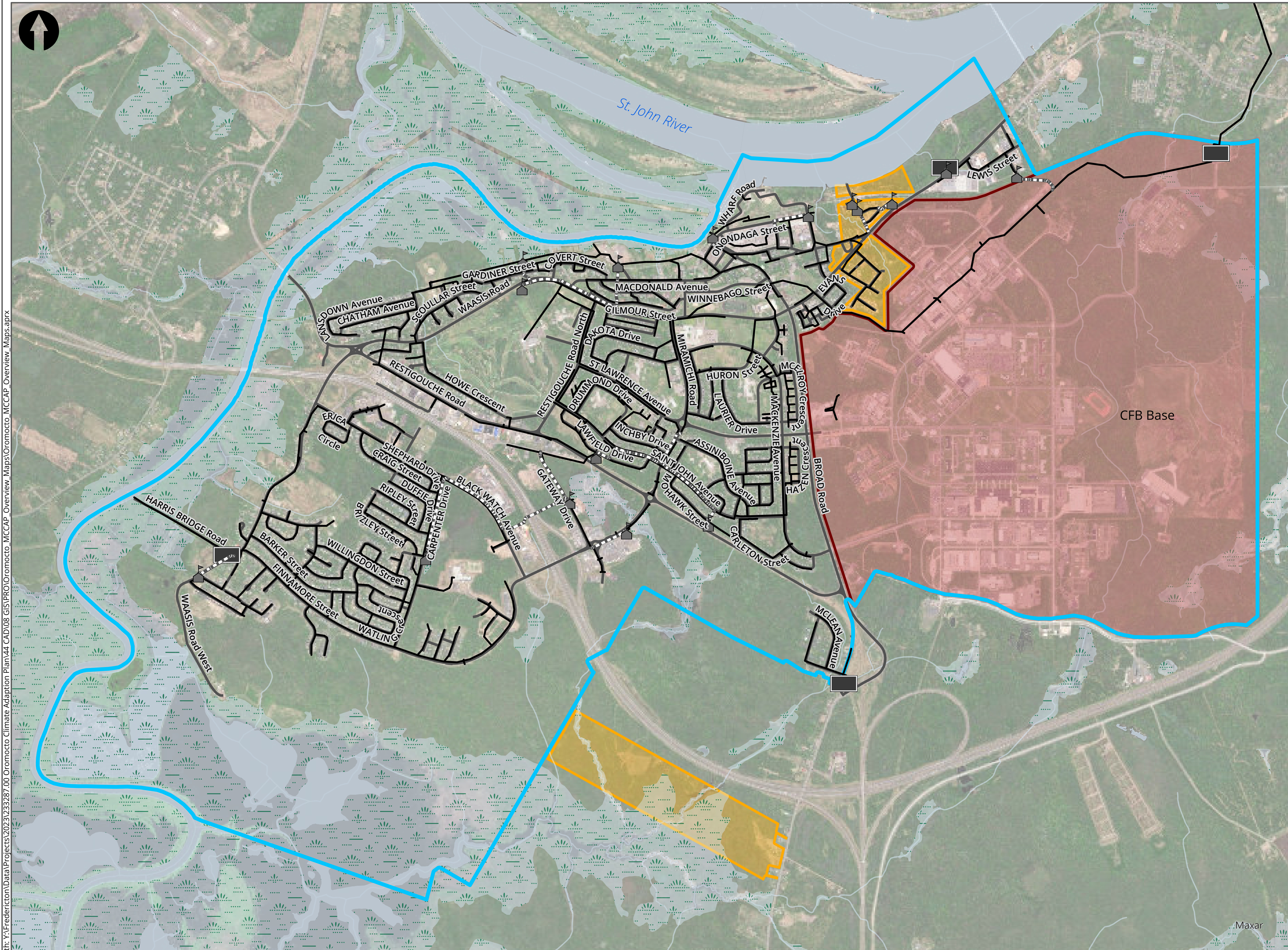
OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

WATER SYSTEM

CBCL

Date:	MAR 2024	Scale:	1:25,000
Drawn:	CM	Checked:	KB
Project No:	233287.00	Figure No:	1



Legend:

- Sanitary Lift Station
- Sanitary Pressurized Main
- Sanitary Treatment Plant
- Sanitary Gravity Main
- Wetland
- Waterbody
- Oromocto
- CFB Base
- Oromocto First Nation

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

SANITARY SYSTEM

CBCL

Date:	DEC 2023	Scale:	1:25,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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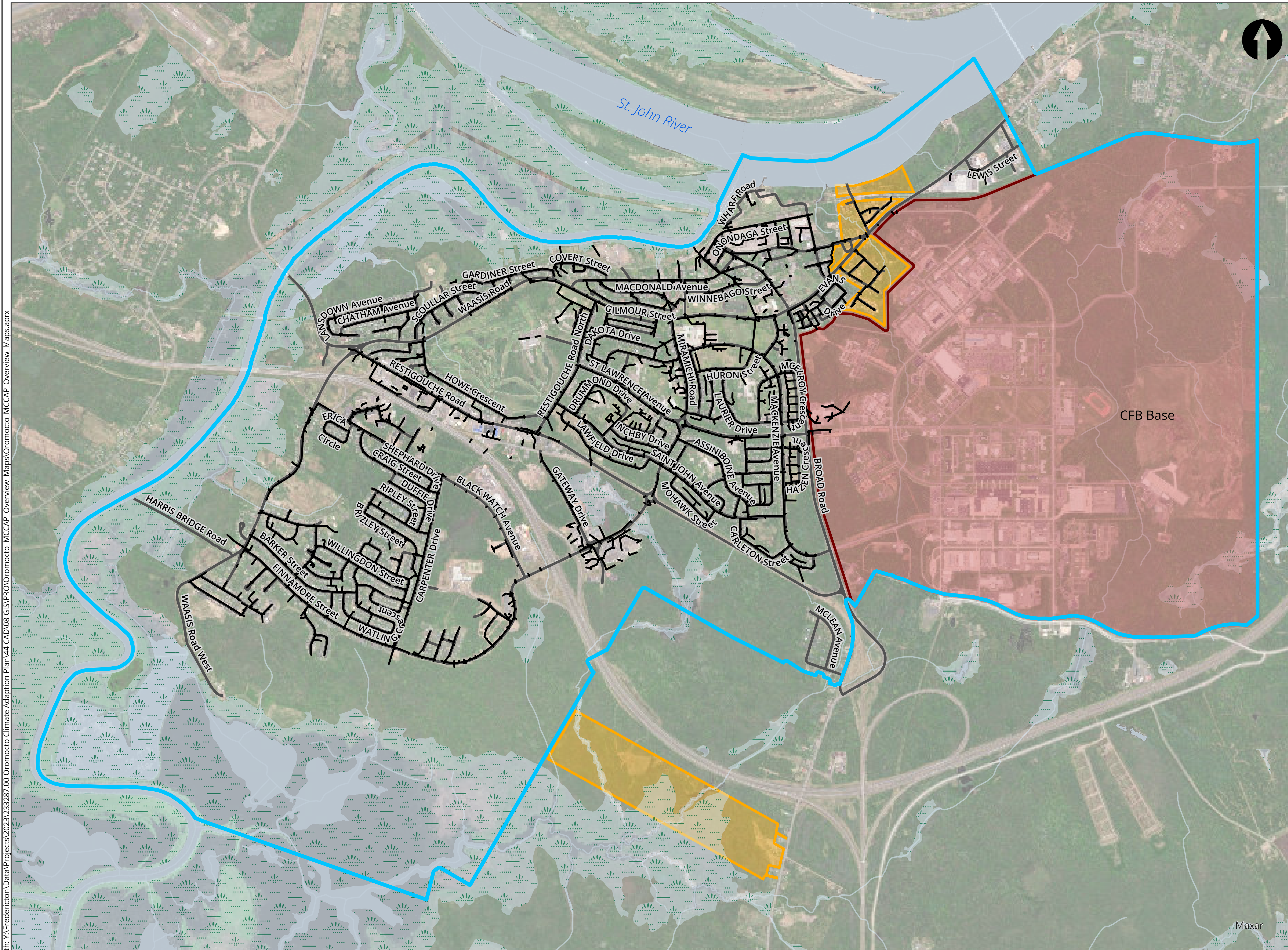

Legend:

- Storm Main
- Oromocto
- Oromocto First Nation
- CFB Base
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

STORM SYSTEM

CBCL

Date:	DEC 2023	Scale:	1:25,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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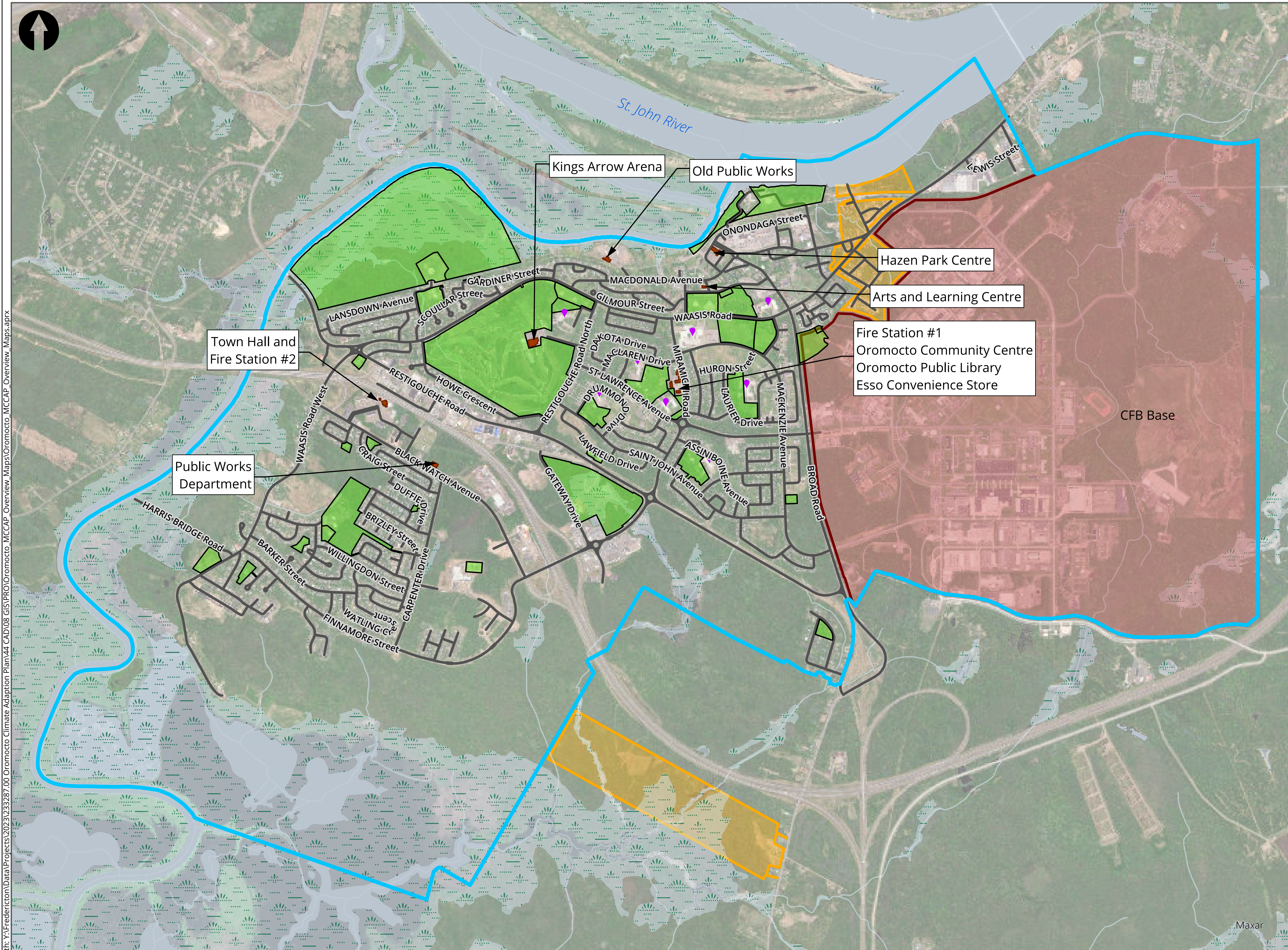

Legend:

- Buildings
- Schools
- Park
- Oromocto
- Oromocto First Nation
- CFB Base
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

TOWN BUILDINGS AND PARKS

CBCL

Date:	DEC 2023	Scale:	1:25,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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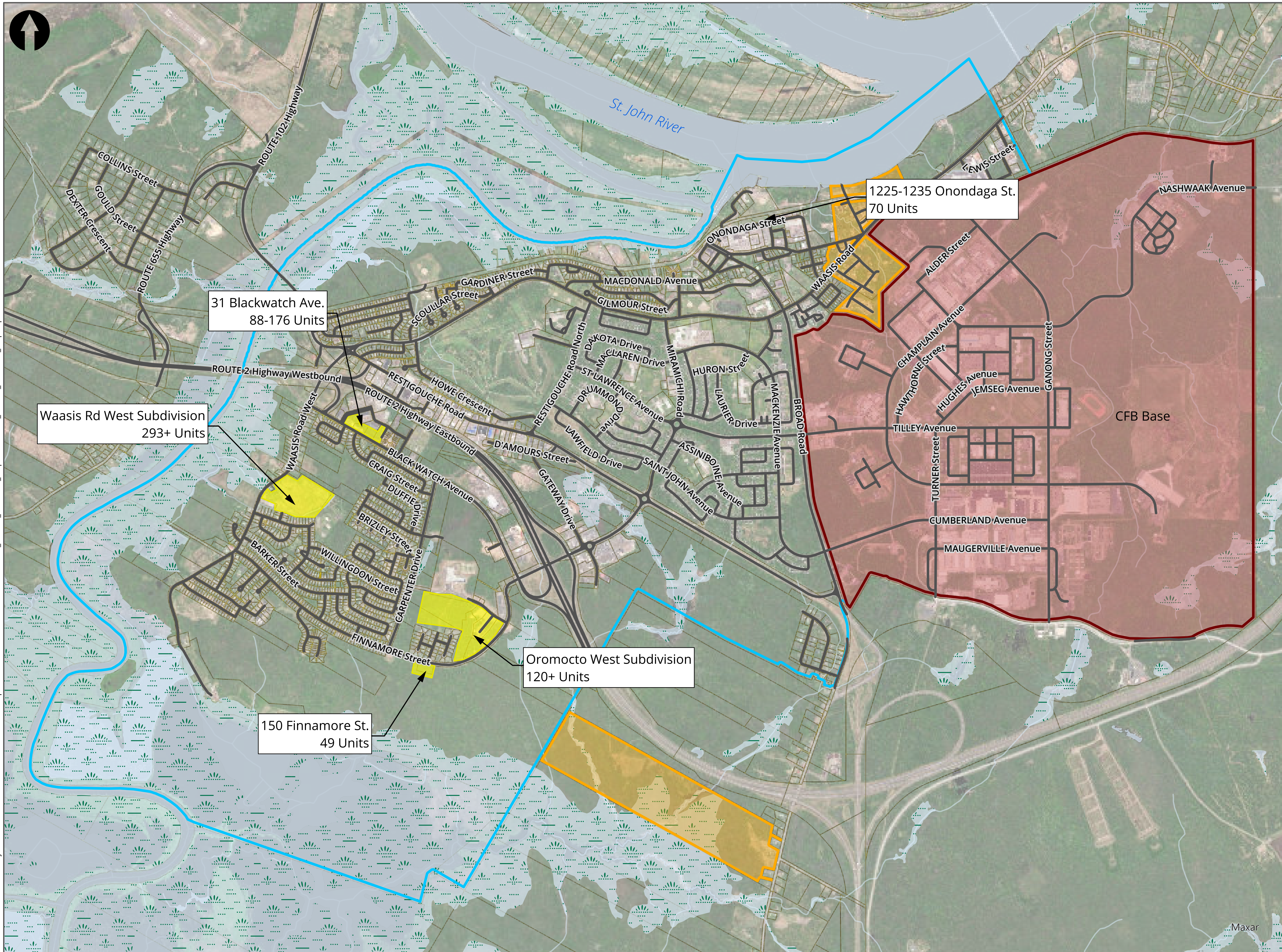


Legend:
- Future Development
- Oromocto
- Oromocto First Nation
- CFB Base
- Waterbody
- Wetland
- parcels

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

POTENTIAL DEVELOPEMENT

CBCL

Date:	DEC 2023	Scale:	1:25,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

APPENDIX B

Risk Matrix

Hazard Category	Hazard	Parameter	Likelihood BL	2030s	2050s	2080s
Riverine Flooding	Riverine Flooding	1 in 100	1	2	3	4
Temperature	Warm Temperatures	Cooling Degree Days	3	4	5	5
Temperature	Extreme Temperatures	Days > 30C	2	3	4	4
Temperature	Freeze-Thaw Cycles	Annual Freeze-Thaw Cycles	3	3	3	3
Precipitation	Extreme Rainfall	1 in 10 year 24 hour	4	4	4	4
Precipitation	Extreme Rainfall	1 in 100 year 24 hour	1	2	3	4
Precipitation	Snowfall	Days with Snowfall > 10cm	3	3	3	2
Precipitation	Ice Accretion	1 in 20 year Ice Thickness	3	3	2	2
Wind & Extreme Events	Wind Load	1 in 50 year Wind Load	2	2	2	3
Wind & Extreme Events	Winter Storms		3	3	3	3
Wind & Extreme Events	Hurricanes/Tropical Storms		1	1	1	2
Other Hazards	Lightning	Lightning Strikes within 25km	3	3	3	3
Other Hazards	Wildfire	Frequency and Intensity of Wildfire (incl. Air Quality)	2	2	3	3
Other Hazards	Low Flows		1	2	2	3
Other Hazards	Drought	Frequency and Intensity of Drought	1	2	2	3

Risk = L x C

Riverine Flooding – 1 in 100

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations (Fire Protection, Police Services, & Emergency Health Services)	All emergency response buildings identified to be outside the floodplain, no direct accessibility or flood related impacts anticipated. Potential flooding and/or erosion of roads leading to reduced or restricted accessibility to emergency response locations or for response services. Potential for operational impacts and delayed response times.	1	2	3	4	5	5	10	15	20
Transportation	Road Network and Active Transportation Routes (incl. bike lanes, sidewalks)	Historical flooding affects several low-lying areas in Lincoln and Oromocto – several subdivision roads and the NB Trail (at Onondaga St.), as well as significant disruption west of Lincoln boundary. In the future, potential overtopping of major road links at several key locations – Route 102 at Tamarack Estates & Lower Lincoln Elementary School, cutting off access to Route 1, with implications on local evacuation routes and regional connectivity to Fredericton. Damage to roads may occur, such as washout of supporting materials and erosion of slopes and revetments.	1	2	3	4	5	5	10	15	20
Water System	Water Supply (from the Base Owned Water Treatment Plant)	The WTP currently is at risk of riverine flooding, this risk is expected to worsen overtime. Flooding of the building and site can result damages to any building components and mechanical/electrical equipment below the flood elevation and restrict site access. Water supply disruptions to the Town may occur.	1	2	3	4	5	5	10	15	20
Water System	Wells	Potential transport of pathogens and contaminants into the Well Head Protection Area resulting in water quality impacts.	1	2	3	4	4	4	8	12	16
Sanitary System	Operation and Treatment Three (3) owned by Town; - WWTP (1) Waasis Rd. West servicing approx. 3000 residents. - WWTP (2) Waasis Rd. servicing Industrial Park. - WWTP (3) Robert St. servicing 20 residents; One owned by the Base - WWTP (4) servicing 6000 residents)	Historic flooding issues with Waasis Rd. West. Waasis Road (Industrial Park) at risk of flooding (existing and future). Exceedance of system capacity leading to discharge of untreated wastewater resulting in exceedance of effluent regulations. High river water levels resulting in restricted discharge leading to significant hydraulic impacts and back-up within the plant.	1	2	3	4	5	5	10	15	20
Sanitary System	Building Structure	Historic flooding issues with Waasis Rd. West. Waasis Road (Industrial Park) at risk of flooding (existing and future). Potential significant damage to building and mechanical/ electrical components below flood elevations.	1	2	3	4	5	5	10	15	20
Sanitary System	Wastewater Collection	Increased river elevations may result in restricted discharge capacity, back-up into the plant and distribution system may occur leading to flooding of residential basements (if no backwater valve is present). Lift stations may become flooding resulting in damages to mechanical/ electrical components below flood elevations. Damages may result in loss of function and require significant repairs/ replacement.	1	2	3	4	4	4	8	12	16
Storm System	Stormwater Management	River water may inflow into the storm system resulting in exceedance of system capacity, back-up and potential flood for residents connected to the system (e.g., at the foundation).	1	2	3	4	2	2	4	6	8

Warm Temperatures – Cooling Degree Days

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Water System	Storage and Distribution (including: Water Tower and Fire Hydrants)	Warmer water temperatures may impact chlorine dosing operations (e.g., increase chlorine boosting demand) throughout the distribution system due to increased formation of disinfection by-products.	3	4	5	5	2	6	8	10	10
Sanitary System	Operation and Treatment	Potential loss of aeration capacity due to warmer water temperatures (from increased air temperatures) which may impact operations. If system capacity is impacted then discharge requirements may be exceeded. Potential odour issues.	3	4	5	5	3	9	12	15	15

Extreme Temperatures – Days > 30C

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Potential for increased heat related illness, such as dehydration, heat exhaustion, heat cramps, and heat stroke leading to increased demand for emergency services and/or response and use of community centers (e.g., Town hall is equipped with A/C). Vulnerable populations such as elderly persons and children may be more at risk.	2	3	4	4	3	6	9	12	12

Freeze-Thaw Cycles – Annual Freeze-Thaw Cycles

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Minor to negligible changes of impacts to hard standing surfaces (e.g., asphalt or concrete) due to melting and re-freezing of water in cracks causing expansion of cracks, weathering, spalling, and deterioration over time reducing its service life.	3	3	3	3	1	3	3	3	3
Emergency Services and Public Safety	Building Structure (Two (2) Fire Stations, Townhall and Community Centre)	It is assumed all foundations were constructed below the frost line and no impact is anticipated. Exposed masonry construction components (e.g., mortar joints, masonry units, concrete) may experience deterioration (e.g., scaling, cracking, spalling, delamination). Impacts may include shortened service life, maintenance will continue to be required.	3	3	3	3	2	6	6	6	6
Transportation	Road Network and Active Transportation Routes	Minor to negligible changes of impacts to hard standing surfaces (e.g., asphalt or concrete) due to melting and re-freezing of water in cracks causing expansion of cracks, weathering, spalling, and deterioration over time reducing its service life.	3	3	3	3	1	3	3	3	3
Water System	Storage and Distribution	It is assumed that the distribution system constructed below the frost line, therefore no impacts are anticipated. Typical wear and tear to exposed masonry materials (e.g., concrete) are expected, typical maintenance will continue to be required.	3	3	3	3	1	3	3	3	3
Sanitary System	Operation and Treatment	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.	3	3	3	3	1	3	3	3	3
Sanitary System	Building Structure	It is assumed all foundations were constructed below the frost line. Exposed masonry construction components (e.g., mortar joints, masonry units, concrete) may experience deterioration (e.g., scaling, cracking, spalling, delamination). Impacts may include shortened service life, increased maintenance requirements and aesthetic issues.	3	3	3	3	2	6	6	6	6

Extreme Rainfall – 1 in 10 year 24 hour

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Transportation	Road Network and Active Transportation Routes	Localized water build up/pooling on roads may occur resulting in reduced or restricted function (e.g. access impacts). Secondary residential roads with insufficient stormwater infrastructure may be more vulnerable to impacts. Increased wear and tear on materials may leading to increased maintenance requirements.	4	4	4	4	2	8	8	8	8
Sanitary System	Operation and Treatment	Due to Inflow and Infiltration capacity may be exceeded resulting in discharge of untreated effluent and exceedance of discharge requirements over a short period.	4	4	4	4	2	8	8	8	8
Sanitary System	Wastewater Collection	Inflow and infiltration into the collection system may result in loss of system capacity and potential back-up leading to flooding of residential basements (if no backwater valve is present).	4	4	4	4	3	12	12	12	12
Storm System	Stormwater Management	Stormwater system may have insufficient capacity to handle flows resulting in system back-up, overflow, and potential localized flooding.	4	4	4	4	3	12	12	12	12

Extreme Rainfall – 1 in 100 year 24 hour

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Potential flooding and/or erosion of roads leading to reduced or restricted accessibility to emergency response locations or for response services. Potential for localized on site flooding leading to impacts such as restricted or complete loss of parking lot and building access. Operational impacts and delayed response times may occur.	1	2	3	4	4	4	8	12	16
Emergency Services and Public Safety	Building Structure	Potential localized flooding on site may occur and may lead to water ingress and associated flooding damages. Building components below flood elevation are at risk of damage. Damages may require significant repairs and/or replacement. Buildings with basements are more vulnerable to flood risks.	1	2	3	4	2	2	4	6	8
Transportation	Road Network and Active Transportation Routes	Flooding of roads may result in reduced or restricted access to areas of the community. Damage to roads may occur, such as washout of supporting materials and erosion of slopes and revetments. Increased wear and tear on materials leading to increased maintenance requirements.	1	2	3	4	4	4	8	12	16
Water System	Water Supply	Potential flooding of the building and site can result damages to any building components and mechanical/electrical equipment below the flood elevation and restrict site access. Water supply disruptions to the Town may occur Potential increase in nutrient transport and loading which can contribute to an algae bloom (with additional contributing factors).	1	2	3	4	3	3	6	9	12
Water System	Wells	Potential transport of pathogens and contaminants into the Well Head Protection Area (WHPA) resulting in water quality impacts.	1	2	3	4	3	3	6	9	12
Sanitary System	Operation and Treatment	Due to Inflow and Infiltration capacity may be exceeded resulting in discharge of untreated effluent and exceedance of discharge requirements over a short period. Potential accessibility issues, restricted or complete loss of parking lot function leading to disruption to operations.	1	2	3	4	3	3	6	9	12
Sanitary System	Building Structure	Potential localized flooding on site may occur and may lead to water ingress and associated flooding damages. Building components below flood elevation are at risk of damage. Damages may require significant repairs and/or replacement. Buildings with basements are more vulnerable to flood risks.	1	2	3	4	3	3	6	9	12
Sanitary System	Wastewater Collection	Inflow and infiltration into the collection system may result in loss of system capacity and potential back-up leading to flooding of residential basements (if no backwater valve is present).	1	2	3	4	4	4	8	12	16
Storm System	Stormwater Management	Stormwater system may have insufficient capacity to handle flows resulting in system back-up, overflow, and potential significant flooding including onto roads and properties. .	1	2	3	4	4	4	8	12	16

Snowfall – Days with Snowfall > 10cm

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Potential minor disruption to service response operations such as reduced/restricted access due to snow accumulation. Snow removal operations and site maintenance will continue to be required.	3	3	3	2	1	3	3	3	2
Transportation	Road Network and Active Transportation Routes	Wear and tear to road surfaces (e.g., asphalt) from snow removal operations. Low health and safety risk anticipated should regular snow removal operations continue.	3	3	3	2	1	3	3	3	2
Sanitary System	Operation and Treatment	Potential access issues due to snow accumulation. Minor impact to snow removal operations and site maintenance.	3	3	3	2	1	3	3	3	2
Storm System	Stormwater Management	Possible for snow building at inlets or outlets which may temporarily reduce capacity of the drainage system. Snow clearing may be required to restore capacity. Potential for localized pooling of ice/water.	3	3	3	2	2	6	6	6	4

Ice Accretion – 1 in 20 year Ice Thickness

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Building Structure	Depending on roof design (e.g., sloped roof), may experience ice damming. Health and safety risk due to falling ice or slip and fall. De-icing operations may be required.	3	3	2	2	2	6	6	4	4
Transportation	Road Network and Active Transportation Routes	Wear and tear to road surfaces (e.g. asphalt) from de-icing operations. Minor to negligible health and safety risk should regular de-icing operations continue.	3	3	2	2	1	3	3	2	2
Sanitary System	Building Structure	Depending on roof design (e.g., sloped roof), may experience ice damming. Health and safety risk due to falling ice or slip and fall. De-icing operations may be required.	3	3	2	2	2	6	6	4	4
Storm System	Stormwater Management	Ice accretion can cause blockages at inlets or outlets which may temporarily reduce capacity of the drainage system.	3	3	2	2	2	6	6	4	4

Wind Load – 1 in 50 year Wind Load

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Building Structure	Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.	2	2	2	3	3	6	6	6	9
Water System	Storage and Distribution	It is unclear to what wind-load or governing structural load the Water Tower was constructed to, should be wind-load be governing in design and exceeded potential damages may occur and immediate repairs required. Disruption in services may occur during repairs. Potential minor damages due to windblown debris and to other infrastructure (antenna) installed on water tower roof.	2	2	2	3	3	6	6	6	9
Sanitary System	Building Structure	Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.	2	2	2	3	3	6	6	6	9

Winter Storms

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Potential impacts such as reduced/restricted access due to snow accumulation, unsafe operating conditions, and delays in service response times. Potential short-term loss of primary power source impacting operations. Town hall (fire dept.) is equipped with a back-up generator and stores several mobile generators available to be used at other facilities. Snow removal operations will continue to be required.	3	3	3	3	2	6	6	6	6
Transportation	Road Network and Active Transportation Routes	Potential health and safety risks during use of transportation routes during event. Snow removal activities are anticipated to continue to be required. Wear and tear to asphalt and concrete surfaces from snow clearing and de-icing operations. Interruption of power lines may occur resulting in short-term loss of function of signalization.	3	3	3	3	3	9	9	9	9
Water System	Water Supply	Potential loss of primary power source. It is assumed that the Base is equipped with adequate back-up generators to handle disruption and no impacts to supply will occur.	3	3	3	3	1	3	3	3	3
Sanitary System	Operation and Treatment	Potential loss of primary power supply. WWTP (1) is equipped with a generator. does have generator for potential power outages. If WWTP is not equipped with a back-up generator then impact to operations and short-term loss of treatment capacity are anticipated leading to discharge of untreated wastewater. Potential impacts to site accessibility.	3	3	3	3	2	6	6	6	6
Sanitary System	Wastewater Collection	Potential flooding concern due to rain-on-snow events. Inflow and infiltration into the collection system may result in loss of system capacity and potential back-up leading to flooding of residential basements (if no backwater valve is present).	3	3	3	3	3	9	9	9	9
Storm System	Stormwater Management	Possible for snow/ice building at inlets or outlets which may temporarily reduce capacity of the drainage system. Snow/ice clearing may be required to restore capacity. Potential for localized pooling of ice/water.	3	3	3	3	2	6	6	6	6

Hurricanes/Tropical Storms

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Potential restricted/reduced service access due to fallen or windblown debris. Unsafe operating conditions resulting in health and safety risk. Delays in response time anticipated. Potential increased service demand. Potential loss of primary power source. Town hall (fire dept.) is equipped with a back-up generator and stores several mobile generators available to be used at other facilities.	1	1	1	2	4	4	4	4	8
Emergency Services and Public Safety	Building Structure	Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.	1	1	1	2	4	4	4	4	8
Transportation	Road Network and Active Transportation Routes	Increased maintenance to clear off wind-blown debris (e.g. power lines, signalization, trees) from road surfaces and maintain transportation routes. Potential increased maintenance to clear localized flooding/ pooling of water from heavy rainfall and repair damaged infrastructure due to impact of debris or uplift.	1	1	1	2	3	3	3	3	6
Water System	Water Supply	Supply chain routes may be disrupted (applicable if WTP is dependent on delivery of treatment supplies), if prolonged, water supply may be disrupted. Potential loss of primary power source. It is assumed that the Base is equipped with adequate back-up generators to handle disruption and no impacts to supply will occur.	1	1	1	2	3	3	3	3	6
Water System	Storage and Distribution	It is unclear to what wind-load or governing structural load the Water Tower was constructed to, should be wind-load be governing in design and exceeded potential damages may occur and immediate repairs required. Disruption in services may occur during repairs. Potential minor damages due to windblown debris and to other infrastructure (antenna) installed on water tower roof.	1	1	1	2	4	4	4	4	8
Sanitary System	Operation and Treatment	Potential loss of primary power supply. WWTP (1) is equipped with a generator. does have generator for potential power outages. If WWTP is not equipped with a back-up generator then impact to operations and short-term loss of treatment capacity are anticipated leading to discharge of untreated wastewater. Potential impacts to site accessibility.	1	1	1	2	3	3	3	3	6
Sanitary System	Building Structure	Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.	1	1	1	2	4	4	4	4	8
Storm System	Stormwater Management	Debris from hurricanes can cause blockages in stormwater systems, resulting in restricted or blocked capacity leading to flooding. Maintenance may be required to clear assets of debris or blockages.	1	1	1	2	2	2	2	2	4

Lightning – Lightning Strikes within 25km

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Building Structure	If the building is not grounded, potential fire risk due to interaction with interior wood or flammable components. Fire damage to the superstructure may require extensive repairs and partial up to complete replacement of asset.	3	3	3	3	2	6	6	6	6
Water System	Storage and Distribution	It is assumed that the tank is grounded and no significant impacts to the tower will occur in the event of a lightning strike. Mounted electrical equipment may be damaged and require repair/ replacement.	3	3	3	3	1	3	3	3	3
Sanitary System	Operation and Treatment	It is assumed that the plants are grounded no significant impacts are anticipated in the event of a lightning strike. Mounted electrical equipment may be damaged and require repair/ replacement.	3	3	3	3	2	6	6	6	6
Sanitary System	Building Structure	If the building is not grounded, potential fire risk due to interaction with interior wood or flammable components. Fire damage to the superstructure may require extensive repairs and partial up to complete replacement of asset.	3	3	3	3	5	15	15	15	15

Wildfire – Frequency and Intensity of Wildfire (incl. Air Quality)

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Emergency Services and Public Safety	Response and Operations	Increased demand for emergency services (e.g., fire fighting services). Potential reduced/restricted access to/from areas of the Town. Road network does not have sufficient redundancies, such as alternative evacuation routes. Significant health and safety risk is anticipated.	2	2	3	3	5	10	10	15	15
Emergency Services and Public Safety	Building Structure	Exposure to wildfire can cause significant impacts such as partial up to complete loss of the asset.	2	2	3	3	5	10	10	15	15
Transportation	Road Network and Active Transportation Routes	Reduced or restricted access for evacuation resulting in potential significant health and safety risk. Damage to exposed road materials and increased susceptibility to erosion of supporting soils leading to potential washout.	2	2	3	3	5	10	10	15	15
Water System	Water Supply	Potential significant damage to the WTP Building leading to prolonged disruption of water supply to the Town. It is noted that the WTP is located near the river surrounded by development and is therefore less vulnerable to Wildfire. Potential massive disruption to watershed, long-term impacts to water quality leading to operational impacts and prolonged disruption of water supply.	2	2	3	3	5	10	10	15	15
Water System	Storage and Distribution	Potential significant infrastructure damage such as to the Water Tower and loss of function. Potential community wide water use restrictions implemented.	2	2	3	3	5	10	10	15	15
Sanitary System	Operation and Treatment	WWTP (3) is most vulnerable to Wildfire impacted due to its location near the edge of the community and closest to forested areas. Impacts may include partial to complete loss of asset and significant operational disruptions or loss of function.	2	2	3	3	5	10	10	15	15
Sanitary System	Building Structure	WWTP (3) is most vulnerable to Wildfire impacts due to its location near the edge of the community and closest to forested areas. Impacts may include partial to complete loss of asset and significant operational disruptions or loss of function.	2	2	3	3	5	10	10	15	15

Low Flows

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Water System	Water Supply	Potential changes in water availability and allowable water extraction quantity, however, not to the extent that water supply to the Town is impacted.	1	2	2	3	1	1	2	2	3
Water System	Storage and Distribution	Potential impact to available storage water capacity. Low flows may impact pressurization in the distribution system if the WTP is impacted.	1	2	2	3	2	2	4	4	6
Sanitary System	Operation and Treatment	During low flows the outfall elevation may be above water depending on its elevation.	1	2	2	3	2	2	4	4	6

Drought – Frequency and Intensity of Drought

Asset Group	Asset Subcomponent	Interaction	Likelihood BL	2030s	2050s	2080s	Consequence	Risk BL	2030s	2050s	2080s
Water System	Water Supply	Potential for conditions contributing to the occurrence of algae blooms. Occurrence of algal blooms (e.g., toxic algal blooms) may result in supply disruptions. Potential community wide water use restrictions may become implemented.	1	2	2	3	4	4	8	8	12
Water System	Storage and Distribution	Potential water resource management challenges due to changing water availability and increased demand.	1	2	2	3	3	3	6	6	9
Water System	Wells	Potential impacts to aquifer recharge and allowable extraction impacting water availability.	1	2	2	3	4	4	8	8	12
Sanitary System	Operation and Treatment	Potential increased concentration of wastewater inflows due to reduced water consumption by town leading to exceedance of discharge regulations.	1	2	2	3	2	2	4	4	6
Sanitary System	Wastewater Collection	Low flows may result in stagnation of wastewater within the distribution system resulting in septic conditions and odour concerns.	1	2	2	3	2	2	4	4	6

Asset Group	Asset Subcomponent	Risk = L x C	Riverine Flooding – Riverine Flooding – 1 in 100				Temperature – Warm Temperatures – Cooling Degree Days				Temperature – Extreme Temperatures – Days > 30C				Temperature – Freeze-Thaw Cycles – Annual Freeze-Thaw Cycles			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	1	2	3	4	3	4	5	5	2	3	4	4	3	3	3	3
Energy Services	Energy Supply and Services (N.B Power services Town via above-ground Transmission Lines. Substation. Town owns and maintains above-ground and underground distribution)	Interaction	Transmission line located within the floodplain (existing and future) impacts may result in disruption of services. Uncertain if substation is directly vulnerable to flooding, however, impacts may result in disruption of services. If flood elevation is greater than substation electrical components a short-term outage may occur, no long-term damage is anticipated. Moving waters/ Erosion may impact structural stability of poles.								Exposure to hot temperatures over time may lead to embrittled insulation of transformers resulting in negligible to minor reduction in service life.				It is assumed that underground equipment was constructed below the frost line and is therefore not impacted. Normal wear and tear to the concrete pad mount supporting the substation. Potential for damaged threaded connection points and reduced structural stability/ leaning of poles due to ground movement, anticipated to be localized incidents and minor to negligible impact to service/operations.			
		Likelihood	1	2	3	4					2	3	4	4	3	3	3	3
		Consequence	3								1				1			
		Risk	3	6	9	12					2	3	4	4	3	3	3	3
Community Services (incl. Public Works Dept., Kings Arrow Arena, Hazen Park Centre, Library, Community Arts and Learning Centre, Marina, Leroy Washburn Turf)	Service and Operation	Interaction	The Marina is vulnerable to flooding, this risk is expected to worsen over time. Flooding may result in partial or complete loss of parking lot capacity, and/or site access leading to delayed or restricted operations and availability of services.								Potential cancelled or rescheduled events due to extreme temperatures. Potential vegetation die-off (e.g., grass on sports fields).				Negligible to minor changes in impacts to hard standing surfaces (e.g., asphalt or concrete) due to melting and re-freezing of water in cracks causing expansion of cracks, weathering, spalling, and deterioration over time reducing it's service life.			
		Likelihood	1	2	3	4					2	3	4	4	3	3	3	3
		Consequence	2								1				1			
		Risk	2	4	6	8					2	3	4	4	3	3	3	3
	Building Structure	Interaction	The Marine and areas surrounding the Hazen Park Center are vulnerable to flooding, this risk is expected to worsen over time. Flooding of the building can result in damages to any building components and mechanical/electrical equipment below the flood elevation. Damages may require significant repairs or replacement.								Potential increased demand for community services centers, such as those equipped with Air Conditioning.				It is assumed all foundations were constructed below the frost line. Exposed masonry construction components (e.g., mortar joints, masonry units, concrete) may experience deterioration (e.g., scaling, cracking, spalling, delamination). Impacts may include shortened service life, increased maintenance requirements and aesthetic issues.			
		Likelihood	1	2	3	4					2	3	4	4	3	3	3	3
		Consequence	3								1				2			
		Risk	3	6	9	12					2	3	4	4	6	6	6	6
	Natural Environment (Trails, Parks, Landscape Features, and Wetlands)	Interaction	Partial or total submergence of parks may result in loss of performance or function as recreational assets temporarily. Maintenance could be required to clear debris and restore walking trails.								Potential damage/loss of vegetation due to extreme temperatures. Potential for increased maintenance and increased water demand.							
		Likelihood	1	2	3	4					2	3	4	4				
		Consequence	3								1							
		Risk	3	6	9	12					2	3	4	4				
Land Use and Policies	Development Practices	Interaction	Several existing subdivisions (e.g., Tamarack Estates, and Wassis Road West) are at historical risk, while areas considered for future development may also be at risk under historical and forecasted conditions. Land Use By-Law restricts development on sites considered marshy, subject to flooding, excessively steep, or unsuitable by virtue of soil topography – at discretion of the Planning Advisory Committee. Land-use Bylaw does make provision restricting development of habitable spaces such that the minimum floor elevation is at least 1 metre above a historical recorded flood record which is lower than the current and future 1 in 100 year flood elevation. As noted, the historical flood record is not specifically illustrated or defined. Future flood risk is not recognized or described.															
		Likelihood	1	2	3	4												
		Consequence	3															
		Risk	3	6	9	12												

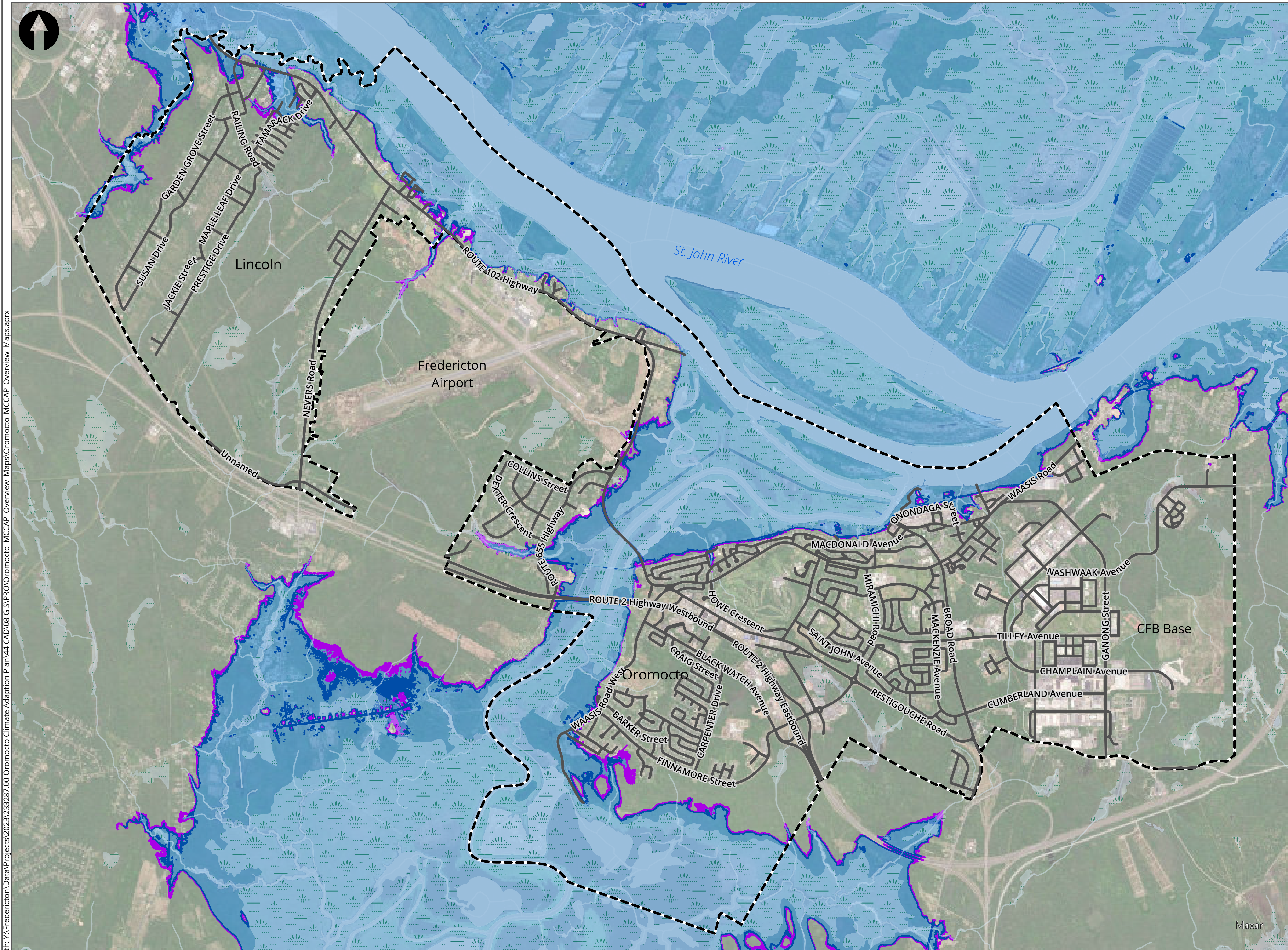
Asset Group	Asset Subcomponent	Risk = L x C	Precipitation – Extreme Rainfall – 1 in 10 year 24 hour				Precipitation – Extreme Rainfall – 1 in 100 year 24 hour				Precipitation – Snowfall – Days with Snowfall > 10cm				Precipitation – Ice Accretion – 1 in 20 year Ice Thickness			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	4	4	4	4	1	2	3	4	3	3	3	2	3	3	2	2
Energy Services	Energy Supply and Services	Interaction					Potential for localized flooding around/within the substation area leading to washout of surrounding materials and minor/ short-term impacts to serviceability and accessibility.								Build-up of ice on distribution lines may impact structural integrity of poles and associated mounted equipment resulting in significant damages and disruption of services. Build-up of ice on trees causing bowing near distribution lines can result in significant damages and disruption of services (if proper vegetation buffer is not maintained).			
		Likelihood					1	2	3	4					3	3	2	2
		Consequence					2								3			
		Risk					2	4	6	8					9	9	6	6
Community Services	Service and Operation	Interaction					Potential localized flooding on site may occur and may lead to accessibility issues, restricted or complete loss of parking lot function, and disruption to operations (e.g., delays or cancellation of activities).				Minor to negligible change in disruption to operations due to restricted access from snow accumulation on walkways/ parking lot areas. Snow removal operations and site maintenance will continue to be required.							
		Likelihood					1	2	3	4	3	3	3	2				
		Consequence					2				1							
		Risk					2	4	6	8	3	3	3	2				
	Building Structure	Interaction					Potential localized flooding on site may occur and may lead to water ingress and associated flooding damages. Building components below flood elevation are at risk of damage. Damages may require significant repairs and/or replacement. Buildings with basements are more vulnerable to flood risks.								Depending on roof design (e.g., sloped roof), may experience ice damming. Health and safety risk due to falling ice or slip and fall. De-icing operations may be required.			
		Likelihood					1	2	3	4					3	3	2	2
		Consequence					2								1			
		Risk					2	4	6	8					3	3	2	2
	Natural Environment	Interaction	Potential localized flooding, could damage vegetation.				Potential localized flooding, could damage vegetation. Potential washout or erosion of trails. Increased maintenance required to restore paths and trails.											
		Likelihood	4	4	4	4	1	2	3	4								
		Consequence	1				2											
		Risk	4	4	4	4	2	4	6	8								
Land Use and Policies	Development Practices	Interaction	Insufficient stormwater management could result in stormwater runoff to roads, private, and commercial properties resulting in damages liable to the Town.				Insufficient stormwater management could result in stormwater runoff to roads, private, and commercial properties resulting in damages liable to the Town.											
		Likelihood	4	4	4	4	1	2	3	4								
		Consequence	3				3											
		Risk	12	12	12	12	3	6	9	12								

Asset Group	Asset Subcomponent	Risk = L x C	Wind & Extreme Events – Wind Load – 1 in 50 year Wind Load				Wind & Extreme Events – Winter Storms				Wind & Extreme Events – Hurricanes/Tropical Storms			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	2	2	2	3	3	3	3	3	1	1	1	2
Energy Services	Energy Supply and Services	Interaction	Potential minor disruption of electrical service to PMQ residences due to impacts to overhead distribution equipment. Potential disruption of electrical service to Town if the overhead transmission line is impacted (which connects to the Towns underground system), however, due to stricter vegetation maintenance around transmission lines it is anticipated that impacts will be minor/ localized resulting in short-term disruptions until service is restored.				Potential minor disruption of electrical service to PMQ residences due to impacts to overhead distribution equipment. Potential disruption of electrical service to Town if the overhead transmission line is impacted (which connects to the Towns underground system), however, due to stricter vegetation maintenance around transmission lines it is anticipated that impacts will be minor/ localized resulting in short-term disruptions until service is restored.				Potential major disruption of electrical service to PMQ residences due to impacts to overhead distribution equipment and significant maintenance required. Potential disruption of electrical service to Town if the overhead transmission line is impacted (which connects to the Towns underground system), however, due to stricter vegetation maintenance around transmission lines it is anticipated that impact due to winds will be localized resulting in moderate disruptions until service is restored.			
		Likelihood	2	2	2	3	3	3	3	3	1	1	1	2
		Consequence	3				3				4			
		Risk	6	6	6	9	9	9	9	9	4	4	4	8
Community Services	Service and Operation	Interaction					Potential impacts such as reduced access due to snow accumulation, unsafe operating conditions, and delays in available services. Potential short-term loss of primary power source impacting operations.				Potential short-term closure of service locations and delay of services due to unsafe operating conditions. Potential localized onsite flooding and windblown debris requiring maintenance to clear to restore operations.			
		Likelihood					3	3	3	3	1	1	1	2
		Consequence					1				1			
		Risk					3	3	3	3	1	1	1	2
	Building Structure	Interaction	Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.								Winds that exceed the design capacity of the lateral load resisting system may result in damages such as distortion of structural elements (e.g., damage to interior finishes or distortion and damage of framing elements), and damage to exterior load bearing walls. Damages may require repairs or partial to total replacement of asset.			
		Likelihood	2	2	2	3					1	1	1	2
		Consequence	2								3			
		Risk	4	4	4	6					3	3	3	6
	Natural Environment	Interaction									Potential damage to vegetation. Potential maintenance required to clean up debris/remove fallen trees.			
		Likelihood									1	1	1	2
		Consequence									2			
		Risk									2	2	2	4
Land Use and Policies	Development Practices	Interaction									Extreme storms could require the execution of detailed community emergency response plans. Impacts to Power supply, redundancies of the power system.			
		Likelihood									1	1	1	2
		Consequence									4			
		Risk									4	4	4	8

Asset Group	Asset Subcomponent	Risk = L x C	Other Hazards – Lightning – Lightning Strikes within 25km				Other Hazards – Wildfire – Frequency and Intensity of Wildfire (incl. Air Quality)				Other Hazards – Low Flows				Other Hazards – Drought – Frequency and Intensity of Drought			
			BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s	BL	2030s	2050s	2080s
		Likelihood	3	3	3	3	2	2	3	3	1	2	2	3	1	2	2	3
Energy Services	Energy Supply and Services	Interaction	A lightning strike to overhead distribution equipment is expected to result in significant localized damages (e.g., to arresters). Impacts may result in localized short-term disruption of services to PMQ residences or potentially wider spread outages if the Transmission line is impacted.				Significant fire risk to all aboveground equipment resulting in significant damages. Impacts may be widespread and result in longer term service disruptions for some areas of the Town. It is noted that the Transmission line is located within the floodplain and therefore saturated ground may reduce the likelihood of fire spread to the asset. The substation is located near the river and surrounded by residential land-use which may also reduce the likelihood of fire spread to the asset. Service is likely to be disrupted during the event to prevent further fire risk due to interaction with electrical assets.											
		Likelihood	3	3	3	3	2	2	3	3								
		Consequence	3				4											
		Risk	9	9	9	9	8	8	12	12								
Community Services	Service and Operation	Interaction	Loss of service and operations if building is impacted by lightning strike, impacts may be short-term up to long-term depending on impacts to the building.				Potential long-term loss of service and operations if building is impacted by wildfire.								Potential vegetation die-off (e.g., grass sports fields) resulting in minor impacts to services and aesthetics.			
		Likelihood	3	3	3	3	2	2	3	3					1	2	2	3
		Consequence	2				3								1			
		Risk	6	6	6	6	6	6	9	9					1	2	2	3
	Building Structure	Interaction	If the building is not grounded, potential fire risk due to interaction with interior wood or flammable components. Fire damage to the superstructure may require extensive repairs and partial up to complete replacement of asset.				Exposure to wildfire can cause significant impacts such as partial up to complete loss of the asset.											
		Likelihood	3	3	3	3	2	2	3	3								
		Consequence	3				3											
		Risk	9	9	9	9	6	6	9	9								
	Natural Environment	Interaction					Potential complete loss of large amounts of vegetation, trees, parks. Increased soil instability in areas. Severely reduced operations, large amounts of maintenance needed to restore natural environment.								Potential damage or loss of vegetation. Potential maintenance required, increased water demand.			
		Likelihood					2	2	3	3					1	2	2	3
		Consequence					3								1			
		Risk					6	6	9	9					1	2	2	3
Land Use and Policies	Development Practices	Interaction					Wildfire risk may require the execution of detailed community emergency response plans. Certain areas of the Town have no road redundancies for alternative evacuation routes resulting in significant health and safety risk.				Potential risk to water supply if population increases. May require future water quantity/security planning to ensure there is proper supply.				Potential risk to water supply if population increases. May require future water quantity/security planning to ensure there is proper supply.			
		Likelihood					2	2	3	3	1	2	2	3	1	2	2	3
		Consequence					5				3				3			
		Risk					10	10	15	15	3	6	6	9	3	6	6	9

APPENDIX C

Flood Risk Maps



Legend:

- 1 in 100 year Present Day Flood Extent
- 1 in 100 year 2100 Flood Extent
- Town of Oromocto
- Waterbody
- Wetland

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

FLOOD MAP

CBCL

Date:	DEC 2023	Scale:	1:40,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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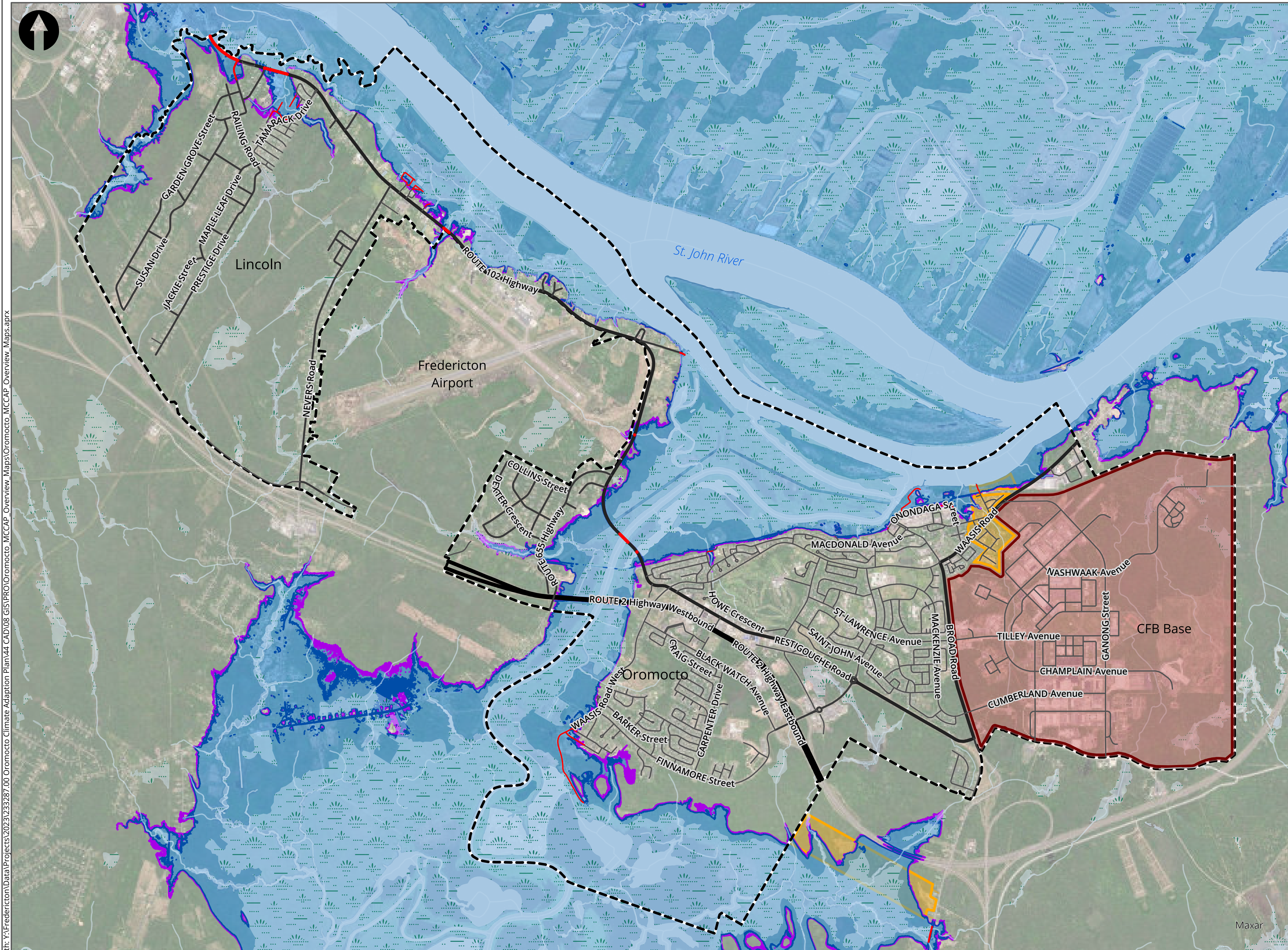

Legend:

	At Risk
Freeway	
Collector	
NBDOT Local Named	
Local Street	
Resource	

1 in 100 year Present Day Flood Extent

1 in 100 year 2100 Flood Extent

Wetland

Waterbody

Town of Oromocto

Oromocto First Nation

CFB Base

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

AT RISK TRANSPORTAION SYSTEM

CBCL

Date:	DEC 2023	Scale:	1:40,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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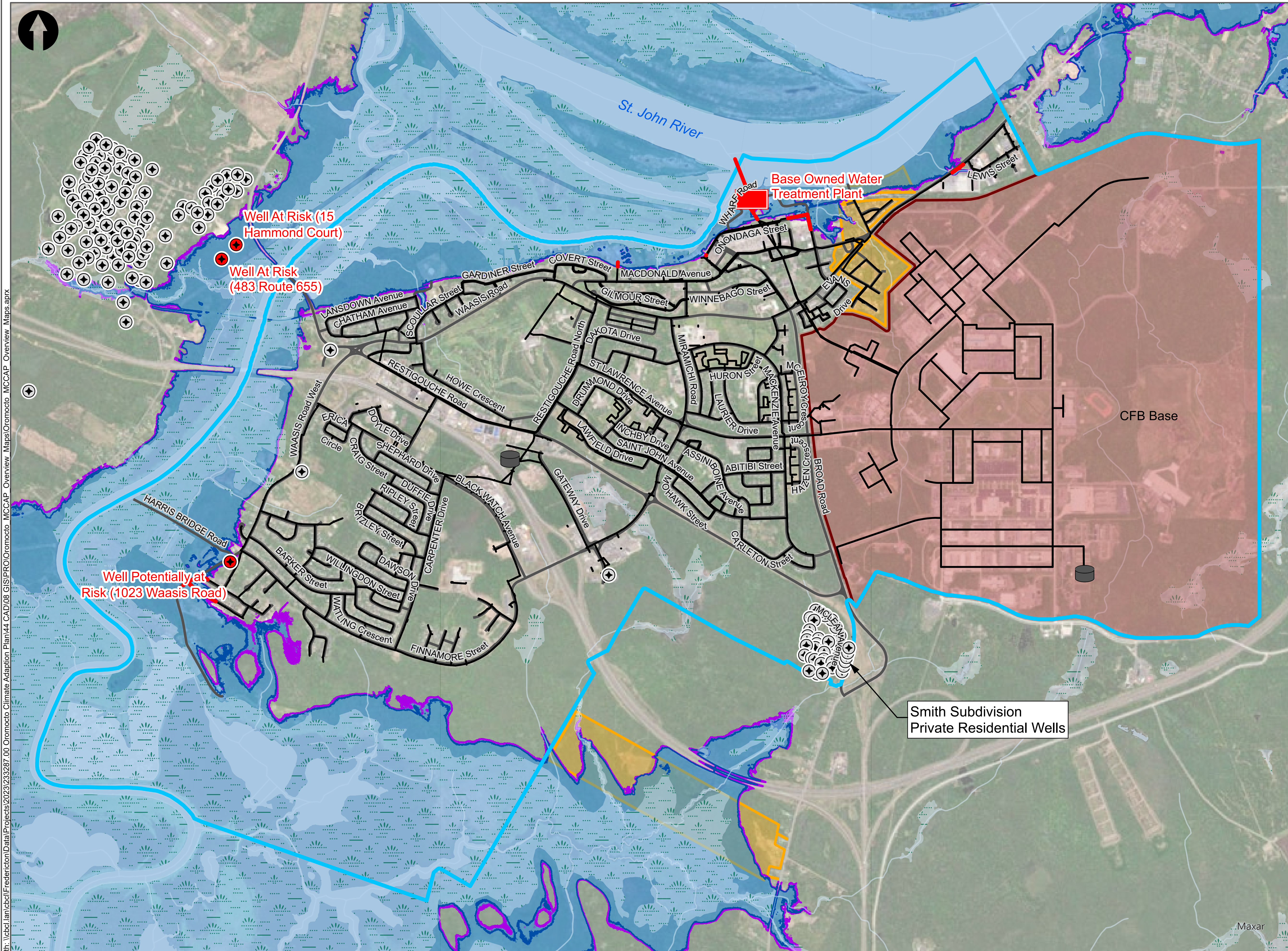

Legend: At Risk

- Water Tower
- Treatment Plant
- Well
- Water Main
- 1 in 100 year Present Day Flood Extent
- 1 in 100 year 2100 Flood Extent
- Wetland
- Waterbody
- Oromocto
- Oromocto First Nation
- CFB Base

No	Date	Issue/Revision
2	06/03/2024	ISSUED REVISIONS
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

AT RISK WATER SYSTEM

CBCL

Date:	MAR 2024	Scale:	1:25,000
Drawn:	CM	Checked:	KB
Project No:	233287.00	Figure No:	1

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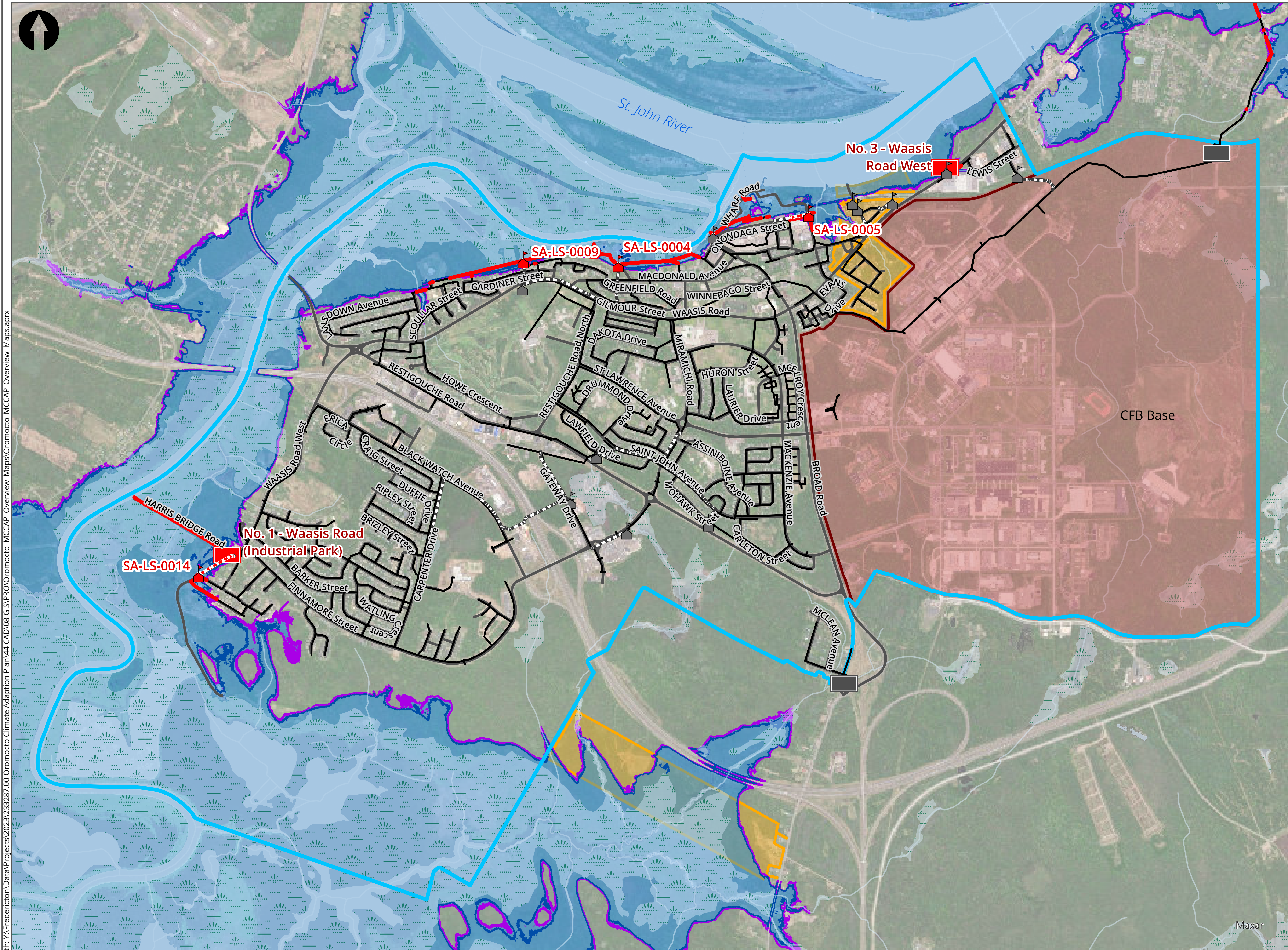

Legend: At Risk

- Sanitary Lift Station
- Sainitary Pressurized Main
- Sanitary Treatment Plant
- Sanitary Gravity Main
- 1 in 100 year Present Day Flood Extent
- 1 in 100 year 2100 Flood Extent
- Wetland
- Waterbody
- Oromocto
- Oromocto First Nation
- CFB Base

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project: OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title: AT RISK SANITARY SYSTEM

CBCL

Date:	DEC 2023	Scale:	1:25,000
Drawn:	SMO	Checked:	KB
Project No:	233287.00	Figure No:	1

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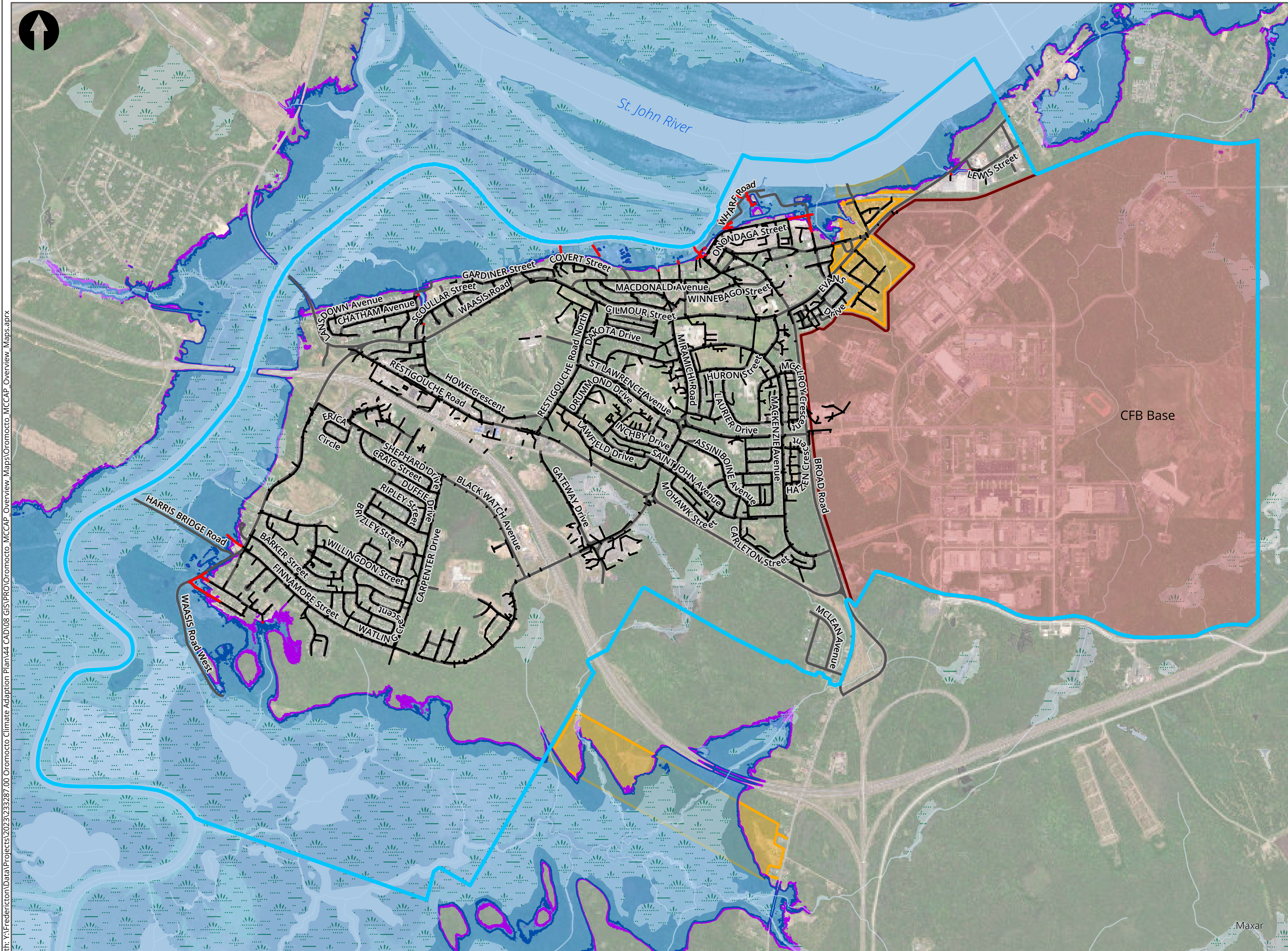

Legend:

	At Risk
Storm Main	(red line)

- 1 in 100 year Present Day Flood Extent
- 1 in 100 year 2100 Flood Extent
- Wetland
- Waterbody
- Oromocto
- Oromocto First Nation
- CFB Base

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

AT RISK STORM SYSTEM

CBCL

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Project No: 233287.00		Figure No: 1	

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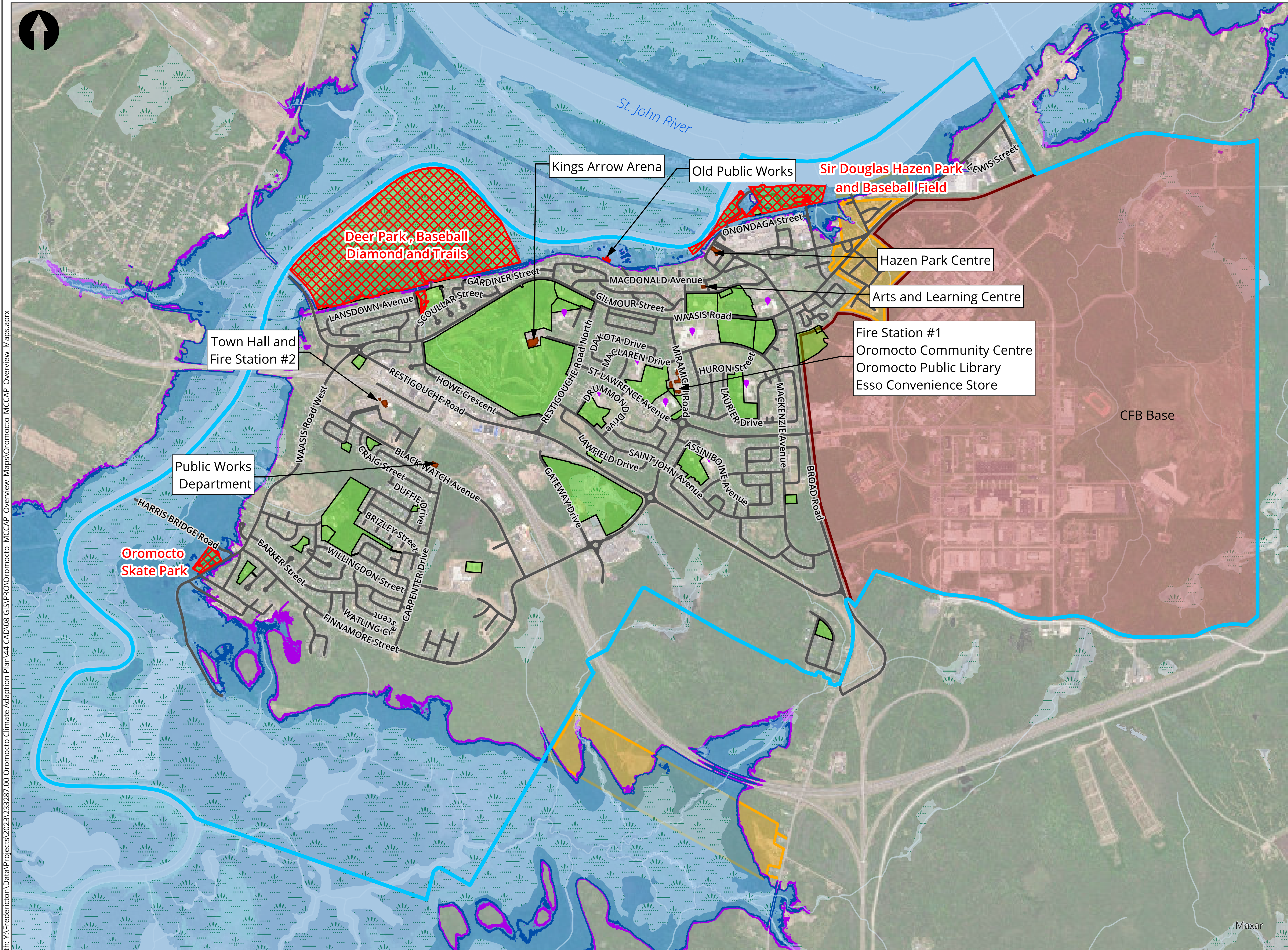

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

AT RISK TOWN BUILDINGS AND PARKS

CBCL

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Project No:	233287.00	Figure No:	1

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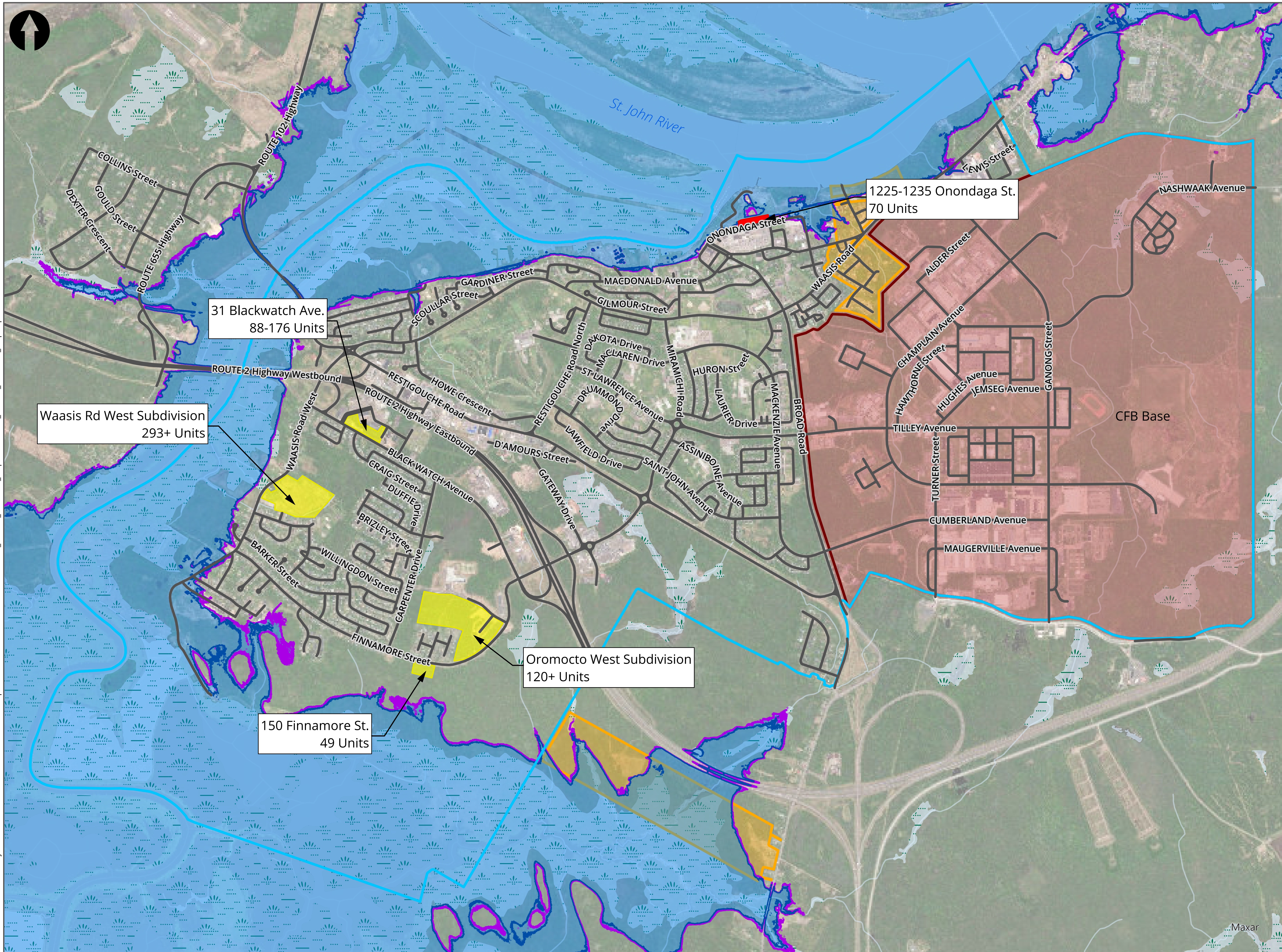

Legend: At Risk

- Future Development
- 1 in 100 year Present Day Flood Extent
- 1 in 100 year 2100 Flood Extent
- Wetland
- Waterbody
- Oromocto
- Oromocto First Nation
- CFB Base

No	Date	Issue/Revision
1	11/12/2023	ISSUED FOR REVIEW

Canada's Model Town OROMOCTO

Project:

OROMOCTO CLIMATE ADAPTATION PLAN

Drawing Title:

AT RISK
POTENTIAL DEVELOPEMENT

CBCL

Date:	DEC 2023	Scale:	1:25,000
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Project No:	233287.00	Figure No:	1

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