ADAPTSJ

ACAP SAINT JOHN

LOWER WEST SIDE

NEIGHBOURHOOD CLIMATE CHANGE ADAPTATION PLAN

Neighbourhood Climate Change Adaptation Plan: Lower West Side Summary Document

Brogan, Bailey
Johnston, Peter
Lyons, Blaine
Stewart-Robertson, Graeme

2019

Published by:

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

PREFACE

Climate Change presents Saint John with generational challenges which will require our communities to question their established structures and ways of knowing. Working collaboratively to adapt to Climate Change therefore presents unique and exciting opportunities for the City to not only improve the quality of life for its residents but to build a growing community of resourceful and compassionate global citizens.

In order to become resilient to the effects of Climate Change our community's residents, ecosystems, businesses and systems must be able to survive, adapt and thrive despite the stresses and shocks caused by its impacts. Accomplishing this requires supporting and fostering an environment where residents of Saint John are well-connected to their neighbours and have social support systems in times of stress and shock. It will require physical environments, such as wetlands and urban forests, that help provide shade and passive cooling opportunities in the summer and reduce the impact of extreme cold in the winter. It will require stormwater infrastructure that can handle larger storm events, and it will require water resources which meet the timing and flow demands of humans and natural systems alike. It will require energy systems that can efficiently handle periods of high demand and buildings that rely less on energy sources such as electricity, oil, and natural gas. It will require affordable transportation systems that function throughout extreme weather events, and it will require land use capable of accommodating population shifts due to climate migration.

That is why ACAP Saint John has initiated AdaptSJ, a process where we will investigate, test and implement ways that climate adaptation can help our city meet its basic development needs, build equitable and vibrant neighbourhoods, and become the resilient, thriving community we all know it can be.

ACAP Saint John’s team is committed to providing Saint John with the best available science and social policy, and to integrate the thoughts and ideas of the community, all of which come together to guide our plan forward. Because at its heart, ACAP has always been an environmental incubator, one that transforms and evolves our region’s landscapes with the help of governments, companies and community collaborators. Our work is designed to be seen, felt and experienced throughout the environment – from our wetlands and coastlines to our streets and public spaces.

CLIMATE CHANGE OVERVIEW

1.1 PHYSICAL DIMENSIONS

Climate change is the greatest challenge facing human civilization today. It directly impacts fundamental resources like food, water, and shelter. Weather, or the fluctuating state of the atmosphere characterized by temperature, wind, precipitation, and clouds, is only predictable over hours, days, or weeks. Climate is the average weather or mean variability of these elements over time. Changes in climate can thus be observed over a period ranging from months to thousands or millions of years. The Intergovernmental Panel on Climate Change (IPCC) is a United Nations scientific body and foremost authority on climate change science. In its most recent and Fifth Scientific Assessment Report (AR5), the IPCC finds that warming of the climate system is "unequivocal".

Climate change impacts are already being felt around the world, including warming atmospheres and oceans, diminishing snow and ice cover, and rising sea levels (IPCC, 2014). These changes are a result of a dramatic increase in greenhouse gas (GHG) emissions from human activities that trap heat from the sun in the atmosphere, an effect known as the Greenhouse Effect (Figure 1).

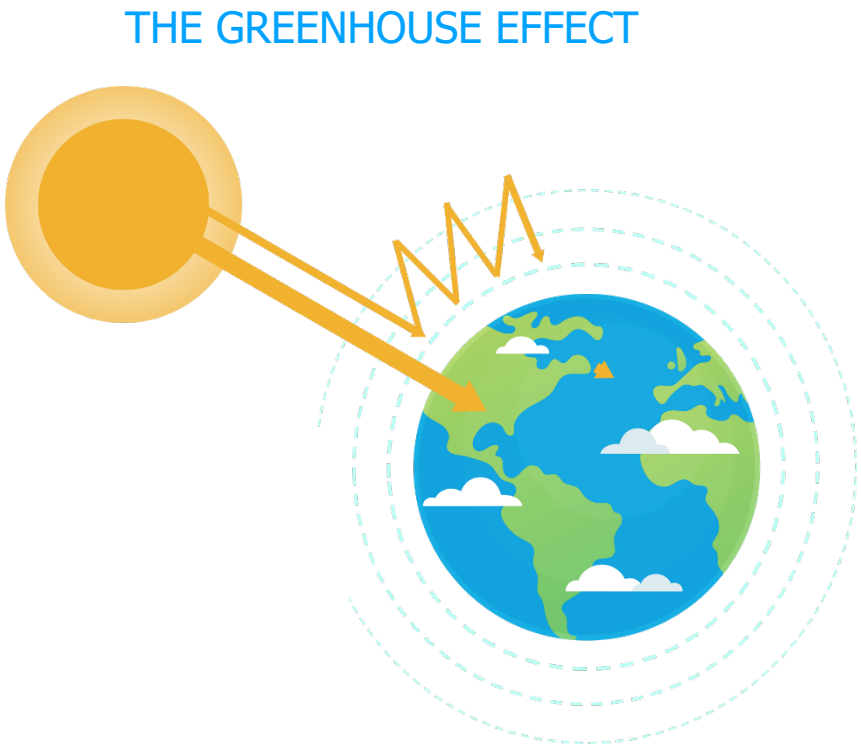

Figure 1: The Greenhouse Effect, where the sun's heat is trapped in the atmosphere by higher quantities of greenhouse gas emissions (Mathematics of Planet Earth, 2012).

Higher concentrations of GHGs in the atmosphere have led to 2016 being the world's hottest year on record (World Meteorological Organization, 2017). This aligns with a trend in global warming that has been observed over the last 60 years (Figure 2).

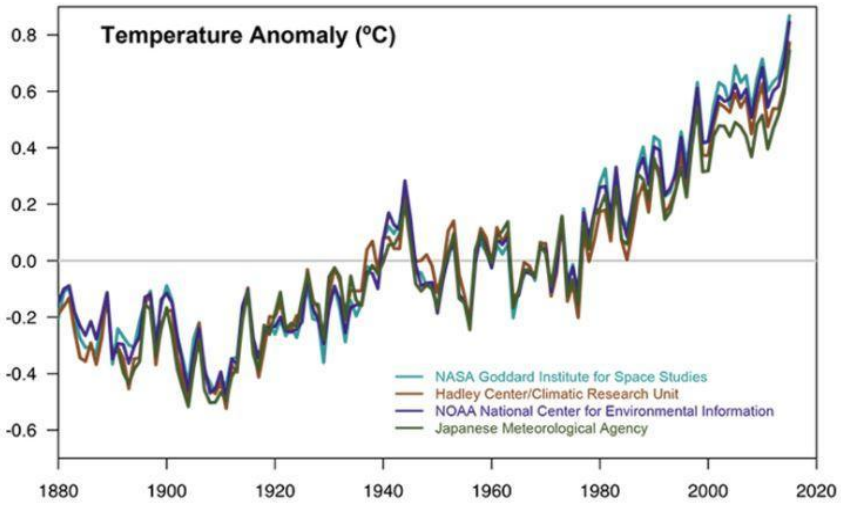

Figure 2: Temperature trends from 1880-2020 (National Aeronautics Space Administration, 2017

In Canada the rate of warming is nearly twice the global average. Temperatures have increased by 1.3 degrees Celsius since 1948 and are projected to hit a 2 degree Celsius rise by 2050 and 4 degree Celsius rise by 2080 (International Council for Local Environmental Initiatives Canada, n.d.). Even with efforts to reduce GHG emissions (mitigation), climate change is already being felt in New Brunswick from rising temperatures, sea level rise, higher intensity precipitation events, increased severity of inland and coastal flooding, accelerated rates of coastal erosion, and land loss that will continue to have negative impacts for the City if no adaptation occurs (NBDELG, 2014). Sea level rise, health risk from extreme heat, flooding, the spread of communicable diseases, urban water quality, and water availability will be the most pressing impacts to the Greater Saint John Area from climate change, requiring local initiative in the coming decades.

Flooding is the most frequent natural disaster in Atlantic Canada. Between 2007-2017 the Government of New Brunswick spent $185 million on disaster recovery primarily from flooding events (NBDELG, 2018). As homeowners' insurance generally does not cover overland flooding, flood protection requires combined responsibility by central government and the private sector to be successful (Vienna University of Technology, 2018). Local governments are linked to climate change issues such as flood protection because of their ability to make planned decisions about key services and infrastructure. Local governments also have the ability to understand flooding vulnerability on a neighbourhood scale, enabling buy-in from the community essential to successful planning implementation.

1.2 ADAPTATION FRAMEWORK

Infrastructure, parks, recreational activity, transportation, and public health and safety are all likely to be affected by climate change. The degree of these changes will depend on global emissions of GHGs over the next three decades, but the impact that climate change will have on our population can be lessened on a municipal scale through adaptation. Adaptation broadly refers to any adjustment that is made to respond to existing or anticipated impacts of climate change on human, natural, or built environments (Natural Resources Canada, 2007). The City of Saint John has a unique opportunity to prepare and respond to these

challenges by identifying the risks of climate change to its natural and built environments, and by taking advantage of the opportunities a changing climate may present.

A central adaptation toolkit, Building Adaptive and Resilient Communities, developed by the International Council for Local Environmental Initiatives (ICLEI-Canada, n.d.) has been implemented by municipalities in British Columbia, Ontario, and Newfoundland. ICLEI-Canada, Partners for Climate Protection and the Federation of Canadian Municipalities are working to guide similar adaptation planning in other Canadian municipalities which consists of five key milestones (Figure 3). This study will address the first three milestones: initiate research and plan and will inform a larger climate change adaptation plan that will apply to the City as a whole, along with the City of Saint John neighbourhood plans.

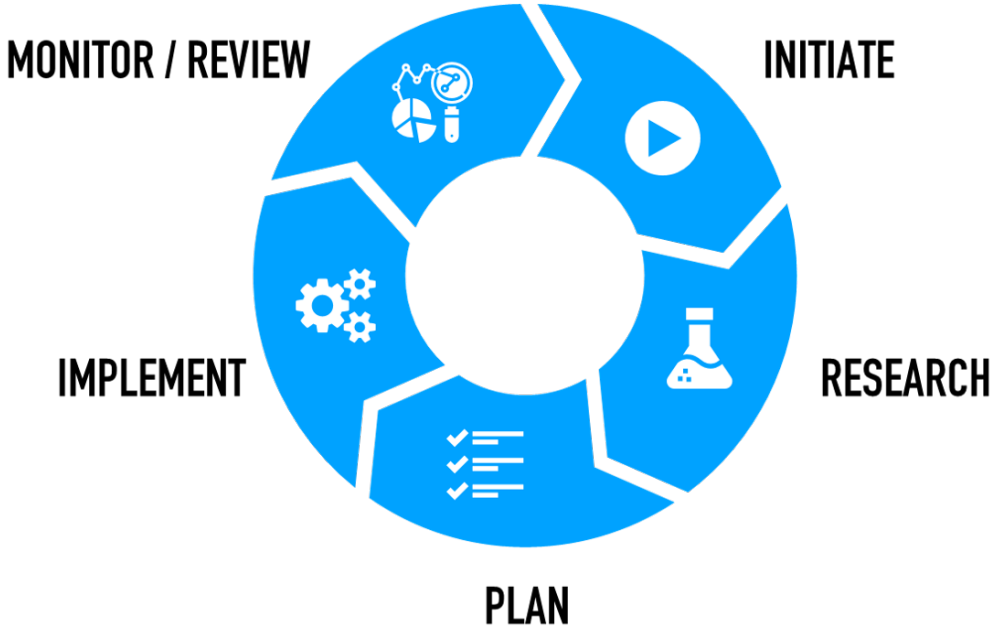

Figure 3: Five key milestones for climate change adaptation beginning with initiate, followed by research, plan, implement and monitor/review (ICLEI-Canada, n.d.).

Adaptation is not without its challenges. The uncertainty of local weather projections means the necessity of addressing climate change is not made obvious until after effects are felt. To protect the public and city assets from its negative impacts, the city-wide climate change adaptation plan uses the precautionary principle, which is to communicate and plan for anticipated climate change impacts based on best available science until cause and effect relationships are fully established scientifically.

Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability requires thinking about both the short and the long-term costs and benefits of current developments. Cities are complex systems and require holistic thinking to consider all sectors and environments. When dealing with complex systems, no one person can possess all the answers, which is why engaged discussion and a shared vision are vital to planning a sustainable and resilient city.

1.3 OBJECTIVES

Neighbourhood planning is scheduled to take place by the City of Saint John Department of Growth and Community Development Services that will address life in priority neighbourhoods in the City of Saint John. To accompany these plans, ACAP Saint John will study Saint John's three most vulnerable neighbourhoods (Central Peninsula, North End and Lower-West Side) to develop a feasibility plan for adaptation. The study neighbourhoods encompass four of Saint John's priority neighbourhoods where poverty rates exceed 30 % of the population (Plan SJ, 2010). Addressing how climate change will affect impoverished populations is important so adaptation practices do not negatively impact the residents of Saint John.

For each neighbourhood the study will identify vulnerabilities to populations, public health and safety, ecosystems and infrastructure due to climate change risks such as sea level rise, and extreme weather. Based on this information ACAP Saint John will outline recommendations for each neighborhood as they apply to climate change adaptation and neighbourhood planning. For example, using green infrastructure for stormwater management; limiting development in risk areas; or managing our urban forest to maximize ecosystem services. Three pilot projects will be recommended (one in each study neighbourhood) that will demonstrate to the City and to the public how climate change adaptation will look in practice in the City of Saint John.

LOCAL PROJECTIONS

2.1 SUMMARY

CATEGORY	PROJECTIONS
TEMPERATURE	• Mean annual temp. increases by 3.5°C by 2071-2100 compared to 1970-2000. • Average winter temp. above -1°C by 2071-2100. • Up to 70 annual very hot days (25°C +) by 2071-2100. • Annual freeze-thaw days increase from 82 to 87 by 2070.
PRECIPITATION	• Annual rainfall increases by 84.5 mm by 2080 compared to 1976-2005. • Precipitation patterns become more erratic and rainfall intensity will increase by 10 %. • Approximately 20 more days will be rain days by 2071-2100.
EXTREME WEATHER	• Increased severity, frequency of summer convective storms and ice storms. • Increased severity, frequency of flooding from extreme rainfall, mid-winter thaws, ice breakups and ice-jam flooding. • Forest fire occurrence increases by 25 % by 2030, 75-140 % by 2100. • Higher incidence, duration and severity of drought from earlier peak spring flows and very low to zero summer flows.
SEA LEVEL RISE	• Atlantic Canada sea level has risen by ~30 cm between 1911-2000. • Saint John sea level rise of 86 cm +/- 38 cm from 2010 to 2100. • Annual storm surge levels increase by 0.8 m compared to 2010. • 1 in 100-year storm levels increase by 1.3 m by 2100 compared to 2010. • Current coastal erosion rates of 0.59-0.99 m/yr.

Table 1: Climate Change Projections for the Greater Saint John Area (Roy and Huard, 2016; PCC, n.d.; Daigle, 2014)

NEIGHBOURHOOD PROFILE: LOWER-WEST SIDE

The Lower West Side of Saint John slopes downward toward the Wəlastəkw on the north and east sides, by a provincial highway to the west, and by Fundy Heights neighbourhood to the south (Figure 4). The Lower-West side is largely a residential area and made up of single detached homes and mid-rise residential buildings. The area is zoned as two-unit residential and mid-high rise residential, with a few small commercial areas that are occupied by convenience stores, restaurants, and daycare facilities. Other zoning in the Lower-West Side includes the transportation zone (Port and railway), park, general commercial zone, and neighbourhood community facility zone. Bay Ferries operates a passenger ferry vessel from the Lower-West Side that travels from Saint John to Digby, Nova Scotia, and completes 1-2 crossings daily.

According to the 2006 census, the poverty rate for the Lower-West Side is 31.5 % (Vibrant Communities, 2008). A community group, Westside Police and Community Together (PACT), is a non-profit community group that builds a positive relationship with the police and the community, helps to address community needs, and improve the livability of the area through promoting healthy living, social events, educational workshops, food, and clothing drives.'

Figure 4: Lower-West Side neighbourhood boundaries.

3.1 INDUSTRIAL DEVELOPMENT

This neighbourhood is also home to Port Saint John's main facilities and shipping as well as some industrial properties and railyards. Port Saint John, located on the northeastern tip of the Lower-West Side is built on reclaimed land and is owned by the Port Authority (Transport Canada). Port Saint John is Eastern Canada's largest shipping port and ships approximately 28 million metric tons of cargo per year (PortSJ, 2017). The Port operates on both the Lower-West Side and on the Central Peninsula, with the bulk of its industrial and shipping operations taking place from the West-Side docks, a scrap metal facility (American Iron and Metal Recycling), the Crosby Molasses Tank Farm, and fish oil storage tanks. Pier 13/14 is classified as derelict and is currently used as a breakwater for Pier 12 where tugboats are stored. The tank farm is connected to Pier 12 via pipeline (exp, 2011). The northern portion of the Port is proposed to be expanded as part of the West Side Port Modernization Project. The design contract was awarded to Hatch Dillon in 2017. The initial construction is set to begin in 2018 and is projected to be completed by 2023 (Port SJ, 2017). A railway runs from the port along the eastern perimeter of the Lower West Side and to the west side of Saint John.

3.2 PARTRIDGE ISLAND

Partridge Island is a 36-acre island located at the entrance of the Saint John Harbour, southeast of the Lower-West Side and is designated as a national and provincial heritage site. Partridge Island has historical significance for its use as a military defense point beginning in 1791 and spanning until the end of the second world war, and as an immigrant quarantine station from 1830-1938 (Canada's Historic Places, n.d.). Approximately 800-1000 immigrants (largely Irish) died and are buried on Partridge Island (New Brunswick Department of Wellness, Culture and Sport, n.d.). New Brunswick's first lighthouse was built on Partridge Island in 1791 and was manned until 1989. An automated lighthouse is still present on the island and is maintained by Department of Fisheries and Oceans (Wright, 2017). Partridge Island is connected to the mainland by a rubble stone breakwater.

3.3 URBAN PARKS AND FOREST

Urban parks such as Market Place Park, Kings Square West, and Queen Square West, are located in the Lower-West Side. The parks are natural assets that are valuable for recreation, culture, stormwater management, heat moderation, air purification, and carbon dioxide absorption. Many mature trees are located within these parks.

Just south of the Port, Market Place Park runs along Market Place and houses many recreational facilities (splash pad, ball field, tennis court, Carleton Community Center, playground, and Carleton Community Center Garden) and a residential neighbourhood. A master plan for Market Place West was developed in 2010 and outlines a six-phase plan to improve this recreational area. This plan envisions connecting harbour passage to this area, building a new soccer field, outdoor skating rink, beach volleyball courts and a dog park (Glen Group, 2010).

A formal inventory of trees - including height, diameter, species, condition, and proximity to utility lines has been conducted by ACAP in 2018 in the lower west side to fully understand the sustainability of the urban forest in the neighbourhood. The inventory data showed 379 trees throughout the Lower-West Side, 87 % of which were identified to be in good condition.

LOWER WEST SIDE: TREE INVENTORY

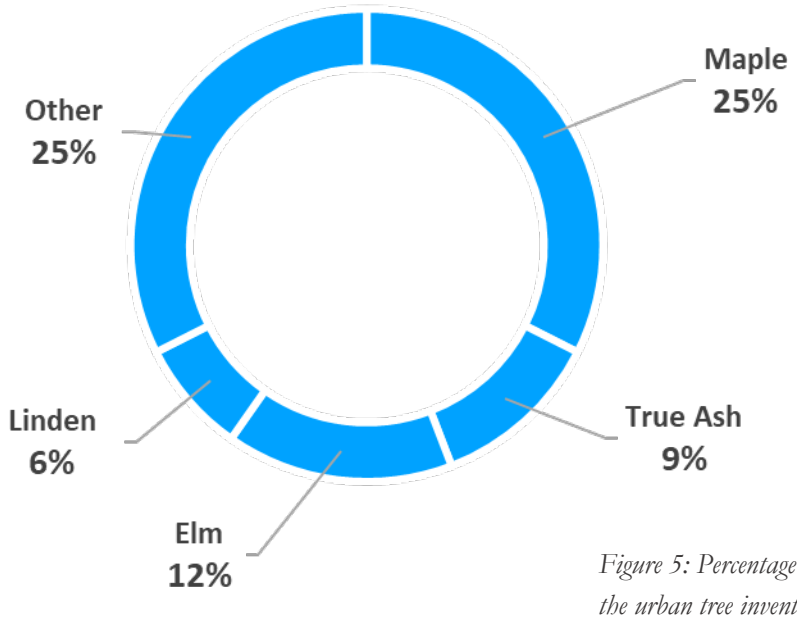

Figure 5: Percentage composition of the urban tree inventory within the Lower West Saint John area.

The Lower-West Side urban tree inventory is mostly dominated by Maple varieties, including species such as the commonly known Sugar maple, Silver Maple, and the predominant Norway Maple, followed by Elm varieties (Figure 5). The presence of a high volume (6 %) of true Ash trees along Queen Street West places the inventory of that individual street in possible danger of decline due to the current Emerald Ash Borer invasion threat. Maple trees were found to be generally in good health. Although the presence of Black Tar Spots (*Rhytisma acerinum*) infection was observed on some Maple trees, it is determined a cosmetic issue and no action is needed for treatment. The remainder of the inventory is generally in good condition, but further monitoring should be continued to ensure that the trees remain in that state.

The ecosystem services that the observed trees can provide to the neighbourhood have been calculated using the I-Tree Software developed by the USDA Forest Service (2006). In total, the residents and the City of Saint John saves approximately $92.77 per tree in the Lower-West Side (Total $35,159.83) (Table 2).

Table 2: Annual public benefits of urban street trees in the Lower-West Side ($/tree) calculated using I-Tree Software (USDA Forest Service, 2006).

Annual Public Benefits of Trees in the Lower West Side ($/tree)					
Energy	CO_2	Air Quality	Stormwater	Aesthetic/other	Total
38.80	1.43	9.81	12.57	30.16	92.77

RISK AND VULNERABILITY ASSESSMENT

4.1 PRIORITY RISKS AND IMPACTS

Saint John will be impacted by climate change in multiple ways, but in order to effectively plan and adapt to climate change, ACAP Saint John has chosen priority impacts that will have the most pronounced effect on the City. The priority risks of climate change in the coming decades will include 1. sea level rise and storm surges, and 2. severe weather that includes: heavy rainfall, stormwater runoff, early winter thaws that lead to more severe flooding, summer drought, negative health impacts of extreme temperature, and subsequent spread of communicable diseases. These impacts were chosen due to the existing social and environmental challenges in the City compared to local predicted impacts of climate change. The principal purpose of this neighbourhood adaptation plan is to protect the well-being and prosperity of the study neighbourhoods and its residents from these impacts. Each of these impacts will affect the city in different ways. For example, sea level rise will be a major impact in the Central Peninsula and Lower-West Side but will not affect the North End as drastically due to its location in the Harbour and topography.

4.2 PUBLIC ENGAGEMENT

ACAP Saint John used a draft version of New Brunswick's Coastal Hazard Flood Mapping (CHFM) that is set to be released in 2019 to identify coastal flood risk areas. This set of maps identifies sea level rise and storm surge risks in the future. The maps outline the current Higher High Water Low Tide [HHWLT] (4.6 m), HHWLT+1m (5.6 m) (the average predicted level of sea level rise by 2100), HHWLT+2m (6.6 m) (which models a Saxby Gale like event - post sea level rise), and a 1 in 100 year storm event in 2100 (6.8 m) from the CGVD28 datum based on projections from Daigle's 2017 Report *Sea Level Rise and Flooding Estimates for New Brunswick Coastal Sections* (Figure 6). These maps were used in our risk and vulnerability assessment and during our public information forums and to identify areas at risk from sea level rise and associated impacts.

ACAP Saint John held two Climate Change Impacts and Adaptation Community Information Sessions in the Fall of 2018. The information sessions were held to inform residents in the study neighbourhoods about the current neighbourhood planning process and adaptation planning that is underway, and to discuss how climate change will affect each community. These sessions also provided opportunities for participants to provide feedback to ACAP Saint John on information that they felt was important to include in the adaptation plans. The CHFMs were presented in these sessions and residents identified community assets, areas that have already observed climate change impacts and areas that may be at risk of future climate change impacts. The feedback that was collected from all of the community consultation sessions is summarized in Table 3.

Table 3: Community feedback collected during ACAP Saint John's community engagement sessions in 2018.

Category	Lower West
Community assets	**Industrial assets:** • Ferry terminal • American Iron and Metal Facility • Port of Saint John • Crosby Molasses Storage Tanks • Railway • Salt Storage **Historical assets:** • Partridge Island **Community assets:** • Market Place • Queen Square
Areas experiencing climate change impacts	Flooding impacts in Market Place Park
Areas of importance that may be at risk	• Partridge Island, potential flooding risks • Port/container shipping area, potential flooding risks • McLaren's/Bayshore Beach, erosion

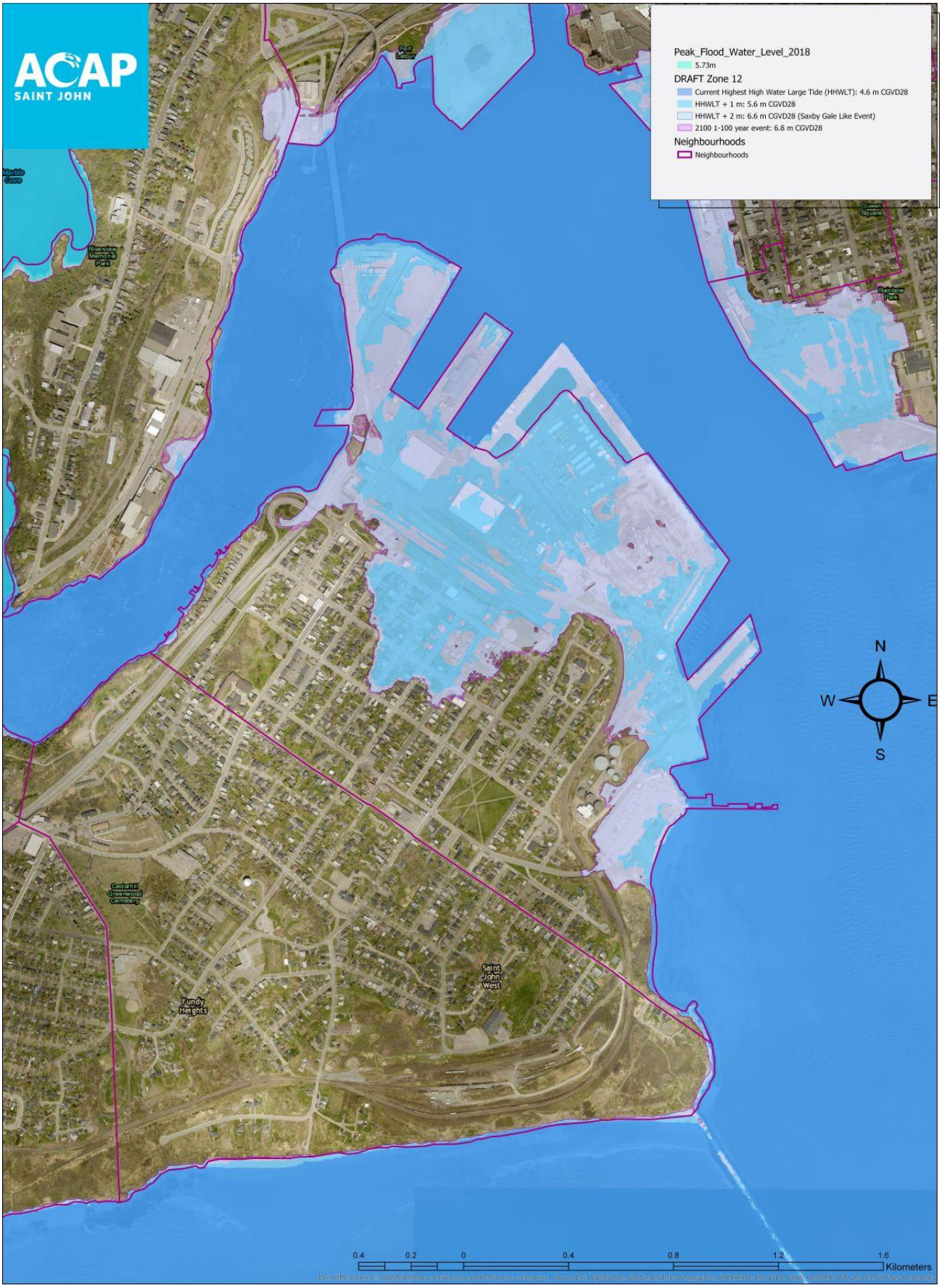

Figure 6: Coastal hazard flood map, Lower-West Side.

4.3 SEA LEVEL RISE

Based on the CHFMs the City of Saint John's GIS department compared projected sea level rise elevations to current infrastructure, emergency services, population statistics, and ecological parameters to identify risks in the study neighbourhoods. Based on the risks identified in Table 4, ACAP will be able to identify adaptation actions will address these risks.

Table 4: Areas at risk during current conditions: highest high water large tide (HHWLT) (4.6m). Items in bold indicate the largest area/population/points affected.

CATEGORY	Current conditions: Sea Level Rise HHWLT (4.6m) Risks (Highly Probable in 2010)	Sea Level Rise HHWLT + 1 m (5.6m) Risk Events (1-2 % probability in 2010, 20-50 % probability in 2050, 50-100 % probability in 2100.	Sea Level Rise HHWLT+2m (6.6m) Risks (5-10 % possibility in 2100).	Worst Case Scenario: Sea Level Rise 2100 1-100 (6.8m) Risks (1 % possibility in 2100).
EVACUATION CONTROL POINTS	One intersection affected	4 control points affected (intersection, auto repair shop, electrical substation and ferry landing)	6 control points affected (intersection, auto repair shop, electrical substation, ferry landing, and community center)	6 control points affected (intersection, auto repair shop, electrical substation, ferry landing, and community center)
EVACUATION ROUTES	Damage to infrastructure, isolation of populations (safety, food security). 2 routes affected by flooding (approximately 618 m)	Damage to infrastructure, isolation of populations (safety, food security). 9 routes affected by flooding (approximately 1.2 km)	Damage to infrastructure, isolation of populations (safety, food security). 31 routes affected by flooding (approximately 4.6 km)	Damage to infrastructure, isolation of populations (safety, food security). 31 routes affected by flooding (approximately 4.6 km)
BUILDINGS IMPACTED	Damage to 11 homes or businesses (1,278m^2)	Damage to 153 homes or businesses (72,863 m^2)	Damage to 252 homes or businesses (88,026 m^2)	Damage to 269 homes or businesses (89,827 m^2)

PROPERTIES IMPACTED	28 properties affected including 3 industrial properties. Combined property values of flooded areas equal $33,111,300.	153 properties affected including 8 industrial properties. Combined property values of flooded areas equal $46,377,000.	190 properties affected including 8 industrial properties. Combined property values of flooded areas equal $50,891,100.	196 properties affected including 8 industrial properties. Combined property values of flooded areas equal $51,462,000.
TOTAL POPULATION AFFECTED	25 % of the total population live in impacted areas	54 % of the total population live in impacted areas	54 % of the total population live in impacted areas	54 % of the total population live in impacted areas
LOW-INCOME POPULATIONS	9 % of people in flood impact areas are considered low-income	21 % of people in flood impact areas are considered low-income	21 % of people in flood impact areas are considered low-income	21 % of people in flood impact areas are considered low-income
SENIOR POPULATIONS	4 % of people in flood impact areas are seniors (65+)	7 % of people in flood impact areas are seniors (65+)	7 % of people in flood impact areas are seniors (65+)	7 % of people in flood impact areas are seniors (65+)
HABITAT-WETLAND	Coastal Squeeze approximately 3.9 ha	Coastal Squeeze approximately 3.9 ha	Coastal Squeeze approximately 3.9 ha	Coastal Squeeze approximately 3.9 ha
HABITAT-FORESTS	None	None	None	None
PETROLEUM STORAGE SITES	None	Contamination: 2 sites at risk of flooding	Contamination: 3 sites at risk of flooding	Contamination: 3 sites at risk of flooding

4.4 SEVERE WEATHER

Table 5: Severe Weather Impacts in the Lower-West Side.

RISK EVENT	CONSEQUENCE
HIGH WINDS	Low lying area could have higher wind impacts due to coastal exposure. As surveyed by ACAP Saint John in 2018, approximately 162 trees were contacting overhead utility lines and 50 trees could overhang utility lines that could result in future outages.
DROUGHT	Carleton Community Center garden could be negatively impacted.
TEMPERATURE EXTREMES: VULNERABLE POPULATIONS	Populations that could be negatively affected by extreme heat/cold include seniors (15 % above the age of 65) and low-income individuals (34 %).
TEMPERATURE EXTREMES: VECTOR BORNE DISEASE	Low amount of forested/ green space (4 %). Less likely for insect populations to thrive.
TEMPERATURE EXTREMES: INVASIVE SPECIES	Ash species consist of 6 % of street trees, at risk to damage/mortality from Emerald Ash Borer.
INCREASED RAINFALL: INLAND FLOODING	Low lying areas along the northern and eastern portions of the Lower-West Side may be at risk (Market Place, Port Facilities, residences).
SPRING FRESHET: INLAND FLOODING	Not at risk of riverine flooding.
HEAT ISLAND EFFECT	Total green space is approximately 5 %. Urban heat island effect may be an issue due to a high number of dark surfaces.

NEIGHBOURHOOD PLAN RECOMMENDATIONS

By 2100 sea level risk could impact approximately six control points, 31 evacuation routes, 269 buildings, and 196 properties, three petroleum storage sites and 54% of the total population of the Lower-West Site. A larger portion of the land that will be impacted by sea level rise is owned by Port Saint John. In order to address the sea level rise impacts in the Lower-West Side, potential options such as a sea wall should be discussed with Port Saint John. Coastal erosion should also be monitored on the eastern side of the Lower West Side.

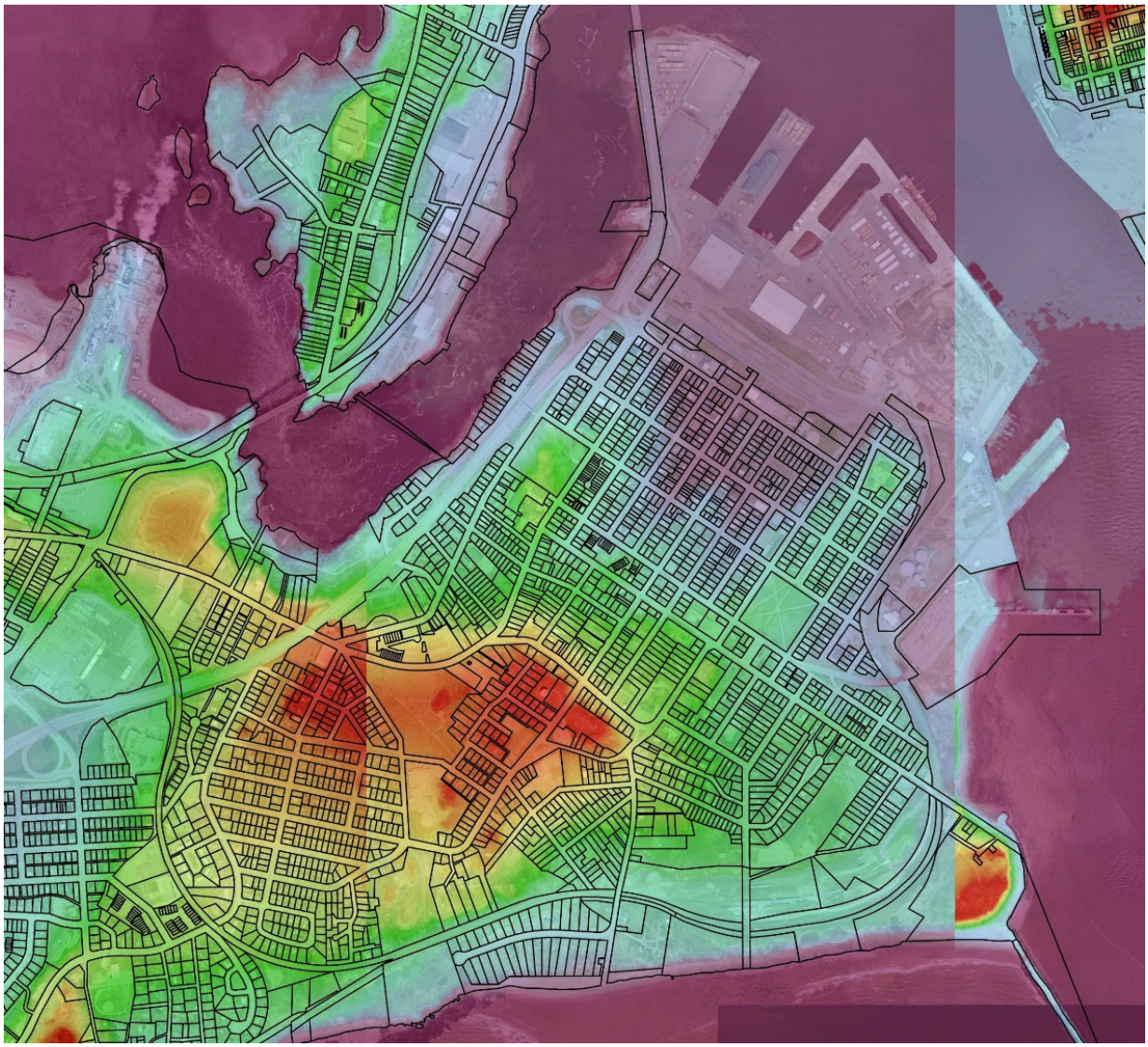

Figure 7: Digital elevation model of the Lower-West Side.

Severe weather has the potential to impact the Lower-West Side through wind impacts that could damage trees, buildings, and utilities. Extreme temperatures and heat island effects could affect the health of seniors (15 % of the population) and low-income residents (34 % of the population), and there is the potential for inland flooding in low lying areas after high rainfalls.

Due to the topography of the Lower-West Side (Figure 7), rainfall is likely to run downhill from the southern to the northern portion of the neighbourhood. In order to reduce the amount of rainfall that will pool at the bottom of this hill, stormwater BMPs should be implemented throughout the neighbourhood, but especially in higher elevations. City owned properties such as Queen Square-West and King Square-West would be excellent sites to implement stormwater management Best Management Practices [BMPs], such as rain gardens, as these sites are located uphill and are public spaces that can demonstrate what green infrastructure looks like in practice. Rain gardens can enhance a public space to add more biodiversity, filter pollutants out of stormwater, and control flooding. Stormwater management BMPs that could be implemented on private properties in the Lower-West Side include collecting rainfall using rain barrels/cisterns, implementing rain gardens, using permeable pavers in driveways, and increasing the overall amount of vegetation in the neighbourhood. Monetary incentives to encourage residents in participation will increase success in implementation of green infrastructure and will reduce costs for flooding repairs. Increasing the amount of vegetated spaces in the neighbourhood will result in multiple benefits to the community. More green space will reduce the heat island effect, improve air quality and create a more appealing environment where people will want to live.

ACAP Saint John's urban forest inventory identified approximately 162 trees in 2018 that were contacting overhead utility lines and approximately 50 trees that overhang utility lines, creating the potential for future problems. These trees should be trimmed in order to avoid outages during high wind events and winter storms. Six trees were also identified as dead, and 10 were noted to be in poor condition. The City should investigate replacing or maintaining these trees. Approximately six percent of the trees surveyed were identified to be ash species. These trees should be monitored for infection by the Emerald Ash Borer.

Aside from the public realm inventory it was observed that many private properties could add a considerable amount to the overall inventory, which has potential to be a great contribution to the community and to climate change adaptation. Providing the proper education about the importance of preserving and maintaining urban trees could result in an increase of communal contributions to not only individual communities but our environment as a whole.

PILOT PROJECT

Based on the topography of the Lower-West Side, (Figure 6) better stormwater management in higher elevations can help to reduce the amount of rainfall that would runoff to lower elevations of this neighbourhood. ACAP Saint John proposes to develop a rain garden within Queen Square West Park that will capture rainfall that is traveling downhill towards flood risk areas (Figure 8). This rain garden will serve as a public demonstration of how green infrastructure can make Saint John a climate resilient city and will enhance a public area in the Lower-West Side. ACAP will leverage community volunteers as well as staff from the City of Saint John Parks and Stormwater Services departments to help with the construction and installation of the rain garden. Volunteers will learn how to construct a rain garden and be provided with guidance on how they can replicate a rain garden project on their property. Educational signage will remind and/or inform community members of the project and the benefits of rain gardens for climate change adaptation and stormwater management.

Queen Square West will serve as a pilot project location for a rain garden to both educate the public on stormwater and runoff and to show them the benefits of such green infrastructure. The garden will stretch along St. James St. West where the grade slopes from the northeast end of the square and will grow native perennials. With enough rain gardens spread across the city the water runoff will be reduced and sediments filtered to greatly decrease the amount of water and sediment running into the city's stormwater infrastructure allowing greater capacity to cope with heavy rainfall and storm surges.

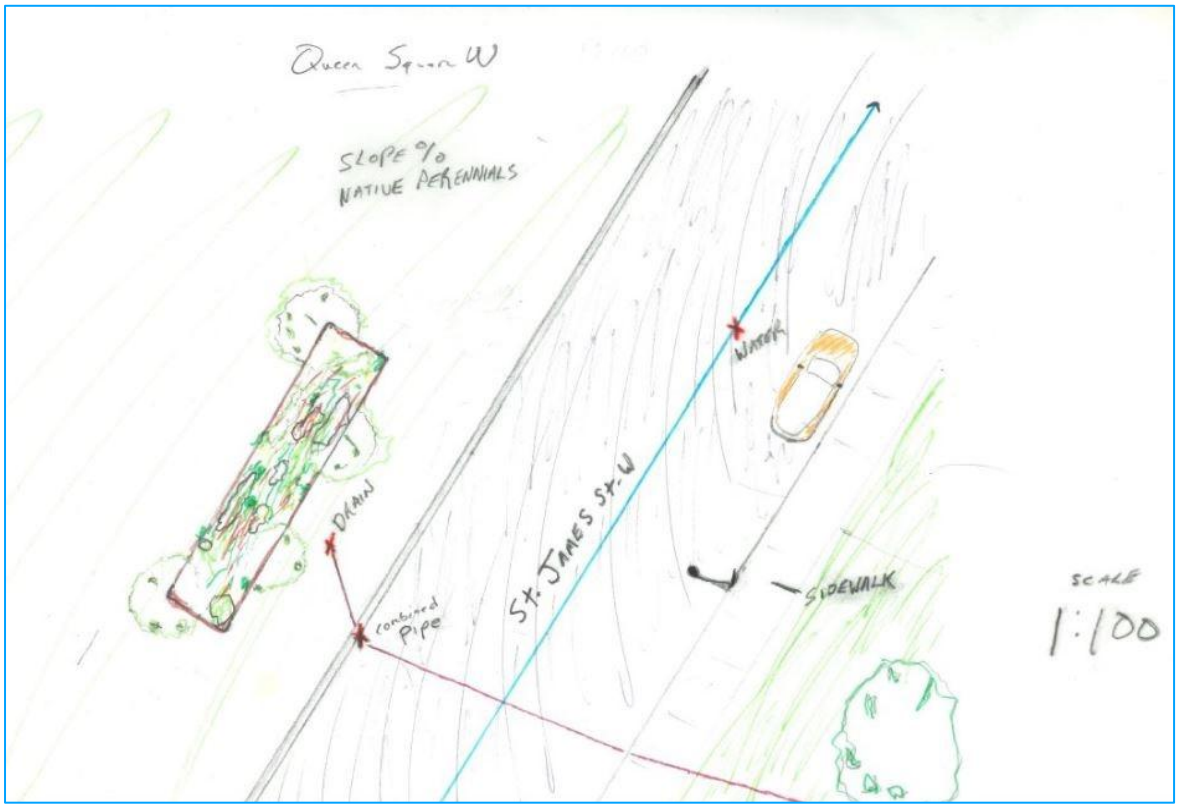

Figure 8: Site plan of a proposed rain garden in Queen's Square West.

Overall promotion of the project will be done through ACAP Saint John's volunteer email list, social media platforms and webpage, flyers, and other local community groups. The local media and City representatives will be invited to attend the event to bolster community engagement. The results from this project will be posted to ACAP's webpage and social media accounts where ACAP can track how the material is being disseminated.

This project is designed to produce tangible results that lend themselves readily to measurement and quantification. For example, the size of the rain garden and capacity, the number of volunteers, in-kind contributions from community partners, number of media articles produced, number of likes/shares/views through social media, number of presentations, requests for information, and page viewings of ACAP's website will be measured to determine success.

Intangible results, such as a more aesthetically pleasing environment or a more environmentally conscientious community are more difficult to measure and will be evaluated based on solicited testimonials or questionnaires, unsolicited opinions (supportive or contradictory), and comments or requests for additional information.

The results from this project will be incorporated into the ACAP's climate change adaptation plan for the City of Saint John as a definitive example of how green infrastructure can reduce flooding in Saint John and will provide a concrete example of what adaptation will look like.

REFERENCES

Canada's Historic Places (n.d.). Partridge Island Quarantine Station National Historic Site of Canada. Parks Canada.

Daigle, R. (2014). Updated Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections: Based on IPCC 5th Assessment Report. Atlantic Climate Adaptation Solutions Association (ACASA), p. 1-49.

Daigle, R. (2017). Sea Level Rise and Flooding Estimates for New Brunswick Coastal Sections, 2017. R.J. Daigle Enviro. New Brunswick Department of Environment and Local Government.

exp (2011). Saint John Port Authority 2011 Land Use Plan. Saint John Port Authority.

Glenn Group Ltd. (2010). Market Place West Master Plan. City of Saint John.

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

International Council for Local Environmental Initiatives Canada (n.d.). Changing Climate, Changing Communities: Guide and Workbook for Municipal Climate Adaptation. ICLEI: Local Governments for Sustainability, p. 1-94.

Mathematics of Planet Earth (2012). Climate System – Greenhouse Effect. Retrieved May 15, 2018, from http://mpe.dimacs.rutgers.edu/images/climate-system-greenhouse-effect-2/

National Aeronautics and Space Administration (NASA) (2017). Scientific consensus: Earth's climate is warming. Retrieved from https://climate.nasa.gov/scientific-consensus/

NBGELG (2014). New Brunswick Climate Change Action Plan 2014-2020 (Rep. No. 9631). Fredericton, NB: Government of New Brunswick, p. 1-16.

NBDELG (2018). Flooding and Land Development. Government of New Brunswick [ASJ1] .

New Brunswick Department of Wellness, Culture and Sport (n.d.) New Brunswick Register of Historic Places. Government of New Brunswick.

Port SJ (2017). 2017 Annual Report. Saint John Port Authority.

Roy, P. and Huard D. (2016). Future Climate Scenarios - Province of New-Brunswick. Montreal: Ouranos. Retrieved from: http://www.acasamaps.ca/

USDA Forest Service (2006) I-Tree Software. United States Government.

Vibrant Communities (2008). A Poverty Outline for Saint John, New Brunswick

Vienna University of Technology (2018). "Flood protection is everyone's responsibility." Retrieved August 1, 2018 from www.sciencedaily.com/releases/2018/03/180321094740.htm

World Meteorological Organization (2017). Press release: WMO confirms 2016 as hottest year on record, about 1.1°C above pre-industrial era. Retrieved from https://public.wmo.int/en/media/press-release/wmo-confirms-2016-hottest-year-record-about-11%C2%B0c-above-pre-industrial-era

Wright, J. (2017). "Get a tour of Saint John's abandoned, historic Partridge Island". CBC News. Accessed on July 18, 2018.