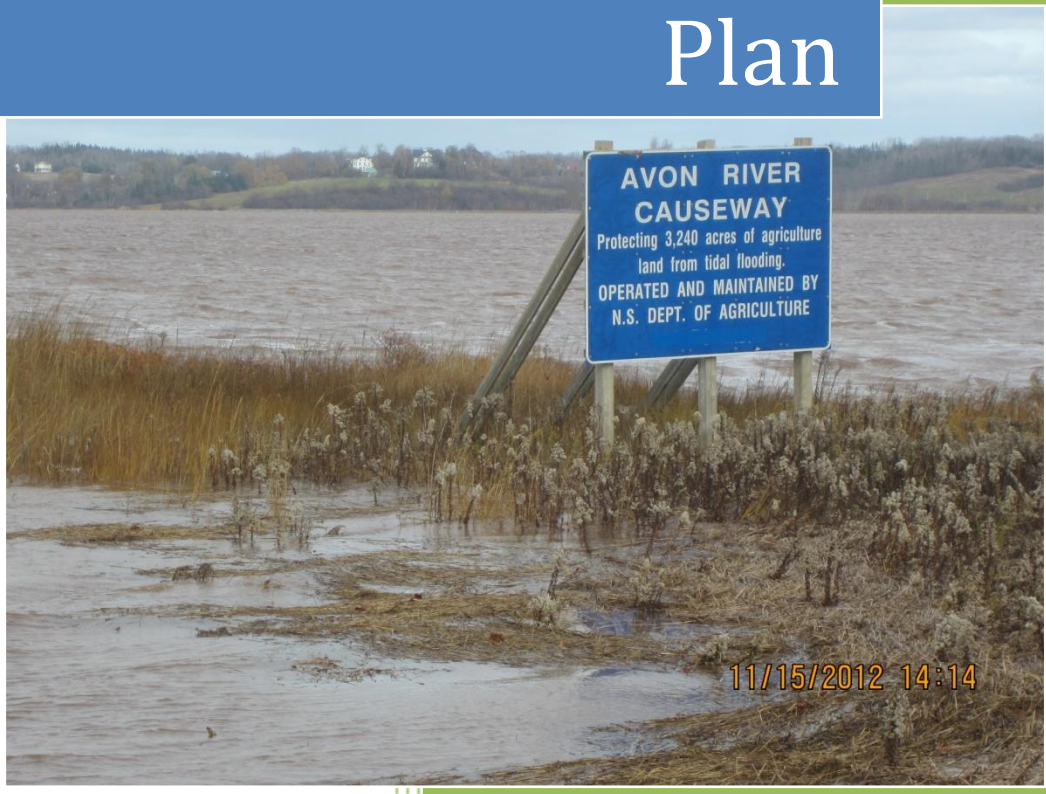
2014

Municipal Climate Change Action Plan



Bill Butler

Town of Windsor

1.1 **Project Background**

The 2010-2014 Canada- Nova Scotia Agreement on the Transfer of Federal Gas Tax Revenues and the Municipal Funding Agreements have a stated requirement for all municipalities in Nova Scotia to prepare and submit a Municipal Climate Change Action Plan to Service Nova Scotia and Municipal Relations by December 31st, 2013. These agreements will allow municipalities within Nova Scotia access to more than $223 million in funding over four years for municipal infrastructure projects to improve social, environmental and cultural sustainability.

This Action Plan will be a continuation of the work that has already been completed through the Integrated Community Sustainability Plans which have been developed by all municipalities during 2010, and will focus on both climate change adaptation and mitigation by outlining how municipalities plan on dealing with the changing climate.

1.2 The Town of Windsor

An aerial view of the Town of Windsor and surrounding areas

The Town of Windsor is one of the oldest towns in Nova Scotia, founded by British Settlers during 1759 shortly after the establishment of Fort Edward (which stills stands in Windsor, and is recognized as the oldest blockhouse still in existence in Canada, having been established in 1750). The Town has transformed its identity several times throughout history, beginning as military stronghold and evolving to a mercantile port, followed by a railroad hub and finally to its current form as a retail service center placed at the gateway to the Annapolis Valley.

The Town is located between the Avon and Ste. Croix rivers, which flow into the Bay of Fundy. Historically, the town was a seafaring community. The development of the Avon Causeway in the early 1970's resulted in the creation of Pesaquid Lake, a lake which has become a central attraction within the town. The lake features a beautiful waterfront, which has been developed for commercial and recreational use within the town, including a world class paddling club and the world famous pumpkin regatta.

Windsor has a population of 3,785 residents (2011 census, a 2% increase from 2006), who occupy 1,669 private dwellings within the Town. The median age of Town residents is 47.9 and 86.6% of the population is over the age of 15. Projections to 2026 expect the Town to maintain its current population level. The primary language spoken within the Town is English, as over 99% of the population classify themselves as English only speakers.

Many residents are attracted to Windsor because of its easy commute to the Halifax area, which allows many residents to seek employment in the city while maintaining a small town lifestyle in the Windsor area. Windsor has developed a strong identity as the "Little Town of Big Firsts", largely due to the Town hosting the first university in Canada (Kings College), being widely regarded as the birthplace of hockey and being the home of Howard Dill's giant pumpkins.

MCCAP Committee Terms of Reference

Background

In accordance with the Canada-Nova Scotia Agreement on the Transfer of Federal Gas Tax Revenues, the Town of Windsor was required to develop an Integrated Community Sustainability Plan (ICSP), which was completed on March 5th, 2010. Subsequent to this plan, the Town is required to take its findings from the ICSP and develop a Municipal Climate Change Adaption Plan (MCCAP) which is intended to identify the significant climate change issues facing the Town of Windsor and prepare recommendations to assist the town in adapting to climate change.

A small MCCAP committee consisting of senior staff (CAO, Directors of Public Works and Director of Planning) and a representative from Council (Deputy Mayor Laurie Murley) was formed to oversee the preparation of the MCCAP. This committee provided direction to a Special Projects Coordinator (Jonathan MacDonald) who was responsible for undertaking necessary research and preparing a draft report. The following Terms of Reference were approved by Council concerning this project.

Purpose

The purpose of the Windsor Climate Change Adaptation Committee is the development of a Municipal Climate Change Adaptation Plan prior to the deadline of December 31st,

Goals

In order to develop the Municipal Climate Change Adaptation Plan, the committee will strive to complete the following goals:

1) *The identification of all impacts and Hazards that may impact the Town of Windsor*
2) *Assessing the risk factors presented by all of the potential hazards facing the Town of Windsor*
3) *Identifying the locations that may be at risk, and categorizing the level of risk*
4) *The establishment of a list of key facilities and infrastructure within the Town of Windsor*

5) *Identifying the social impact of climate change on the Town of Windsor*
6) *Identifying the economic impact of climate change on the Town of Windsor*
7) *Identifying the environmental impact of climate change on the Town of Windsor*
8) *Developing priorities for action*
9) *Creating recommendations for adaptation*

Scope

The Adaptation Committee will consider the following when developing the Municipal Climate Change Adaptation Plan:

1) *The impact of climate change on the residents of the Town of Windsor*
2) *The impact of climate change on the businesses operating within the Town of Windsor*
3) *The impact of climate change on the resource industry within the Town of Windsor*
4) *The impact of climate change on the infrastructure of the Town of Windsor*
5) *The impact of climate change on the environment of the Town of Windsor*

Process

The Adaptation Committee will develop the Municipal Climate Change Adaptation Plan in accordance with the guidelines presented by Service Nova Scotia and Municipal Relations in the Municipal Climate Change Action Plan Guidebook. The adaption committee will present twice to Council prior to the completion of the Adaptation Plan.

Membership

In accordance with the Municipal Climate Change Action Plan Guidebook, the Adaptation Committee should be as encompassing as possible. Therefore, the committee shall be comprised as follows:

a) *One Municipal Councilor*
b) *The Town CAO*
c) *One Representative from the Department of Planning*
d) *One Representative from the Department of Public Works*
e) *The Special Projects Coordinator*

A Chair and Vice-Chair shall be elected at the first meeting and shall serve for the duration of the committee until the MCCAP has been accepted by SNSMR. Should the Chair and Vice-Chair be absent from the meeting, the remaining members of the Committee may appoint an acting Chair.

Quorum

Quorum constitutes of a majority of the total number of present Adaptation Committee members.

Meetings

1) *The Adaptation Committee will meet monthly, or more frequently as required*
2) *Any decision about future meetings will be made by a voting majority of the Adaptation Committee members present*
3) *The meeting notes shall be public and made available to all residents of the Town of Windsor*

MCCAP Assumptions

The research the Town has conducted into climate change has allowed the Town to draw a series of assumptions upon which to base its prediction's of future climate change activity. These assumptions will also form the basis for the Town's strategy for climate change adaptation and mitigation, and are as follows:

1) The Province of Nova Scotia is currently experiencing tectonic subsidence (the land is lowering into the water) and as a result will experience between 20-30 centimeters of sea level rise per century (Proosdij, 2009).
2) Current climate change models are predicting a global increase of approximately 50 centimeters due to human induced climate change over the next century (Proosdij, 2009).
3) For the purposes of this report, the Town will accept that sea level will rise approximately 70 centimeters over the next century.
4) Typically, the Atlantic coastline of both Canada and the United States experience a 25-40 year cycle of high and low hurricane activity. The current high cycle of hurricane activity began in 1995, and will continue for the foreseeable future (AP, 2013).
5) A typical high cycle year for hurricanes along the Atlantic coast consists of 12 storms. In 2012, the Atlantic coast faced one of its highest frequency years in history, with 19 signficant storms. 2013 is predicted to feature between 13-20 significant storms (AP, 2013).
6) It is becoming more likely that the Town of Windsor will face an extreme sudden weather event in the form of a hurricane.
7) The average temperature in the Town of Windsor will rise over the next century, but it will only extend the average growing season by a marginal amount (Daigle, 2011).
8) Over the next century, the change in the likelihood of a period of High Intensity Rainfall is likely to increase by 16% from its current level (Daigle, 2011).
9) With the expected rise in sea level, a high intensity rainfall period during the spring period in which the Bay of Fundy's tides are at the highest could lead to coastal and inland flooding.
10) A high intensity rainfall for a sustained period of time could cause problems with Nova Scotia Power's Hells Gate, which could result in the release of thousands of gallons of water into the Avon River, causing a storm surge which would result in inland flooding throughout the Town (Nova Scotia Power, 2011).

Past Climate Change Issues

The Avon Causeway

The area of land that would one day become the Town of Windsor was originally known as Pesaquid (it has also been referred to as Piziquid or Pisiquid, all of which are translations of a Mi'Kmaq word that means "junction of waters"). This region was first settled by French explorers in 1685, and the British settled in the area in 1749. As tensions remained high between the British, the Acadians, and the Mi'Kmaq during the time, the British quickly erected Fort Edward (1750) in order to display an aura of control over the area. The town began to develop in the low-lying areas that surround the fort.

Settlement of the area faced a challenge with the Avon River, as the only method for transport across the river was a series of rowboats which faced with the challenge of dealing with significant tidal forces from the river. The area would deal with rowboat transportation until 1837, when a private company established the first wooden (and tolled) bridge across the river. The region's climate made maintenance of the bridge a constant challenge, and in 1882 the old wooden bridge was replaced by a steel structure. This steel bridge allowed the area to become a burgeoning hub for rail transportation.

While the steel bridge had been successful in linking Halifax with the Annapolis valley, it did little to alleviate the flooding concerns facing residents of the region. Due to the proximity of both the Avon and Ste. Croix rivers, the low-lying areas on which the Town had developed were often faced with significant flooding from the tides.

In the early 1960's, the federal and provincial governments began investigating the possibility of installing a causeway across the Avon River as a method for flood control as well as to strengthen the transportation linkage between Halifax and the Annapolis Valley. It was agreed that the best option for both organizations would be the establishment of the causeway, and the project began in earnest in 1968.

The project would take just over two years to complete, with the causeway being completed during the summer of 1970 and opened to the public during the fall of the same year. The new causeway was completed at a length of 700 meters and it was comprised of over 1.65 million tons of rock fill and was considered successful in accomplishing both its flooding and transportation goals. It has acted as a barrier to tidal activity, resulting in less flooding throughout the Town's low lying areas while at the same time providing a reliable route from Halifax to the Annapolis Valley.

Construction of the causeway has created a large freshwater lake which has become known as Lake Pesaquid. This lake features a beautiful, expansive waterfront which has been developed into a major focal point for local and regional activities. The lake features a canoe club (The Pesaquid Canoe Club) and more recently a new skateboard park and is home to the annual pumpkin regatta, a feature event that draws tourists from across the world.

Currently, the Nova Scotia Department of Transportation and Infrastructure Renewal is looking at twinning the highway between St. Croix and Hantsport. This has reopened the discussion as to the value of the causeway, with many environmental groups speaking out against it, and arguing for its removal. However, at this time it seems unlikely the causeway will be removed from the river. It is even possible the causeway will be expanded as a result of the decision to twin the highway in the region. The matter remains open for debate at this time.

One of the consequences of the causeway being constructed is that the flood risk to low lying areas of Town is divided into two distinct areas, one area above the causeway which is no longer tidal and the second below the causeway and remaining subject to tidal influences.

Prior Flooding Concerns

Much of the Town of Windsor is low-lying and susceptible to flooding. For example, the older downtown core constructed along the waterfront is actually below sea level during certain tide cycles and prior to the construction of the causeway was periodically flooded by extremely high tides and storm events . Prior to the construction of the Avon Causeway, the Town's primary defense against periodic flooding was its dyke system which was constructed years ago, and reaches a height of 8 metres in elevation. There is a question as to whether or not the dykes are high enough to withstand the sea level rise which will come with climate change.

The Town has approximately 5200 meters of shoreline, 2800 meters of which are located below the level of the Avon Causeway where the causeway provides a high level of flood prevention from tidal influences. The remaining 2400 meters of shoreline is located above the causeway and relies on the dykes for protection from high tides.

In total, approximately 50% of the Town is considered susceptible to flooding, including lands both above and below the causeway. In recognition of the flooding risk, these low lying areas have been included within the Environmental Constraints Designation of the Windsor Municipal Planning Strategy and Land Use By-law which requires that new developments give proper consideration to flood risk

issues. It is anticipated that the increased risk associated with climate change will necessitate a review of these development regulations.

Key Facilities and Infrastructure

The following locations have been identified as key facilities and Infrastructure within the Town of Windsor:

Water Supply and Treatment

Water Treatment Plant
786 Windsor Back Road

Wastewater Collection and Treatment

Sewage Treatment Plant
Location TBD

Roads and Bridges

King Street

Payzant Drive

Water Street

Wentworth Road

Windsor Causeway (Highway 101)

Windsor/Falmouth Bridge

Power Utilities/Supplies

Nova Scotia Power Depot
20 Water Street

Police and Fire

RCMP Branch
140 Morrison Drive

RCMP-Windsor Branch
100 King Street

Windsor Fire Department
100 King Street

Hospitals and Nursing Homes

Dykeland Lodge
124 Cottage Street

Gladys M. Manning Memorial Home
40 Manning Drive

Hants Community Homes
109 Gerrish Street

Hants Community Hospital
89 Payzant Drive

Kendall Lane Housing Society
73 Kendall Lane

Kings Meadow Residence Society
5466 Chester Road

Rest Easy Assisted Living
122 Victoria Road

Victoria Park Guest Home
350 King Street

Schools

Avon View High School
225 Payzant Drive

King's-Edgehill School
254 College Road

West Hants Education Centre
94 Wentworth Road

Windsor Adult High School
94 Wentworth Road

Windsor Elementary School
100 Tremaine Crescent

Windsor Nursery School
236 Victoria Street

Community and Municipal Buildings

Annapolis Valley Regional Library- Windsor Branch
195 Albert Street

Community Centre
78 Thomas Street

Emergency Management Operations - Windsor
100 King Street

Emergency Management Operations – West Hants
76 Morison Drive

Haliburton House
414 Clifton Avenue

Hants Aquatic Center
306 Stannus Street

Shand House Museum
389 Avon Street

Town Hall
100 King Street

West Hants Historical Society
281 King Street

Windsor Exhibition Arena
239 Wentworth Road

Windsor Hockey Heritage Museum
414 Clifton Avenue

Windsor Rotary Club
419 Albert Street

Pharmacies

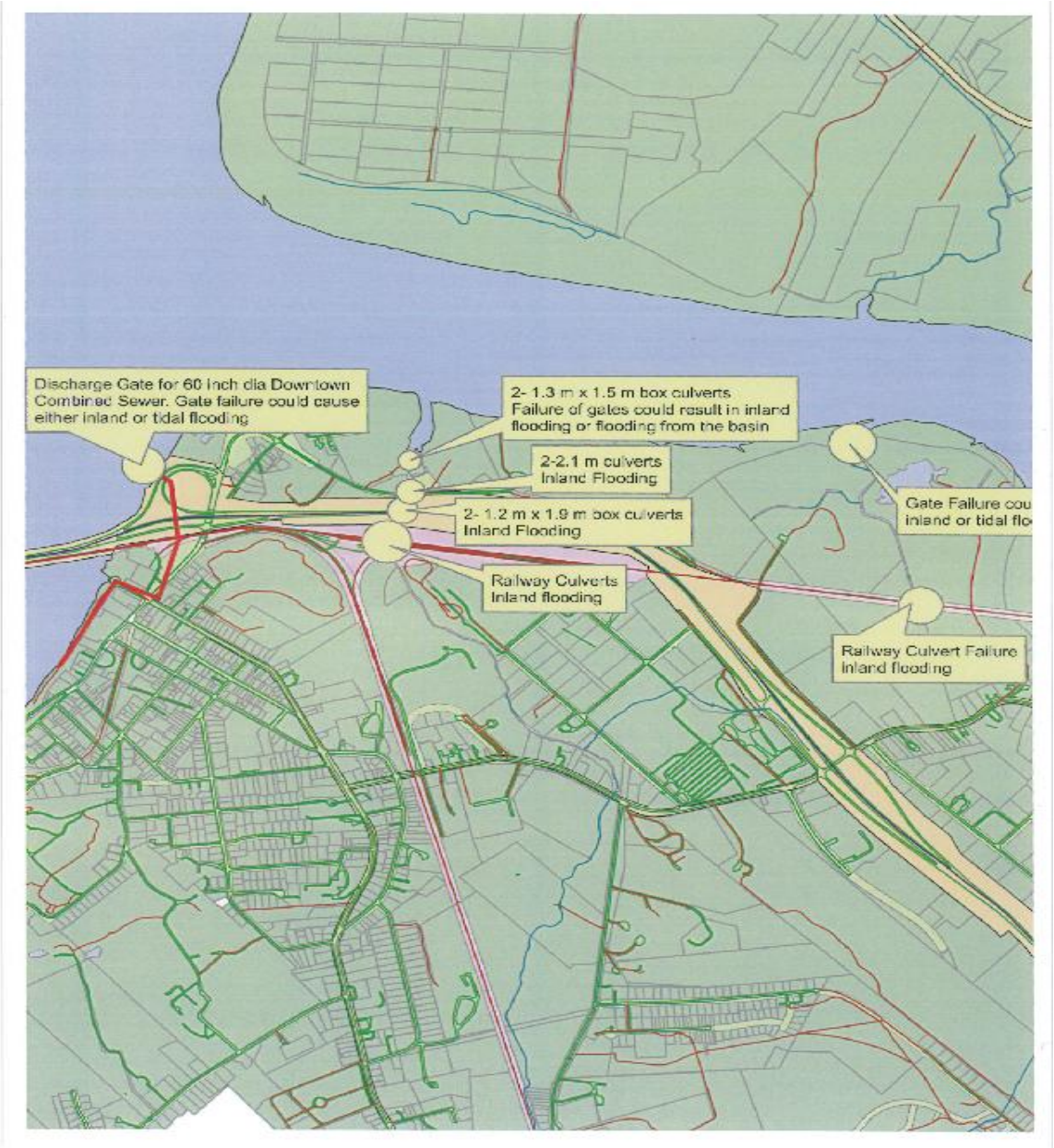
Lawtons
25 Wentworth Road

Sobeys
50 Empire Lane

Superstore
11 Cole Drive

Windsor Pharmasave
30 Gerrish Street

Critical Culverts



The map above shows the location of existing culverts which have already been identified as being critical to the efficient management of storm and/or flood waters. Maintaining the capability of this infrastructure to handle increased stormwater flows resulting from climate change will be critical.

Identified Potential Climate Change Issues

After having reviewed as much of the relevant climate change research as possible, it has been concluded that the Town of Windsor is most susceptible to the risk of flooding within the following categories:

1) Coastal Flooding
2) Inland Flooding
3) High Intensity Rainfall
4) Hurricane

These four climate change hazards represent the greatest risk to the Town's safety and responding effectively to the threat they present will be the focus of adaptation actions. Other potential climate change issues were identified but were felt to represent considerably less risk to the Town.

3.8 **Climate Change Hazard Impact Matrix**

Hazard	Severity			Frequency			Area		
	Severe	Moderate	Minor	Often	Sometimes	Rarely	Large	Medium	Small
Coastal Flooding	X				X		X		
Inland Flooding	X				X		X		
High Intensity Rainfall		X			X			X	
Hurricane	X					X	X		

Coastal Flooding Hazard

Coastal flooding occurs when low-lying land is flooded by sea water generally through tidal and storm actions. Coastal flooding can occur through direct inundation in which the sea level rises above the level of the land and the water directly travels onto the land or through the overtopping of a protective barrier. The Town of Windsor features such barriers (our dyke system) and thus is susceptible to both forms of coastal flooding. The area of town above the causeway where tidal action still occurs is most at risk for this type of flooding.

Climate Issues

As previously stated, the Town expects approximately 70 centimeters of sea level rise over the next century. This sea level rise, in conjunction with the Town's proximity to the Bay of Fundy and Avon/Ste. Croix rivers has presented the Town with the potential of a significant coastal flooding problem in the future.

The Avon River estuary features significant tidal activity, which is emphasized by the variation in tidal range present in the area. Tides occur twice daily, and can range from 8.2 meters to 15.6 m at their highest point. In general, higher tides are recorded in the area during the spring tidal period. However, the tidal activity in the region is considered to be asymmetric, so it is not always the case that the highest tides will occur during the spring tidal period.

The highest tides in the region will occur when the perigee cycle's high point (tidal cycle based on lunar activity) coincides with the spring tidal cycle. This occurrence produces what is known as "Saros Tides" (which occur every 18.years). A record of the Saros Tides over the past few decades have shown that the monthly high water mark for tides in the region has been increasing over 4.5 year cycles.

The Town is protected by a dyke system which has an elevation elevation of 8.0 metres. Since 2002, the region has experienced at least eleven tides which have surpassed the 8.0 metre elevation and have overtopped the dykes in the region. See below.

	Recorded Tide Height
February 1st, 2006	8.211
November 25th, 2003	8.206
February 9th, 2005	8.170
February 10th, 2005	8.129
February 11th, 2005	8.129
December 25th, 2003	8.082
December 13th, 2004	8.046
December 24th, 2003	8.040
December 12th, 2002	8.004
August 21st, 2005	8.004
February 28th, 2006	8.004

(Proosdij, 2009)

As is evident from this table, the highest tides do not always coincide with the spring tidal period. Thus the Town of Windsor must be prepared for the possibility of coastal flooding throughout the entire year.

Unfortunately, tidal activity is not the only cause of coastal flooding in the region. Storm surges, when combined with the tidal activity already present in the region can lead to substantial flooding. Storm surges are a large rise in the water level which accompanies a coastal storm and are caused by a combination of strong winds and low atmospheric pressure.

If a storm surge were to occur during the high tidal period, the results for this region could be devastating. Current environmental scientists predict the probability of this occurring at 3%. However, every reoccurrence of the Saros Tide cycle increases the high tide mark by at least 3.6 centimeters, which means a smaller storm surge is required to raise water levels high enough to overtop the dykes in the region.

Anticipated Future Effects

The most likely scenario that will face the Town in the future is the combination of sea level rise (approximately 70 centimeters) with a one in 20 year storm surge (5% chance of happening each year) and an increase in the high water mark for tidal activity in the region. A one in 20 year storm surge is classified as raising the water levels in the region to an elevation of 8.1 metres.

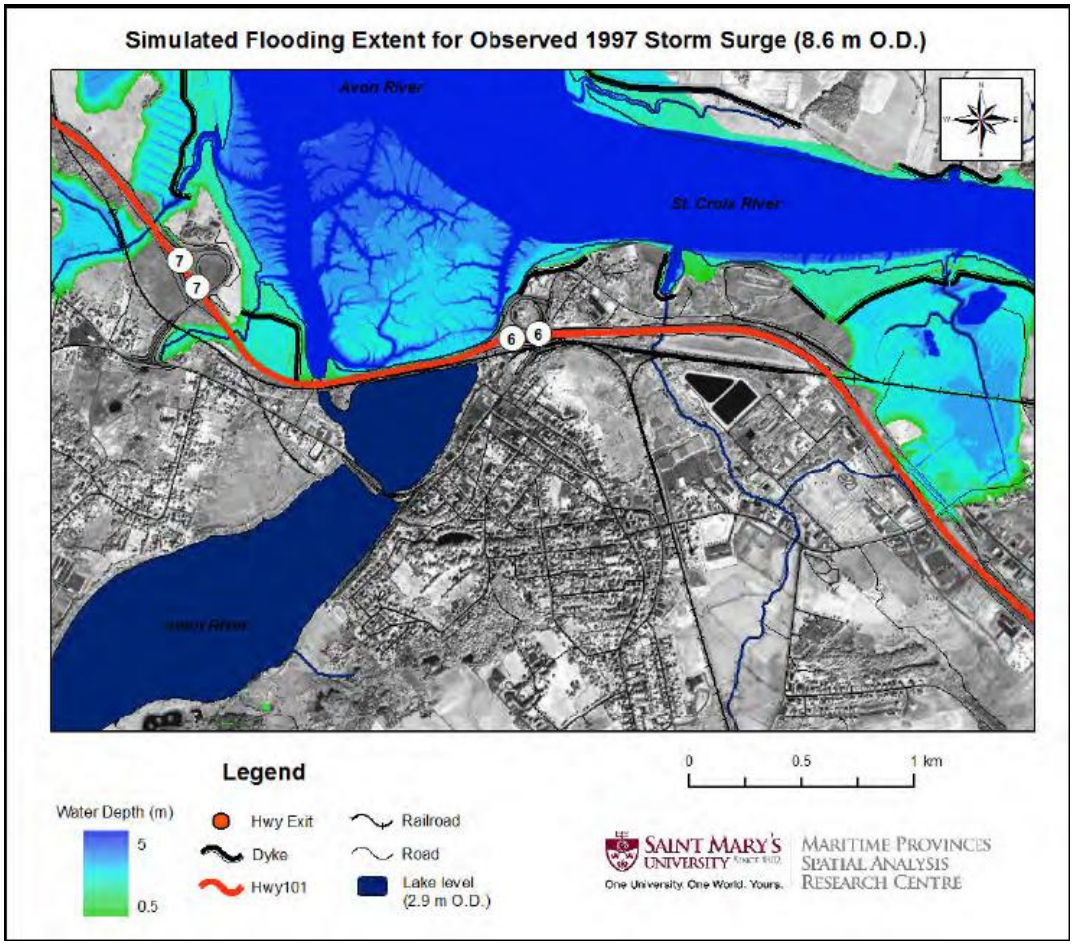
This combination would raise the water levels in the region enough to slightly overtop the dykes, but most of the environmental damage would occur to the dykes themselves. Most of the dykes in the region which are not protected by a foreshore marsh would experience high amounts of coastal erosion, but the developed areas of Town would experience minimal flooding.

This event would be similar to the flood event that occurred in 1997 when the high water mark reached 8.6 metres and the damage was limited to the marshland areas along with flooding of a few minor roads within the Town. See Map 1.

In the worst case scenario, the Town would face what research considers the “probable maximum flood for the region”. In this scenario, the sea level rise is combined with a one in 100 year storm surge (1% chance of occurring each year) and the rise in the high water level for tidal activity in the region. This scenario would lead to a high water elevation of 9.4 metres, which would easily overtop every dyke in the region. See Map 2.

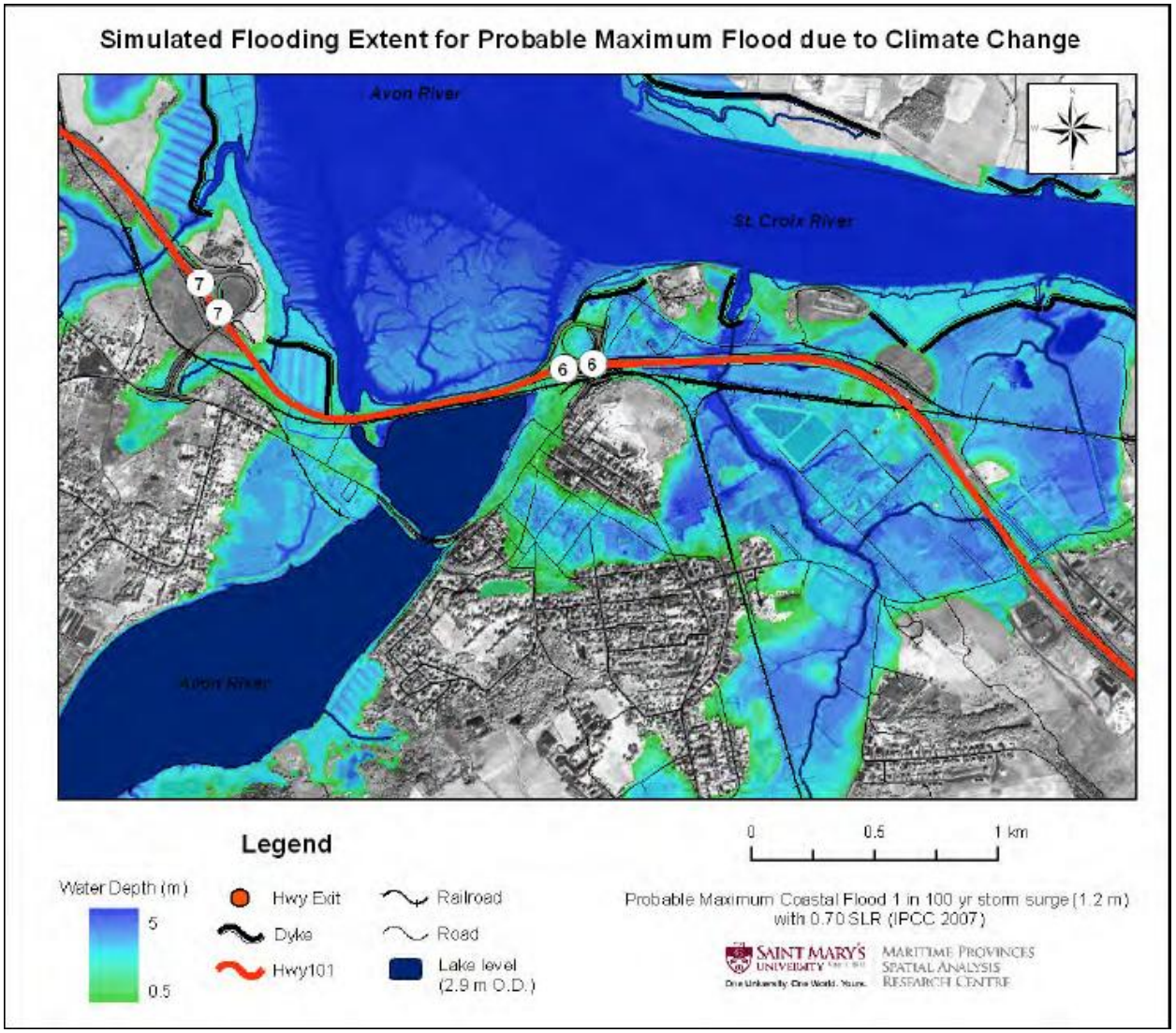
Flooding from this event would flood a significant portion of the Town. The area that would face the most flood activity would be the Tregothic Marsh body. This flood would cover areas of Highway 101 and would submerge most of the rail lines within the Town. Most of the downtown core would remain free of flooding but most, if not all, of the highway exits into and out of Town would be submerged. While it is not known which of these extremes the Town will face in the future, it is accepted that the frequency of flood activity is likely to increase in the future.

Map 1



This map highlights the flooding that occurred during the 1997 storm surge, and shows the impact a 1 in 20 year storm surge would have on the Town of Windsor (Proosdij, 2009). The only expected damage will occur along the coastline with a majority of that damage suffered by the dykes themselves. However, there is the potential for several minor roads and railways that are located between Highway 101 and the Ste. Croix River to experience minor flooding.

Map 2



This map highlights the probable maximum flood for the Town of Windsor (Proosdij, 2009). Under this scenario, the entire region between Highway 101 and the Ste. Croix region will face significant flooding. As well, the waterfront and surrounding downtown core, reaching as far back as King Street will experience flood activity. The entire Tregothic Marsh Body will feature extensive flooding, as will the area that encompasses both Wentworth and College Roads. All land within half a kilometer of the causeway on the Falmouth side will also experience significant flooding.

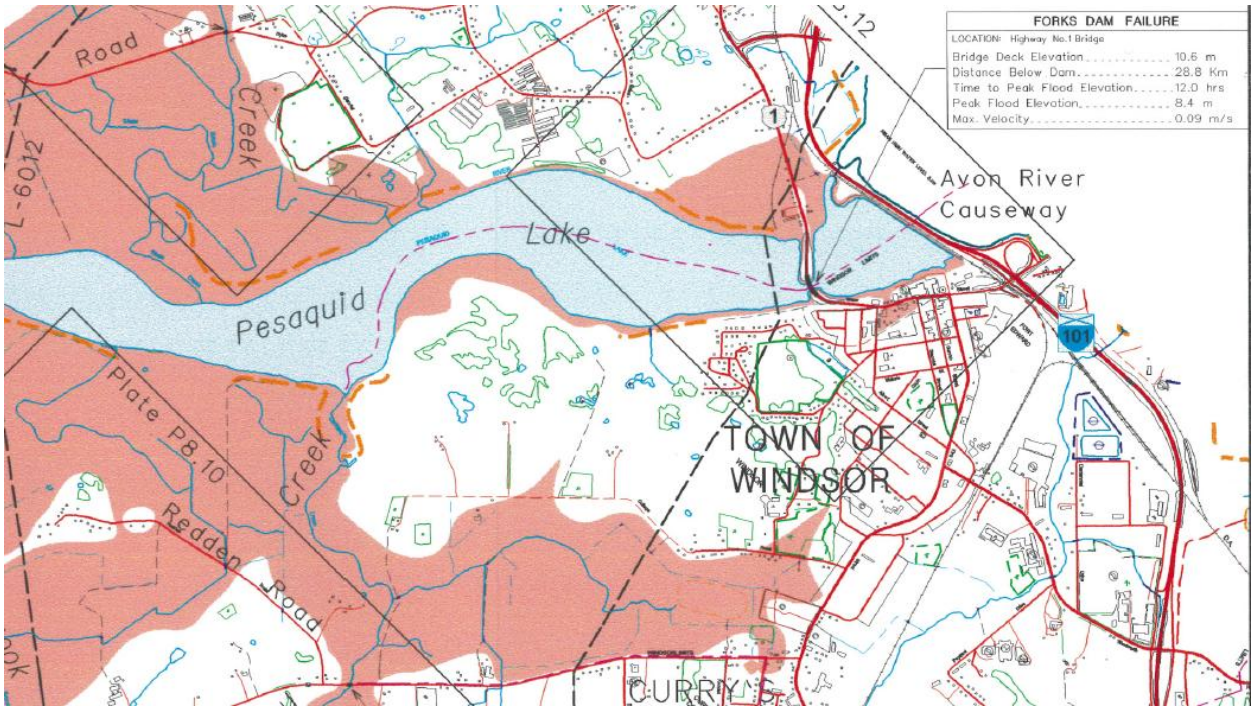
Inland Flooding Hazard

Construction of the Highway 101 causeway and the barrier it created removed the downtown area and southern portions of town from direct tidal influences. However, the portion of the Avon River below the causeway remained part of the Nova Scotia Power Avon Hydro System which consists of two hydroelectric stations on the Avon River with a series of upstream reservoirs. Total generating capacity from this system is 7.2 MW.

Water flow from this power system flows towards the causeway which effectively dams the mouth of the Avon River. Releases from Lake Pesaquid which has formed behind the causeway, are controlled by gates operated by the N.S. Department of Agriculture.

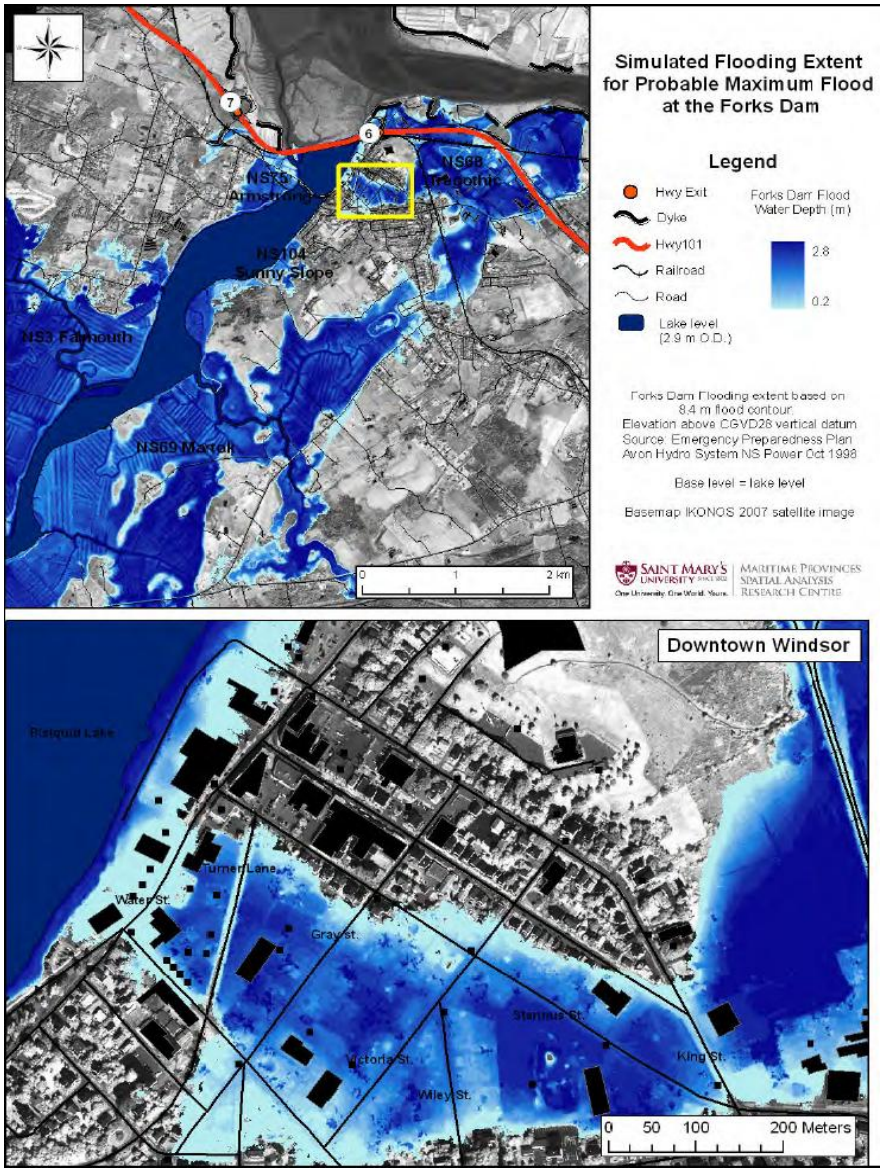
However, The Avon River System is unique in that it is connected to an upstream hydro system which has four dams which, if they failed individually or in combination, would have significant flooding potential. These dams are the Forks Dam, the Card Lake Dam, the Falls Lake Dam, and the South Canoe Lake Dam. Map 3 shown below which was prepared as part of the Avon Hydro System Emergency Preparedness Plan, shows the extent of flooding which would occur as the result of a dam failure at the Forks Dam. Extensive agricultural areas in the southeast part of town would be flooded along with lands in the downtown area. Similar flooding would occur from the individual failure of the other dams.

Map 3



However, if simultaneous dam failures occurred, the potential flooding would be much greater. Map 4 shown below, illustrates the probable impact should both the Falls Lake and Forks Dams fail together. The increased volumes of water would have the potential to flow past King Street which functions as the internal barrier within town separating area subject to inland and coastal flooding. In this case, extensive developed areas of town would be at risk.

Map 4



The reason for this extensive flooding is found in the changes that have been undertaken since the construction of the Avon causeway. Once it had been determined that the Avon causeway would provide sufficient flood protection from coastal flooding for the downtown core, many of the dykes that would have protected the Town from inland flooding were removed in order to manage the costs of dyke upkeep.

High Intensity Rainfall Hazard

For the purposes of this report, High Intensity Rainfall will be considered a rainfall that releases more than 80mm of rain over a period of two hours or less. Periods of high intensity rainfall were rare prior to the 1980's, but have become more frequent over time as the climate changes.

As a result of climate change, the frequency of high intensity rainfall events is expected to increase by 16% over the next 70 years. This increased frequency can lead to the increased frequency of negative climate change issues that are facing the Town.

The combination of a high intensity rainfall, with the rising water levels in the Avon River can lead to the increase of inland flooding events. If a period of high intensity rainfall were to occur at the same time as high tide, the extra freshwater in the river would be unable to drain into the Bay of Fundy which would lead to significant inland flooding.

If a period of high intensity rainfall were to occur at the same time as a Saros Tide cycle, the resulting tide would likely reach an elevation above 8.0 metres (this would also factor in the approximately 70 cm of sea level rise that will occur over the next century) and this would lead to coastal flooding within the Town.

The increased frequency of periods of high intensity rainfall is one of the driving factors behind the expected sea level rise over the next century. The more frequent the rainfalls become, the less time the Bay and Rivers will have to drain the extra water. The increase in the frequency of high intensity rainfall over the next century will result in the Town facing an increase in both coastal and inland flood risks.

In addition to high intensity rainfall, the potential consequences of larger snowstorms and blizzards is also a concern, particularly if these events result in rapid snow melting and run-off that blocked storm drainage systems cannot adequately handle.

Hurricane Hazard

Hurricanes typically occur on the western (the North American) side of the Atlantic Ocean. Hurricanes are formed when warm, moist air from the ocean's surface begins to rise into the atmosphere. This surface air is replaced by cooler air which will shortly become warmed by the ocean's surface. As the warm air rises, its water vapor begins to condensate and creates rain. This rain releases the latent heat within the warm air, cooling it, but at the same time warming the air below, causing it to rise. This cycle continues and creates a pattern of wind that circles around the center of the storm.

At the surface of the storm, winds coming from all directions converge and collide, pushing the warm, humid air upward. This process continues strengthening the intensity of the wind. When the air reaches

the top of the storm, wind is present to push the warm air away and dissipate it. These wind sources are what comprise the intense winds which accompany a hurricane event.

The rise in sea temperature throughout the western section of the Atlantic Ocean is predicted to create more hurricane events each year than ever before. Since the water is warmer, it sends more moisture into the air, and forces more air to come to dissipate the build-up, thus increasing the intensity of the winds that accompany a hurricane event.

As sea temperatures continue to rise in the Atlantic, Nova Scotia can expect an increase in the frequency and intensity of hurricane activity throughout the province. The length of the hurricane season has also been lengthened as a result of rise in sea temperature, which means the Town must be prepared for the likelihood of a hurricane event over a longer period each year.

Windsor's location puts it at both an advantage and a disadvantage when it comes to hurricane activity. The disadvantage is that the Town of Windsor is close enough to the coast to experience hurricane activity. The advantage is that Windsor is unlikely to become the touchdown point for a hurricane event, and thus will be able to prepare in advance for a hurricane event within the Town borders. However, a hurricane event still possesses the power to cause significant damage to the Town, whether it has time to prepare for the hurricane or not.

Windsor has been fortunate to avoid these events throughout most of its history. However, with the prediction of more hurricanes striking Nova Scotia, the probabilities of one impacting the Town are greater. The high winds and intense rainfall which accompany hurricanes have the potential to create worst case scenarios for both inland and coastal flooding situations and result in, in combination, result in considerably more flooding than would result from either scenario alone. A significant hurricane has the potential to become Windsor's "perfect storm" and cause extreme levels of flooding. A hurricane event in the Avon region could result in periods of high intensity rainfall, severe wind damage throughout the town, flying debris, and the presence of both coastal and inland flooding throughout the town. The town must be prepared for one or all of these issues to occur in the future.

Issues

Levels of Preparedness

The Town's overall level of preparedness for the most severe flooding scenarios outlined in this report would fall into the low to moderate category. The Town is currently in the process of developing a new EMO strategy which will use information from this report in order to establish a proper emergency management response to coastal and inland flooding events. As part of this process, the Town must ensure that residents are aware and well-versed in the emergency response plan should this type of event occur in the future.

Informational Gaps

The Town has been the beneficiary of a considerable amount of detailed research carried out through the ACAS Program which has demonstrated the increasing flooding risks which will arise from climate change, both coastal and inland. The research to date has tended to view the threat from coastal and inland flooding potential as being discrete from one another. However, during a major event such as a hurricane, the potential for the two to combine together and significantly increase the consequences to the Town is very real.

In order for the Town to effectively plan for climate change, further research is needed to clearly define a realistic "worst case" scenario which would result from the impact of simultaneous inland and coastal flooding events. If the Town is prepared for this scale of event, anything less will be manageable.

Affected Locations

Under the most likely coastal flooding event, the primary damage will occur along the coastline, with a majority of that damage suffered by the dykes themselves. However, there is the potential for several minor roads and railways that are located between Highway 101 and the Ste. Croix River to experience minor flooding.

Under the probable maximum flood scenario, the entire region between Highway 101 and the Ste. Croix River will face significant flood activity. As well, the waterfront and surrounding downtown core, reaching as far back as King Street will experience flood activity. The entire Tregothic Marsh Body will

feature extensive flooding, as will the region that encompasses both Wentworth and College Roads. All land within half a kilometer from the Avon causeway on the Falmouth side will also experience significant flooding.
The entire downtown core would be impacted from a significant inland flooding event with substantial flooding occurring along Stannus Street and stretching all the way past Wiley Street over King Street and draining into the Tregothic Marsh Body. The area between Highway 101 and the Ste. Croix River will also experience a high level of flooding. This area also includes the region that was once known as the island and the Windsor tourist bureau and surrounding areas.

Facilities and Infrastructure

There is the potential for key infrastructure and facilities within the Town to be impacted by a significant flooding event, whether coastal or inland.

Specific Issues Anticipated

Any flooding event could lead to the closure of the key roads and/or make transportation on these roads difficult.

There is the potential of flood water blocking access to the hospital. The Hospital is currently located on a street with only one entrance, and should the road become inaccessible, emergency medical services may have to be rerouted.

Should the College Road experience any flooding or accessibility issues, the Gladys M Manning nursing home presents a unique problem as this is the only point of access. A secondary access point to the complex should be established in order to mitigate these concerns.

High winds and rain are also likely to interrupt both power and communication services throughout the town. Such high winds will also blow debris throughout the town, making travel unsafe. It is recommended that residents stay within their homes in the event of a hurricane.

Hurricane winds which coincide with a high tidal period, will exacerbate flooding and limit accessibility to certain areas in the town. The town should ensure that alternate routes are available for the delivery of emergency services to residents.

The Fire hall is currently located on King Street, which is in the probable flood zone. Should this area flood prior to the Town accessing it's fire services, it could mean the town is forced to rely on neighboring municipalities to ensure emergency services are available to residents of the town.

Facilities and Infrastructure Key for Emergencies

The fire hall and the hospital are the two most important facilities in the event of a major flooding event. The hospital must be accessible for anyone who may be injured or otherwise need care. The fire hall must be accessible in order to ensure that emergency services remain available to all residents during the event.

The key roads have been identified as King Street and Wentworth Road, as they will allow emergency services access to residents throughout the town. It is important that these roads remain operational.

It will be important for the next EMO plan to incorporate an emergency shelter option for the town's residents in the case of a flood. This shelter will have to be located outside the flood zone, and preferably on higher ground to ensure there is no risk of the flood relief center flooding.

Who will be Affected?

Anyone who lives within the probable flood zone or within a one kilometer radius of the zone has the potential to be seriously affected by the presence of inland flooding. This area encompasses the entire downtown core for the Town, the Tregothic Marsh Body and the entire region between Highway 101 and the Ste. Croix River.

EMO Integration

The Town is currently in the process of developing a new EMO strategy. This strategy will encompass the information contained within this MCCAP and help develop strategies that will protect the vulnerable groups within the Town.

Hazards which will Affect Health and Safety

The following are a list of hazards that would result from coastal flooding that could affect the health and safety of residents within the Town:

1) The flooding could seriously damage the homes of residents, weakening the structure and causing safety concerns within.
2) The loss of power could cause significant problems with service delivery throughout the Town
3) Flooding could lead to roads being washed out, which will limit the ability of residents to leave the Town and hamper the delivery of emergency services within the Town
4) If any of the gas stations flood, gas or diesel could be released into the water and present a serious health risk for residents.

5) A high intensity rainfall or high winds could lead to significant periods of reduced visibility throughout the Town. This could lead to an increase in vehicle accidents both on Highway 101 and throughout the Town itself.
6) A power outage may occur throughout the town
7) The town's communication structure may experience an outage (phones/internet won't work)
8) Blowing debris may injure residents or damage businesses

Economic Implications

The Town's current identity is as a retail service center. Many of the business and retail services within the Town are located in the Downtown core, which is all within a two kilometer radius of the waterfront. If the probable maximum flood were to occur, this entire sector should be considered vulnerable to flooding, and this would create serious economic impacts for the Town.

The tourism industry within the Town should also be considered extremely vulnerable to the effects of coastal flooding in the region. The Town's waterfront has established itself as one of the premier tourist destinations, and the waterfront is host to a variety of activities throughout the year. Any damage to the waterfront region within the Town could have serious implications for the tourism industry.

The Town hall is also located within a likely flood zone. This building is where the Town conducts a significant amount of its business, and if it were damaged due to flooding, there could be economic implications for the Town's government.

Perhaps the most significant economic implication of a potential flood is the loss of assessment value within the Town. If the Town were to experience a significant downturn in assessment value as a result of significant flood damage, the Town's operating budget would face a substantial shortfall in revenue collection.

Options for Dealing with Threats

The Town is currently undertaking a waterfront development project that is expected to run over many years. One potential option is to ensure that all waterfront development is "flood-proofed" (including the use of flood resistant materials [i.e. concrete rather than wood]) and that development features flood strategies in case the area does flood.

The Town should consider encouraging development in areas which are not at risk of flooding, rather than continuing to expand upon the Tregothic Marsh Body.

The Town also needs to evaluate the location of its key infrastructure. As the Town Hall continues to age, it will eventually become necessary to relocate the Town's operations. The Town should consider establishing new infrastructure in areas that feature minimal flood risk.

In the long term, The Town should consider adapting its land use and building code by-laws to ensure that all development in at risk areas are built with the potential flooding in mind. This should occur over a transitional period of a few years, in order to ensure all developers and residents are aware of the changes they should undertake in order to prepare for potential flooding in the future.

Environmental Issues

The Town has experienced flooding throughout its long history. Perhaps the most significant environmental problem that has occurred is the prevalence of coastal erosion. Most of the marsh land that once protected the region's dykes have eroded significantly, and the establishment of the Avon causeway has caused the loss of a significant portion of the salt water marsh land.

Coastal erosion has led to the land sinking slowly into the water, and thus it is expected that the sea level will rise approximately 20 centimeters over the next century as a result of this region. This contributes to a vicious cycle which will lead to increased flooding activity in the region, which erodes more of the coast, which sinks the land further, which leads to a higher frequency of floods.

Expected Change in Environmental Problems

It is expected that the sea level will rise approximately 70 centimeters over the next century. It is also expected that the frequency of high tides will continue to reoccur, and that significant storm surges will continue to become more likely. All of these changes will lead to more events during which the dykes are overtopped, and the Town will thus face increased occurrences of flooding.

Sensitive Habitats, Ecosystems, Wildlife and Endangered Species

Coastal flooding will not impact any sensitive habitats, ecosystems, wildlife or endangered species within the Town of Windsor.

Inland flooding could impact the quality of Piziquid Lake as the water will rush through the Avon River and flood the lake itself.

Dangerous or Hazardous Materials

The Town has identified a few dangerous or hazardous materials that may be released as a result of flooding activity within the Town:

1) Home heating oil
2) Gas or diesel from Gas Stations
3) Fertilizer from surrounding agricultural land
4) Raw sewage

Emergency Preparedness Plan

The EMO plan that is currently under development by the Town will take information from this report in order to develop a specific hazard response plan.

Adaptation Measures

Short Term (1-5 years)

The Town has developed the following priorities for infrastructure adaptation in the short term:

1) Develop flood mitigation strategies for buildings within the probable flood zone
2) Review the current best practices for flood prevention
3) Review and evaluate the town's storm drainage infrastructure
4) Investigate alternative locations for key infrastructure that has yet to be built
5) Review the Nova Scotia Power emergency plan for dam failure
6) Work with the Province to raise the level of the dykes to a level sufficient to meet climate changes.

Medium Term (5-10 years)

The Town has developed the following priorities for infrastructure adaptation over the medium term:

1) Consider flood resistant upgrades to infrastructure within the probable flood zone
2) Update the Town's storm drainage infrastructure to ensure it meets the future needs of the Town
3) Investigate the possibility of building new infrastructure on high ground rather than in the probable flood zone
4) Continue the implementation of the mitigation strategy

Long Term (10+ years)

The Town has developed the following priorities for infrastructure adaptation over the long term:

1) Continue the implementation of the mitigation strategy
2) Review the Municipal Climate Change Action Plan, and update it as necessary
3) Continue to encourage infrastructure development outside the probable flood zone

Outreach Adaptation

Short Term (1-5 years)

The Town has developed the following priorities for outreach adaptation over the short term:

1) Publish this Municipal Climate Change Action Plan, and ensure it is available both via hard copy and through the Town's website
2) Hold a public information session to explain the information found within the Municipal Climate Change Action Plan
3) Encourage business within the probable flood zone to develop a flood preparation strategy
4) Complete the Emergency Management Plan
5) Encourage the Chamber of Commerce to educate its members about the potential climate change risks they face

Medium Term (5-10 years)

The Town has developed the following priorities for outreach adaptation over the medium term:

1) Promote the Emergency Management plan and ensure that it is accessible to all residents of the Town
2) Continue to promote the Municipal Climate Change Action Plan, and use it as an educational tool to ensure residents are aware of the potential climate change implications facing the Town of Windsor
3) Continue working with the Chamber of Commerce to ensure its members are educated regarding climate change risks
4) Encourage public discussion regarding the potential impacts of climate change that may occur in the Town of Windsor in the future

Long Term (10+ years)

The Town has developed the following priorities for outreach adaptation over the medium term:

1) Review and re-evaluate the Municipal Climate Change Action Plan based on the feedback from working with the public and the Chamber of Commerce
2) Continue making the Municipal Climate Change Action Plan accessible to the public and soliciting feedback to ensure the long term climate change strategy for the Town of Windsor is sound

Policy and Planning Adaptation

Short Term (1-5 years)

The Town has developed the following priorities for policy and planning adaptation over the short term:

1) Review the current Municipal Planning Strategy to ensure it considers climate change risk
2) Review the Town's land by-use law

3) Review the Town's building code by-law for construction within the probable flood zone
4) Consider writing climate change information into future infrastructure planning and development

Medium Term (5-10 years)

The Town has developed the following priorities for policy and planning adaptation over the medium term:

1) Encourage development outside of the probable flood zone
2) Ensure all future developers who develop within the probable flood zone are aware of the risks in developing within that region
3) Ensure all planning documents address the future climate change issues that may occur in the future

Long Term (10 years+)

The Town has developed the following priorities for policy and planning adaptation over the long term:

1) Review the Municipal Climate Change Action Plan and update it as necessary to ensure it continues to meet the needs of the Town of Windsor

Mitigation Measures

2009 Corporate Inventory Energy Audit

In 2009, the Town of Windsor conducted a corporate inventory of all energy consumption by Town owned and operated assets (Appendix A). This inventory formed the basis for the Energy and Emissions Inventory Report- Town of Windsor, which was completed in 2011 by the Union of Nova Scotia Municipalities- Municipal Sustainability Office. This report analyzed the amount of Greenhouse Gasses (GhG) emitted by Town owned and operated assets throughout the period of January 1st, 2009 until December 31st, 2009. These emissions were compared and contrasted with the level of energy consumption in the Town, and a series of recommendations for GHG emissions mitigation were outlined.

The town was responsible for the release of 2,277.40 tonnes of GHG during the 2009 calendar year. The main culprit in the release of these emissions was the reliance on standard energy sources by the Town, as the Town consumed 3,593,513.37 eKWh during the same period. Most of this energy was consumed by Town owned/operated buildings (1,572,479.78 eKWh or 43.76% of the total consumption) and the operation of water/wastewater facilities by the Town (1,048,392.15 eKWh or 29.17% of the total consumption). This energy consumption created 834.55 tonnes (from operating buildings) and 720 tonnes (from water/wastewater operations) of GHG respectively.

The remaining energy consumption was divided between the maintenance and operation of the Town's vehicle fleet (399,928.45 or 11.13%) and the operation of street and area lights throughout the Town (572,713,000 or 15.94%). The street lights emitted 481.11 tonnes of GHG during the year, while the vehicle fleet accounted for the creation of 97.37 tonnes as well.

Key Areas for Improvement

The results of the 2011 report concerning GhG and energy use highlight several areas that the Town can improve upon moving into the future. Buildings will continue to comprise the largest percentage of the Town's energy use and emissions, but there is room for improvement. The Town Hall and Fire station is the least efficient building currently owned and operated by the Town. In the future, the Town should look at implementing energy efficient programs within this building to reduce its overall consumption level and thus reduce its GhG emissions. The 2011 report suggested the Town investigate the possibility of installing motion sensors for the lighting within the offices, as well as shift away from traditional florescent sources of lighting to more energy efficient models such as CFL lighting.

The Town can supplement this energy reduction by investigating the possibility of upgrading the street and area lights from their current state to modern, energy efficient LED lighting. Test projects undertaken by the Province of Nova Scotia and the Halifax Regional Municipality have shown this transition can be effective, reducing overall energy consumption while maintaining a high standard of lighting for citizens.

The Town is currently in the process of developing a wastewater treatment plant for the Town's residents. It is suggested that during the planning phases of this project, energy efficient options be considered to limit the overall burden of electricity use on the Town. These energy efficient options will also help mitigate the creation of GhG this new facility will provide.

Efforts to Date

Since the Town's corporate energy inventory and the resulting report on energy use, the Town has been working to implement the recommendations of the report, and other energy/greenhouse gas reduction strategies. Work that has been done to date includes, but is not limited to:

1) The replacement of ballasts and lights within the Town hall with more efficient alternatives
2) The use of LED streetlights for the newly constructed waterfront skate park
3) Investigation into the use of wind turbine power
4) Discussions on the implementation of an idling policy
5) Discussions on moving the Town toward the use of non-traditional energy sources
6) An ice rink energy efficiency project for the Town's arena
7) A Christmas light exchange, allowing residents to replace their old lights with more energy efficient options
8) Investigation into the replacement of all streetlights within the Town with LED streetlights
9) A tree canopy project
10) Proposed sewage treatment plant

Moving forward, the Town will continue implementing recommendations from the report and creating new strategies for energy and greenhouse gas reduction.

Energy and Emissions Summary Table

Emission Category	Energy Type	Energy Consumption	Cost ($)	Units	Emission Factor (Tco2/Units)	Emissions (Tco2E)	Notes
Buildings	Electricity	993445.00	104946.41	19	43.92	834.55	
	Natural Gas	0	0	0	0	0	No buildings owned or operated by the Town are fueled with Natural Gas
	Fuel Oil	53863.70	34087.41	2	72.18	144.35	
Water and Wastewater	Electricity	778479.00	76825.58	7	93.42	653.97	
Streetlights	Electricity	572,713	N/A	390	1.23	481.00	
Vehicles	Regular Gasoline	18371.00	N/A	8	5.38	42.99	
	Diesel	20679.00	N/A	9	6.04	54.39	
Solid Waste	N/A	0	0	0	0	0	A solid waste plant will be constructed shortly

Mitigation Goals

Short Term (1-5 years)

The Town has the following goals for mitigation in the short term:

1) Continue to review and implement the recommendations from the 2009 corporate energy audit
2) Continue discussions regarding the implementation of an idling policy for the Town
3) Investigate replacing the current streetlights with energy efficient LED streetlights
4) Continue its successful energy reduction strategies, such as the tree canopy project and the Christmas light exchange programs
5) Supporting province in increasing height of Tregothic Marsh dykes

Medium Term (5-10 years)

The Town has the following goals for mitigation in the medium term:

1) Continue the discussion on the use of wind turbine power for the town
2) Evaluate replacing lights within all town-owned structures with more energy efficient models
3) Discuss the potential of purchasing more energy efficient vehicles
4) Investigate the potential of writing energy efficient suggestions and guidelines for developers within the Town

Long Term (10+ years)

The Town has the following goals for mitigation in the long term:

1) Investigate the use of non-traditional energy sources for Town buildings and programs
2) Investigate including climate change reduction policies for development and construction within the Town
3) Review the Municipal Planning Strategy and investigate adding greenhouse gas restrictions to the strategy
4) Continue to review the MCCAP and Corporate Energy Inventory recommendations and update them as needed, to help modernize the implementation of the recommendations found within each document

Appendices

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