March 2018

Background Report: Land

Background Report 3 of 9

Prepared by West Hants Planning and Development Department

WEST HANTS
NOVA SCOTIA

Executive Summary

Most land in the Municipality of the District of West Hants (West Hants) is zoned General Resource. A large portion of this is used for forestry. Karst environments can develop in areas of where limestone, dolomite, and gypsum are present; they have been reported to have more productive forest sites than other areas due to the well-drained and nutrient rich soils. However, karst can be challenging for development and may require further examination.

There is 30.5 km of running dyke in West Hants that protect the coastline from the tides. Increasing flood risk and climate change are growing concerns which will require a revaluation of development regulations.

Watercourse setbacks for development differ between West Hants and the former Town of Hantsport which may need further attention to determine the reasoning and the best practices for building near watercourses.

Table of Contents

1. Geology

The bedrock and surficial geology are important to consider when planning the land uses of an area, especially when it concerns the construction of buildings, roads and other infrastructure.

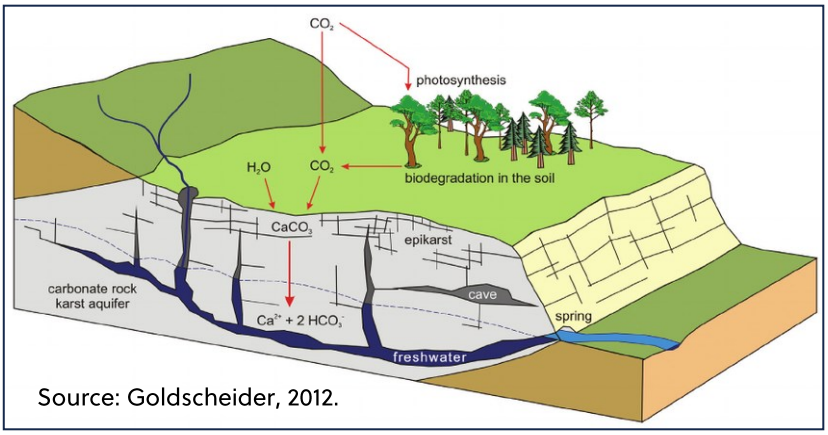
The West Hants Municipal Planning Strategy (MPS) states that certain areas of West Hants, especially around Upper Falmouth and Highway 101, may be subject to subsidence due to the bedrock, surficial geology and groundwater activity. The most visible evidence is the presence of sinkholes or karst topography.

1.1 Bedrock Geology

Bedrock is the layer of rock between the Earth's crust and the soil at the Earth's surface. Much of the bedrock in West Hants (Figure 2) is comprised of sedimentary rocks such as sandstone, siltstone, conglomerate and limestone, with some presence of metamorphic rocks such as shale and schist.

There is also a karst environment (Figure 1). This is when, over time, water dissolves carbonate bedrock such as limestone and dolomite, sometimes at a great distance below the surface. The process can create openings in the bedrock, such as sinkholes, and underground drainage systems including springs and caves.

Figure 1: An Example of a Karst Environment



Source: Goldscheider, 2012.

The American Geological Institute report *Living with Karst: A Fragile Foundation* provides guidelines for living in a karst environment. It suggests that in areas where prohibiting development in karst regions is not achievable, regulations regarding the placement of landfills and underground wells and pipes should be implemented to mitigate water contamination. To reduce erosion and protect groundwater on karst land which is used for agriculture, the report recommends reseeding cleared areas quickly, using fertilizers and pesticides sparingly, and not putting waste into sinkholes.

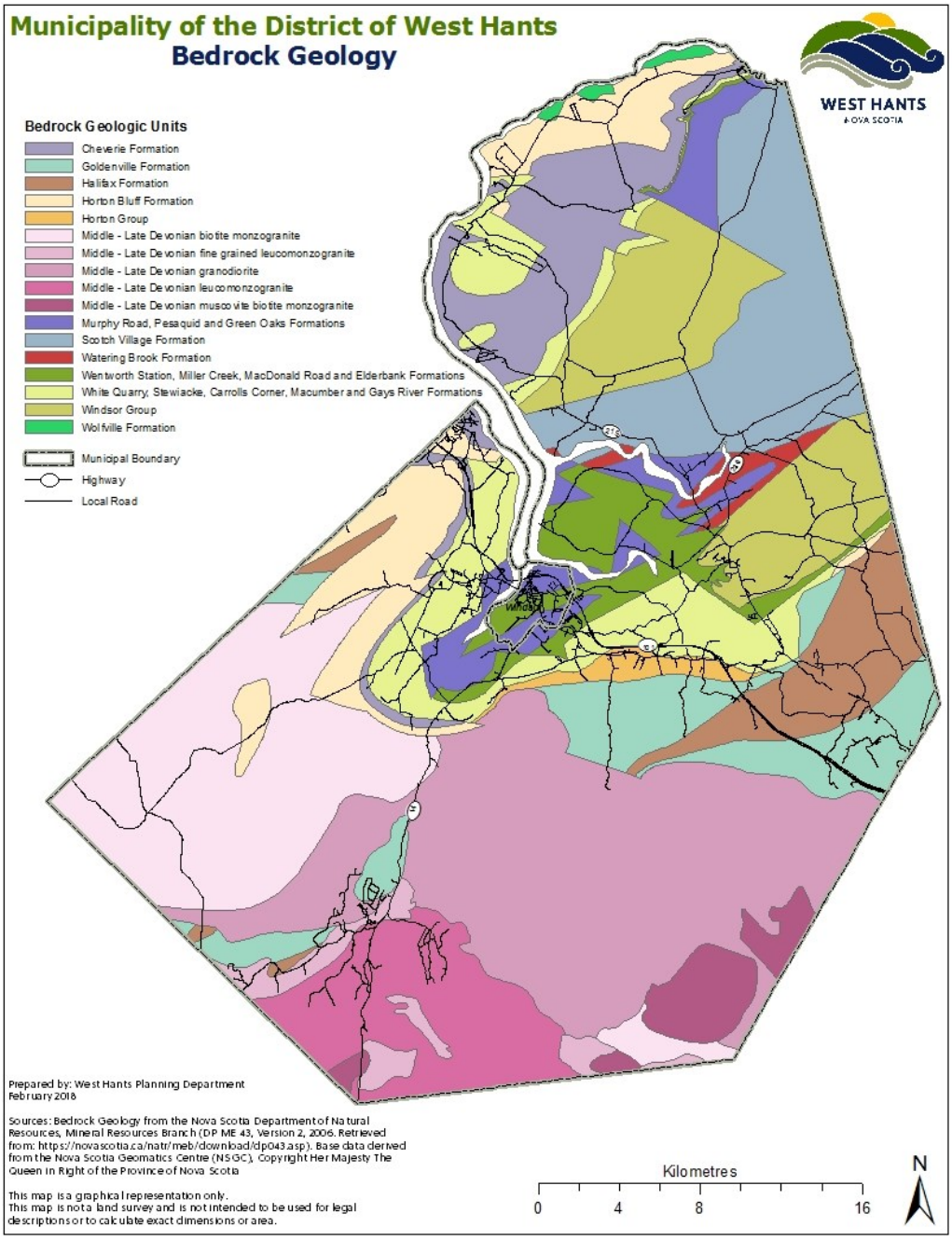
One of the most uncertain qualities of karst environments is sinkholes. Although human activity such as withdrawing groundwater can influence sinkhole collapse, sinkholes are extremely hard to forecast. The American Geological Institute advises thorough mapping of karst environments to determine trends in fractures, possible sinkholes and identify caves, and establishing natural vegetation buffers to assist in removing pollutants and preventing sediments from reaching groundwater.

The purpose of the Nova Scotia *Mineral Resources Act* (1990) is to ensure responsible mineral resource exploration, mining and production following sustainable development

practices. The Crown owns all minerals in the Province and the rights to explore, mine and remove the minerals from the land. The Act applies to all minerals plus gypsum and limestone.

Gypsum is found in a number of geological formations: the Murphy Road, Pesaquid and Green Oaks Formations, Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations, and the Watering Brook Formation. It is not considered a mineral in the Mineral Resources Act however it does need to be registered with the Department of Natural Resources as a non-mineral.

Figure 2: Bedrock Geology Map for West Hants



Limestone and dolomite are common in the Windsor Group (Figure 1). Dolomite is a Crown mineral in Nova Scotia under the Mineral Resources Act. Limestone is not considered a mineral unless it is designated by the Department of Natural Resources as a Crown mineral. Mining permits are required to mine both limestone and dolomite in Nova Scotia, and non-crown limestone needs a non-mineral registration from the Department of Natural Resources.

1.2 Surficial Geology

Surficial geology refers to the material which lies on top of the bedrock. The majority of the surficial geology in West Hants is Stony or Silty Till Plain (Ground Moraine) (Figure 3). Both the silty and stony till can be flat to rolling with surface boulders and is generally between 2-30 m thick. The silty till can provide the best agricultural land with moderate drainage, but there are some limitations such as stoniness and rapid drainage for using this land for crops.

Bedrock is another significant surficial geological unit in the southern regions of West Hants. The bedrock can be flat to strongly rolling, with ridges of exposed hard rock and thin till areas. Much of the bedrock areas are forested and are not useful for most crops.

Marine deposits, which include gravel, sand, silt and clay, can be found in the central areas of West Hants, along the coast. These deposits create beaches, spits and bars, and salt marshes and mud flats. These deposits create great recreational areas and wildlife habitats.

Other deposits such as organic, alluvial, glaciofluvial, and silty drumlins can be found scattered throughout West Hants.

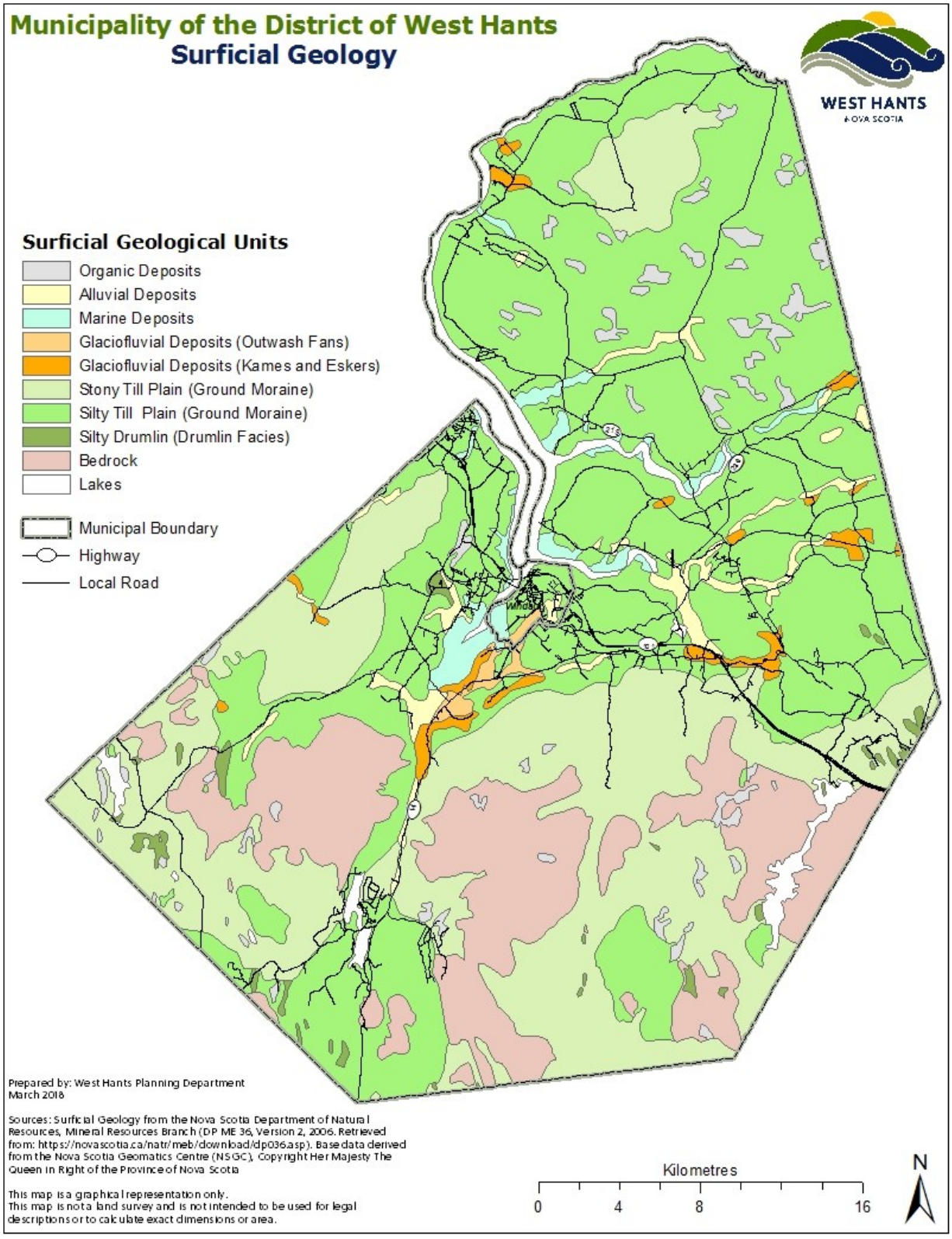
Organic deposits include moss and peat and form bogs and swamps. The organic deposits create habitats for wildlife, are a source of fertilizer and can extract contaminants from groundwater.

Alluvial deposits include gravel, sand and mud, which are usually coarse at the base and finer at the top. These deposits can be seen in flat or gently sloping river valley floodplains and are a major source of groundwater. There are some limitations for using this land for crops and construction as it has poor drainage.

Glaciofluvial deposits include kames, eskers and outwash fans. Kames and eskers include materials such as gravel, sand and silt, and can be in the form of steep-sided mounds, terraces in valleys, and steep sided ridges. The land is most suited for growing blueberries or for animal pastures as there are major limitations to using this land for crops due to the irregular topography and rapid drainage. Outwash fans are comprised of gravel and sand, which can be used as aggregate for concrete.

The silty drumlin deposit is made of till and red clay. Similar to the silty till, the silty drumlin is good for agriculture as it has moderate drainage and stoniness.

Figure 3: Surficial Geology Map for West Hants



2. Dykelands

West Hants covers approximately 306,904.9 acres (124,200 hectares) of land, and has more than 160 km of coastline. Prominent features of the landscape in West Hants are dykes, dykelands and drainage structures called aboiteaux. There is approximately 6,019 acres (2,436 hectares) of dykelands and 30.5 km of running dyke in West Hants, comprising approximately 2% of the total land area of the municipality. Dykelands can be found along the flood plains of the Avon, Herbert, Kennetcook, Meander, and St. Croix rivers. The dykelands and aboiteaux were created approximately 300 years ago by Acadian settlers to protect farmland on the salt marshes from high tide. As dykelands are nutrient rich they are still used for producing hay and animal grazing, as well as the production of corn, grains and sod. Dykelands can also provide habitat for a wide range of species.

The Nova Scotia Department of Agriculture (Land Protection Section) is responsible for the protection of agricultural land behind dykes. In 1949, the Marshland Reclamation Commission was created and enabled owners of marshlands to create marsh bodies. In Nova Scotia, marsh bodies are able to create a mission statement and objectives, make rules and by-laws to regulate its lands and enter into agreements with the Minister or others for construction, repair, and maintenance of marshlands, among other things. In West Hants there are currently 19 incorporated marsh bodies (Figure 4). In 2000, the *Marshland Reclamation Act* was replaced by the *Agricultural Marshland Conservation Act* and the Agricultural Marshland Conservation Commission.

Due to the risk of flooding and the high agriculture productivity of dykelands, West Hants regulates the uses, size and structures allowed to be constructed on dykelands. Infilling of dykelands is highly regulated and must not impede flood water drainage flow or reduce the capacity of flood water storage.

Figure 4: Marsh Bodies within West Hants

NSDA Number	Marsh body name	NSDA Number	Marsh body name
NS003	Falmouth Great Dyke	**NS079**	Chambers
NS014	Elderkin	**NS085**	Mantua Poplar Grove
NS027	Newport Town	**NS088**	Burlington
NS038	St. Croix	**NS089**	Cogmugun
NS048	Centre Burlington	**NS093**	Greenhill
NS050	Herbert River	**NS099**	Upper Burlington
NS061	Kennetcook	**NS100**	Wentworth
NS068	Tregothic	**NS104**	Sunny Slope
NS069	Martock	**NS105**	Belmont
NS075	Armstrong		

3. Water

To preserve natural habitat and limit environmental impacts on watercourses and waterbodies, the West Hants Land Use By-law (LUB) states that no structure shall be located closer than 50 ft. (15.24 m) from a watercourse, unless it is being used for a marine use, water distribution or irrigation, water and sewage treatment uses, or is necessary for the prevention of flood, erosion or to facilitate drainage. The Hantsport Land Use By-law (HLUB) has a similar policy, however it requires all main buildings to be setback 98.4 ft. (30 m) from a watercourse.

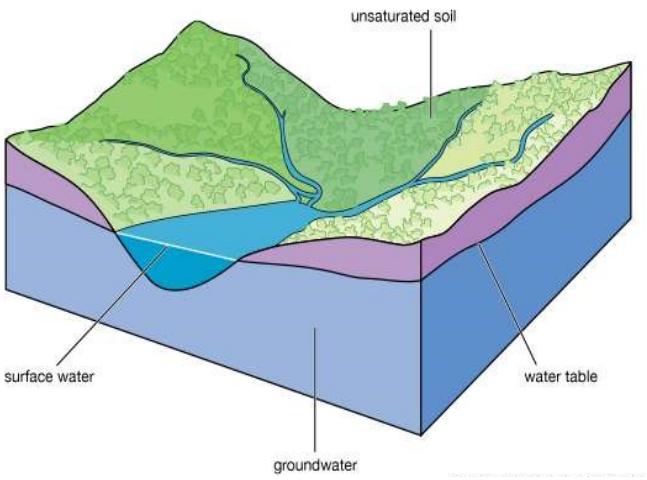
The West Hants Subdivision By-law prevents developments from obstructing public access to the lakes and rivers by requiring waterfront land as parkland dedication and by enabling the purchase of waterfront lands from the money collected in lieu of parkland dedication.

Water supply areas, including the three watersheds which provide water to the residents of West Hants, are additionally protected by the *Statement of Provincial Interest regarding Drinking Water* and specific watershed regulations and are discussed in the *Infrastructure Background Report*.

3.1 Groundwater

Groundwater is water held under the ground's surface in the soil or in underground aquifers between rocks (Figure 5). It is most commonly used to supply resident's water through drilled wells. A *Groundwater Resources and Hydrogeology* (1969) report stated that for most uses the groundwater in the Windsor-Hantsport-Walton area of the Province is fair to good, however it is hard water, meaning there is over 100 parts per million (ppm) of calcium and magnesium sulphates and carbonates. This means that all water needs to be filtered before consumption. Saltwater intrusion in wells was not recognized as an issue but groundwater was found to be saltier in dykeland areas.

Figure 5: A Cross Section Showing Surface Water and Groundwater



Source: Encyclopedia Britannica,, 2018.

The Department of Environment performs groundwater monitoring in the Province through their Groundwater Observation Well Network program. This is used to evaluate the quality and quantity of groundwater resources over time and determine the impacts of climate change and human activity on groundwater resources. The program began in 1965 and currently has 40 well sites over the Province. The only monitored well site in West Hants is in Smileys Provincial Park. The well was originally constructed in 1967 to be used as a water supply for the park, however was no longer needed and in 2011 was converted to a monitored well site for the program.

3.2 Surface Water

Surface water is water found in natural watercourses and waterbodies such as the ocean, lakes and rivers. Surface water is largely of good quality in Nova Scotia, although it must be properly filtered and monitored if being utilized as a drinking water source. It is generally used for recreational uses and wildlife habitat, however it can support industries such as farming and power generation. Over half of the municipal water supplies in the Province get their water from surface water sources.

4. Land Cover

The Department of Natural Resources *Ecological Land Classification Guide* (2017) would classify West Hants in the Central Lowlands ecoregion. The climate in this region is favourable for farming including for cattle and crops. The moist soils permit forests of hemlock, white pine, black and red spruce, white birch, red maple, and aspen. Hemlock trees are mainly found on slopes near rivers, whereas the white pine can be found in coarser soils.

The soils in West Hants are vulnerable to droughts in the summer months which can increase the risk of forest fires. Pine and oak trees and shrubs commonly grow in areas after wildfires.

The majority (71%) of the land in West Hants is zoned General Resource. A large portion of this is used for forestry and forestry-related uses. Karst environments can be productive forestry sites due to the well-drained and nutrient rich soils.

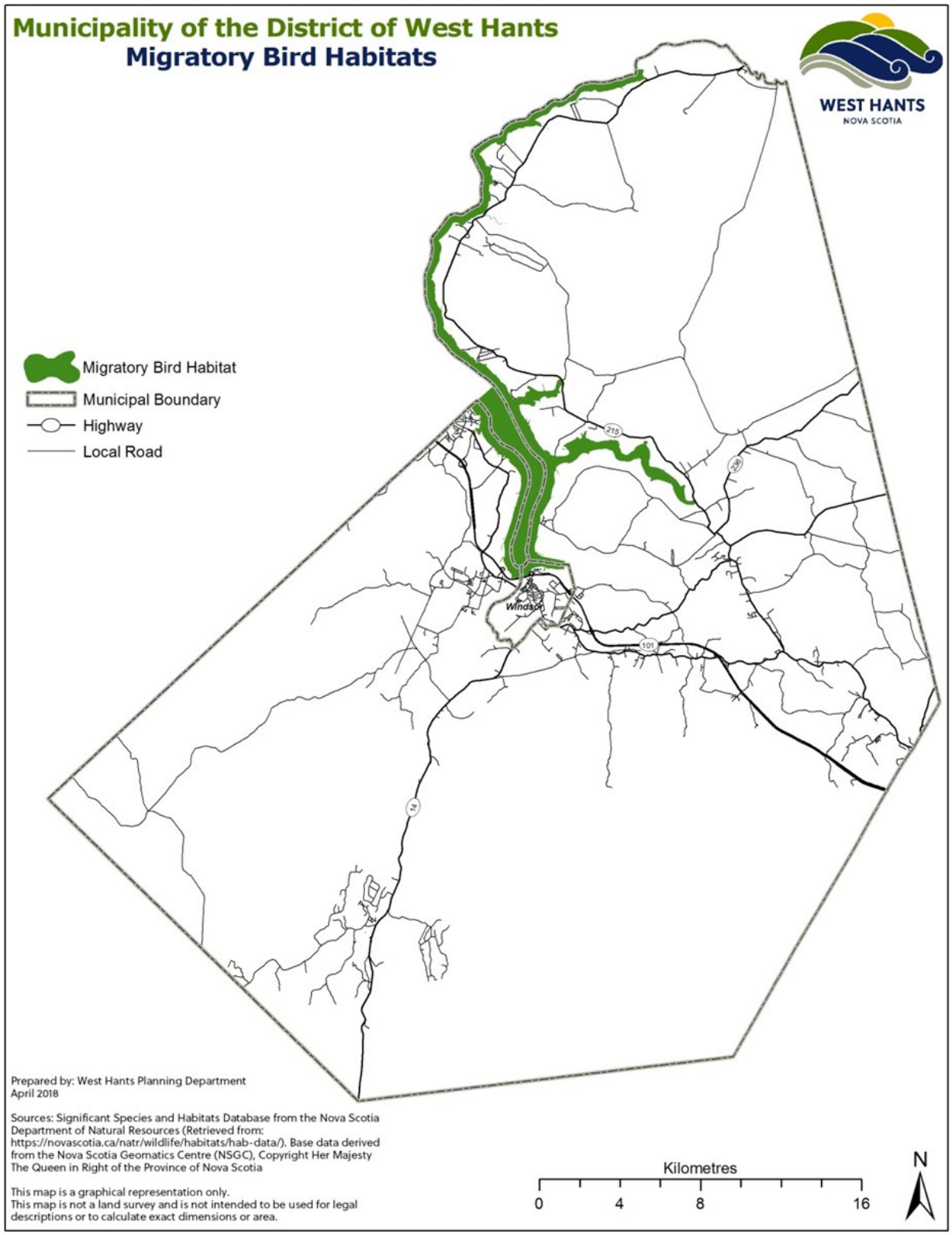
4.1 Wildlife Habitats

West Hants has many areas with significant species and habitats. One such habitat, the southern bight of the Minas Basin, is proposed as a Wildlife Management Area by the Province (Figure 6). This area is a crucial feeding site for migrating shorebirds. It is already recognized as a Ramsar Wetland of International Importance, although this recognition does not have any legal implications for protection of the area. The proposed Wildlife Management Area would protect the birds and their habitat, and human access to these sites would be restricted during migration. However, there has been no movement on the designation for this Wildlife Management Area since the early 2000's.

The unique karst environment provides habitat for rare plants, lichen and endangered bat species. The ram's head lady's slipper which is used as one of the West Hants logos would be one of these unique species.

Wildlife habitats and watercourses have a minimal amount of protection under the Provincial Forests Act in areas which are being used for wood production. On forest lands that are greater than three (3) hectares, ten (10) trees must be left standing for each hectare of forest land cut. Where there is a watercourse within the forest land no activity that will result in sediments being deposited into the water can take place within 20 m of the watercourse. In karst regions this is especially important as the sediments could be transported into the groundwater.

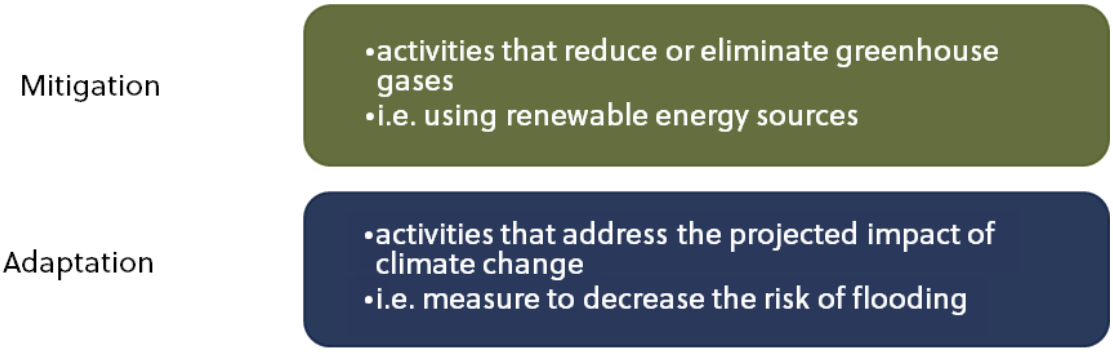
Figure 6: Proposed Wildlife Management Area in West Hants



5. Flood Risk and Climate Change

Climate change planning focuses on two key areas (Figure 7).

Figure 7: Mitigation and Adaptation



The West Hants Municipal Climate Change Action Plan (MCCAP) was approved by Council in 2013. Based on risk to life and potential damage to infrastructure, the most concerning natural hazards identified in the MCCAP are coastal flooding, drought, and inland flooding. The MCCAP committee has focused on adaptation efforts such as storm water management plans. However, greenhouse gas emissions reduction targets are included in the MCCAP.

The *Statement of Provincial Interest Regarding Flood Risk Areas* only apply to the five locations designated under the Canada-Nova Scotia Flood Damage Reduction Program, none of which are in West Hants.

In 2009, Dr. Danika van Proosdij assessed flood risk along Highway 101 near Windsor. The availability of a LIDAR elevation survey, which is precise topographical information, was crucial to the completion of the project. Specific areas of concern identified in this study include highway conditions at Exits 5, 6, and 8. Increasing the elevation for certain sections of the highway can be done during the highway twinning project to address climate change concerns. Dr. van Proosdij also suggests development should be restricted in low lying areas.

Emma Stucke completed a thesis project at Dalhousie University in 2016 comparing climate change projections with land use planning policies and by-laws to determine if adaptive climate change principles had been incorporated into the existing West Hants planning documents. She found that land use planning policies and by-laws in West Hants are not adapted to climate change because vulnerable land uses are permitted in flood risk areas. However, there are policy changes that could address these concerns

Source: Emma Stucke, 2016.

6. Challenges and Opportunities

Land and environmental factors are the foundation when determining land uses in a municipality. The underlying and surficial geology, dykelands, ground and surface water, and land cover have influenced how the land has been developed in the past. Flood risk and climate change will influence how we plan to use the land in the future.

Geology

The karst environment can provide unique opportunities as far as forestry and habitat for rare species; however, it can also provide challenges for various land uses. As sinkholes are hard to predict it could beneficial for mapping to be completed to determine the extent of the karst environment in West Hants. The West Hants *Municipal Climate Change Action Plan* (2013) identified partnering with local industries, stakeholders and the Department of Natural Resources to acquire the mapping as a high priority item.

Dykeland

Figure 9: December 2017 Breach

Source: Mark Davison Photography

Climate change is a major concern for coastal communities. The dykelands in West Hants are below sea level, and the running dykes were created in a time before sea level rise and coastal flooding were considered a potential issue. There are concerns that the dykes may not be high enough to combat the rising water levels and increased storm surges, and that dyke breaches may become more common. In December 2017, the rail line near Hantsport became suspended in the air when the aboiteau was worn away by the tide (Figure 9). The rail line is privately owned by the Windsor and Hantsport Railway Company (WHRC) and it is up to the owner to maintain and repair. However, with the possibility of incidents like this happening more often, West Hants should engage in discussion with stakeholders on how to mitigate potential issues, as other infrastructure such as power poles and roadways is dependent on the dykes for protection.

West Hants has restricted development on low lying dykeland to preserve the agricultural land and mitigate potential infrastructure issues due to flooding, and the Provincial government has a specific Municipal Infrastructure Program that assists municipalities when investing in infrastructure that reduces flood risks and community vulnerability. The Flood Risk Infrastructure Investment Program can match up to 50% of the eligible project costs. This funding could be an option for West Hants should dykeland flooding or a dyke breach pose a threat on Municipal infrastructure.

Water

The West Hants and Hantsport Land Use By-laws have significantly different setbacks for buildings from watercourses, 50 ft. and 98.4 ft. respectively. A future study could be done to determine why there is such a difference in the setback distance, if there is any research to determine what an adequate setback is, and if there should be changes made to these policies.

Flood Risk and Climate Change

The areas that will see the greatest impact of flood risk and climate change are the coastal regions of West Hants. LIDAR (light detection and ranging) technology could be utilized to determine detailed topographic data which could be used to determine the extent of the impact. It involves a laser scan of the area from the air that can be used to create a digital elevation model (DEM) of an area which can graphically show the impacts on the landscape under different flood risk scenarios. There has been some LIDAR conducted in the area in the past, however availability of this data to municipal staff is limited. LIDAR data collection can be a costly endeavour, however partnerships between West Hants, Windsor, and the Province to conduct the data collection and evaluation could reduce costs. The Municipality of the District of Lunenburg partnered with the Municipality of Chester and is using LIDAR data to assist in determining areas of development in coastal areas, requiring the land to be above 2.5 meters in elevation before development could be considered.

Bibliography

American Geological Institute, (2001). Living with Karst: A Fragile Foundation. Retrieved from https://www.americangeosciences.org/sites/default/files/karst.pdf

Avon River Heritage Society. (2018). The Karst Environment of the Avon Peninsula. Retrieved from http://www.avonriverheritage.com/karst-environment.html

British Columbia Ministry of Forests. (2003). Karst Management Handbook for British Columbia. Retrieved from https://www.for.gov.bc.ca/hfp/publications/00189/karst-mgmt-handbook-web.pdf

Chronicle Herald. (2016). Chester, Lunenburg to map coast to coast to collect data for climate change strategy. Retrieved from http://thechronicleherald.ca/novascotia/1361443-chester-lunenburg-to-map-coast-to-collect-data-for-climate-change-strategy

Department of Environment. (2015). Nova Scotia Groundwater Observation Well Network. Retrieved from https://novascotia.ca/nse/groundwater/docs/GroundwaterObservationWellNetwork2015Report.pdf

Department of Environment. (2018). Surface Water. Retrieved from https://novascotia.ca/nse/surface.water/

Department of Natural Resources. (2017). Ecological Land Classification Guide. Retrieved from https://novascotia.ca/natr/forestry/ecological/pdf/Ecological-Land-Classification-guide.pdf

Department of Natural Resources. (2018). Groundwater. Retrieved from https://novascotia.ca/nse/groundwater/groundwatermagmt.asp

Department of Natural Resources. (2018). Limestone and Dolomite in Nova Scotia. Retrieved from https://novascotia.ca/natr/meb/data/pubs/ic/ic13.pdf

Department of Natural Resources. (2018). Map Gallery. Retrieved from https://novascotia.ca/natr/meb/geoscience-online/maps-gallery.asp

Department of Natural Resources. (2018). Minas Basin Proposed Wildlife Management Areas. Retrieved from https://novascotia.ca/natr/wildlife/habitats/sanctuaries/pdfs/basin.pdf

Dr. Feltmate and Dr. Thistlethwaite. (2010). *Climate Change Adaptation: A Priorities Plan for Canada.* University of Waterloo.

Dr. Proosdji. (2009). *Assessment of Flooding Hazard along the Highway 101 corridor near Windsor, NS using LIDAR.* Saint Mary's University.

Encyclopedia Britannica. (2018). Groundwater. Retrieved from https://www.britannica.com/science/groundwater

Office of the Legislative Counsel, Nova Scotia House of Assembly. (1990). Mineral Resources Act. Retrieved from https://nslegislature.ca/sites/default/files/legc/statutes/mineralr.htm

Province of Nova Scotia. (1969). Groundwater Resources and Hydrogeology of the Windsor-Hantsport-Walton Area, Nova Scotia. Retrieved from https://novascotia.ca/nse/groundwater/docs/GroundwaterResourcesReport_Windsor-Hansport-WaltonArea.pdf

Province of Nova Scotia. (2009). Wildlife Habitat and Watercourse Protection under the Forest Act. Retrieved from https://novascotia.ca/just/regulations/regs/fowhwp.htm

Province of Nova Scotia. (2017). *Statements of Provincial Interest made under Section 193 and subsections 194(2) and (5) of the Municipal Government Act.* Province of Nova Scotia.

Stucke, E. (2016). Planning for Climate Change in Coastal Nova Scotia. Dalhousie University, *Thesis.*

Webster, T. L., Forbes, D. L., Dickie, S. and Shreenan, R. (2004). Using topographic lidar to map flood risk from storm-surge events for Charlottetown, Prince Edward Island, Canada.