CHAPTER 4 ENVIRONMENTAL BASELINE

4.1 Geophysical Environment

4.1.1 Climatology and Meteorology

At the regional scale, Atlantic Canada lies within a zone of prevailing westerly winds that carry air from the interior of the North American continent. This zone experiences the passage of high and low pressure systems which are in turn influenced by ocean currents and continental topography. The low pressure systems moving through this area typically track across the continent, or up the seaboard, resulting in the onset of wind from an easterly direction, thickening cloud and a gradual drop in pressure. The frequent movement of such systems through Atlantic Canada brings significant precipitation. Winters are usually cold with frequent snowfall and freezing precipitation. Spring is typically late (sometime in May), cool and cloudy. Summers are short in duration, warm and are characterized by less precipitation than in other seasons.

In recent years, extreme weather events have been occurring more frequently. The Province has been subjected to both drought and intense storms, including the landfall of Hurricane Juan in September 2003. Tropic weather events are expected to be both more intense and frequent as the effects of climate change influence ocean warming and coastal currents. Climate models predict an increase in extreme local events throughout this century.

This section provides a general description of the region's climate, i.e., climate norms, over a 30-year period and the meteorological conditions at the Pugwash wind farm site. The site is situated within the Northumberland Shore climate region. The Northumberland Shore Climate Region is characterized by a delayed spring, a warm summer and fall, but a cold winter and the lowest precipitation in the province, being sheltered from storm events from the south and east.

Climate norms, i.e., 30-year averages, for the 1971 to 2000 period are from the weather station located in Pugwash for temperature and precipitation and the weather station located in Truro for wind; these are tabulated in the sections that follow. Extreme weather data are also provided for the period of record.

4.1.1.1 PRECIPITATION

Precipitation data recorded is summarized in Table 4.1. The total annual precipitation (1052.2 mm) is defined as the total rainfall plus water equivalent of snowfall and other forms of frozen precipitation. Rainfall is generally higher in the fall with snow and freezing precipitation frequent between October and March. Monthly precipitation ranges from 70.3 mm in February to 101.6 mm in December.

Table 4.1: Precipitation Normals and Extremes

Month	*Mean Rainfall (mm)*	*Mean Snowfall (cm)*	*Total Precipitation (mm)*	*Extreme Daily Rainfall (mm)*	*Extreme Daily Snowfall (cm)*	*Extreme Daily Precipitation (mm)*
JAN	52.4	46.2	98.6	44.7	34	44.7
FEB	28.5	41.8	70.3	28.4	**70**	70
MAR	42.4	38.6	81	39.9	35	39.9
APR	65.7	14.4	80	52	30	56
MAY	84.8	1.2	86.1	84.8	10	84.8
JUN	77.5	0	77.5	74.2	0	74.2
JUL	79.5	0	79.5	**101.6**	0	**101.6**
AUG	85.6	0	85.6	58.4	0	58.4
SEP	92.7	0	92.7	60.8	0	60.8
OCT	98.7	0	98.7	79.5	2.8	79.5
NOV	93.5	7.7	101.2	63.8	13	63.8
DEC	62.4	38.8	101.2	53	29	53
YEAR	863.6	188.7	1052	-	-	-

Source: Environment Canada Climate Normals: 1971-2000.

4.1.1.2 TEMPERATURE

The Atlantic Provinces tend to experience a large annual temperature variation. Daily mean temperatures range from -6.7°C in January to 19.7°C in July. The annual daily mean is 6.6°C. Daily maximums, minimums and extreme temperatures at the Pugwash weather station are reported in Table 4.2.

Table 4.2: Temperature Norms and Extremes

Month	*Daily Maximum (°C)*	*Daily Minimum (°C)*	*Daily Mean (°C)*	*Extreme Maximum (°C)*	*Extreme Minimum (°C)*
JAN	-1.8	-11.6	-6.7	18	-33
FEB	-1.6	-11.1	-6.3	17	**-37**
MAR	2.6	-6	-1.7	19	-27.5
APR	8.1	0	4.1	25.5	-13
MAY	15.6	5.8	10.7	32.2	-5.6
JUN	20.9	11	16	33	-1

Month	*Daily Maximum (°C)*	*Daily Minimum (°C)*	*Daily Mean (°C)*	*Extreme Maximum (°C)*	*Extreme Minimum (°C)*
JUL	24.7	14.8	19.7	**36**	2.8
AUG	23.9	14.4	19.2	33.9	3
SEP	19.2	10.3	14.7	32.5	-5
OCT	13.1	4.8	8.9	25.5	-6
NOV	7	-0.1	3.5	23	-20
DEC	1	-7.5	-3.3	16.5	-29
YEAR	11.1	2.1	6.6	18	-33

Source: Environment Canada Climate Normals: 1971-2000.

4.1.1.3 WIND

Table 4.3 provides a summary of wind data at the Truro[7] weather station. The average annual wind speed is 13.78 km/hr for all directions. Maximum hourly speeds of 93 km/hr were measured in January. Extreme gusts of 134 km/hr were recorded in February. Table 4.4 presents a frequency distribution of wind directions for the 1960 to 2000 period of record.

Table 4.3: 30-Year Normals Wind Data: Truro Weather Station

Wind	*Average Per Month*												
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Year*
Speed (km/h)	13.7	14	14.8								13.1	13.3	14.8
Prevailing Direction	W	W	W								W	W	--
Extreme hourly Speed (km/h)	93	71	64	61	61	48	48	58	51	64	68	69	93
Extreme Gust Speed (km/h)	115	134	94	84	89	81	122	76	81	107	108	108	134
Direction	SE	SW	SE	E	SE	S	E	SW	SW	SE	W	W	S

Source: Environment Canada Climate Normals: 1960-1986.

[7] This is the nearest station to the site to have recorded wind data, but given its distance from the wind farm site and the fact that it is located on the other side of the Cobequid Hills, there is some question as to the relevance of the data.

Table 4.4: Summary of Wind Direction Frequency: Truro Weather Station

Wind Direction	*Percent Frequency*
N	0
NE	0
E	16.6
SE	33.3
S	8.3
SW	25
W	16.6
NW	0

Source: Environment Canada Climate Normals: 1971-2000.

4.1.1.4 Visibility and Fog

Since fog has been identified as a factor that may increase the likelihood of bird collisions with WTGs, visibility and fog statistics have been reviewed for the Northumberland Strait. The closest weather station to Pugwash with visibility statistics was located in Charlottetown, Prince Edward Island. The month with the greatest number of hours with less than 1 km of visibility is March with 35 hours. The average number of hours per year with visibility less the 1 km is 100 hours. The average number of days per year with fog for this region is 60. Table 4.5 presents a visibility statistics for the 1960 to 2000 period of record.

Table 4-5: Summary of Visibility Statistics: Charlottetown Weather Station

Hours of Visibility	*Visibility*											
	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Hours with visibility less than 1 km	34	30	35	31	19	11	8	5	4	6	12	29
Hours with visibility 1 to 9 km	148	132	136	129	101	91	96	102	76	74	111	169

Source: Environment Canada Climate Normals: 1971-2000.

4.1.1.5 Air Quality

Because of the location of the Project site and the fact that the Project will not emit emissions to the atmosphere, no laboratory testing to determine air quality was undertaken. It is expected that the area's air quality is comparable to that across much of northern Nova Scotia.

4.1.2 Topography and Hydrology

As was indicated on Figure 1.1, the project site is located on approximately 450-500 hectares on land some 2 km from the Village of Pugwash in Cumberland County. The area is located on the east side of the Pugwash Basin and spans the north and south sides of the Irishtown Road. The area is part of the Nova Scotia Theme Region known as the Northumberland Plain and is part of Northumberland Strait sub-Unit (#521a). This region is characterised by low ridges and valleys along

the coast; elevations rarely exceed 50 m. The ridges jut out to sea as headlands such as at Pugwash. The valleys form harbours and inlets along the coast. Much of the region lies north of the primary watershed boundary that dissects the Cobequid Hills region. Secondary and tertiary watersheds drain north through alternating weak and resistance strata so that the stream courses have adjusted to drain through the weaker rock to form trellised drainage patterns.

There are very few lakes in the region and pH levels are generally alkaline. The coastline is characterised by barachois ponds and tidal marshes. The soils in the Pugwash area are generally well drained sandy loam to sandy clay loam. As depicted on Figure 4.1, the proposed wind farm straddles two watersheds. One, which captures the headwaters of the Matheson Brook drains northwards into the Northumberland Strait. The second, which captures the waters of the Tidemill Brook and its tributaries drains westward into the Pugwash Basin and into the Northumberland Strait. No part of the area that will be used for, or impacted by, the development and operation of the wind farm drains to the south or east towards Wallace Bay and the Wallace Bay National Wildlife Area (NWA); the latter will not be impacted by runoff from the project area.

4.1.3 Geology and Soils

The proposed Pugwash wind farm is located within the Northumberland Strait sub-Unit of the Northumberland Plains Theme Region of Nova Scotia. The subunit is underlain by fine red sandstones of the late carboniferous Pictou Group. Theses sandstones have been thrown into broad folds and form two anticlines. The crests of these anticlines have been partially eroded away, exposing underlying Windsor evaporates or Canso Group strata. Gypsum outcrops in many places and there are important salt deposits in this area.

Because of the tightly compact and slow permeability of the tills, soils are characterized as being imperfectly drained with most surface waters having to be removed laterally or through evapotranspiration. Imperfectly drained, reddish brown sandy loams, loams, and clay loams occupy extensive areas of the rolling landscape. Better drained soils are found on the upper slopes on permeable sandy loam tills (Neily, et al., 2003). Ridged topography, usually with a thick veneer of till, is prominent throughout the ecodistrict.

4.2 Ecological Context

4.2.1 Nova Scotia Land Classification System

The *Nova Scotia Ecological Land Classification System* (Neily, et al., 2003) is a planning tool developed by NSDNR to help describe the environment in terms of the physical and biological processes affecting the structure, function and biodiversity of the land. The intent of the tool is to identify the major ecological characteristics of an area and the interconnectivity between the various components within, e.g., landforms, soils, water, and vegetation. From a hierarchical perspective, under the *Nova Scotia Ecological Land Classification System* (ELC), Pugwash lies within the Northumberland Bras D'Or Lowlands Ecoregion (at a scale of 1:500,000), and at closer examination the Northumberland Lowlands Ecodistrict (1:250,000).

NORTHUMBERLAND STRAIT

Pugwash Pt

Matheson Cove

Upper Gulf Shore

Gulf Shore Road

Matheson Brook

Pugwash Harbour

Pineo Pt

Irishtown Road

PUGWASH

Tidemill Brook

Pugwash Basin

Miller Road

Victoria Island

North Wallace Bay

South Pugwash

Wallace Bay

Scott Brook

Crowley Rd

South Wallace Bay

Head of Wallace Bay

Wallace Bridge

Wallace Bridge Station

Legend

- Proposed Turbine Locations

Road/Cable Connections

- Cable
- Road

Roads

- Paved Road
- Unpaved Road
- Lanes / Driveways
- ROAD ruin/inactive/abandoned
- Cart Track / Footpath
- Power Line
- Rivers and streams
- Lakes and Waterbodies
- Gulf Shore Provincial Park
- Wallace Bay National Wildlife Area
- Nature Conservancy of Canada Land

Watershed Boundaries

Figure 4.1
Watersheds

Drawn By: MSD	Date: 26/01/2012
Project # 111257.00	Scale @ 11" x 17"

CBCL LIMITED
Consulting Engineers

0 0.5 1 2 Km

N

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Units: Meter

At a scale of 1:50,000, the proposed wind farm site is comprised of three of the largest ecosections found within the Northumberland Lowlands (Neily, et al., 2003). These three ecosections, which are described in terms of their soil drainage, soil texture and topographic pattern (see Table 4.6 below for codes), account for over 60 percent of the ecodistrict land mass, suggesting that they are common to the area. They are:

- IFHO Imperfectly drained, fine textured soils on hummocky terrain- found in the southern portion of the study area, i.e., in the vicinity of the substation;
- WMHO Well drained, medium textured soils on hummocky terrain – seen along both Miller Road and Gulf Shore Road; and
- IMHO Imperfectly drained, medium textured soils on hummocky terrain – seen along the Irishtown Road.

Table 4.6: Ecosection Codes for Soil Drainage, Soil Texture and Topographic Landform

Soil Drainage	
P	Poorly drained
I	Imperfectly drained
W	Well drained
X	Not applicable
Soil Texture	
C	Course textured - sands and loamy sands
M	Medium textured - sandy loams, loams, and silt loams
F	Fine textured - sandy clay loams, clay loams, and clay
X	Not applicable
Topographic Pattern/Landform	
SM	Smooth is land showing no particular pattern with a smooth topography.
HO	Hummocky is a series of small rounded hills having their height less than 1.5 times their base with a relief amplitude up to 15 m
KK	Hills include knobs (small rounded hills having their height greater than 1.5 times their base with a relief amplitude up to 45 m) and knolls (hills having their height less than 1.5 times their base with a relief amplitude from 15 to 60 m.)
DM	Drumlins and flutes are caused by glacial ice movement and are recognized in patterns of elongated smooth streamlined hills (drumlins) and shallow straight parallel troughs (flutes).
DS	Dissections are narrow canyons flowing from hilly or mountainous topography or steep slope
RD	Ridged is a pattern of linear or curvilinear ridges associated with the underlying geomorphology (bedrock).
WA	water
MS	Salty marsh
UR	urban
CB	Coastal beach

http://www.gov.ns.ca/natr/forestry/gis/pdf/elc.pdf

4.2.2 Vegetation and Habitat

Black and red spruce forests dominate the landscape. Early successional species such as balsam fir, red maple, white birch and aspen typically following disturbances including forest harvesting and fire. Indeed fire and windthrow are natural disturbances common to the area –fire as a result of warm summers and moisture loss and windthrow as a result of shallow-rooted trees due to imperfectly drained soils. Stands of tolerant hardwoods are confined to the better drained, upper slopes and hilltops, although these are rare within this ecodistrict. Also reported in this ecodistrict are occurrences of tamarack growing on abandoned farmland, white spruce following alder and eastern white cedar growing on imperfectly drained soils where competition favours its establishment.

4.2.3 Terrestrial Habitats and Site Vegetation

At the site level, habitat is as much a reflection of social intervention (both current and past land use activities) as it is a reflection of the ecological character (herein described at the ecosection level of analysis -biological and physical character). An organism's habitat is the place where the organism lives and grows. Habitat is typically, in part, defined by the current vegetative cover, which in turn is a reflection of land use and ecology. Being able to describe a site's habitats allows for better interpretation of the site's vegetative communities, wildlife and land use. The general terrestrial habitats (Figure 4.2) found in the study area today include:

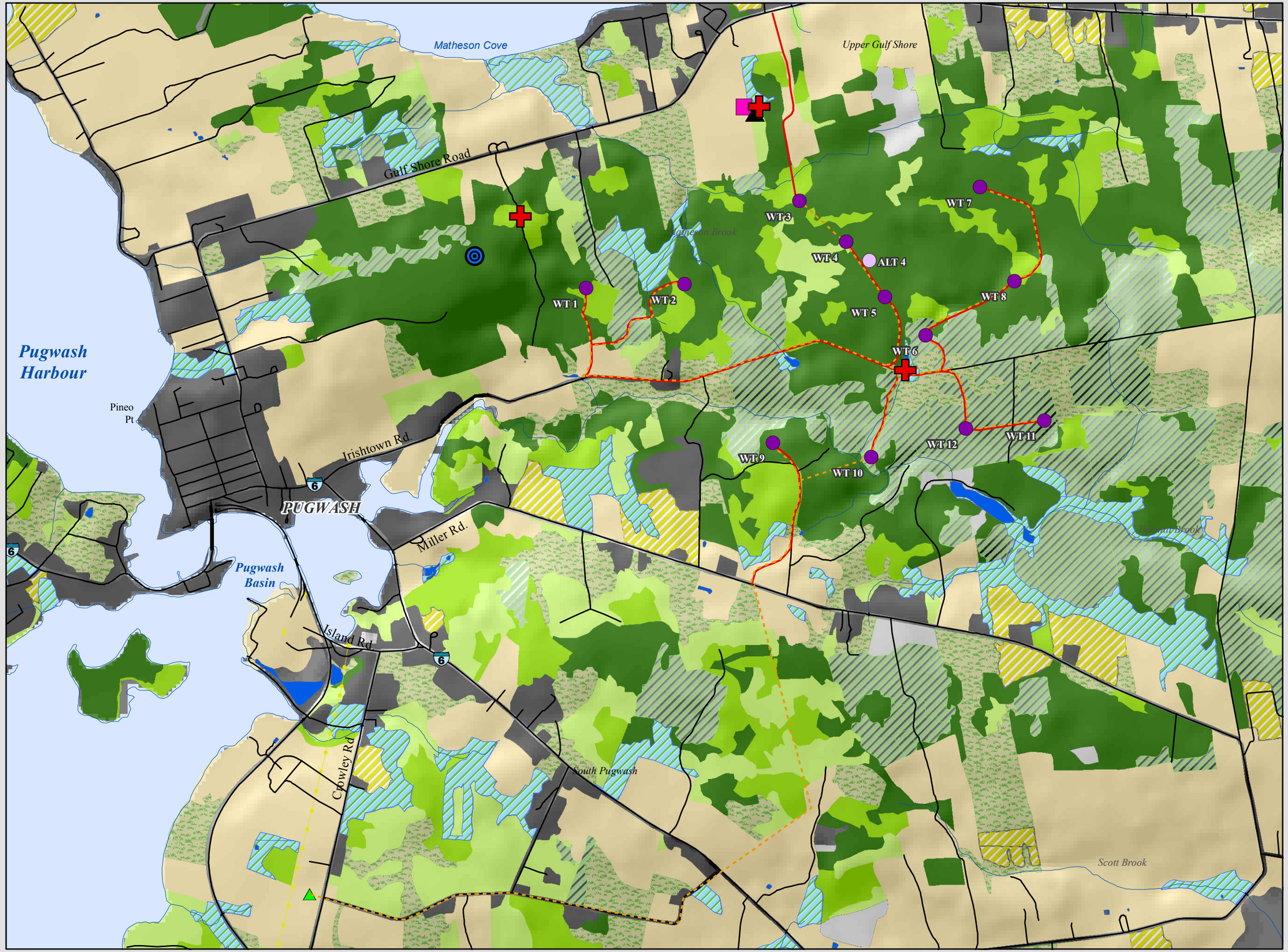
- Softwood Forest;
- Harwood Forest;
- Mixedwood Forest;
- Clearcut;
- Agriculture;
- Old Field;
- Brush/ Scrub;
- Wetland;
- Urban; and
- Watercourses.

These are described in the sections that follow.

4.2.3.1 Softwood Forest

The coniferous forest found on site is largely comprised of stands of white, black and sometimes red spruce. Defined as having greater than 75% softwood (NSDNR), coniferous stands can be found growing in three main areas: on old abandoned farm fields (typically large-sized mature white and red spruce), treed swamps (black spruce) and planted in plantations (red spruce). To a large degree, because of the low flat nature of the site, much of the coniferous forest is either wet forest, or wetland. Turbines WT2, WT3, WT-Alt4 and WT7 are all situated in softwood forest stands. Turbine WT4 is also situated in a treed swamp.

Plantation plantings of spruce can be found on site. Plantations, like clearcut, vary in age and appearance with some of the younger plantations appearing as clearcuts. Plantations, unlike clearcuts, are managed in that young hardwoods are clipped out to allow less competition with the planted softwood. Turbine WT9 is situated in a plantation, while WT1 and WT10 are adjacent to plantations.



Legend

Species at Risk

- Black Ash
- Halberd-Leaf Tearthumb
- Hop Sedge
- Purple-Stem Swamp Beggar-Ticks
- 2012 Alternative Turbine
- 2012 Proposed Turbine Locations

Road/Cable Connections

- Cable
- Road
- Proposed Substation

Roads

- Roads
- Power Line
- Rivers and streams
- Lakes and Waterbodies

Habitat Types

- Softwood
- Mixedwood
- Hardwood
- Clearcut
- Agriculture
- Old Field
- Brush/Scrub
- Wetlands
- Urban
- Natural Stands

Figure 4.2
Terrestrial Habitats

Drawn By: MSD	Date: 26/01/2012
Approved:	Scale @ 11" x 17"

CBCL LIMITED
Consulting Engineers

0 175 350 700 m

N

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Units: Meter

4.2.3.2 Hardwood Forest

The hardwood forest identified by NSDNR represents forest stands where the softwood is less than 25 percent. Hardwood forest found on site is not very prominent and represents perhaps the most well-drained lands, and or areas, where clear-cutting took place historically, perhaps as a result of forest harvesting, fir, or old agricultural lands. Whether as a result of harvesting or fire, the hardwood stands observed on site are typically comprised of red maple, yellow birch, aspen and in some areas beech. There are no turbines situated in the hardwood forest stands.

4.2.3.3 Mixedwood Forest

Having between 74% and 26% softwood (NSDNR), mixed forest in this area is typically comprised of spruce, balsam fir, red maple, birch and aspen. A mature stand of hemlock-yellow birch-red maple-red spruce was found to the west of the proposed access to turbines WT5 and WT-Alt4. Turbines WT1 and WT8 are located in mixedwood forest stands.

4.2.3.4 Clearcut

The clearcut areas illustrated on Figure 4.2 are indicative of forest harvesting both recently and in the past. Within the area of the turbines, the clearcut habitat is perhaps the second largest land cover, next to the softwood forest. Clearcuts vary in age, from as recent as one year or less, to 20 years or more. Older clearcuts usually evolve into mixedwood, or even hardwood forests. Turbines WT10, WT11 and WT12 are situated in clearcut areas that were cut between eight to 15 years ago. The habitat where Turbine WT12 is proposed is also classified as a shrub swamp. Turbine WT6 is located in an older clearcut, while Turbine WT5 is situated in a clearcut that is about one to two years old.

4.2.3.5 Agriculture

Most of the active agricultural lands can be found adjacent the local roads, including the Gulf Shore Road, Irishtown Road, Miller Road, Crowley Road and Highway No. 6. These are mostly used for pasture for livestock; only a small percentage of the proposed project, principally the access roads, impact any portion of these agricultural lands.

4.2.3.6 Old Field

Figure 4.2 shows most of the old field habitat, as identified by NSDNR (2008), located along Miller Road. Field investigations around turbines WT1 and WT2, however, would suggest that the existing pastures may at one time have extended further into the forest than is depicted on the map. Old Field habitat would include those fields abandoned and allowed to revert back to forest. At WT1 and WT2 the old fields are now captured under the heading of coniferous forest, but on the ground stands of white spruce can be seen growing on uniformly flat landscapes.

4.2.3.7 Brush/ Scrub and alder groves

The brush/ scrub habitat includes shrub and thicket areas that are neither clearcuts, alder groves nor wetland. NSDNR (2008) describe them as being those areas containing less than 25% merchantable tree cover and which contain non-merchantable woody plants consisting of at least 25% cover. Within the study area, these areas would appear as being a mix of alder, willow, serviceberry, cherry, wild raisin and occasionally balsam fir and could be the result of natural fire.

NSDNR (2008) distinguish between alder groves that have more than 75% cover and alder groves that have less than 75% cover. Alders tend to grow on disturbed, dry sites, and sites with poor nutrients, perhaps as a result of topsoil loss, and in low-ling areas where imperfectly drained soils may form. The alder habitat is important because, in this area, ground investigations have determined that it is often indicative of wetland habitat. While no turbines are proposed to be placed in the alder groves, several access roads, and necessary upgrades to the Irishtown Road, will require encroachment into the alder groves.

4.2.3.8 Wetlands

NSDNR (2008) has identified a number of wetlands within the study area; the proposed configuration of the WTGs and access roads has avoided these wetlands. Upon closer examination at ground level, however, there is a greater amount of wetland habitat within the study area than was initially believed. The wetland habitat observed to date has all been either treed swamp, or shrub swamp. Although every attempt has been made to avoid wetlands, Turbines WT4 and WT12 will likely be constructed in wetlands. The location of Turbine WT4 is within a black spruce treed swamp, while WT12 would be located in a disturbed shrub swamp in a clearcut. The shrub swamps are largely alder-dominated swamp thicket with about 25% tree cover. These 'wet' sites would likely be more tree-dominated were it not for a history of tree harvesting and/or cattle grazing in the area. These wetlands, i.e., those associated with WT4 and WT12 will be formally delineated as an integral part of preparing the necessary

wetland alteration applications for NSE; this will be done after release from the environmental assessment process.

4.2.3.9 URBAN

Urban areas as depicted on Figure 4.2 are non-forested areas primarily classified as residential, or industrial and related structures such as streets, sidewalks, parking lots, etc .(NSDNR, 2008). Also included within this classification would be house lots in wooded areas outside of towns and villages which are not adjacent to agricultural land and those lots surrounded by forest. In cases of ribbon development along some roads, a strip may be delineated along the road and classed as urban. Any obvious urban area within an agricultural landscape would be delineated and coded accordingly. Categories that will be classified as urban include golf courses, picnic parks, campgrounds, cemeteries, light houses, ball parks, community land fill, the Pugwash sports track, etc.

4.2.3.10 WATERCOURSE

As indicated on Figure 4.1 and referenced in section 4.1.2, there are two drainage systems within the study area. The Tidemill system, which lies largely to the south of Irishtown Road, drains to the west into Pugwash Basin. The Matheson Brook system, located to the north of Irishtown Road, drains north into the Northumberland Strait via Matheson Cove. Each system has numerous tributaries that help drain the land in and around the proposed turbines and access roads. In 2011, five watercourses (observed leading to and from culverts along Irishtown Road) were accessed for their potential to support fish habitat. All assessments reported that the potential for fish habitat was either not present, or of poor quality in terms of spawning, rearing and or overwintering potential. Watercourses in this area measured roughly between 50 cm to 100 cm in channel width with water depths ranging from 5 cm up to 20 cm.

4.2.4 Aquatic Environment

As indicated in section 3.2.2.1, a site visit was conducted by a qualified aquatic biologist on October 12, 2011 to assess known watercourses within the study area for their potential as fish habitat. Table 4.7 presents the findings of the site investigation; Figure 3.2 identifies where these assessments occurred.

Table 4.7: Summary of Fish Habitat Quality and Potential for Fish Presence

*Watercourse**	*Easting*	*Northing*	*Spawning Habitat (Salmonids)*	*Rearing Habitat*	*Overwintering Habitat*	*Potential for Fish Presence Open Water*	*Potential for Fish Presence Frozen*
Tributaries to Tidemill Brook System (drains west to Pugwash Basin)							
Culvert 1	450649.947	5078222.202	Poor	Poor	Poor	Low	Low
Culvert 4	452270.948	5078024.129	Poor	Poor	Poor	Low	Low
Tributaries to Matheson Brook System (drains north to Northumberland Strait via Matheson Cove)							
Culvert 2	451008.611	5078568.955	None - Ephemeral	None - Ephemeral	None - Ephemeral	None - Ephemeral	None - Ephemeral
Culvert 3	451700.919	5078403.409	None - Ephemeral	None - Ephemeral	None - Ephemeral	None - Ephemeral	None - Ephemeral
Unmapped watercourse	451900.502	5079049.448	Moderate	Moderate	Moderate	Moderate - Good	Moderate

*See Figure 3.2 for locations

With the exception of the unmapped watercourse just south of WT3, all watercourses and tributaries had either poor or no potential for fish habitat. This is because the tributaries surveyed are considered ephemeral, have poor substrate and/or are too shallow to sustain fish.

The unmapped watercourse, where sampled, had a wetted channel width of between 1 and 2 m; it was characterized in this location by rifles, runs and pools with some pools being greater than 600 mm in depth which would suggest good overwintering potential for fish. This unmapped watercourse had undercut banks and was characterized by fines, gravels and cobbles; considerable amounts of large and small woody debris was strewn on its banks.

4.3 Species of Concern

Section 2(1) of the *CEAA* has amended the definition of "environmental effect" to clarify that under *SARA*, an environmental assessment must always consider project impacts on listed wildlife species, their critical habitat or the residences of individuals of that species. Environmental effect is defined as any effect on species of concern and their habitat resulting from project activities. There are no identified areas of provincially identified sensitive habitat within the immediate survey area. The Wallace Bay NWA, however, is located approximately 3 to 5 km to the east; this area was established and is protected under the *Canada Wildlife Act*. To be considered for such designation, a site must contain "nationally significant" habitat for migratory birds, support wildlife or ecosystems at risk, or represent rare or unusual wildlife habitat. The Wallace Bay NWA provides important migration and breeding habitat for waterfowl. In 1973, Ducks Unlimited constructed 3.8 km of dykes and five water control structures to establish 144 ha of impounded wetlands in this area.

As detailed in section 3.2.1, a short list of species of conservation concern was derived from ACCDC listings acquired in 2006 and 2011 (see Appendix A); this list includes 36 vascular plant species, 29

birds, one fish species, 17 invertebrate species and two amphibian and reptile species. The shortlist represents those species identified within 25 km of the study area, are sub-nationally ranked S3 or rarer, and are ranked by NSDNR as RED, YELLOW or GREEN.

4.3.1 Birds

As detailed in sections 3.2.1 and 3.2.2.2, avifauna has been assessed at both the desktop level and by in-field surveys. The desktop level analysis comprised of a 100 km radius ACCDC data request, from which a 25 km radius short-list of 29 species of conservation concern relevant to the study area was compiled (See Appendix A). Of the 29 species identified in the short-list, only three were actually observed during field surveys conducted on site; these were: the Northern Goshawk (Accipiter gentilis), Greater Yellowlegs (*Tringa melanoleuca*) and the Solitary Sandpiper (*Tringa solitaria*). In addition to these three species, an additional three species of conservation concern were identified during the field surveys, but did not appear in the ACCDC data. These were the Gray Jay *(Perisoreus Canadensis), the* Boreal Chickadee *(Poecile hudsonicus)* and the Common Nighthawk *(Chordeiles minor).* The remainder of this section presents the results of the field surveys and discusses the identified avian species of conservation concern.

4.3.1.1 Results of the Breeding Bird Surveys

Based on the field program detailed in Section 3.2.2.2, 55 species of 'breeding' birds were identified. Of these 55 species, 10 were classified as possible breeders, 15 as probable breeders and 30 as confirmed breeders. None of these species are considered to be rare, or of "Special Concern" in Nova Scotia. Because of the nature of the habitat in the study area (mostly second-growth mixed forest and clearcuts), it was not anticipated that any species with special habitat requirements, such as raised bogs, mature hardwoods, blueberry barrens, etc., would be found; this turned out to be the case (Dalzell, personnel communication, January 2007). Table 4.8 summarizes the results of the breeding bird survey.

Table 4.8: Results of the Breeding Bird Survey

Possible Breeders	*Probable Breeders*	*Confirmed Breeders*
Green-winged Teal	Broad-winged Hawk	American Kestrel
Ruffed Grouse	Common Nighthawk	Mourning Dove
Northern Harrier	Downy Woodpecker	Yellow-bellied Sapsucker
Sharp-shinned Hawk	Hairy Woodpecker	Northern Flicker
Red-tailed Hawk	Blue-headed Vireo	Eastern Wood-Pewee
Pileated Woodpecker	Blue Jay	Alder Flycatcher
Gray Jay	Brown Creeper	Red-eyed Vireo
Boreal Chickadee	Swainson's Thrush	American Crow
Black-throated Blue Warbler	Tennessee Warbler	Common Raven
Swamp Sparrow	Northern Parula Warbler	Black-capped Chickadee
	Yellow-rumped Warbler	Red-breasted Nuthatch
	Bay-breasted Warbler	Golden-crowned Kinglet
	Lincoln's Sparrow	Ruby-crowned Kinglet
	Purple Finch	Veery
	American Goldfinch	Hermit Thrush
		American Robin
		European Starling

Possible Breeders	*Probable Breeders*	*Confirmed Breeders*
		Cedar Waxwing Chestnut-sided Warbler Magnlia Warbler Black-throated Green Warbler Blackburnian Warbler Palm Warbler Black-and-White Warbler American Redstart Ovenbird Comon Yellowthroat Song Sparrow White-throated Sparrow Dark-eyed Junco

4.3.1.2 Results of the Fall Migration (Stopover) Counts

According to the field program outlined in Section 3.2.2.2, the fall migration counts were conducted along a transect, and surveys rarely exceeded a count of 25 birds per day. As some migrants were located in the same area on subsequent counts, it was possible to estimate the 'maximum stopover time' for particular species, e.g., Blue-headed Vireo. By using these as 'yardstick' species, it was possible to estimate the 'maximum stopover time' to be approximately 10 days, but not all species stayed the maximum number of days. It should also be noted that without conducting a survey every day, it was impossible to say with certainty how long a migrant, or migrants, had actually been in the area. Migration stopover use in the fall of 2006 was found to be low (< 25 birds/day) and the entire area was estimated to contain fewer than 300 birds during the height of the migration period. Overall, the study area is predicted to be of low migration stopover importance for migrating birds. It is likely that birds overfly this land area to reach the Wallace Bay NWA.

4.3.1.3 Shorebirds, Waterfowl and Raptors

Dalzell made a special effort to determine if the study area was a major movement corridor for waterfowl, shorebirds, raptors, etc., that could be moving between Wallace Bay, Pugwash Harbour and the Northumberland Strait. A total of nine raptor species, three waterfowl species, three shorebird species and two gull species were tallied during these counts.

The nine species of raptors identified (with totals in parentheses) were: Osprey (1), Bald Eagle (1), Northern Harrier (3), Sharp-shinned Hawk (6), Northern Goshawk (2), Broad-winged Hawk (3), Red-tailed Hawk (2), American Kestrel (7) and Merlin (4). Based on the number of hours spent surveying (~30h), these counts represent very low totals; it was also deemed likely that some birds were counted on more than one occasion on subsequent days in the same area. This suggests that the area does not serve as a significant fall raptor migration corridor.

The three species of waterfowl observed (with totals in parentheses) were: Canada Goose (100+), American Black Duck (5) and Common Merganser (12). Only the movement of Canada Geese appears to be significant, but considering that thousands of geese stage approximately 6-10 km to the east at the Wallace Bay NWA every fall, more Canada Geese were expected. It is anticipated

that a small number of geese will over-fly the constructed WTGs, but will quickly become habituated to their presence and avoid them.

The three species of shorebirds observed (with totals in parentheses) are: Greater Yellowlegs (2), Lesser Yellowlegs (4) and Solitary Sandpiper (5). Again, these species were observed in very low numbers, indicating that the area is not heavily traversed by shorebirds flying between the nearby bodies of water.

The only two (2) gull species tallied (with totals in parentheses) were: Ring-billed Gull (100+) and Herring Gull (25+). These birds were typically seen moving between Pugwash Harbour and the Northumberland Strait, but always travelling well above 100m from the ground.

4.3.1.4 Bird Species of Conservation Concern

Six avian species of conservation concern were detected during the field program detailed in Section 3.2.2.2. These species were the: Northern Goshawk, Gray Jay, Boreal Chickadee, Common Nighthawk, Greater Yellowlegs and Solitary Sandpiper; these species are discussed further below.

Northern Goshawk *(Accipiter gentilis)*
The Northern Goshawk is 'Yellow' listed under the NSDNR General Status List. This is not a soaring hawk, but rather a low-flying, acrobatic bird of the forest where it preys on animals as small as red-tailed squirrel and as large as spruce grouse. It shows a habitat preference for heavily wooded areas, often mature, mixed-wood forests. It typically nests low to the ground, <10 m high, showing a propensity for deciduous tree species, with the use of conifer material as nest lining. Habitat for the Northern Goshawk does exist on site and to a greater extent in the surrounding area.

Gray Jay *(Perisoreus canadensis)*
The Gray Jay is 'Yellow' listed under the NSDNR General Status List. Its preferred habitat is conifer-dominated forest as it requires mature conifer trees for the storage of food caches to successfully overwinter. Gray Jays typically nest approximately 1-4 m from the ground in spruce or fir trees, selecting a nest lining of fur, feathers and decaying wood material for insulation. There is suitable habitat for the Gray Jay on site and in the surrounding area.

Boreal Chickadee *(Poecile hudsonicus)*
The Boreal Chickadee is 'Yellow' listed under the NSDNR General Status List. Its preferred habitat is conifer-dominated forest where it exclusively uses spruce trees for its caches of insect larvae critical to its overwintering survival. This bird typically breeds in damp, well-shaded, coniferous forest where it nests in natural cavities that it lines with dry mosses and available animal fur. There is suitable habitat for the Boreal Chickadee on site and in the surrounding area.

Common Nighthawk *(Chordeiles minor)*
The Common Nighthawk is 'Yellow' listed under the NSDNR General Status List, *Threatened* Schedule 1 federally under *SARA* and listed as *Threatened* provincially pursuant the *Nova Scotia Endangered Species Act*. Its preferred breeding habitat is grassland and open or barren areas within forested land with low vegetation where it lays its eggs directly onto the bare ground. This bird is an

aerial insectivore preying on insects on the wing, usually at dusk or dawn, in open areas. From late August to early October, migrating flocks of nighthawks can number in the hundreds en route to wintering grounds in South America. Habitat suitable for the Common Nighthawk does exist on and near the project site.

Greater Yellowlegs (*Tringa melanoleuca*)
The Greater Yellowlegs is "Green' listed under the NSDNR General Status List, but it was identified in the 25 km ACCDC short-list as S3B, indicating that it is uncommon throughout its range in the province. This species breeds in swamps, bogs and conifer forests with abundant clearings. Its nest consists of a shallow depression in moss or peat, lined with lichens, grasses and spruce twigs. Habitat suitable for Greater Yellowlegs does exist on site, but very few were observed over-flying the area during the field surveys.

Solitary Sandpiper (*Tringa solitaria*)
The Solitary Sandpiper is 'Green' listed under the NS General Status Ranking List, but it was identified in the 25 km ACCDC short-list as S1?B, indicating that it *may* be extremely rare throughout its range in the province. The '?' mark indicates a level of uncertainty regarding its actual status in the province. Unlike most shorebirds, the Solitary Sandpiper prefers the swampy margins of brackish pools, freshwater ponds and woodland streams, and is frequently seen far from the coast. When breeding it typically makes use of abandoned songbird nests, including those of the American Robin, Rusty Blackbird, Eastern Kingbird, Gray Jay, and Cedar Waxwing. Habitat suitable for the Solitary Sandpiper does exist on site, but very few were observed over-flying the area during field surveys.

4.3.2 Plants

Appendix A presents a short list of 36 vascular plant species of conservation concern within 25 km of the study area that have the same habitat type as has been identified in the field, and which have a subnational rank of S3 or rarer and listed by NSDNR as RED, YELLOW, or GREEN.

4.3.2.1 Site Coverage and Plant Communities

In 2006, as detailed in section 3.2.2.3, a vascular plant survey was conducted for the wind farm study area by Sean Blaney (AC CDC) in which he identified 334 different species. Since then the specific locations of the wind turbines have changed, although the general study area has not. In 2011 each of the new turbine locations and their proposed access roads were visited to determine the various habitats found within the study area. Habitats identified in 2011 were cross-referenced with the 2006 plant survey for confirmation of the various plant communities within the study area. Plant communities at the proposed turbine locations are provided in Table 4.9. All of the turbine sites lie within a softwood, mixedwood, clearcut or wetland habitat. The plant communities and habitats observed at these locations and elsewhere in the study area are not considered rare in a provincial context (Blaney, 2006).

4.3.2.2 Rare Plants Observed in the Field

Of the 36 shortlisted vascular plant species of conservation concern presented in Appendix A, Blaney (2006) identified three during his survey: hop sedge (*Carex lupulina*, OBL, S3 and secure); black ash (*Fraxinus nigra*, FACW, S3 and sensitive); and halberd-leaf tearthumb (*Polygonum arifolium*, OBL, S2

Table 4.9: Plant Communities and Dominant Species at Proposed Turbine Sites and Their Wetland Indicator Status(*)

Turbine #	*Tree Species (~order of Abundance)*	*Forest Age (approx.)*	*Dominant Tall Shrub / Sapling Species*	*Herbaceous & Low Shrub Dominants*	*Community Description and Habitat Designation*
WT1	white spruce (*Picea glauca*, FAC); gray birch (*Betula populifolia*, FAC); balsam fir (*Abies balsamea*, FAC); yellow birch (*Betula alleghaniensis*, FAC)	50+	black chokecherry (*Prunus virginiana*, FAC); balsam fir (*Abies balsamea*, FAC); white spruce (*picea glauca*, FAC)	bunchberry (*Cornus canadensis*, FAC); dwarf raspberry (*Rubus pubescens*, FAC); white-top aster (*Doellingeria umbellate*, FAC); red raspberry (*Rubus idaeus*, FAC); rough-leaved goldenrod (*Solidago rugosa,* FAC); Canada goldenrod (*Solidago Canadensis,* FAC); meadow hawkweed (*Hieracium caespitosum,* FACU)	Young stand regenerating from old field. Mixedwood Forest Habitat.
WT2	white spruce (*Picea glauca*, FAC); red spruce (*Picea rubens*, FAC)	20-30	balsam fir (*Abies balsamea*, FAC); red spruce (*Picea rubens*, FAC); yellow birch (*Betula alleghaniensis*, FAC)	Moss-covered – minimal	Dry coniferous forest. Softwood Forest Habitat.
WT3	white spruce (*Picea glauca*, FAC); red maple (*Acer rubrum*, FAC); yellow birch (*Betula alleghaniensis*, FAC)	50	red maple (*Acer rubrum*, FAC); yellow birch (*Betula alleghaniensis*, FAC)	bunchberry (*Cornus canadensis*, FAC); starflower (*Trientalis borealis*, FAC)	Dry coniferous forest. Softwood Forest Habitat.
WT4	black spruce (*Picea mariana*, FACW)	50	red maple (*Acer rubrum*, FAC); wild raisin (*Viburnum nudum var. cassinoides*, FAC); minimal	Minimal understorey	Black spruce treed swamp with little understorey. Wetland Habitat.
WT-Alt4	white spruce (*Picea glauca*, FAC); black spruce (*Picea mariana*, FACW)	50	minimal	Minimal understorey	Spruce forest. Softwood Forest Habitat.
WT5	none	3-5	red maple (*Acer rubrum*,	white-top aster (*Doellingeria*	Clearcut of mature mesic, red

Turbine #	***Tree Species (~order of Abundance)***	***Forest Age (approx.)***	***Dominant Tall Shrub / Sapling Species***	***Herbaceous & Low Shrub Dominants***	***Community Description and Habitat Designation***
			FAC); balsam fir (*Abies balsamea*, FAC); white birch (*Betula papyrifera* FACU)	*umbellate*, FAC); red raspberry (*Rubus idaeus*, FAC); rough-leaved goldenrod (*Solidago rugosa,* FAC); Canada goldenrod (*Solidago Canadensis,* FAC); meadow hawkweed (*Hieracium caespitosum,* FACU); bracken fern (*Pteridium aquilinum*, FAC)	spruce, hemlock; red maple; most recent clearcut site within the project footprint. Clearcut Habitat.
WT6	none	15-20	trembling aspen (*Populus tremuloides*, FAC); gray birch (Betula populifolia, FAC); white birch (*Betula papyrifera*, FACU)	trembling aspen (*Populus tremuloides*, FAC); balsam fir (*Abies balsamea*, FAC); gray birch (*Betula populifolia*, FAC); white spruce (*Picea glauca*, FAC); wild sarsaparilla (*Aralia nudicaulis*, FAC); dwarf raspberry (*Rubus pubescens*, FAC); woodland horsetail (*Equisetum sylvaticum*, FAC); rough-leaved goldenrod (*Solidago rugosa,* FAC)	Young mixed forest regenerating from older clearcut 15-20 years old. Clearcut Habitat.
WT7	black spruce (*Picea mariana,* F ACW)	50	minimal	mosses	Wet coniferous forest. Softwood Forest Habitat.
WT8	black spruce (*Picea mariana,* F ACW); white spruce (*Picea glauca*, FAC); white birch (*Betula papyrifera*, FACU); red maple (*Acer rubrum*, FAC)	50	black spruce (*Picea mariana,* F ACW); white birch (*Betula papyrifera*, FACU); balsam fir (*Abies balsamea*, FAC)	mosses	Dry coniferous forest. Mixedwood Forest Habitat.
WT9	none	30	red spruce (*Picea rubens*,	white-top aster (*Doellingeria*	Young coniferous plantation

Turbine #	*Tree Species (~order of Abundance)*	*Forest Age (approx.)*	*Dominant Tall Shrub / Sapling Species*	*Herbaceous & Low Shrub Dominants*	*Community Description and Habitat Designation*
			FAC); white birch (*Betula papyrifera*, FACU); gray birch (Betula populifolia, FAC); balsam fir (*Abies balsamea*, FAC);	*umbellate*, FAC); red raspberry (*Rubus idaeus*, FAC); rough-leaved goldenrod (*Solidago rugosa,* FAC); Canada goldenrod (*Solidago Canadensis,* FAC); meadow hawkweed (*Hieracium caespitosum,* FACU); bracken fern (*Pteridium aquilinum*, FAC)	in cutover. Softwood Forest Habitat.
WT10	none	12-15	white spruce (*Picea glauca*, FAC); trembling aspen (*Populus tremuloides*, FAC); gray birch (Betula populifolia, FAC); white birch (*Betula papyrifera*, FACU); speckled alder (*Alnus incana*, FACW)	gray birch (*Betula populifolia*, FAC); trembling aspen (*Populus tremuloides*, FAC); balsam fir (*Abies balsamea*, FAC); white spruce (*Picea glauca*, FAC); wild sarsaparilla, (*Aralia nudicaulis*, FAC); dwarf raspberry, (*Rubus pubescens*, FAC); woodland horsetail (*Equisetum sylvaticum*, FAC); rough-leaved goldenrod (*Solidago rugosa*, FAC); white-top aster (*Doellingeria umbellate*, FAC)	Young mixed forest regenerating from older clearcut 8-15years old. Clearcut Habitat.
WT11	none	12-15	trembling aspen (*Populus tremuloides*, FAC); gray birch (Betula populifolia, FAC); white birch (*Betula papyrifera*, FACU); speckled alder (*Alnus incana*, FACW)	gray birch (*Betula populifolia*, FAC); trembling aspen (*Populus tremuloides*, FAC); balsam fir (*Abies balsamea*, FAC); white spruce (*Picea glauca*, FAC);	Young mixed forest regenerating from older clearcut 8-15years old. Clearcut Habitat.

Turbine #	*Tree Species (~order of Abundance)*	*Forest Age (approx.)*	*Dominant Tall Shrub / Sapling Species*	*Herbaceous & Low Shrub Dominants*	*Community Description and Habitat Designation*
				wild sarsaparilla, (*Aralia nudicaulis*, FAC); dwarf raspberry, (*Rubus pubescens*, FAC); woodland horsetail (*Equisetum sylvaticum*, FAC); rough-leaved goldenrod (*Solidago rugosa*, FAC); white-top aster (*Doellingeria umbellate*, FAC)	
WT12	none	15-20	trembling aspen (*Populus tremuloides*, FAC); gray birch (Betula populifolia, FAC); white birch (*Betula papyrifera*, FACU); speckled alder (*Alnus incana*, FACW)	gray birch (*Betula populifolia*, FAC); trembling aspen (*Populus tremuloides*, FAC); balsam fir (*Abies balsamea*, FAC); white spruce (*Picea glauca*, FAC); wild sarsaparilla, (*Aralia nudicaulis*, FAC); dwarf raspberry, (*Rubus pubescens*, FAC); woodland horsetail (*Equisetum sylvaticum*, FAC); rough-leaved goldenrod (*Solidago rugosa*, FAC); white-top aster (*Doellingeria umbellate*, FAC)	Young mixed forest regenerating from older clearcut 12-15 years old. Clearcut Habitat

(*) Refer to Appendix A for interpreting USDA Wetlands Indicator Status

Source: Derived from field work conducted by Blaney in 2006 and CBCL Limited in 2011

and sensitive). In addition, Blaney (2006) found two other species of conservation concern, not included on the 2011 shotlist: purple-stem swamp beggar-ticks (*Bidens connata*, FACW+, S3? and sensitive) and green mountain blackberry (*Rubus vermontanus*, FACW, S? and Undetermined). Descriptions of the each of these species' occurrences and their significance are given below.

***Polygonum arifolium,* OBL - Halberd-Leaf Tearthumb (S2, Sensitive, YELLOW)**

The most significant rare plant record found within the study area was that of halberd-leaf tearthumb (*Polygonum arifolium*). A very large population, with thousands of plants spread over a few hectares, was found in the area to the west of the proposed access road to turbine WT3, off of Gulf Shore Road. Blaney (2006) observed that the plant occurred in a fairly rich alder swamp with scattered red maple, white spruce, white ash, American elm and white birch. Cattle were grazing within most of the area in which the plants occurred. This species is known in Nova Scotia from only five well-documented records, all in Cumberland County. Other reports, not supported by specimens, are also noted from Kings and Colchester Counties in *Roland's Flora of Nova Scotia* (1998). The population found during the 2006 Blaney study is almost certainly the largest known in Nova Scotia, and warrants consideration in siting of the access road. A detailed site survey of the proposed access road alignment for WT3 will be conducted because of the near-by presence of the halberd-leaf tearthumb.

Occurrences: 45.86904°N, 63.62403°W.

***Fraxinus nigra,* FACW - Black Ash (S3, Sensitive, YELLOW)**

Blaney (2006) identified a single, small, black ash tree, about 5 cm diameter at breast height, in the same alder swamp where the halberd-leaved tearthumb was observed. Black Ash is widespread in Nova Scotia, but is quite uncommon and declining, with few seed-producing trees present in most populations. The tree was non-reproductive, but appeared relatively healthy and was approaching a size when seed production would be possible. The AC CDC database contains 27 specimen and AC CDC sight record occurrences, but an effort to compile records from knowledgeable foresters and others might produce substantially more occurrences not documented by specimens. Nonetheless, any potentially seed-producing tree in mainland Nova Scotia is notable, and could be valuable in efforts to cultivate the species for restoration. A detailed site survey of the proposed access road alignment for WT3, as referenced above, will be conducted.

Occurrences: 45.86904°N, 63.62403°W.

***Carex lupulina,* OBL- Hop Sedge (S3, Secure, GREEN)**

Blaney (2006) found one single occurrence of hop sedge (Carex lupulina) near the eastern boundary limits of the Village of Pugwash. Approximately 42 flowering stems in about six clumps were found in a seasonally flooded depression along a very small stream in mixed forest at the edge of a clearcut, over an area of about 8m by 3m. The species is considered secure in Nova Scotia largely due to the number of records from the northern Annapolis Valley, but it is very rare in Cumberland, Colchester and Pictou Counties, and the record is certainly of some interest as a result.

Occurrences: 45.86175W, 63.64326W – six clumps as noted above.

***Bidens connata,* FACW+ - Purple-Stem Swamp Beggar-Ticks (S3?, sensitive, YELLOW)**

Blaney (2006) found *Bidens connata* at four different sites within the study area. Populations were largest in the same alder swamp supporting halberd-leaved tearthumb and black ash near the proposed access road to WT3. It was also fairly common on peaty muck margins of the alder shrub swamp/ pond on the north side of the Irishtown Road, just to the east of the proposed access road to WT5. This species was mapped from only 12 locations in Roland's Flora of Nova Scotia (1998), but since that time, AC CDC fieldwork has found seven more locations in Cumberland, Yarmouth and Digby Counties. The wide distribution and unspecialized habitats of records suggest that the species is probably more uncommon and overlooked than truly rare, and in future its General Status rank may change to Secure.

Occurrences: 1) west of access road to T-3 45.86904°N, 63.62403°W – common in grazed swamp thicket, 2) 45.86367°N, 63.64010°W – a few plants in flooded ditch along farmer's lane, 3) between and around 45.85639°N, 63.61334°W and 45.85738°N, 63.61340° - fairly common in peaty muck around pond, 4) a few plants on moist, sandy margin of unpaved road.

***Rubus vermontanus,* FACW - Green Mountain Blackberry (S?, Undetermined)**

This species was found by Blaney (2006) in small numbers at a few locations around the edges of swamps**.** Precise locations were unrecorded. In the broad sense (including *Rubus tardatus, R. supar* and *R. univocus*) as treated by *Roland's Flora of Nova Scotia* (1998), this species is considered "one of the most characteristic species of boggy thickets and lake margins of Nova Scotia" [M.L. Fernald cited in Roland and Smith (1969)], making it fairly clear that the species is not rare provincially and is thus likely to be ranked Secure when ranks are next reviewed (Blaney, 2006).

4.3.3 Mammals

Nova Scotia provides habitat to 57 species of mammals (Davis and Brown, 1996), and most are relatively widespread in their distribution across the province. The Whitetail deer (*Odolcoileus Virginianus*), the coyote (*Canislatrans*), the American black bear (*Ursus americanus*), the racoon (*Procyon lotor*) and the porcupine (*Erethizon dorsatum*) are amoung the mammals likely to frequent the lands in and around the Project area. Based on the ACCDC screening, there were no listed mammals in proximity to the project site. In the execution of the field work in the fall of 2011, a den of a black bear was identified and evidence of beaver in the area noted. In January 2012, the likely hoof print of a moose was identified in proximity to WT1, but there was no sighting.

4.3.3.1 RESULTS OF RESEARCH AND FIELD WORK; BATS

Based on the field program detailed in Section 3.2.2.4, a total of 507 bat echolocations call sequences over 33 nights at the two locations at the wind farm site were recorded. Four hundred and ninety five (495) of these sequences were attributable to *Myotis* species, 10 were hoary bat sequence calls and two call sequences had characteristics consistent with the eastern pipistrelle bat. Only 19 of the *Myotis* call sequences were recorded at Location 2; the balance, as well as the call sequences of the eastern pipistrelle and the hoary bat, was recorded at Location #1 (Figure 3.2). The average number of sequences per night at this site (both locations) was 30 (SD=22) during the sample period. In 129 nights of monitoring along five forested edges from June – August 1999 in the Greater Fundy National Park Ecosystem, the average number of sequences per night was 27 (SD=44). The level of activity at this site is comparable to the average nightly activity levels found in New Brunswick. This data is summarized on Table 4.10.

Table 4.10: Echolocation Call Sequences by Species

	Myotis **			*E. Pipistrelle*	*L. cinereus*	Total for
Evening of *	Loc. 1	Loc. 2	Total	Loc. 1	Loc. 1	all species
21-Aug-06	8	0	8	0	0	8
22-Aug-06	6	2	8	0	0	8
23-Aug-06	29	13	42	0	0	42
24-Aug-06	3	4	7	0	0	7
25-Aug-06	22	0	22	0	0	22
26-Aug-06	31	0	31	0	0	31
27-Aug-06	52	0	52	1	0	53
28-Aug-06	64	0	64	0	10	74
29-Aug-06	74	0	74	1	0	75
30-Aug-06	5	0	5	0	0	5
31-Aug-06	5	0	5	0	0	5
1-Sep-06	30	0	30	0	0	30
2-Sep-06	26	0	26	0	0	26
3-Sep-06	40	0	40	0	0	40
4-Sep-06	34	0	34	0	0	34
5-Sep-06	26	0	26	0	0	26
6-Sep-06	21	-	21	0	0	21
Total	476	19	495	2	10	507

* Monitored from 19:00 on the evening of until 07:00 the following morning.

** Includes the little brown bat (*Myotis lucifugus*) and the northern long-eared bat (*M. septentrionalis*).

Although the calls of the *Myotis* species were not distinguished, the majority of the *Myotis* sequences recorded at both locations likely represent the little brown bat for at least two reasons. First the northern long-eared bat has low intensity calls and is thus not recorded as well as the little

brown bat (Broders *et al*., 2004). Secondly, the northern long-eared is a recognized forest interior species (Broders *et al*., 2006; Jung *et al*., 1999; Lacki & Hutchinson, 1999; Sasse & Pekins, 1996) and is less likely to use open areas for foraging and commuting.

Ten of the greater than 500 echolocation call sequences recorded were attributable to the hoary bat. These call, however, were all recorded at the same location within a very short timeframe (approximately six minutes) and are therefore likely representative of a single individual. No calls were recorded for any of the other three migratory species at either of the recording locations. Location records for all of the migratory species in Nova Scotia are patchy with off-shore accounts suggesting only occasional migratory movements through the province (Broders *el al*., 2003b; van Zyll de Jong, 1985). Thus, the small number of recorded call sequences from migratory species was not unexpected.

The majority of the recorded echolocation sequences at the Pugwash site were calls of the two *Myotis* species known to occur in Nova Scotia, i.e., the little brown bat and the northern long-eared bat. This was expected as these two species are the most common species in the Province and two of only three species of bats with significant populations in Nova Scotia (Broders *et al*., 2003b). These species also typically forage at heights below the level of the turbine blades. As indicated above, the majority of the *Myotis* calls are likely attributable to the little brown bat. Only two call sequences of the other species, the eastern pipistrelle, were recorded. This species is likely only abundant in southwest Nova Scotia (Broders *el al*., 2003a); it was not expected to be well represented in this survey.

Migratory bat species fly at 40 m and higher (Arnett *et al.,* 2006) putting these species at the greatest risk of collision with rotor blades. The limitations of the recording equipment would not pick up the calls of bats flying at these higher levels.

4.3.4 Fish

The only fish of conservation concern identified in the ACCDC shortlist of conservation concern was the Atlantic Salmon (*Salmo salar*) (see Appendix A). The preferred freshwater habitats for each life stage of the Atlantic Salmon are riffles and pools with high percentage pebble and gravel substrate. As detailed in Section 4.2.4, there is no such habitat associated with the intermittent streams that characterize the study area.

4.3.5 Herpetiles

There are 22 species of terrestrial and freshwater herpetile species in the province. Based on the ACCDC Shortlist Screening, the only listed species reported within 100 km of the project site that is ranked RED or YELLOW is the wood turtle *(Clemmys insculpa).* Section 4.3.5.1 provides information on the species and section 4.3.5.2 records the results of the research and field program undertaken.

4.3.5.1 Herpetile Species at Risk

Wood Turtle *(Clemmys insculpa)*

The wood turtle has been federally legislated as a species of concern and provincially as a vulnerable species, due to loss of habitat from increasing land development. Their preferred habitat can be defined as slow moving rivers and streams, intervals and their adjacent riparian zones. Streams with gravel banks with southern exposure are especially important as potential nesting and basking areas. The wood turtle typically congregates in small populations of up to 100 individuals near riparian habitat characterized by high depositional sandy banks that are scoured by winter and spring floods.

4.3.5.2 Research and Field Program

The field specialist for wood turtle, Ross Hall, had no prior professional knowledge of wood turtles occurring in the Pugwash watershed, a fact that was substantiated by John Gilhen, author of *Amphibians and Reptiles of Nova Scotia (1984)* and scientist emeritus at the Nova Scotia Museum of Natural History. Wood turtle populations do occur in the River Philip and Wallace River watersheds, however, and could potentially cross from the upper tributaries of these watersheds into the Pugwash watershed. As detailed in section 3.2.2.5, Matheson and Tidemill Brooks were visited in June and August 2006. No wood turtles were seen on either visit. As noted in section 3.2.2.5, water flow in both brooks could be classified as intermittent or ephemeral, and much of the bottom substrate was characterized as mud, not the sand or gravel preferred by the wood turtles. Based on the field observations of Ross Hall, the absence or poor quality of hibernation opportunities, egg laying habitat, marginal riparian habitat and past agricultural disturbances, it can be logically deducted that there are no wood turtles in the area of the proposed wind farm.

4.3.6 Invertebrates and Freshwater Mussels

There are 17 species of invertebrates identified in the ACCDC Short List Screening (Appendix A); of these 12 are ranked as RED, YELLOW or UNDETERMINED, by NSDNR. Of these 12, two are molluscs, two are butterflies and the remaining eight are dragonflies.

4.3.6.1 Research and Field Program - Fresh Water Mussels

In late August, 2006, as detailed in section 3.2.2.5, a search was made of the two water courses, Matheson Brook and Tidemill Brook, that flow from the Project site. No freshwater mussels were found because the flows in the both brooks were intermittent in nature; freshwater mussels would not survive in a water course of an intermittent nature.

4.3.6.2 Research and Field Program - Butterflies and Dragonflies

The 10 species of butterflies and dragonflies conservation concern identified in the ACCDC Short List Screening as potentially being within the Study Area are described below based on their habitat and/or larval-stage host food plants.

Salt Marsh Copper (*Lycaena dospassosi*) **(S2, UNDETERMINED)**

The Salt Marsh Copper is a small butterfly common to salt marshes whose larval-stage food plant is silverweed (*Potentilla egedii*), a common coastal successional species along shorelines and marshes. Although this species was found 5 km from the project area, it does not include any coastal marshes; the Salt Marsh Copper is therefore not a species of concern.

Monarch Butterfly (*Danaus plexippus*) **(S2B, YELLOW)**

The Monarch Butterfly can be found almost anywhere during the spring (northward) migration. During the breeding season, monarchs can be expected to be found near the larval-stage food plants, namely common milkweed (*Asclepias syriacal*) and swamp milkweed (*A. incarnata*). In the fall they are found, often in large numbers, near the coast before they head south. A single sighting of the monarch 9 km from the Study Area was recorded in 2006. *Asclepias incarnata* is also reported by ACCDC as being within 100 km of the study area. No milkweeds were found during the 2006 Blaney survey. Although the monarch butterfly is found in the larger regional area, it is unlikely, because of the lack of its food source, that the project area would be considered prime habitat.

Prince Baskettail (*Epitheca princeps*) **(S2, YELLOW)**

The Prince Baskettail is commonly found in proximity to ponds, lakes and rivers where it lays eggs on *Typha* and other similar aquatic emergent plants. ACCDC has two reported sightings of this dragonfly in 2002, 16 km from the project area. This type of habitat is common where surface drainage has been disturbed and managed poorly. There are only two known areas, both adjacent to Irishtown Road, where Typha (cattails) is known to grow in small ponds associated with shrub swamps. The cattails and associated ponding may well be a result of poor surface water drainage along the Irishtown Road; these areas could conceivably provide habitat for the Prince Baskettail.

Ebony Boghaunter (*Williamsonia fletcheri*) **(S1, RED)**

The Ebony Boghaunter is found in sphagnum bogs and swamps, often with open water, adjacent to coniferous or mixed woodlands. A single sighting was recorded for this species in 2002 approximately 16 km from the project area. Its larval stage (naiad) requires open water associated with sphagnum bogs. There are no sphagnum bogs associated with the project area.

Delicate Emerald (*Somatochlora franklini*) **(S2, UNDETERMINED)**

A single sighting of the Delicate Emerald was recorded in 1997 approximately 17 km from the project area. This dragonfly is usually found in sedge and moss-filled fens at the foot of hillsides below a seepage, or in wide-open meadows. It is not usually encountered near open water. The adult males fly through stretches of tall grasses, sedges and shrubs. There are no large expanses of grass or sedge-filled fens within the project area; the likelihood of finding the Delicate Emerald in this area is remote.

Harpoon Clubtail (Gomphus descriptus) **(S2, YELLOW)**

The Harpoon Clubtail dragonfly inhabits clean rivers and streams, often near gravel bars. Although AC CDC has two sightings of this dragonfly recorded in 1993 18 km from the project area, the necessary habitat is not found on site.

Lance-tipped Darner (*Aeshna constricta*) **(S3, UNDETERMINED)**

The Lance-tipped Darner frequents marshy ponds and streams and is often found among the vegetation of seasonal ponds. ACCDC reports one sighting in 1993, approximately 21 km from the project area. Similar to the Prince Baskettail, this species like stands of aquatic emergent vegetation. There is not a lot of this fairly common plant community within the project area, although it is seen along the Irishtown Road.

Ocellated Darner (*Boyeria grafiana*) **(S3, UNDETERMINED)**

The Ocellated Darner is found along rocky, small to medium, fast moving streams and around the shores of ponds and lakes. This Darner was reported being seen once in 1994, approximately 21 km from the project area. The nature of the streams/brooks in the project area do not provide habitat conducive to this species.

Northern Pygmy Clubtail (*Lanthus parvulus*) **(S3, YELLOW)**

Although a single sighting of the Northern Pygmy Clubtaiol was recorded in 1993, 21 km from the project area, this species prefers habitat around rocky streams; this habitat is not found within the project area.

Brook Snaketail (Ophiogomphus asperses) **(S1, RED)**

This NSDNR RED-listed species preferred habitat is clear, sand-bottomed streams with intermittent rapids, often associated with dense woodlands. A single sighting was recorded in 1996 approximately 25 km from the project area. Although the project area does have dense coniferous woodlands, there are no sand-bottomed streams with intermittent rapids in the area.

4.4 Socio-Economic Environment

4.4.1 Key Settlements and Local Population Trends

The nearest community to the project site is the Village of Pugwash to the west of the proposed wind farm (Figure 4.3). The Village, with an approximate permanent population of 900 people, is located in Cumberland County on the shores of the Northumberland Strait, along Highway 6 (the Sunrise Trail), approximately 60 km from the Nova Scotia-New Brunswick border. The economy is primarily built on fishing, mining, small-scale manufacturing, tourism, wood lot harvesting and farming. The village has an elementary school, named after Cyrus Eaton, as well as a regional high school that draws students from rural Cumberland County.

The Village of Pugwash is governed by the Pugwash Village Commission, a formal corporate entity created by

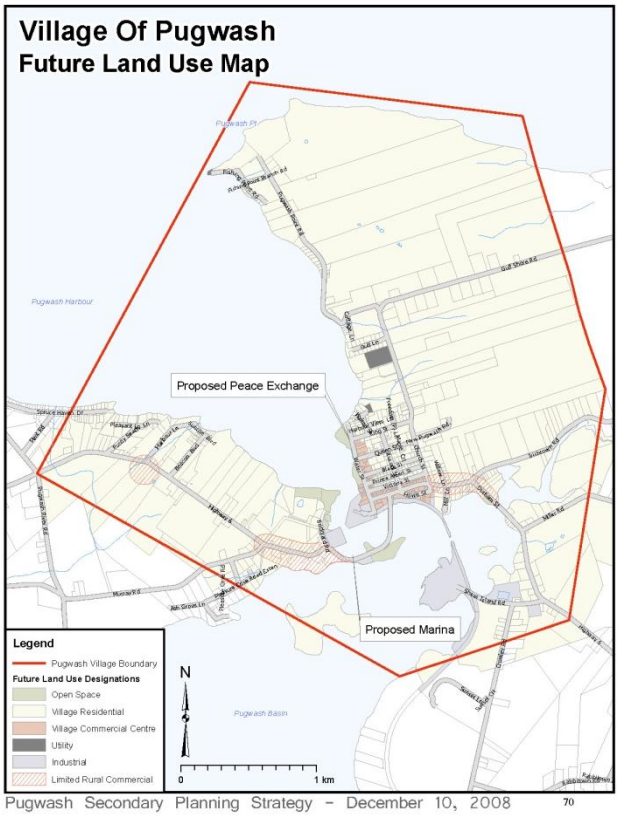


Figure 4.3: Village of Pugwash Boundary (Source: Pugwash Secondary Planning Strategy)

legislation in 1948. Cumberland County Subdivision D is governed locally by the Municipality of the County of Cumberland. In November 2010, an application to dissolve the Village of Pugwash was filed with the Nova Scotia Utility and Review Board (NSUARB) arguing that modern communication and transportation have made the Village Commission obsolete and that government services were readily accessible at all three senior levels of government. Subsequent to a preliminary hearing, the Municipality of the County of Cumberland conducted a study[8] to assist the NSUARB and the voters of the Village to make informed decisions regarding the dissolution of the Village of Pugwash.

At the end of the 19th century, Pugwash was a prosperous village with over 3,000 permanent residents. The village was home to a thriving lumber industry, a productive fishery, shipbuilding, several hotels and a major exporting port. Devastated by several fires between 1898 and 1929, the village rebounded, but never to the degree of the pre-fire area. Today, the Village is the location for a library, a Community Access Program (C@P) site offering public internet access for locals and visitors, amenities such as a hospital, schools, RCMP detachment, financial institution, ground search & rescue, post office, four churches, hardware, grocery, gift, pharmacy, liquor and convenience stores.

The community of Pugwash, as defined by the Nova Scotia Community Counts (Figure 4.4), had a total population of 1,512 in 2006. Even though the community has experienced a 9.8% population decline between 1996 and 2006, cottage developments in the area have meant an increasing influx of seasonal residents. During the summer, the village service area swells to over five thousand people.[9] Many of the seasonal residents live along the coast of the Northumberland Strait to the north of the project site.

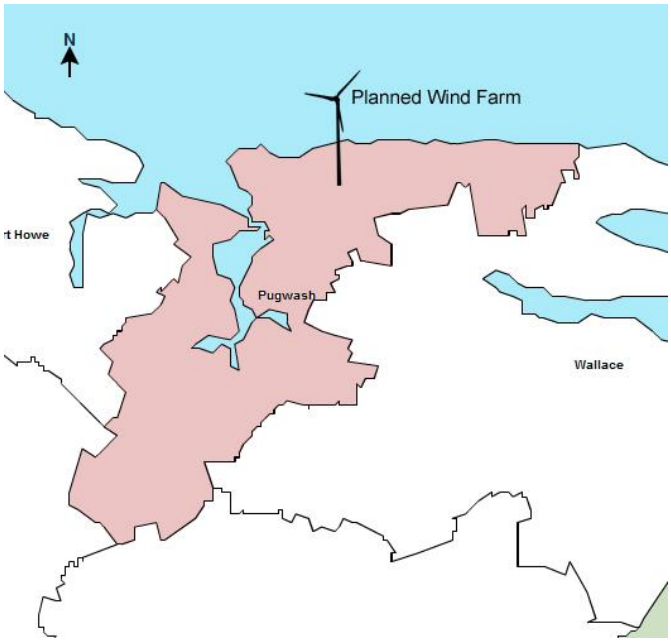


Figure 4.4: Community of Pugwash Boundary (Adapted from: Nova Scotia Community Counts)

The permanent population of the community is relatively old when compared to the rest of the Province. 22.6% of the population was 65 years and older (15.1% in Nova Scotia) and only 19.9% was under the age of 20 (22.8% in Nova Scotia) based on the 2006 census. Families in Pugwash had a median income of $46,242, compared with the median of $55,412 for Nova Scotia. A total of 14.5% of families in Pugwash had low income status in 2006, compared with 10.3% in Nova Scotia.

The closest proposed wind turbine is located approximately 2 km to the west of the village core.

[8] Study Regarding the Service Delivery and Financial Impact of the Dissolution of the Village of Pugwash.
[9] Pugwash Secondary Planning Strategy, page 52.

Cottage developments along the coast are located about 1 km or more to the north of the proposed wind farm, while residences along Miller Road are situated 0.7 km or more to the south of the proposed project.

Pugwash is famous for being the site of an international conference of scholars organized by Bertrand Russell in 1957 and hosted by Pugwash native and steel magnate, Cyrus Eaton. The conference brought high-level scientists from both sides of the Cold War divide to state their opposition to nuclear weapons. The name Pugwash Conferences on Science and World Affairs has since hosted other conferences sharing a common theme of promoting peace.

The village celebrates its Scottish heritage each July 1, with the annual Gathering of the Clans and Fisherman's regatta.

4.4.2 Existing Land Use and Economic Activity

Traditionally the entire Gulf Shore area was used for farming and forestry. The area continues to be farmed, while residents, both seasonal and permanent, use the area extensively for recreational purposes. The natural beauty and tranquil environment have attracted the development of a significant number of cottages and seasonal homes along the shore. Part of this attraction is the beaches, which host the warmest water north of the Carolinas; another is the beautiful scenic views which can be enjoyed along the Gulf Shore Road. The proposed Pugwash wind farm location is situated on privately owned land to the south of the Gulf Shore Road well set back from the shore. Approximately 85% of this land is forested; the balance used for agricultural purposes.

The nature of the residential development along the shore has changed over the years. Although the shore has been a holiday destination for a very long time and many families had built small cottages to which they returned every year, the nature of this use has intensified and increased. With improved transportation linkages to the major urban areas, people are perhaps spending more time at the shore and certainly appear to be constructing larger properties. Some of these properties have become year round residences. Today there is a wide range of property types along the Gulf Shore Road from the relatively modest to the very sophisticated. This shift, together with the development of the Northumberland Links Golf Course and several cottage complexes for rent, including the Scottish Pines Log Cottages, is reflective of the nature of the tourist and recreational use that occurs in the area. This use is of economic importance both to the community of Pugwash and to the Municipality. It is anticipated that these trends, which have evolved over the past 20 or more years, will continue as people capitalize on serene amenities and the rural way of life. The Gulf Shore Road is also popular for hiking, walking and biking; it hosts the cycle leg of the annual Gulf Shore triathlon. Other recreational uses in the vicinity of the project site include the Gulf Shore Provincial Park, a picnic park on a hilltop along Gulf Shore Road overlooking the Northumberland Strait, the Northumberland Links Golf Course at 1776 Gulf Shore Road and the Sport Pugwash Horse Raceway, an all-weather walking and horse training track on Miller Road.

For a small community, Pugwash has a rather diverse economy. The salt mine, for example, accesses a deposit approximately 500 m thick and it is the largest underground salt mine in Atlantic Canada. Most of the mine is located under the Pugwash River; no shafts run under the village. The

salt mine presently employs about 200 people. The salt is shipped from Pugwash Harbour, as well as by rail from a facility in nearby Oxford. The first salt was loaded in 1959, and it is estimated that the mine has a 100 year lifespan. The mine produces approximately 1,200,000 tonnes of salt per year. The Pugwash Community Master Plan (2010) noted that there has been some concern in the area about the future of the salt mine and the continuation of operations. On the other hand, according to the Mining Association of Nova Scotia, salt production in the Nova Scotia is thriving at the two existing production facilities in the province.[10]

Pugwash Harbour continues to be an important asset to the community. It is home to two marinas (the Pugwash Yacht Club and the Brickyard Marina), the Canadian Salt, Chase's Lobster Pound Ltd. wharf and holding facility and the Harbour Authority wharf. Due to its location on the dividing line between two fishing areas, Pugwash benefits from two lobster seasons, but the viability of the fishing industry is nevertheless somewhat volatile as it depends on a fluctuating number of lobsters.

Other employers in the area include Irving and MacTara (forestry), Basic Sprit, Seagull Pewter and Sunset Industries (manufacturing), as well as the Fox Harbour Golf Resort (hospitality). The Pugwash Area Chamber of Commerce has approximately 60 members. Within the larger area of Cumberland, i.e., Subdivision D, most people are employed in agriculture and other resource-based services, followed by other services, manufacturing, health care and social services, and retail (Figure 4.5).

The employment rate for Pugwash residents aged 25 and over decreased by 3.9 percentage points to 49.1% between 1996 and 2006. During the same period, Nova Scotia's employment rate experienced an increase by 3.6 percentage points to 58%.

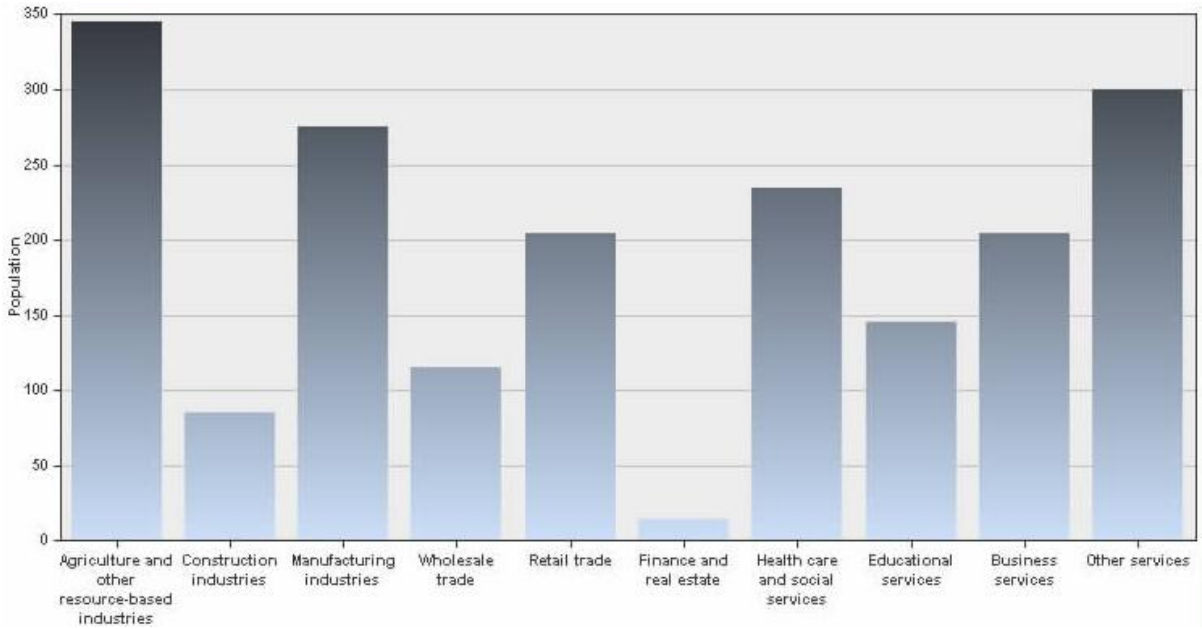


Figure 4.5: Employment by Sector, Cumberland, Subdivision D (Source: Statistics Canada, 2006 Community Profiles)

[10] Mining Association of Nova Scotia, Newsletter, March 2011.

4.4.3 Transportation Routes and Traffic Patterns

The Gulf Shore area is both locally and provincially important as a tourist destination. Route 6, which follows the coast from the New Brunswick boarder along the Northumberland shore to the Canso Causeway, is designated by Nova Scotia Tourism as the Sunrise Trail, one of the provincial scenic travel-ways. The intent of these routes is to attract people off the TransCanada Highway to the coast and to the communities and facilities along the coast. The Nova Scotia Department of Tourism recognizes the area as a valued resource in particular due to its unique warm waters and sandy beaches relative to other provincial coastal areas. The Gulf Shore Road is signed as a "Scenic Diversion" along the way. It provides access to many of the seasonal residences along the coast. The Irish Town Road, which connects the project site with the surrounding road network, was recently upgraded and is in good condition.

NSTIR's 2007 traffic counts for the area show that Annual Average Daily Traffic (A.A.D.T.)[11] on Route 6 was:

- 420 vehicles westbound, 1.5 km east of North Wallace Road;
- 460 vehicles eastbound, 1.5 km east of North Wallace Road; and
- 2,340 vehicles east and westbound combined, at the intersection with Pugwash River Road.

Secondary road traffic counts as collected in 2000 for the area show a volume on Gulf Shore Road of:

- 850 vehicles east and westbound combined, 0.5 km east of Pugwash Point Road; and
- 380 vehicles east and westbound combined, 0.25 km west of Ferry Road.

4.4.4 Archaeological Findings

The results of both the November and December reconnaissance programs are reported in the archaeological report in Appendix B.

Only one of the areas surveyed is of particular archaeological note, i.e., the location of the probable stone bridge and the three stone mounds likely resulting from field clearing on formally agricultural lands to the west of WT2. Although these mounds are not of archaeological significance on their own, large mounds such as these would have involved a great deal of effort on the part of the farmers or settlers. Taking this into account, it is probable that a homestead is located in proximity to the stones, very likely on or near the crest of the low hill around which the mounds are centred. Although no such homestead remains were identified, it is possible that either the foundation was just outside the area surveyed or that the homestead was a log cabin-style structure with no discernable cellar and no stone foundation.

4.4.5 Mi'Kmaq Ecological Knowledge

As indicated in Section 3.3.2, a MEKs study has been commissioned from Membertou Geomatics Solutions. The results will be provided to NSE when the work has been completed.

[11] Annual Average Daily Traffic (A.A.D.T.) is the average number of vehicles passing the count location in a 24 hour period, averaged on the basis of one year.

4.4.6 Communications and Radar Systems

The document entitled "Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radio Communication , Radar and Seismoatic Systems" produced by the Radio Advisory Board of Canada (RABC) in conjunction with the Canada Wind Energy Association (CanWEA) provides guidelines wherever there is a possibility that a wind farm may impact such systems. The crux of these guidelines is a "series of analytical methodologies and thresholds that help to indicate where a potential interference may occur, thereby acting as a voluntary (but highly recommended) trigger for proponents of wind farms to notify the Applicable authority".
The referenced document provides basic information on the manner in which interference may arise and its effects on systems. Radio communication systems include two main types: broadcast-type systems, including cellular type networks, and point-to-point (one way or two ways) or point-to-multipoint systems. Radar systems are used for several purposes including:

- Predicting the weather;
- The Canadian Air Defense System; and
- Air traffic control systems.

Wind farms may also affect the functioning of the 52 Seismological Monitoring Stations located in Canada to detect and record ground motion signals related to distant earth quakes, etc. To address these concerns a number of parties were consulted in regard to the proposed wind farm at Pugwash. The results of these communications are summarized in the sections below.

4.4.6.1 DND Air Defence and Air Control Radar Systems

The role of the Canadian Air Defence System is to provide aerospace surveillance, thereby contributing to the defence of North America, through radar systems located throughout Canada's arctic, coastal and inland regions. The Department of National Defence (DND) was contacted, and a response received on December 15, 2011 from Adin Switzer, AEC Liaison Officer stated:

"The results of our analysis have shown that in relation to the Department of National Defence consultation zones outlined on our website and in the RABC/CanWEA document Technical Information and Coordination Process Between Wind Turbines and Radio Communication and Radar Systems, the site will have no or minimal impact to DND operations. As such, with respect to the Department of National Defence, Air Traffic Control, Air Defence Radars and DND airports and NAVAIDS, we have no objection with your project as submitted."

4.4.6.2 Canadian Coast Guard

On December 5, 2011, Lee Goldberg wrote that the Canadian Coast Guard did not have any communications or radar sites near the proposed wind farm and would not be expecting any interference issues to arise.

4.4.6.3 Meteorological Service of Canada

On December 12, 2011, Carolyn Rennie of the Meteorological Service of Canada wrote that any interference that may be created by the proposed Project would be minimal and, as a consequence, that they had no concerns.

4.4.6.4 NAVCANADA

NavCanada was provided with the same materials as the above referenced parties, but as of early January, a response had not been received. From inquiries made, a response is anticipated by mid February; this will be forwarded to NSE.

4.4.7 Noise Modeling

As referenced in section 3.3.4, noise modeling was undertaken to determine potential noise levels at 181 building locations within 1.5 km of a WTG, or 500 m of the proposed substation. The regulation of noise in the province is established by NSE through Guidelines for Noise Measurement and Assessment (Noise Guidelines) (NSDOE, 1989) which establish the following general noise limits for residential or sensitive areas defined as "areas where people normally live, work, or take part in recreation":

- Leq <= 65 dBA between 0700 and 1900 hours;
- Leq <=60 dBA between 1900 and 2300 hours; and
- Leq<= 55dBA between 2300 and 0700 hours.

There are, however, no noise limits specific to WTGs prescribed by either the Nova Scotia government of by the Municipality of the County of Cumberland.

The full results of the analysis undertaken are provided in Appendix C where the noise levels at 182 points of reception are presented. For each receptor, the following information is provided:

- Distance to the closest WTG;
- Sound pressure level at the receptor location at the applicable receptor height;
- Sound level limit for that receptor; and
- Whether or not the noise levels at the receptor comply with the prescribed limit.

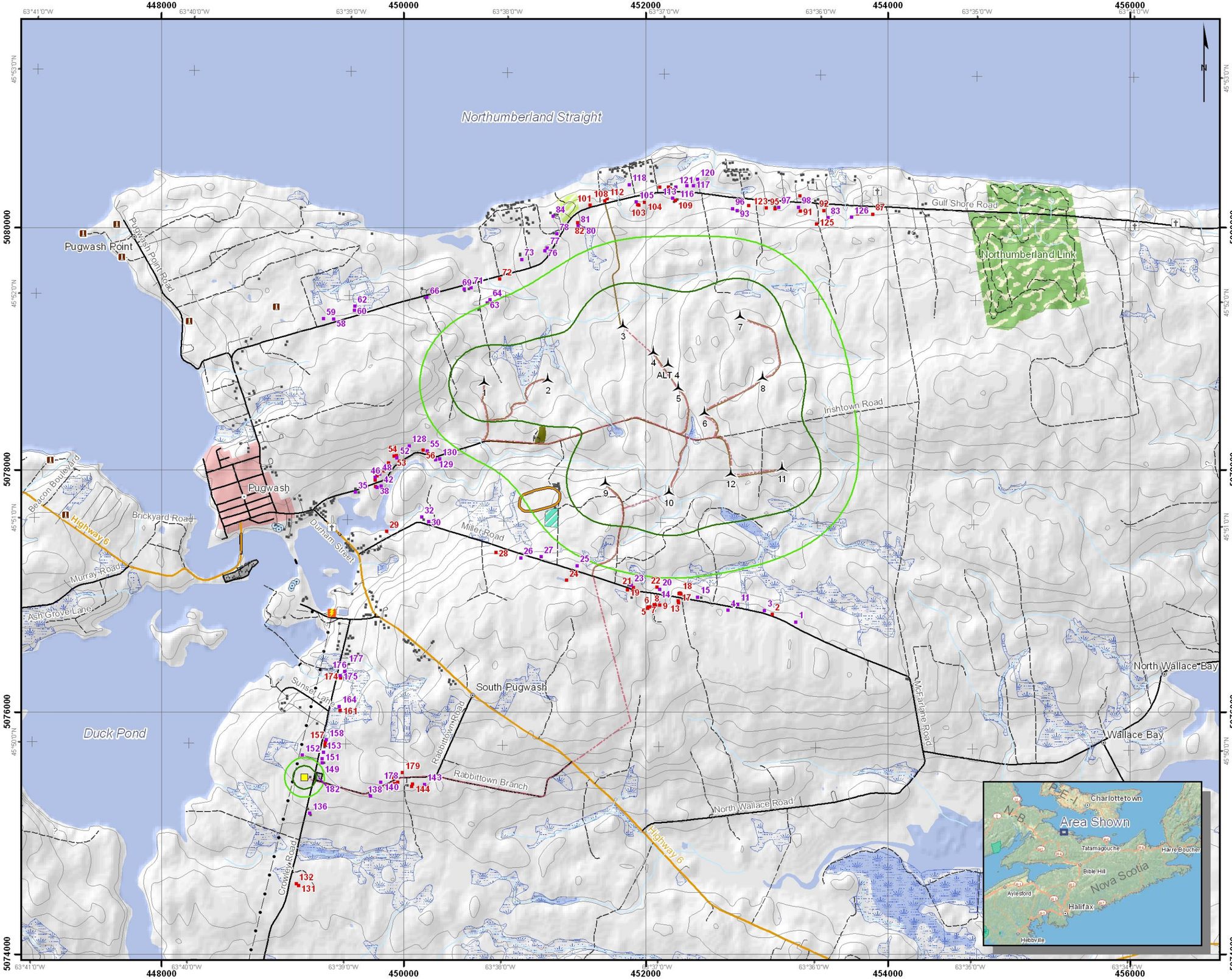
The point of reception with the highest calculated sound pressure level is #182 (cemetery) at 43.6 dBA and located 111 m from the substation. The dwelling with the highest calculated sound pressure level is #63 at 39.9 dBA, located 665 m from WTG 1. Figure 4.6 graphically depicts the findings.

4.4.8 Modeling of Shadow Flicker

As referenced in section 3.3.5, modeling was undertaken to determine whether any of the 102 dwellings within 1,555 m of a WTG would be impacted by shadow flicker. There are no applicable local or provincial requirements with regard to shadow flicker that apply to the proposed site. It is generally accepted that shadow flicker from WTGs does not occur beyond a certain distance. The UK wind industry, for example, considers this distance to be equivalent to 10 rotor diameters, while the Danish industry suggests a value of between 500 and 1,000 m. Garrad Hassan adopted a conservative approach and assumed the length that a shadow can be cast on the basis of the following formula:

D = 10 X (hub height + rotor radius)

Beyond this distance, a viewer does not perceive the turbine blade to be chopping the light, but rather as an object passing in front of the sun.



Legend

Project Components

- Wind Turbine (13) Siemens SWT 2.3 101
- Substation
- Collection System
- Access Road

Other Components

- Dwelling
- Dwelling (unsure)
- Other Building
- Tank
- Cemetery
- Transformer Station
- Navigation Aid
- Race Track
- Transmission Line
- Highway
- Road
- Trail / Seasonal Road
- Private Road
- Watercourse
- Contours (Interval: 5 m)
- Cemetery
- Picnic Site
- Park / Sports Field
- Domestic Waste
- Golf Course
- Residential Area
- Wetland
- Waterbody

Predicted Sound Level

- 40 dB(A) at 1.5 m agl*
- 45 dB(A) at 1.5 m agl*

*AGL: Above Ground Level

Figure 4.6

0 0.375 0.75 1.5 kilometres

AWPC
ATLANTIC WIND POWER CORPORATION

Pugwash Wind Farm

PREDICTED SOUND LEVEL FROM WIND TURBINES - SIEMENS SWT 2.3 101

GL Garrad Hassan

800149-130112-001-FL
Layout_13WTG_111214
January 13, 2012

Projection: UTM Zone 20, NAD83
Sources: NSTDB 10k, CanVec, Nova Scotia Geomatics Center, Aerial Imagery

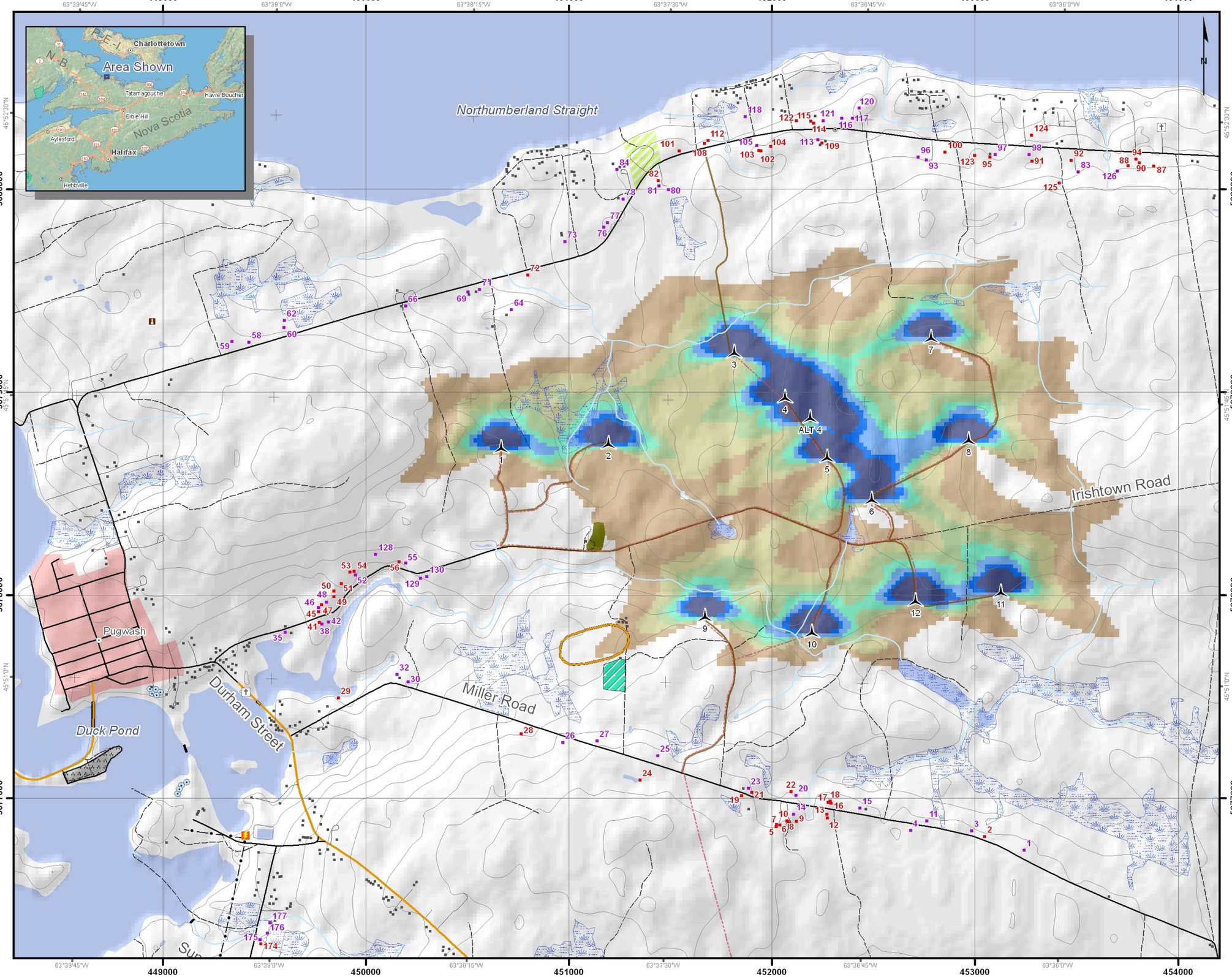
The full analysis undertaken by Garrad Hassan is presented in Appendix D. Figure 4.7 illustrates predicted shadow flicker duration at receptors at 1,555 m from the WTGs. The map takes into account average annual cloud cover. For illustrative purposes, shadow flicker is shown when occurring 30 hours or more per year. As per the predicted levels dwelling #76 would experience the most shadow flicker with a onetime maximum duration of 36 minutes on December 24th and a total of nine hours per year; these results are considered to be conservative.

4.5 Environmental and Socio-economic Factors Susceptible to Impact

Based on the experience of the Project team and the work undertaken to compile this environmental baseline, the following physical, ecological and socio-economic factors should be evaluated further:

- Ground and Surface Water Quality: because of relatively flat topography associated with the Project area and the high water table, care must be taken throughout construction and all subsequent activities to prevent the degradation of surface waters;
- Radio and Radar Interference: recommended by Guideline;
- Wetlands: protected by legislation;
- Fish Habitat: protected by legislation;
- Forest Cover: although the forest cover across the Project area is already fragmented and intermittently logged, additional cover will be removed to facilitate the siting of the turbines;
- Species of Concern: a legislative requirement;
- Migratory and Breeding Birds: given the nature of the Project, birds are susceptive to collision with the rotating blades of the turbines;
- Bats: given the nature of the Project, bats are susceptible to collision with the rotating blades of the turbines;
- Aboriginal Use of Land: a legislative requirement;
- Archaeological Resources: a legislative requirement;
- Traffic: the movement of the WTG component parts will involve the movement of large loads on the local roads; and
- Noise: a consideration that was taken into account in the layout, but remains of public concern.

Additional topics that have been subject to further analysis include rural ambiance, land use, employment and the economy, property values, visual impacts and health and safety. These are issues that have been raised in the public forum and are further addressed in Chapter 7.



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- Contours (Interval: 5 m)
- Cemetery
- Picnic Site
- Park / Sports Field
- Domestic Waste
- Residential Area
- Wetland
- Waterbody

Shadow Flicker [hour/year]

- 30 - 59
- 60 - 89
- 90 - 119
- 120 - 149
- 150 - 179
- 180 - 209
- 210 and over

This map presents the result of the shadow flicker calculation and it takes into account statistics of the cloud cover.

Figure 4.7

0 0.25 0.5 1 kilometres

AWPC
ATLANTIC WIND POWER CORPORATION

Pugwash Wind Farm

SHADOW FLICKER ANALYSIS

GL Garrad Hassan

800149-130112-001-FL
Layout_13WTG_111214
January 13, 2012

Projection: UTM Zone 20, NAD83
Sources: NSTDB 10k, CanVec, Nova Scotia Geomatics Center, Aerial Imagery