5.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 GEOPHYSICAL ENVIRONMENT

The following sections outline the geophysical environment of the Study Area including the physiography and topography, surficial geology, bedrock geology, and hydrogeology of the area. These observations are based solely on a review of publically-available regional resource mapping. A site reconnaissance is required to identify specific issues at the individual turbine sites. Detailed geotechnical investigations will be conducted at each turbine site prior to construction.

5.1.1 Physiography and Topography

The Project is located south and west of Dalhousie Mountain Wind Farm and immediately east of the Gully Lake Wilderness Area (see Figure 1.2 and 5.2). The proposed turbines extend approximately 16 km along the border of Colchester and Pictou Counties in a north to northwesterly direction from Mount Thom at Highway 104 northward between the rural communities of Mount Thom, Upper Mount Thom, Berichan and Earltown on the West and Lower Mount Thom, Brookfield, Dalhousie Settlement, Loganville and South Loganville on the east (Figure 1.2).

This area is characterized by deeply incised river valleys and flat uplands in the rugged Cobequid Mountains physiographic region. Elevations range from in excess of 330 m in the uplands to about 150 m in major valleys. Drainage in the south portion near Highway 104 is primarily to the south and southwest towards the Salmon River watershed. The majority of the Study Area drains northward to Northumberland Strait via tributaries of River John.

5.1.2 Surficial Geology

The Project Study Area is overlain by variable thicknesses of glacial till and reworked glacial to post glacial sediments and recent alluvial and organic deposits. The overburden thickness is expected to range from nil over upland bedrock features (exposed bedrock and residuum), to in excess of 30 m along the flanks of the mountains and in river valleys (*e.g.*, Apple River sand and gravel unit and Alluvial river deposits). Two extensive groundwater moraine glacial tills are identified: the more permeable and well drained Cobequid sand Till (CO); and the siltier less permeable Eatonville-Hants Till.

A review of 61 water supply well logs in surrounding communities suggests overburden thickness ranging from nil to 20.7 m, average 6.8 m (Table 5.1). Thin overburden cover is noted in the Upper and Lower Mount Thom areas, and thicker deposits are noted east of Earltown and at Diamond, possibly associated with the Apple River units. Overburden thickness is expected to be thin in the vicinity of most proposed turbine locations on higher topography, as evident from the distribution of residuum, exposed bedrock and numerous bedrock exposures present along road cuts and drainage courses. Thicker overburden cover would be expected in the southern sedimentary areas, and in valley fill situations. It is anticipated that most of the turbines located on the higher topography would be underlain by exposed bedrock or thin veneers of these glacial types.

Table 5.1 Summary of Water Wells Records Within the Study Area

		All (N=61)	Loganville (N=3)	Berichan (N=1)	Diamond (N=8)	Upper Mount Thom (N=10)	Lower Mount Thom (N=21)	Mount Thom (N=6)	East of Earltown (N=12)
Well Depth (m)	Min	15.8	15.8	27.4	24.4	31.1	30.5	19.8	18.3
	Max	92.3	42.7	27.4	90.8	62.5	85.3	67.7	92.3
	Mean	47.9	29.5	27.4	53.2	48.8	49.1	41.4	51.1
Yield (L/min)	Min	0.9	31.8	0.9	3.2	2.3	3.4	2.3	2.3
	Max	273.0	45.5	31.8	22.7	113.7	54.6	68.2	272.8
	Mean	28.3	36.4	31.8	11.5	18.3	18.5	27.5	63.8
Diameter (mm)	Min	102.0	152.4	152.4	101.6	101.6	101.6	152.4	127.0
	Max	152.0	152.4	152.4	152.4	152.4	152.4	152.4	152.4
	Mean	125.6	152.4	152.4	136.5	147.3	145.1	152.4	145.5
Casing (m)	Min	4.6	6.1	7.3	6.1	6.1	4.6	6.7	6.1
	Max	47.5	19.8	7.3	13.7	28.0	47.5	18.0	21.6
	Mean	11.6	11.9	7.3	9.5	12.0	12.8	9.7	11.6
Water Level (m)	Min	1.4	3.7	8.2	2.4	1.4	1.5	2.4	1.5
	Max	48.8	3.7	8.2	24.4	12.8	12.2	15.2	48.8
	Mean	6.8	3.7	8.2	7.7	4.2	6.1	7.5	10.4
Till depth (m)	Min	0.1	4.3	6.4	2.4	0.1	0.6	4.3	1.2
	Max	20.7	6.1	6.4	20.7	16.2	17.4	16.5	20.7
	Mean	6.8	5.1	6.4	6.5	6.6	6.5	7.3	7.8

Source: on-Line NS Well Logs Database (NSE 2011b) http://www.gov.ns.ca/nse/welldatabase/wellsearch.asp

Quaternary mapping of the area (Stea and Finck 1982) indicates the following major subdivisions:

Post Glacial Reworked Sediments:

- Organic deposits - peat, bog environments (> 1 m thick). Organic deposits appear to be intermittent and associated with small wetlands. Poor aquifer potential.
- Colluvial deposits - shattered rock, gavel, sand, silt, minor clay; forms on steep slopes; 1-10 m thick. This lithology is rare in the Study area. Poor aquifer potential.
- Alluvial deposits - gravel, sand, silt, minor clay and organic materials; forms in stream flood plains; 2-15 m thick. This lithology is rare in the Study Area. Poor to moderate aquifer potential.

- Apple River Member - locally highly permeable, ice contact stratified drift, gravelly sand, sand, silt; forms thick (20-30 m) terraces along valley sides. This deposit is extensive east of Loganville along West Branch River John, and along Steele Brook. Good aquifer potential.

Wisconsinan Glacial deposits:

- Cobequid Till - loose to compact, greyish-brown, very stony sand till with boulders (forms thin veneer ground moraine over parts of Cobequid highlands, <1 to 5 m thick). Poor to moderate aquifer potential.
- Eatonville-Hants Till - massive, moderately compact and fissile, reddish-brown, silty sand till derived from sandstone & shale (<1 to 15 m thick). Poor aquifer potential.

Pre-Glaciation:

- Glacially scoured bedrock with discontinuous thin veneer of glacial till.
- Residuum - mechanically and weathered bedrock surface overlain by 1-6 m of glacial till

5.1.3 Bedrock Geology

The bedrock controls the topography in the Study Area. The upland areas and northerly portion of the Project Study Area are generally underlain by hard, fractured crystalline, meta-sedimentary, volcanic and igneous intrusive (plutons) rocks of Devonian or older age; the lower areas along the southerly portions consist of younger and more erodible sedimentary bedrock of the Parrsboro Formation and Canso Group. The hard rock highlands are separated from the sedimentary lowlands by major faults, including the east-west trending Rockland Brook Fault on the south, and the Loganville Fault on the north.

In order of increasing age, the bedrock consists of several units (Donahue and Wallace 1982):

- Late carboniferous aged sedimentary rocks (quartz and lithic wacke, siltstone, shale, red polymictic conglomerate, and quartz arsenite) of the Parrsboro Formation
- Middle carboniferous aged sedimentary rocks (wacke, siltstone and shale) of the Canso Group
- Late Devonian to carboniferous aged sedimentary and volcanic rocks (wacke, siltstone, conglomerate and felsic volcanics) of the Nuttby Mountain Formation
- Early Devonian aged orange-tan alkali feldspar granite of the Glen Road Pluton
- Early Devonian aged orange-tan syenite of the Eight Mile Brook Pluton
- Early Devonian aged grey diorite of the Mount Thom and Gully Brook Plutons
- Middle to late Silurian aged volcanic rocks (wacke, rhyolitic lava flows, rhyolite, crystal tuff, dacite with minor siltstone and wacke
- Late Cambrian aged red, grey to pale orange syenogranite of the Salmon River Pluton
- Precambrian aged gneiss and granite of the undivided Mount Thom Complex

5.1.4 Hydrogeology/Groundwater

Based on the overburden and bedrock lithology descriptions, the area could be subdivided into five aquifer types:

- Poorly permeable, relatively thin sand and silt glacial till ground moraine;
- Permeable saturated sand and gravel deposits such as the Apple River Member;
- Sandstone, wacke and conglomerate of the Parrsboro Formation;
- Siltstone, sandstone and shale of the Canso Group, and
- Fractured crystalline bedrock (Plutons, volcanics, gneiss, syenite, etc.)

The glacial tills are generally considered to be poor aquifers. Where sufficient saturated thickness occurs, the sandy and silty glacial tills can provide sufficient yield to dug wells for single family domestic uses. Water quality is usually good, with a tendency for iron and manganese in excess of aesthetic guidelines.

Where sufficient saturated thickness is present, saturated sand and gravel deposits located along major watercourses or as kame terraces along the flanks of the highlands can provide large yields (>227 L/min) to properly constructed screened wells and dug wells. These deposits generally yield water of excellent quality, but due to their permeability are highly vulnerable to pollution form overlying land uses.

Moderate yields (>45 L/min) of good quality groundwater are expected from the sandstone and conglomerate units of the Parrsboro Formation. Only a very small area north of Upper to Lower Mount Thom is underlain by this formation.

Low to moderate yields (Est. 10 to 45 L/min) are anticipated from drilled wells completed into the Nuttby Mountain and Canso Group rocks that underlie the southernmost portions of the proposed wind farm. Based on experience elsewhere, water quality issues such as hardness, iron, manganese and salinity could be associated with the Canso Group.

The fractured crystalline bedrock comprising the upland areas is considered to be a poor aquifer and is expected to yield low yields (Generally < 15 L/min) of typically good quality groundwater to drilled wells. These areas would be recharge areas, and would be expected to exhibit a deep water table (10m or more below grade) depending on topography.

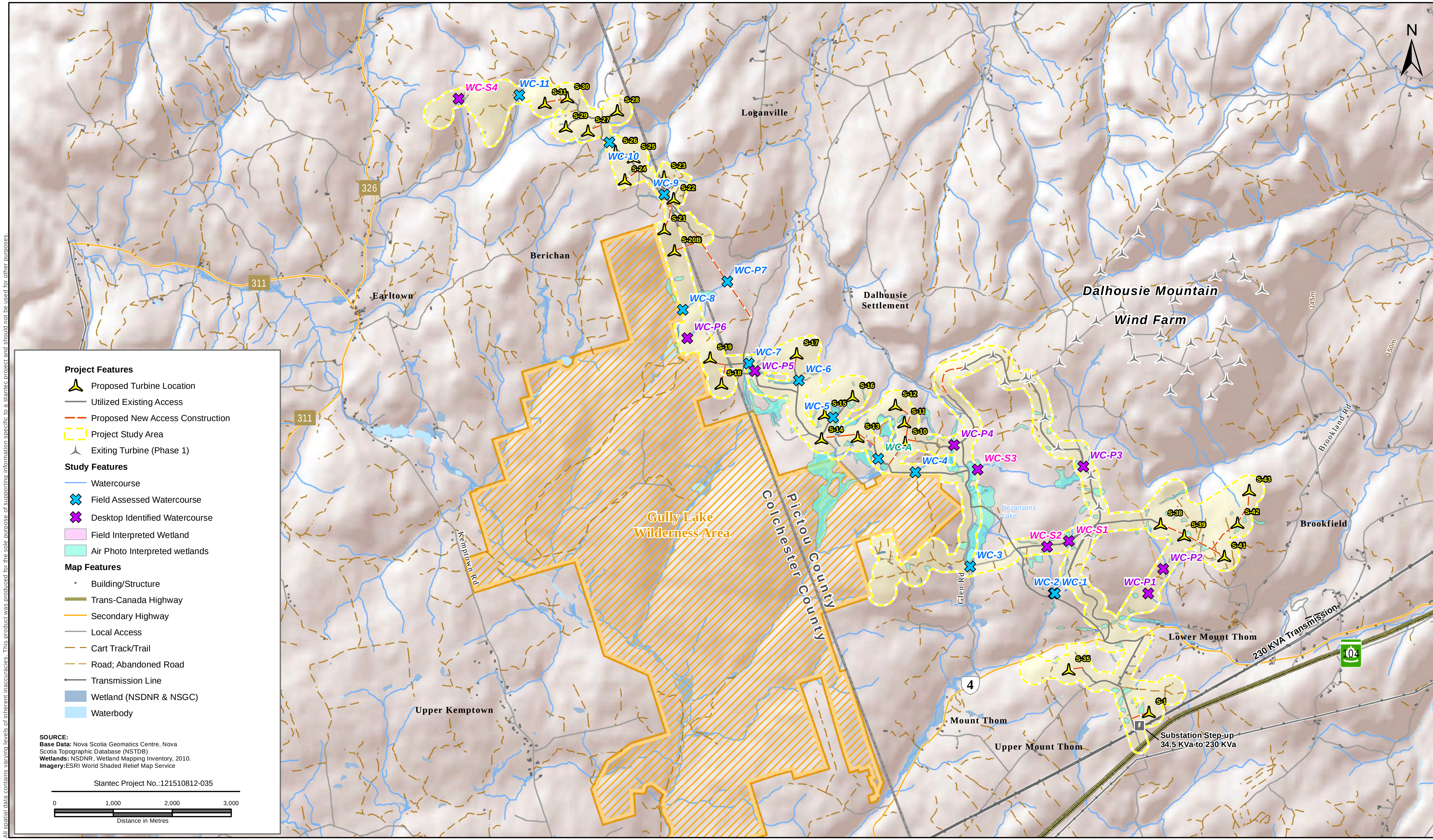
All residential and commercial water supplies in the Study Area would be from on-site drilled or dug wells or springs. Domestic wells are scattered throughout the Study Area, coinciding with existing roads and structures. It is suspected that many of the rural residents use dug wells. No field truthing has been completed to verify the presence or absence of water supply wells.

A summary of the pertinent well properties for 61 drilled wells completed in surrounding communities is presented in Table 5.1 for wells constructed between 1953 and 2009. Wells within several kilometers of the Study Area are generally installed in shale, sandstone, siltstone and minor coal of the younger sedimentary formations, or in granite slate and quartzite of the crystalline bedrock. At least two wells in the East Earltown area were completed in thick sand and gravel deposits. Domestic water supply wells in the area generally average 47.9 m deep with an average 11.9 m of casing and estimated yields of 0.9 to 273 L/min (mean 28.3 L/min); higher yields in excess of 70 L/min are typically associated with thick sand and gravel deposits east of Earltown. The static water level is reported to range from 1.4 to 48.8 m, mean 6.8 m below grade.

Domestic wells are scattered throughout the Project Study Area, coinciding with existing roads and structures. There are reportedly no dug wells in the vicinity of the Project activities, and all drilled wells draw groundwater from bedrock formations. In consideration that the turbines would be located greater than 600 m from the nearest residence, effects on groundwater users are considered to be unlikely. The precise location of nearby wells and any specific mitigative measures, if necessary, will be determined as part of preconstruction surveys.

5.2 AQUATIC ENVIRONMENT

The Aquatic Environment section summarizes the results of aquatic field surveys conducted by Stantec aquatic specialists from August 29 – 31, 2011 along the proposed Clydesdale Wind Farm access road corridors (Figure 5.1). This work was undertaken, in part, to identify potential triggers under *CEAA* associated with the proposed wind farm development as well as to provide baseline information for the fish and fish habitat existing conditions. In particular, the surveys were carried out to identify fish habitat within the Project Study Area at each watercourse with the potential to interact with the Project through proposed access road crossing locations and in particular, identify potential access road crossings that may require Authorization under the federal *Fisheries Act* associated with Harmful Alteration, Disruption or Destruction (HADD) of fish habitat. Field investigations also evaluated the potential for any water crossings to require Authorization under the *Navigable Waters Protection Act (NWPA).* The aquatic habitat assessment information was used to support future evaluation of design options or crossing structures and to develop mitigative measures to avoid HADD.



PREPARED BY: J. Petho	Clydesdale Ridge Wind Farm Project	FIGURE NO.: 5.1	
REVIEWED BY: C. Shupe		DATE: May 15, 2012	
CLIENT: Dalhousie Mountain Wind Farm	**Watercourses and Wetlands**	Stantec	

Path: V:\1215\active\121510xxx\121510812_clydesdale_ ridge\geomatics\mapping\mxd\Report Figures\ST_NS_121510812-035_Wetlands_Watercourses_20120430.mxd

Coordinate System: NAD 1983 UTM Zone 20N

Watercourses with the potential to interact with the Project were identified through a review of existing 1:10,000 scale maps in relation to the proposed Project Study Area at the time of the survey (i.e., August 2011). Where possible, the aquatic field team identified additional potential watercourse crossings observed along the existing access road during their survey. A total of eleven potential watercourse crossings (WC-1 – WC-11) were identified from the existing mapping and known turbine layout options at the time of the survey. One additional potential watercourse crossing (WC-A) was identified in-field (Figure 5.1). Since the aquatic survey was completed, the Proponent has dropped 11 turbine sites. It is estimated that the Project will require no more than 12 water crossing locations. A detailed fish habitat assessment was completed for each of the twelve potential watercourse crossings. The habitat assessment extended 100 m upstream of the proposed access road crossing and 200 m downstream. A designation of watercourse or drainage channel was made based on the field assessment. Since August 2011, the proposed layout has been modified, resulting in some differences in crossing locations. Results are presented to characterize the aquatic environment in the Project Study Area. Follow-up surveys may be required to assess final watercourse crossing locations to support Water Approval applications as required.

The detailed habitat assessment was carried out at each potential watercourse crossing using internal Stantec sampling protocol. The sampling protocol used is based on multiple existing protocols including the Environment Canada CABIN protocol (Canadian Aquatic Biomonitoring Network; Reynoldson *et al*. 2007), the Ontario Benthos Biomonitoring Network (OBBN) protocol (Jones *et al.* 2005), and the modified New Brunswick Department of Natural Resources (NBDNR) and Fisheries and Oceans Stream Assessment Protocol (Hooper *et al*. 1995). The stream habitat assessment included the identification of physical units (*i.e.*, run, riffle, or pool), designation of substrate type, and description of the riparian zone. The presence or absence of macrophytes, algae, over-head cover, and woody debris was also recorded since all of these habitat features affect the ability of the watercourse to support fish communities. The depth and width (wetted and bankfull) of streams and rivers were recorded as well.

One *in-situ* water quality sample was taken within each identified watercourse. The water quality measurement was taken within 10 m of the downstream end of the access road centerline. The flow state at the time of the water quality sampling was also recorded. Measurements were collected using a handheld water quality meter (Yellow Springs International (YSI) 556 MPS unit) and included dissolved oxygen, pH, water temperature and specific conductivity.

Based on the potential presence of *SARA* species within some watercourses located in the Study Area, a reduced electrofishing program was conducted. Using available mapping, it was confirmed prior to the field survey that four watercourses (WC-1, WC-2, WC-3, and WC-11) are tributaries to Salmon River, a watercourse protected by *SARA* because of its potential to support the endangered inner Bay of Fundy (iBoF) Atlantic salmon population. In these four watercourses, special consideration was given to assessing habitat types used by iBoF Atlantic salmon and no electrofishing was conducted in these waters.

A presence-absence electrofishing survey was carried out within all other lotic watercourses meeting the following requirements: anticipated to connect to known or suspected fish-bearing watercourses; containing sufficient water levels at the time of the survey to effectively electrofish; and meeting the water temperature requirements of the electrofishing permit (*i.e.*, <22 degrees Celsius). Electrofishing was completed using a Smith-Root Model LR-24 backpack electrofishing unit, operated by two qualified aquatic specialists.

The electrofishing survey was completed starting 100 m downstream of the proposed access road crossing. The electrofishers worked their way upstream as far as access and water depth allowed, focusing on the sampling of all habitat types observed. The lotic watercourses were considered open systems and any fish caught in tributaries were considered to be part of the larger lotic fish community.

5.2.1 Species At Risk

There are two freshwater fish species and one mussel species in Nova Scotia with special conservation status as designated by *SARA*:

- Atlantic whitefish (*Coregonus huntsmani*) – Endangered;
- Atlantic salmon [inner Bay of Fundy (iBoF) population] (*Salmo salar*) – Endangered; and
- Yellow lampmussel (*Lampsilis cariosa*) – Special Concern.

Of these species, the iBoF population of Atlantic salmon has the potential to inhabit watercourses within the Study Area. Three watercourses identified as having the potential to be crossed by Project activities (*i.e.*, via either access road or powerline) are tributaries to Salmon River. Salmon River connects to the inner Bay of Fundy in the vicinity of the town of Truro. Salmon River and its tributaries are protected under *SARA* because of their potential to support iBoF Atlantic salmon during the freshwater phase of their life cycle.

Atlantic Salmon

The Inner Bay of Fundy Atlantic salmon is anadromous, meaning the species spawns in fresh water but spends much of its life at sea. Inland, this fish favours natural stream channels with rapids, pools and gravelly bottoms in which hatchlings can hide from predators. The fish prefer cool water that is free from chemical and organic pollution, with temperatures maintained between 15°C and 25°C in summer. When living in the Bay of Fundy itself, these salmon prefer relatively stable water temperatures—between 1°C and 13°C year round (COSEWIC 2006) with a preference around 8°C. Recent studies on sea surface temperatures show how limiting the marine environment is for iBoF salmon (COSEWIC 2006).

Atlantic salmon spawn in river and stream beds in October or November. Two to six years after hatching as freshwater fish, they adapt to saltwater life and head out to sea. Within the iBoF population, about 93% of the fish return to spawn after one winter at sea, the majority (73%) of which are female fish (COSEWIC 2006).

Inner Bay of Fundy salmon runs that totaled 30,000 to 40,000 in the mid-1980s declined to less than 500 in 1998. In 2003, fewer than 100 adults are estimated to have returned to the 32 rivers known to historically provide habitat (COSEWIC 2006). In fact, juvenile salmon have not recently been detected in nearly half of this fish's historic spawning grounds.

The Inner Bay of Fundy Atlantic Salmon has been listed as endangered under the *Species at Risk Act* since June 2003. A recovery strategy that includes identification of their critical habitat has been developed (DFO 2010).

5.2.2 Species of Conservation Concern

COSEWIC Fish Species of Conservation Concern

American eel (*Anguilla rostrata*) was recently assessed as Threatened by COSEWIC. While this species is not currently afforded the additional protection of a *SARA* designation, there is potential in the future for the species to be listed by the Act. American eel are widespread within Nova Scotia waters and inhabit a range of habitat types and have the potential to inhabit watercourses within the Project Study Area.

Provincial Fish Species of Conservation Concern

There is one species of freshwater fish listed under the Nova Scotia *Endangered Species Act*. That species is the Atlantic whitefish, which is also listed under *SARA*. Given that Atlantic whitefish are not known to inhabit the watershed associated with this Project, their listing under the *Endangered Species Act* did not affect the assessment.

Two fish species anticipated to be found within the Study Area have also been given at-risk designations provincially: Atlantic salmon (*Salmo salar*) and brook trout (*Salvelinus fontinalis*). Atlantic salmon is listed by NSDNR as "Red", indicating that they are known to be or thought to be at risk. The Atlantic Canada Conservation Data Centre (ACCDC) considers Atlantic salmon to be globally widespread and abundant but locally rare with the potential to be vulnerable to extirpation due to rarity or other factors. Salmonids are generally considered a sensitive family of fish, indicative of good water quality in relation to pH, dissolved oxygen, and metals (or other contaminant) levels. Brook trout are also salmonids and as such are similarly sensitive to several environmental conditions. NSDNR lists brook trout as "Yellow", or sensitive to human activities or natural events. Brook trout is not listed on federal or provincial lists of conservation concern. ACCDC considers brook trout it to be globally widespread and abundant and locally widespread, fairly common, and apparently secure with many occurrences, but of long term concern (ACCDC 2011).

5.2.3 Surface Water

The majority of the Project is situated along a ridgeline which separates three primary watersheds, 1DO, 1DP and 1DH (River John, Salmon River and Pictou River Watersheds, respectively). This division causes water from within the Project Study Area to flow in three different general directions based on the location within the Project Study Area. These three watersheds total an area of 34,735,387 km^2 (NSGC 2011). Within these three primary watersheds, the Project Study area occurs in approximately 68 km^2 of drainage area. As the Project is located along a predominant ridgeline, the drainage area encompassed by the Project is minimal.

The River John watershed encompasses the majority of the Project Study Area and drains all the stream crossings from WC-4 and WC-S3 north to WC-10. These stream crossings flow through various tributaries into the West River John which eventually flows into the Northumberland Strait. The River John is known to support recreational fisheries for brook trout, brown trout and fall-run Atlantic salmon. There are no Protected Water Areas or municipal water withdrawals within the River John watershed.

The Salmon/Debert watershed drains two sections of the Project Study Area. One section in the sourthern portion of the Project Study Area includes watercourses WC-1 to WC-3 including WC-S1 and WC-S2. The second section is located in the northern portion and includes WC-11 and WC-S4. Due to changes made to optimize the site layout, these watercourses are no longer proposed to be crossed. The Salmon/Debert watershed is the second largest drainage area within the Project Study Area. The water from the two sections of the Project Study Area flows into Steele Run and White Brook, respectively before joining the Salmon River and finally the Bay of Fundy. With the direct connection to the Bay of Fundy, the watercourses within the Salmon/Debert watershed have the potential to contain IBoF Atlantic Salmon. The IBoF Atlantic Salmon populations are protected under SARA, and therefore the watercourses in the Project Study Area constitutes SARA habitat; alteration of SARA habitat is prohibited without ministerial approval. There are no Protected Water Areas or municipal water withdrawals within the Salmon/Debert watershed.

The Pictou River watershed encompasses the eastern section of the Project including WC-P1, WC-P2 and the majority of the drainage area within the existing Dalhousie Mountain Wind Farm. These watercourses will eventually drain into the East River of Pictou through various tributaries. There are no Protected Water Areas or municipal within the Pictou River watershed that will interact with the Project.

As the Project is unlikely to result in an interaction with surface water levels or result in an alteration of surface water regimes within the Project Study Area or watershed, existing water withdrawal permits in the watershed were not addressed.

Water quality within the Project Study Area can be described as temperate and slightly acidic with low conductivity, based on conditions observed during the field assessments. These conditions are typical to Nova Scotia, and are further assessed as they pertain to fish habitat in Section 5.2.4. Since the Project Study Area is underlain by Parrsboro Formation and Canso Group bedrock and not Halifax formation slates, acid generating rock is not anticipated to be a risk during the construction activities.

5.2.4 Aquatic Environment Survey Results

The results of the field-based fish and fish habitat surveys confirmed that the Project Study Area is dominated by clear, hard-bottomed headwater streams that support salmonid spawning and rearing habitat, which was confirmed by the presence of salmonids in several streams. Following the field assessment, three of the twelve potential watercourses were re-classified as local drainage channels (WC-5, WC-9, and WC-A). As such, these three drainage channels will not be afforded the protection of a watercourse designation. It is anticipated that the drainage channels will not require a permit for Watercourse Alteration from NSE. These drainage channel designations (WC-5, WC-9, and WC-A) were determined to be accurate at the time of the survey and were based on channel morphology, water quality and quantity, habitat characteristics and substrate composition. The three drainage channels identified in the Project Study Area conveyed water into wetlands or upland depressions; therefore, they were not connected to fish-bearing waters. The physical habitat features and water quality data collected at the drainage channels is included in summary tables below since these data contributed to the decision to designate them as drainage channels instead of watercourses. However, the discussion in the following sections will focus upon the nine field-confirmed watercourses.

Physical Habitat

A summary of the physical habitat characteristics observed in the nine confirmed watercourses and three drainage channels is provided in Table 5.2. The GPS coordinates and gradient provided in Table 5.2 for each stream and drainage channel are desktop calculations that were determined using available mapping. The status of fish presence or absence, the identification of barriers to fish passage, and the potential need for new crossing structures is summarized for each watercourse and drainage channel.

Table 5.2 Fish Habitat Assessment Summary (August 2011) for the Clydesdale Wind Farm Study Area

Project	Water-course ID	Name	Watercourse Coordinates (NAD 83) Easting	Watercourse Coordinates (NAD 83) Northing	Watercourse on 1:10000 NSGC maps	Nature of Watercourse	Watercourse Crossing Structure	Fish Presence Within Study Area	Fish species confirmed (common name)	Rationale for Fish Habitat Determination	Estimated Length of Watercourse at Crossing (m)	Average Bank Channel Width (m)	Average Depth (cm)	Gradient along Survey Area [1] (%)	Upstream Bank Slope Left (^{0})	Upstream Bank Slope Right (^{0})	Downstream Bank Slope Left (^{0})	Downstream Bank Slope Right (^{0})	Upstream Stability Left	Upstream Stability Right	Downstream Stability Left	Downstream Stability Right	Are There Known Fish Passage Obstructions in Assessment Area[1]?	New Crossing Structure Required for Fish Passage?
Clydesdale Wind Farm	WC-1	Unnamed tributary to Steele Run	501162	5042269	Yes	Clear water, hard bottomed stream	None	Anticipated (*SARA* waters)	-	Potential spawning and foraging habitat present; direct connection between WC-1 and larger fish-bearing waters	up to 10 m	2.4	8.5	3.7	14	4	10	4					None Observed	Yes (New structure required at proposed single crossing downstream of WC-1 and WC-2 confluence)
Clydesdale Wind Farm	WC-2	Unnamed tributary to Steele Run	501137	5042267	Yes	Clear water, hard bottomed stream with heavy woody debris cover	None	Anticipated (*SARA* waters)	-	Potential spawning and foraging habitat present; direct connection between WC-2 and larger fish-bearing waters	up to 10 m	1.7	7.5	3.5	0	15	30	20					None Observed	
Clydesdale Wind Farm	WC-3	Unnamed tributary to Steele Run	499720	5042724	Yes	Run between Bezansons Lake and Steele Run stream	Culvert (corrugated steel pipe)	Anticipated (*SARA* waters)	-	Potential spawning and foraging habitat present; direct connection between WC-3 and larger fish-bearing waters	up to 10 m	2.2	12	1.3	10	15	5	5					None Observed	No (Existing structure acceptable)
Clydesdale Wind Farm	WC-4	Unnamed tributary to West Branch River John	498791	5044324	Yes	Hard bottomed headwater steam	Culvert (corrugated steel pipe)	Present	brook trout	Electrofishing survey [2]	up to 10 m	2.1	10	5	3	5	44	14					None Observed	No (Existing structure acceptable)
Clydesdale Wind Farm	WC-5	Drainage channel	497398	5045254	Yes	Soft bottomed, grass-dominated drainage channel between wetlands	None (old crossing removed; road acting as dam)	Absent	-	Wet area drainage channel; insufficient connection to larger fish-bearing waters.	up to 10 m	4.8	7	1.3	No channel	No channel	4	2					No connection to fish-bearing waters	No (Drainage channel; therefore, no fish passage needed.)
Clydesdale Wind Farm	WC-6	Unnamed tributary to West Branch River John	496816	5045884	Yes	Hard bottomed headwater steam, draining through wetland area	Culvert (corrugated steel pipe)	Present	brook trout	Electrofishing survey [2]	up to 10 m	2.2	13	3.3	2	1	-4	0					None Observed	No (Existing structure acceptable)
Clydesdale Wind Farm	WC-7	Unnamed tributary to West Branch River John	495968	5046169	Yes	Hard bottomed headwater steam downstream of proposed crossing; flooded beaver area upstream of RoW	None	Present	brook trout brown trout	Electrofishing survey [2]	up to 10 m	4.5	14	1.7	3	3	5	35					Beaver dam upstream provides at least partial obstruction during low flow periods	Yes (New structure required)
Clydesdale Wind Farm	WC-8	Unnamed tributary to West Branch River John	494843	5047082	Yes	Clear water, hard bottomed stream draining MacIntosh Lake; braided at proposed crossing.	None	Present	brook trout	Electrofishing survey [2]	up to 10 m	3.8	15	6	5	15	25	4					None Observed	Yes (New structure required)
Clydesdale Wind Farm	WC-9	Unnamed tributary to West Branch River John	494528	5049038	Yes	Narrow drainage channels through wetland area	None	Absent	-	Wet area drainage channel; insufficient connection to larger fish-bearing waters.	up to 10 m	1.4	15	3.3	1	10	0	0					No connection to fish-bearing waters	No (Drainage channel; therefore, no fish passage needed.)
Clydesdale Wind Farm	WC-10	Murray Brook	493600	5049925	Yes	Narrow channel, hard bottomed at RoW; braided through wetland area; soft bottomed downstream of wetland.	Hung culvert (corrugated steel pipe)	Present	brook trout	Observed in pool during habitat survey; electrofishing survey.	up to 10 m	0.7	7	7.3	25	5	10	10					Hung culvert	Repair/Replacement needed
Clydesdale Wind Farm	WC-11	Unnamed tributary to MacKays Mill Brook	492074	5050727	Yes	Flooded upstream of proposed crossing (multiple beaver dams); downstream channel defined, then becoming overgrown	Timber bridge	Present	Not identified to species	Observed in pool during habitat survey	up to 10 m	2.6	6 (where not flooded by beaver dams)	2	35	45	0-45	10					Multiple Beaver Dams providing at least partial obstruction to fish passage during low flow periods	Yes (replacement of timber bridge needed)
Clydesdale Wind Farm	WC-A	Unnamed stream	498165	5044553	No	Short drainage channel (<100m downstream of proposed crossing)	Hung culvert (High Density Polyethylene)	Absent	-	Wet area drainage channel; Electrofishing survey [2]	up to 10 m	4.5	6	Not Available	o	15 (poor visibility)	2	2					Hung culvert	No (Drainage channel; therefore, no fish passage needed.)

[1] Habitat Assessment Area: 100 m upstream and 200 m downstream of proposed Clydesdale Wind Farm Access Road Crossing
[2] Area Electrofished: 100 m downstream of proposed access road crossing

Green	Stable and vegetated
Yellow	Bare Stable
Red	Eroding

Water Quality

Water quality was measured *in situ* approximately 10 m downstream of the proposed watercourse or drainage channel crossing during the August 2011 field survey. The water quality data is summarized in Table 5.3. Water quality was measured at one location, at one point in time within the vicinity of the proposed crossing for each watercourse. Natural variation in the water quality parameters measured *in situ* is expected seasonally and annually within lotic systems. The water quality measurements were collected in run flow types whenever possible.

Two water quality measurements were taken at Watercourse Crossing 3. This crossing location was situated immediately downstream of Bezansons Lake outlet, as such, water quality was measured from the lake outlet as well as 10 m downstream of the crossing location. Water quality at these two locations were measured to determine water quality within the two different physical habitat units.

Table 5.3 *In Situ* Water Quality Assessment Summary (August 2011) and CCME FAL (2007) Exceedances, Clydesdale Wind Farm Study Area

Stantec Field Reference Number	Water Temperature (^{0}C)	pH	Specific Conductivity (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)
WC-A (DC [1])	15.08	**6.38**	23	10.23	101.7
WC-1	20.17	6.63	295	**9.40**	104.1
WC-2	19.64	7.70	32	**8.62**	94.1
WC-3 Bezansons Lake Outlet	24.18	6.69	23	**8.15**	97.4
WC-3 Unnamed Tributary to Steele Run	24.55	6.79	25	**6.82**	82.8
WC-4	14.27	**6.44**	26	11.20	98.6
WC-5 (DC)	16.29	6.52	126	**8.92**	78.9
WC-6	15.54	**6.21**	35	**5.76**	57.7
WC-7	11.72	7.63	42	**9.27**	97.1
WC-8	20.91	6.57	25	9.52	106.1
WC-9 (DC) [2]	22.98	6.62	35	**6.82**	58.6
WC-10	14.66	6.61	36	10.37	101.3
WC-11	18.87	**6.34**	70	**3.48**	37.8

Exceedances of the CCME FAL Guidelines are highlighted in **bold font** and colored as per the legend below
[1] DC=Drainage Channel
[2] Taken approximately 175 m downstream of proposed crossing, downstream of wetland area.

Dissolved Oxygen Guidance Exceedance Legend

CCME FWAL - DO warm spp. Early life stage	DO < 6.0	
CCME FWAL - DO warm spp. Other life stage	DO < 5.5	
CCME FWAL - DO cold spp. Early life stage	DO < 9.5	
CCME FWAL - DO cold spp. Other life stage	DO < 6.5	

Water quality data was compared to the 2007 *Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life* (FAL) from the Canadian Council of Ministers of the Environment (CCME). This document provides guidelines specific to Canada in relation to the water quality parameters required for the growth and development of eggs and juvenile fish into mature spawning adults. FAL guidelines (CCME 2007) for pH suggest that a pH of 6.5 units is the minimum level observed before stress is induced on fish and eggs. Three streams fell below this threshold value. Within Nova Scotia, pH levels below 6.5 are common and fish recruitment and development are continuing in streams supporting these low pH levels. Acidification can be caused by a variety of factors including influences from wetlands, naturally occurring organic acids and geological sources (CCME 2005), as well as anthropogenic effects. Natural soil composition conditions such as higher sulfur content affect pH because, once oxidized and in contact with water, sulfuric acid is created which leaches into the ground and surface water, lowering pH. The presence of fish (discussed in greater detail in fish survey section below) in all three of these low pH watercourses confirms that the pH does not prohibit fish from inhabiting these streams.

Dissolved oxygen was also measured during the field surveys. The atmosphere and photosynthesis of aquatic plants are the major sources of dissolved oxygen in water and the balance between the input of oxygen and consumptive metabolism of organisms and oxidizable matter received controls the dissolved oxygen content in the water (CCME 1999). The concentration of dissolved oxygen in a watercourse also depends on a number of independent variables that include surface and interstitial water velocity/discharge, hydraulic gradient, sediment texture and porosity, bottom morphology, daily water temperature fluctuation, and the consumptive oxygen demand of the substrate (CCME 1999).

The FAL guidelines set a minimum of 9.5 mg/L for early life stages and 6.5 mg/L for other life stages of cold water species (*i.e.*, salmonids). At the time of the survey, the dissolved oxygen in all but three of the watercourses assessed fell below the minimum guideline (see Table 5.3). In several of these streams, juvenile salmonid were still caught during the fish survey period. CCME guidelines pertaining to the dissolved oxygen concentration for the protection of warm-water aquatic species are 6.0 mg/L for early life stages and 5.5 mg/L for all other life stages. Dissolved oxygen concentrations were above guidelines pertaining to the warm water aquatic species in all but two watercourses.

The lowest dissolved oxygen concentrations were observed in streams WC-6 and WC-11, at the time of the field survey (Table 5.3). The low dissolved oxygen levels recorded in these streams corresponds to the substrate type, water velocity, flow state and proximity to wetlands. Both streams are influenced by deposition of organic matter and fines (silt, sand and clay) from the nearby wetlands. This fine substrate matter enables growth of microbes and fauna within the sediment which aids in oxygen depletion at the sediment water interface. The low water velocities and flow states present in both streams at the time of the survey serves to impede water column mixing and limits the transfer of atmospheric oxygen to the top of the water column.

Guidelines for conductivity and temperature are not available from the CCME. Specific conductivity in eight of the nine freshwater streams surveyed within the Project Study Area ranged from 25 - 70 µS/cm. Watercourse WC-1 supported a higher specific conductivity of 295 µS/cm, which is still well within the range observed in Nova Scotia waters known to support aquatic life. Temperatures within the watercourses were representative of late-summer conditions in headwater streams, falling between 11.72 and 24.55°C at the time of the survey.

Salmonid species are the most sensitive group of fish expected to inhabit the streams in the Project Study Area. As discussed in the fish survey section below, the majority of the watercourses fished during the 2011 survey confirmed that the water quality in the Study Area streams can support aquatic life. The Project Study Area streams are currently supporting sensitive fish species known to inhabit areas dominated by good water quality. The water quality parameters measured *in situ* and the results of the physical habitat assessment suggest that the Project Study Area watercourses are not currently subjected to negative anthropogenic effects.

Fish Survey

Four of the nine streams assessed in the Project Study Area are known to connect to Salmon River, which is protected under *SARA* for its potential to support iBoF Atlantic salmon. These four streams (WC-1, WC-2, WC-3 and WC-11) were not included in the electrofishing survey. A total of two different species were confirmed present within the five remaining watercourses in the Project Study Area, based on the 2011 field assessments. The two fish species are salmonids: brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo salar*) (see Table 5.4 and photos in **Appendix E**). Based on the physical habitat and water quality assessment completed above, it is anticipated that iBoF Atlantic salmon have the potential to inhabit WC-1, WC-2, WC-3 and WC-11. It is further anticipated that all nine watercourses assessed in the Project Study Area have the potential to support American eel.

Table 5.4 Fish Survey Summary (August 2011), Clydesdale Wind Farm Study Area

Watercourse ID	Date (DMY)	Area Fished	Gear Type	Frequency (Hz)	Volts (V)	Duty Cycle (%)	Fishing Effort (sec)	Water Temp (°C)	Specific Conductivity (µS/cm)	Fish Results Scientific Name	Fish Results Common Name	Number Caught	Size Range (cm)
WC-A	31/08/2011	100 m DS	LR-24[1]	90	650	12	372	15.20	23	-	-	0	-
WC-4	31/08/2011	100 m DS	LR-24[1]	90	650	12	-	14.10	26	*Salvelinus fontinalis*	Brook trout	44	3.9 - 12.3
WC-6	31/08/2011	100 m DS	LR-24[1]	90	600	12	365	15.54	35	*Salvelinus fontinalis*	Brook trout	16	3.8 - 13.4
WC-7	31/08/2011	100 m DS	LR-24[1]	90	650	12	852	11.72	42	*Salvelinus fontinalis*	Brook trout	62	5.2 - 21.2
										Salmo trutta trutta	Brown trout	4	5.2 - 6.7
WC-8	31/08/2011	100 m DS	LR-24[1]	90	650	12	262	20.91	25	*Salvelinus fontinalis*	Brook trout	5	5.9 - 11.6
WC-10	31/08/2011	100 m DS	LR-24[1]	90	650	12	296	17.20	35	*Salvelinus fontinalis*	Brook trout	7	4.9 - 14.4

[1] Smith Root Backpack Electrofishing Unit, Model LR-24

There are no “Special Trout Management Areas”, as designated by the Nova Scotia Department of Fisheries and Aquaculture (NSFA), within the Assessment Area nor are there any downstream of the Assessment Area (NSFA 2011a). The NSFA has initiated salmonid stocking programs within the province. The one lake in the Project Study Area, Bezansons Lake, was not part of the 2011 stocking program (NSFA 2011b). Within Pictou County, River John was stocked in 2011 with sea run speckled trout, also known as brook trout (*Salvelinus fontinalis*) (NSFA 2011b). Multiple watercourses in the Study Area are headwater streams that feed West Branch River John (see Table 5.2), which itself feeds River John. The brook trout confirmed in the Study Area watercourses may be part of this stocking program. No recreational fishing activities are anticipated to occur within the headwater streams located in the Project Study Area.

The Study Area has been subdivided into two habitat units for the purposes of the fish population assessment. This division is based on the watershed drainage boundaries within the Study Area. All nine streams assessed during the 2011 field survey drain into one of two major river systems, creating the following two habitat units:

- Salmon River tributaries (WC-1, 2, 3, and 11)
- West Branch River John tributaries (WC-4, 6, 7, 8, and 10)

Salmon River Tributaries (WC-1, 2, 3 and 11)

As discussed previously, the Salmon River tributaries were not included in the 2011 electrofishing survey within the Project Study Area because they are part of the inner Bay of Fundy waters protected by *SARA*. These tributaries are protected by *SARA* because they have been identified as having the potential to support the endangered inner Bay of Fundy population of Atlantic salmon (see Section 5.2.1). The 2011 field-based physical habitat and water quality assessment confirmed that three of the four watercourses (WC-1, 2, and 3) can be classified as clear water, hard-bottomed, headwater streams. This habitat classification mirrors the classification applied to the majority of the West Branch River John tributaries (see following section). During the electrofishing survey carried out within the West Branch River John tributaries, two salmonid species were confirmed present (see Table 5.4). Therefore, for the purposes of the current assessment, it is assumed that WC-1, 2 and 3 provide fish habitat that can support salmonid species of fish, potentially including brook trout, brown trout and iBoF Atlantic salmon.

At the time of the field assessment, WC-11 did not exhibit the clear water, hard-bottomed steam type characteristic of the Project Study Area; however, fish were observed in a pool within WC-11 during the habitat survey. Therefore, it has been confirmed that WC-11 also provides habitat supportive of fish species and has the potential to bear salmonid species.

West Branch River John Tributaries (WC-4, 6, 7, 8, and 10)

There were five West Branch River John tributaries located within the Project Study Area included in the August 2011 field assessment, based on the proposed turbine layout options available at that time. All five watercourses can be classified as hard-bottomed, head water streams that provide salmonid spawning and rearing habitat. Brook trout were caught in the five tributaries during the 2011 electrofishing survey. Brown trout were also caught in WC-7 but in no other streams at the time of the survey. It is likely that brown trout have the potential to inhabit all five West Branch River John tributaries in the Project Study Area. The presence or absence of brown trout in other tributaries in the Project Study Area may be influenced by water temperature, which varies seasonally and annually.

The salmonids caught during the survey were dominated by juveniles, but a few larger-bodied brook trout were caught as well (see Table 5.4), suggesting that the tributaries contain sufficiently diverse physical habitat to maintain multiple life stages of salmonids. No small-bodied fish species (*e.g.*, minnows) were caught during the 2011 fish survey.

Spawning Periods

The two habitat units within the Project Study Area experience differing drainage patterns, but support a very similar fish assemblage. The primary difference between the two is that the Salmon River tributaries (WC-1, 2, 3 and 11) have the potential to support a third species of salmonid, iBoF Atlantic salmon, not located within the West Branch River John tributaries. As such, spawning activities within both habitat units will be comparable.

All three salmonid species present or anticipated to inhabit the Project Study Area watercourses are anadromous, meaning that adults of these species reside in saltwater and migrate to freshwater to spawn. Brook trout, brown trout and iBoF Atlantic salmon spawn in the fall over well-aerated, gravel substrates. Brown trout spawning typically starts later in the fall than the other two salmonid species (see Table 5.5), and can continue into early winter depending on water temperatures (Scott and Crossman 1998). Eggs of all three species incubate over winter in the gravel and emerge in the late winter or spring, depending upon water temperature.

Table 5.5 Summary of Spawning Times (Scott and Crossman 1998) for all fish caught or anticipated within the Project Study Area.

Scientific Name	Common Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Anguilla rostrata	American eel					1			2	2			
Salmo salar	Atlantic salmon												
Salvelinus fontinalus	Brook trout												
Salmo trutta trutta	Brown trout												

1 Upstream Migration of immature fish

2 Downstream migration of mature spawners

Spawning

Eggs/Sacfry in substrate

Anticipated overwintering period

Source: Scott and Crossman 1998

5.2.5 Additional Potential Watercourse Crossings

Since the aquatic field surveys carried out August 29 – 31, 2011, there have been some changes to the proposed turbine layout options and corresponding Project Study Area. Figure 5.1 identifies the proposed location for all turbines as well as the proposed routes to achieve access to the turbines for construction.

Separate crossings at watercourses WC-1 and WC-2 may no longer be required. The access road crossing location has shifted and is now proposed to be positioned slightly downstream of where these two watercourses converge (see Figure 5.1). It is anticipated that the aquatic environment conditions at the new proposed crossing will be similar to those observed at WC-1 and WC-2.

Additionally, several watercourses which did not interact with the original layout for turbines or access road crossings are now included in the Project Study Area. Using existing mapping, it is anticipated that an additional eleven watercourses exist within the Project Study Area (not all of which will require crossing). The Stantec ID, name and coordinates for each of these additional desktop identified watercourses are included in Table 5.6. While none of these watercourses were assessed in the field, a desktop review of available mapping suggests that these watercourses will be similar in nature to those assessed during the field survey. As such, it is likely that the watercourses will be dominated by hard-bottomed, headwater conditions and will bear water quality and fish habitat that support fish and other forms of aquatic life. Follow-up field surveys will be completed to confirm the habitat conditions and fish presence or absence within the watercourses not yet assessed. It is anticipated that these field surveys will be carried out following the finalization of the turbine layout.

Table 5.6 Potential Watercourse Crossings Identified by Desktop within the Currently Proposed Layout Options

Watercourse ID	Watercourse Name	UTM Coordinate	
		Easting	Northing
WC-P1	Tributary to Eight Mile Brook	502747	5042265
WC-P2	Tributary to Eight Mile Brook	503001	5042684
WC-P3	Tributary to Eight Mile Brook	501641	5044423
WC-P4	West Branch River John	499450	5044787
WC-P5	Tributary to West Branch River John	496069	5046044
WC-P6	Tributary to West Branch River John	494922	5046600
WC-P7	Tributary to West Branch River John	495603	5047561
WC-S1	Tributary to Steele Run	501401	5043158
WC-S2	Tributary to Steele Run	501030	5043062
WC-S3	Tributary to West Branch River John	499848	5044369
WC-S4	Tributary to MacKay's Mill Brook	491041	5050667

5.2.6 Watercourse Crossings Summary

The physical habitat, water quality and fish population assessments confirmed that the watercourses crossed by the proposed access roads in the Project Study Area are predominantly hard-bottomed, headwater streams that support at least one, sometimes more, species of salmonid fish. Fish habitat is protected under the *Fisheries Act* and by DFO's *Policy for the Management of Fish Habitat* (DFO 1986). This policy applies to all projects and activities in or near water which could result in the Harmful Alteration, Disruption, or Destruction (HADD) of fish habitat by chemical, physical, or biological means. The guiding principle of this policy is to achieve no net loss of the productive capacity of fish habitats. The Species at Risk Assessment determined that watercourses in the Salmon/Debert River watershed (WC 1, WC-2, WC-3, WC S1 and WC – S2) have the potential for IBoF Atlantic Salmon populations and as such can be described as species at risk waters. Fish and fish habitat in species at risk waters are protected through the *Species at Risk Act*.

Twelve watercourses in the Project Study Area were field assessed during the August 2011 fish and fish habitat survey. These locations were chosen to be assessed based on a preliminary road layout. A summary of the habitat characteristics and crossing structure status for each field-assessed stream and drainage channel is provided in Table 5.2. Eleven additional watercourses were assessed through desktop review resulting in 23 watercourses in the Project Study Area.

Based on the proposed turbine and road layout twelve watercourse crossings are anticipated. At four of these watercourse crossing locations culverts were present (WC-4, WC-6, WC-A and WC-10). Two crossing locations require the installation of crossing structures as none existed during the field assessments (WC-5 and WC-9). The crossing structures at the remaining six potential crossing locations are unknown and may require the installation of new structures or the repair of existing culverts.

All of the watercourse crossings identified through the desktop review and field assessments are anticipated to require crossing structures that facilitate fish passage and reduce habitat loss, such as the use of open bottomed culverts. A follow-up field survey will confirm which of these desktop assessed watercourses will require new or replacement crossing structures, and which have adequate existing structures.

5.2.7 Navigable Waters

The Navigable Waters Protection Program (NWPP) ensures the public's right to navigate Canada's waters without obstruction. This is accomplished through the administration of the *Navigable Waters Protection Act (NWPA)*. The *NWPA* is a federal law designed to protect the public right of navigation. In order to minimize the impact to navigation, the NWPP ensures that works constructed in navigable waterways are reviewed and regulated.

The only potentially navigable watercourse identified in the Project Study Area is Bezansons Lake. The proposed turbine layout options will not require a crossing of the lake itself.

Watercourse WC-3 is the outlet of Bezansons Lake. The proposed crossing of WC-3 will be within the unnavigable stream portion of the watercourse, not the lake. Therefore, no Authorization is required under *NWPA* for any of the watercourses in the Project Study Area.

5.3 TERRESTRIAL ENVIRONMENT

The terrestrial environment section details the flora and fauna, including any species of special conservation concern, which may be present within the Project Study Area.

5.3.1 Vegetation Types

The Project Study Area is located within the Cobequid Hills Ecodistrict, as identified by NSDNR's Ecological Land Classification (Neily *et al.* 2003). This ecodistrict is located within the Nova Scotia Uplands Ecoregion which is characterized by warm summers and long cold winters. This ecodistrict is relatively dry with a mean annual precipitation of 1,182 mm; however, it has the greatest snowfall of all of the ecodistricts of the Nova Scotia Uplands Ecoregion with 300 cm of snow in an average year. The Cobequid Hills Ecodistrict has a hilly topography and elevations range between 150 and 300 m above sea level (Neily *et al*. 2003). The highest points on the mainland of Nova Scotia, Nuttby Mountain and Dalhousie Mountain are found in this ecodistrict.

The soils of the Cobequid Hills Ecodistrict are dominated by course gravelly to stony sandy loams derived from igneous and metamorphic rocks. The slopes of the hills are typically steep and have well drained course to medium textured soils. The valley bottoms contain imperfectly drained course textured soils on level to hummocky terrain (Neily *et al*. 2003). The Cobequid Hills Ecodistrict is geologically complex. Most of the strata are precarboniferous and are resistant to erosion. There are many faults present in this ecodistrict with the most prominanent being the Cobequid fault which extends along the southern side of the ecodistrict from Truro to Cape Chignecto.

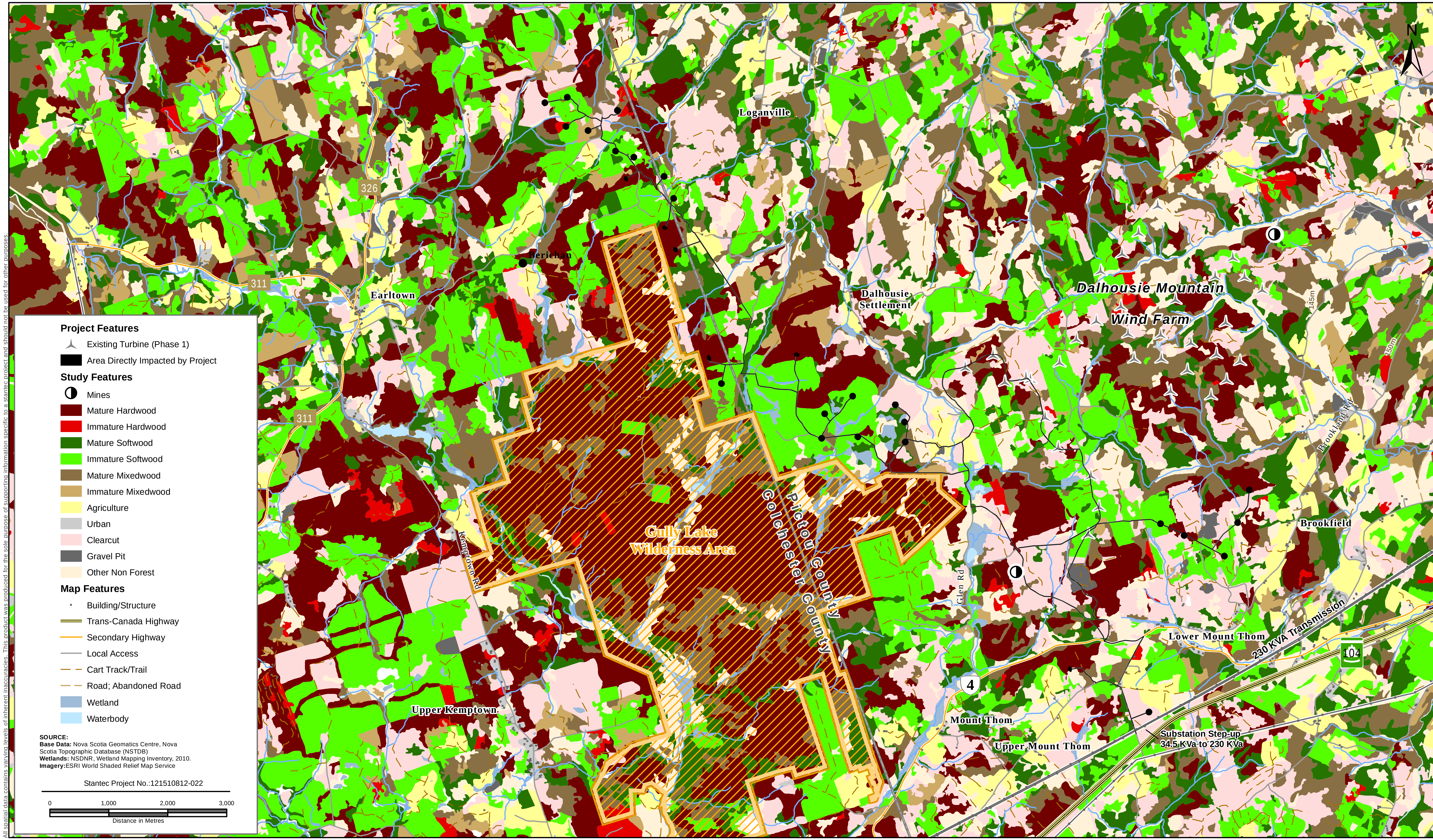
Forests of Cobequid Hills Ecodistrict are characterized by the presence of large expanses of tolerant hardwood forest that extends from the crests to the lower slopes. These stands are dominated by sugar maple (*Acer saccharum*), yellow birch (*Betula allegheniensis*), American beech (*Fagus grandifolia*), and red maple (*Acer rubrum*). In the valleys and lower slopes these species combine with white spruce (*Picea glauca*), red spruce (*Picea rubens*) and balsam fir to form mixedwood stands. Steep sloped ravines often support stands of eastern hemlock (*Tsuga Canadensis*), eastern white pine (*Pinus strobus*), white ash (*Fraxinus Americana*), and ironwood (*Ostrya virginiana*). Hardwoods growing on the crests of hills in this ecodistrict are often damaged by ice and snow accumulation resulting in reduced height and poor growth form. Stands of white spruce are common in valleys and lower slopes where abandoned farms have reverted to forest.

The Project Study Area is mostly forested but does support other vegetation types including wetlands, blueberry fields and disturbed areas such as roads and quarries. Table 5.7 lists the vegetation present in the Project Study Area and the hectares for each vegetation type (based on provincial mapping; as shown in **Appendix M** Turbine Site Photographs). The provincial mapping does not account for recent clearing activities and other disturbances. Figures 5.2 and 5.3 present the distribution of vegetation types and interior forest habitat.

Table 5.7 Vegetation Types found in the Project Study Area and Surrounding Areas

Vegetation Type	Surrounding Region (all habitats on Figure 5.2)		Project Study Area		Project Area (Footprint)	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Mature Hardwood Forest	7901	22.9%	351	19.8%	8.7	24.0%
Immature Hardwood Forest	493	1.4%	12	0.7%	0.7	1.9%
Mature Softwood Forest	3765	10.9%	92	5.2%	1.5	4.1%
Immature Softwood Forest	5710	16.6%	557	31.5%	14.2	39.2%
Mature Mixedwood Forest	4900	14.2%	108	6.1%	2.8	7.7%
Immature Mixedwood Forest	1032	3.0%	29	1.6%	1.1	3.0%
Clear-cut	4191	12.2%	337	19.0%	4	11.0%
Wetlands	373	1.1%	33	1.9%	0.1	0.3%
Agriculture	1802	5.2%	77	4.3%	0.6	1.7%
Other non-forested Areas	3652	10.6%	135	7.6%	2.6	7.2%
Gravel Pits	150	0.4%	25	1.4%	0	0.0%
Urban	189	0.5%	1	0.1%	0	0.0%
Open Water	60	0.2%	4	0.2%	0	0.0%
Total*	34493	100%	1771	100%	36.2	100%

Note: This analysis is based on 29 turbines, using NSDNR forestry data which underestimates cleared area and wetland habitat (refer to Table 5.8 for more accurate wetland data). It has also overestimated the area to be cleared at each tubine site, therefore the actual area of disturbance (particularly for mature forests) is expected to be much less than presented above.

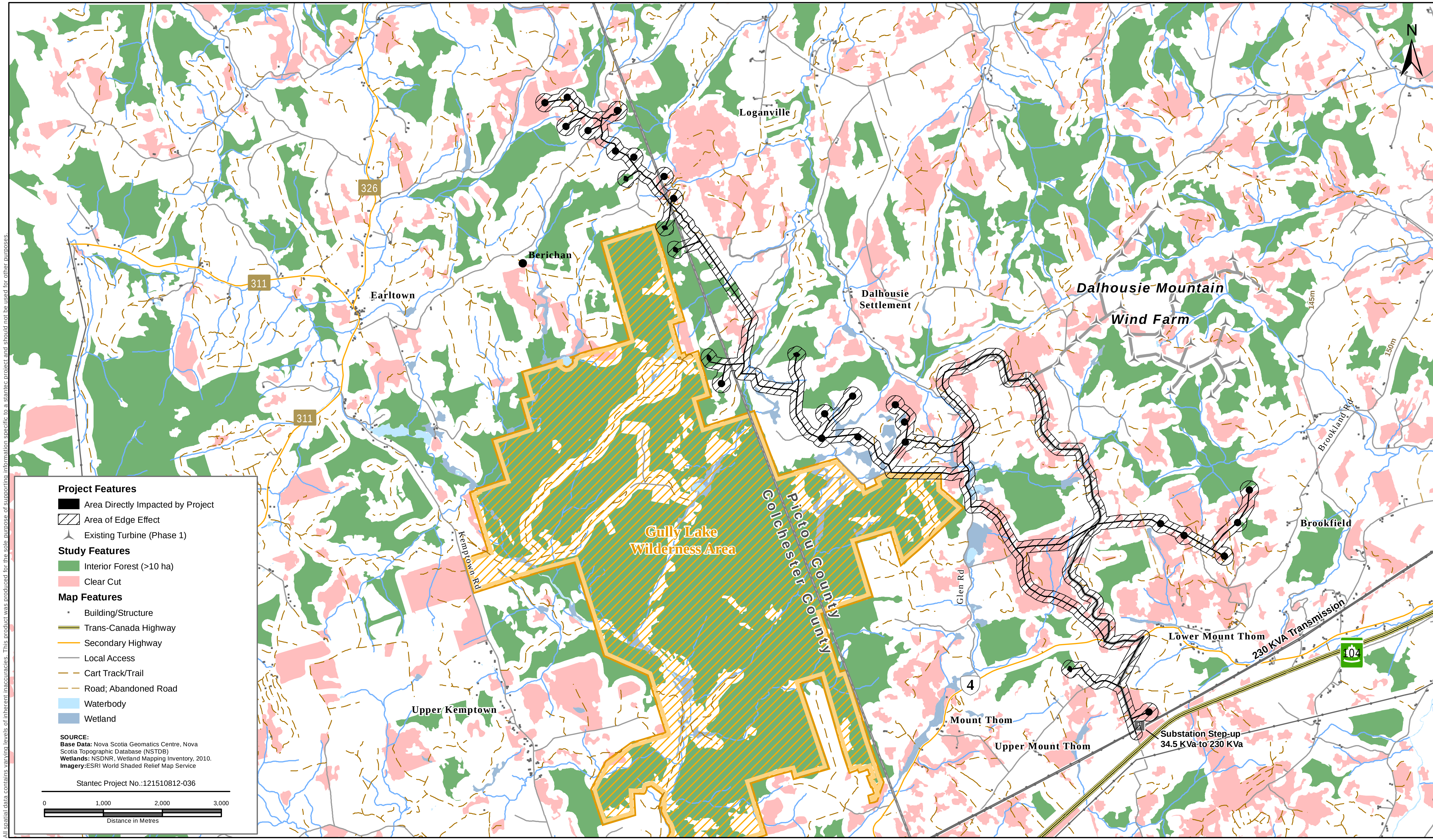


All spatial data contains varying levels of inherent inaccuracies. This product was produced for the sole purpose of supporting information specific to a stantec project and should not be used for other purposes.

PREPARED BY: J. Petho	Clydesdale Ridge Wind Farm Project	FIGURE NO.: 5.2
REVIEWED BY: C. Shupe		DATE: May 16, 2012
CLIENT: Dalhousie Mountain Wind Farm	**Vegetation Type Overview**	Stantec

Path: V:\1215\active\121510xxx\121510812_clydesdale_ ridge\geomatics\mapping\mxd\Report Figures\ST_NS_121510812-022_Forest_Habitat_20120427.mxd

Coordinate System: NAD 1983 UTM Zone 20N



PREPARED BY: K Keizer	Clydesdale Ridge Wind Farm Project	FIGURE NO.: 5.3
REVIEWED BY: C. Shupe		DATE: May 16, 2012
CLIENT: Dalhousie Mountain Wind Farm	**Interior Forest Overview**	Stantec

Path: V:\1215\active\121510xxx\121510812_clydesdale_ ridge\geomatics\mapping\mxd\Report Figures\ST_NS_121510812-036_Interior_Forest_20120404.mxd

Coordinate System: NAD 1983 UTM Zone 20N

Forests in the Project Study Area consist mainly of immature softwood stands (557 ha, 31.4% of the Project Study Area) and mature hardwood stands (351 ha, 19.8% of the Project Study Area). Hardwood stands in the Project Study Region are typically dominated by a mixture of sugar maple (*Acer saccharum*) and yellow birch (*Betula alleghaniensis*) with scattered balsam fir (*Abies balsamea*) in the overstory. The shrub understory is composed largely of striped maple (*Acer pensylvanicum*), fly-honeysuckle (*Lonicera canadensis*), and advanced regeneration of sugar maple and balsam fir. The ground vegetation layer is composed largely of wood ferns (*Dryopteris intermedia*, *D. carthusiana* and *D. campyloptera*). These stands correspond to the sugar maple/hay-scented fern (yellow birch variant) (TH1a) vegetation type (Neily *et al.* 2011). Development of the wind farm is expected to result in the loss of 8.7 ha of mature hardwood forest. As noted in Table 5.7, this calculation is based on NSDNR habitat mapping which does not reflect recent harvesting by landowners. The actual loss is predicted to be much less than 8.7 ha.

Many of the mature hardwood forests in the Project Study Area have been harvested. Some of these regenerating stands develop into immature hardwood forest stands that are similar in species composition to the mature stands except that the abundance of red maple (*Acer rubrum*) is higher in some stands. These immature hardwood forest stands occupy only 12.3 ha (0.7%) of the Project Study Area. It is expected that 0.73 ha of immature hardwood forest will be lost as a result of development of the wind farm.

Mature softwood stands in the Project Study Area are typically associated with abandoned agricultural land. Old field stands that have not been harvested since abandonment are typically dominated by white spruce (*Picea glauca*) along with a few balsam fir and do not have a well-developed shrub layer. The ground vegetation layer generally consists of a patchy cover of mosses including Schreber's moss (*Pleurozium schreberi*), stair-step moss (*Hylocomium splendens*) and shaggy moss (*Rhytidiadelphus triquetrus*). These stands correspond to the white spruce/aster-goldenrod/shaggy moss (OF1) vegetation type (Neily *et al.* 2011).

When these stands are harvested or succumb to disease or insect infestation, the new stands typically contain more balsam fir and more understory species characteristic of natural softwood stands. In the Project Study Area, these stands are composed mainly of balsam fir and have a sparse shrub understory composed of advanced regeneration of balsam fir and yellow birch. The ground vegetation layer is composed largely of Schreber's moss, stair-step moss, broom moss (*Dicranum sp.),* dwarf dogwood (*Cornus canadensis*), and false wild lily-of-the-valley (*Maianthemum canadense*). These stands correspond to the balsam fir-white spruce/evergreen wood fern-wood aster (OF4) vegetation type (Neily *et al.* 2011). Mature softwood forest stands cover 92.3 ha (5.2%) of the Project Study Area and it is expected that development of the wind farm will result in the loss of 1.5 ha of mature softwood forest (or less given caveats above regarding calculations).

Most immature softwood stands in the Project Study Area are characterized by a dense canopy dominated by a mixture of red spruce (*Picea rubens*) and balsam fir with scattered white birch (*Betula papyrifera*) and yellow birch. The ground vegetation layer of these stands is typically sparse and composed largely of broom moss, Schreber's moss, evergreen wood fern (*Dryopteris intermedia*), and New York fern (*Thelypteris noveboracensis*). As these stands mature they are likely to develop into the red spruce-balsam fir/Schreber's moss (SH5) vegetation type (Neily *et al.* 2011).

Other immature softwood stands in the Project Study Area have a dense canopy composed almost entirely of balsam fir with a few scattered wire birch (*Betula populifolia*). The ground vegetation layer is composed mainly of Schreber's moss. Over time these stands can be expected to develop into the balsam fir/wood fern/Schreber's moss (SH8) vegetation type (Neily *et al.* 2011). Altogether, immature softwood forest covers 557 ha (31.5%) of the Project Study Area of which approximately 14.2 ha or less will be lost as a result of development of the wind farm.

Immature mixedwood stands occupy 29.4 ha (1.6%) of the Project Study Area. These stands are characterized by moderately dense canopies that are composed largely of a mixture of balsam fir, yellow birch, white spruce, and red maple. The shrub layer is composed mostly of a mixture of blackberry (*Rubus canadensis*) and red raspberry (*Rubus idaeus*). The ground vegetation layer is quite heterogeneous in regards to species composition. The most abundant species include hay-scented fern (*Dennstaedtia punctilobula*), wild sarsaparilla (*Aralia nudicaulis*) and rough goldenrod (*Solidago rugosa*). As these stands mature they can be expected to develop into the red spruce-yellow birch/evergreen wood fern (MW1) vegetation type (Neily *et al.* 2011). The Project is expected to result in the loss of 1.09 ha or less of this vegetation type.

Mature mixedwood forest occupies 108 ha (6.1%) of the Project Study Area. Approximately 2.8 ha (or less given the outdated mapping and conservative approach in footprint calculation) of this vegetation type is expected to be lost as a result of Project activities. This vegetation type was not sampled at any of the proposed turbine sites in the Project Study Area so there are no descriptions for this vegetation type. It is likely that most of these stands belong to the red spruce-yellow birch/evergreen wood fern (MW1) vegetation type (Neily *et al.* 2011).

Forest plantations are relatively abundant in the Project Study Area. Five species have been planted in the Project Study Area including European larch (*Larix decidua*), Norway spruce (*Picea abies*), red pine (*Pinus resinosa*), red spruce/black spruce hybrids, and American larch (*Larix laricina*). There is also a Christmas tree plantation in the Project Study Area. These stands are not differentiated from natural stands on the base mapping used to develop the vegetation type mapping so it is not possible to determine how much is present or how much will be affected by the Project. Most plantations would be mapped as immature softwood forest.

Agricultural activity is limited in the Project Study Area but includes blueberry production. Three blueberry fields are present in the Project Study Area, one on the Glen Road, one on the Berichan Road and the other on the Clydesdale Road. All of these fields have been established on old pastures. Old pastures are present on the Gunshot Road and at Upper Mount Thom. Thirteen fields are present on the Gunshot Road. Seven fields have been idle long enough to be colonized by white spruce saplings. Three old fields are present within the Project Study Area at Upper Mount Thom. The total area of agricultural land in the Project Study Area is 77 ha which represents 4.3% of the total area. It is expected that development of the wind farm will result in the loss of 0.6 ha of agricultural land. All of the agricultural land is located along existing roads, some already upgraded for the Dalhousie Mountain wind farm. Actual loss of agricultural land will be minimal, and only along narrow strips alongside roads.

Heavily disturbed habitat is scattered throughout the Project Study Area. The area is serviced by a large number of woods roads as well as three unpaved roads that are maintained by the Department of Transportation and Infrastructure Renewal and several paved roads. These roads will provide most of the access routes to the proposed wind turbine sites. Two gravel quarries and one gravel pit are also found in the Project Study Area. These heavily disturbed areas are captured within the Other Non-Forested Area category which occupies 135 ha (7.6%) of the Project Study Area. This is probably an overestimate of the amount of heavily disturbed habitat since this category includes both the disturbed portion of the road and the road right-of-way which may not be disturbed. The total area of this category affected by wind farm development is estimated to be 2.6 ha. The gravel pits and quarries found in the Project Study area occupy 25 ha (1.4%) of the Project Study Area. Wind farm development will not affect any of the pits or quarries.

Wetlands are not particularly abundant in the overall Project Study Area owing to the rolling topography. Based on NSDNR forestry data, a total of 33 ha of wetland have been identified in the Project Study Area, comprising 1.9% of the Project Study Area (refer to Table 5.8). However, considering NSDNR wetland data, aerial photography interpretation, and field verification, it is estimated that there is closer to 100 ha of wetland habitat in the Study Area, of which 2 ha is expected to be affected by Project construction (upgrading of existing infrastructure and/or new proposed infrastructure) (refer to Table 5.8 in Section 5.3.3). Most wetlands are small but a few large wetlands are present mainly near the center of the Project Study Area where the topography is flatter. Most wetlands in the Study Area are tall shrub dominated swamps dominated by speckled alder (*Alnus incana*) or mixedwood treed swamps characterized by a cover of red maple, white ash (*Fraxinus americana*), balsam fir and black spruce (*Picea mariana*). Some bog habitat is present in the central portion of the Project Study Area and small fresh marshes are scattered throughout the Project Study Area in heavily disturbed areas such as roadsides and clear-cuts. Fens and low shrub dominated swamps are present in a few locations along sluggish watercourses (refer to Section 5.3.3 for more information on wetlands).

The habitat composition of the Project Study Area is generally similar to that of the surrounding region (Table 5.7) although there are some features that differentiate the two areas. The Project Study Area typically contains smaller proportions of mature forest and a higher proportion of clear-cut and immature forest. This is attributable to the fact that the Project Study Area has been located in an area that has been recently subjected to forest harvesting in order to minimize the amount of disturbance to relatively undisturbed habitat and to take advantage of the presence of an existing road network in this area.

5.3.2 Rare Plants and Species Richness

Rare plants and floral species richness in the Project Study Area was described using a combination of desktop and field surveys. Prior to conducting field surveys, aerial photography of the site was reviewed to determine the types and distribution of various habitats within the area. The air photo interpretation exercise was used to assist in a rare plant modeling exercise.

A rare plant modeling exercise was performed to determine the likelihood of presence of rare or sensitive plants within the Project Study Area. As part of the modeling exercise, all records of plant species listed by the NSDNR (2011) to be At Risk, May be at Risk, Sensitive to human activities or natural events, or ranked as S1, S2, or S3 by the ACCDC (2011) within a radius of 100 km from the center of the Project Study Area were compiled by means of an ACCDC data search. The habitat requirements of these species which had been recorded within 100 km from the center of the proposed development were then compared to the range of environmental conditions within the Project Study Area to determine if suitable habitat was present for these taxa. In instances where appropriate habitat was present for a particular species, that taxon was considered to be potentially present in the Project Study Area, and the habitat was identified as a target for field surveys. The phenology and ease of identification of each of the species potentially present in the Project Study Area was also incorporated into the model in order to determine when the rare or sensitive taxa would be best identified.

A total of 167 rare or sensitive vascular plant species have been recorded within 100 km of the center of the Project Study Area. Based on the results of the habitat model, there is potential for 49 of these species to be found within the Project Study Area. Two rare non-vascular taxa have been recorded within the 100 km radius around the Project Study Area, neither of which was considered to have potential to exist in the Project Study Area. Table 1 in **Appendix F** lists these species, their preferred habitats and their phenology.

The results of the habitat modeling exercise indicated that all of the habitat types present in the Project Study Area could potentially harbor rare species. However, because many of the rare or sensitive plants were associated with wetlands, mature deciduous forest and the shores of water bodies, these habitats were considered to be most likely to harbor plants of conservation interest. Therefore, although all habitat types present in the Project Study Area were surveyed particular attention was paid to the aforementioned areas.

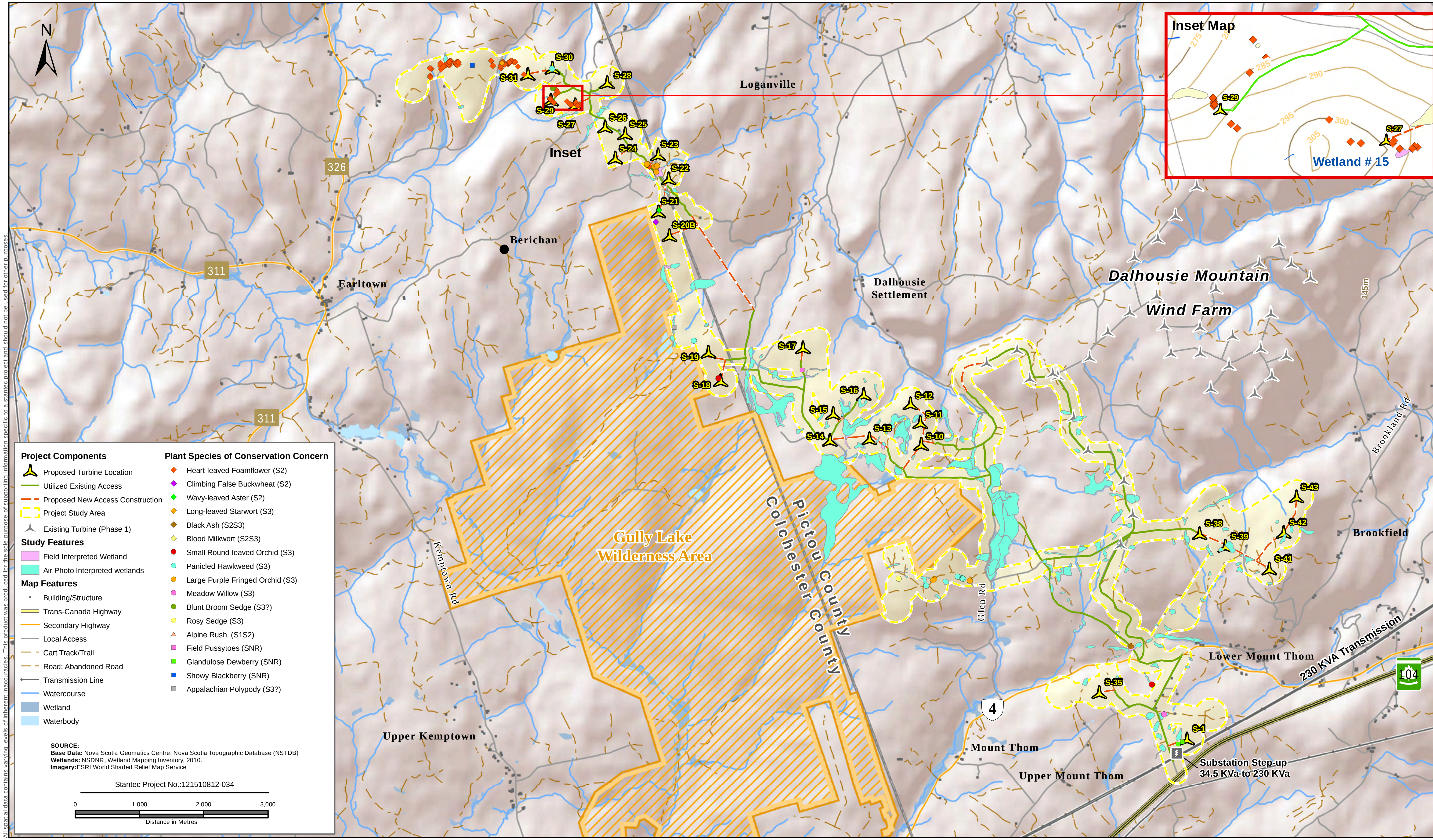
Although many of the vascular plant species highlighted by the model have restricted flowering periods, most are readily identified by their seeds, fruit and/or general morphological characteristics, such as leaf shape, throughout the growing season. Field surveys were conducted during June and August 2011 and are considered sufficient for the identification of all of the species identified by the model.

During the field surveys, a total of 37 proposed turbine sites were visited. Each of these sites consisted of a 100 m diameter circular plot representing the footprint of the turbine. Each plot was surveyed by an experienced botanist, once in June and once in August. During each survey, the botanist traveled through the plot visiting all vegetation types present in it. Each turbine site was approached along the proposed access road and/or transmission line route leading to it. Vegetation information for the access roads and transmission lines was collected along these routes. A vascular plant inventory for the Project Study Area was compiled using a Trimble Nomad. These units were also loaded with Project site mapping and were used as the primary navigation aid during the field surveys. The location of the first occurrence of each species was recorded using the Nomad's onboard GPS. Species having ACCDC general stratus ranks of S3 or below were recorded each time a population was encountered to provide a map of the distribution of these species. Wherever possible, the abundance of these uncommon and rare species was recorded at each of the locations where they were found to provide an indication of their abundance. The way in which abundance was recorded varied with species. For most species, the number of shoots present at a particular location was counted. In instances where large numbers of shoots were present, the numbers of shoots were estimated. In instances where large, dense patches of a particular species were present, the size of the patch was estimated. Other information collected at each turbine site included descriptions of the vegetation types present.

Following completion of the field surveys, the layout of the wind farm was altered with seven turbines moved to the east of the original turbine layout. This area had not been surveyed during the 2011 field season. However, much of this area was surveyed in 2007 as part of the EA for the Dalhousie Mountain Wind Farm (Phase I). The vascular plant inventory data collected for the Dalhousie Mountain Wind Farm can be used to determine if species of conservation interest are present in this area.

A total of 405 vascular plant taxa were recorded within the Project Study Area during the surveys. When the vascular plant list from the Dalhousie Mountain Wind Farm EA is merged with the 2011 field survey data, the total number of vascular plants recorded in the area increases to 448. These species are listed in Table 3 of **Appendix F** along with information regarding their population status in Nova Scotia. Figure 5.4 presents the vegetation survey results.

Species richness in the Project Study Area is relatively high. This is attributable mainly to the large size of the Project Study Area as well as the presence of forest stands in a variety of successional stages. The Project Study Area has been subjected to a substantial amount of disturbance in the form of large scale timber harvesting as well as past agricultural activity. These disturbances have contributed to increased species richness by allowing weedy species characteristic of disturbed habitats to become established. Many of these weedy species are non-native plant species that have become established in Nova Scotia following European settlement of the area. Seventeen percent of the species recorded in the Project Study Area are non-native species. This proportion of non-native species richness is similar to levels observed in other areas of Nova Scotia that have a history of European occupation.



PREPARED BY: J. Petho	Clydesdale Ridge Wind Farm Project	FIGURE NO.: 5.4
REVIEWED BY: C. Shupe		DATE: May 16, 2012
CLIENT: Dalhousie Mountain Wind Farm	**Plant Species of Conservation Concern**	Stantec

Path: V:\1215\active\121510xxx\121510812_clydesdale_ ridge\geomatics\mapping\mxd\Report Figures\ST_NS_121510812-034_Veg_Survey_Results_20120404.mxd

Coordinate System: NAD 1983 UTM Zone 20N

The plant species composition of the Project Study Area suggests a moderately productive area. Species characteristic of fertile sites were encountered at the northwestern end of the Project Study Area west of the Berichan Road. Species such as ericaceous shrubs that are abundant on infertile acidic sites were generally not abundant in most of the Project Study Area but were relatively common in the central portion of the Project Study Area southwest of Dalhousie Settlement.

Seven of the species identified as potentially present in the Project Study Area by the rare plant modeling exercise were found in or near it during the field surveys and the Dalhousie Mountain Wind Farm EA (2008). These included round-leaf hepatica (*Hepatica nobilis*), heart-leaved foamflower (*Tiarella cordifolia*), climbing false buckwheat (*Polygonum scandens*), squashberry (*Viburnum edule*), black ash (*Fraxinus nigra*), blood milkwort (*Polygala sanguinea*), and long-leaved stitchwort (*Stellaria longifolia).* Round-leaved hepatica is listed as May be at Risk by NSDNR. The remaining species are listed as Sensitive by NSDNR indicating that the Nova Scotia population is considered to be sensitive to human activities and natural events. ACCDC lists round-lobed hepatica as S1S2 indicating that they are believed to be extremely rare to rare in Nova Scotia. Climbing false buckwheat, squashberry and heart-leaved foamflower are listed as S2 indicating that they are believed to be rare in Nova Scotia, while black ash, and blood milkwort are listed as S2S3 by ACCDC indicating that the species is considered to be rare to uncommon in Nova Scotia. Long-leaved stitchwort is considered to be uncommon (S3) in Nova Scotia by ACCDC.

Round-leaved hepatica was encountered at one location during the 2007 surveys. This site was located outside of the Project Study Area approximately 2 km north of the nearest proposed turbine location (S-43). Thirty-five plants of this species were found along a very rich seepy streambed in mature sugar maple – yellow birch forest.

Heart-leaved foamflower was noted at 87 locations in the Project Study Area including 3 of the proposed turbine sites. The rest were found on or in relatively close proximity to the proposed access routes to the turbine sites. The number of individual plants associated with these sites is unknown since many of the aboveground shoots present in a given clump may be part of the same genetically unique plant (genet). The number of shoots can be used as an indicator of abundance. An estimated 3,200 shoots were observed during the field surveys. This species was restricted to the northwestern end of the Project Study Area in a two kilometer segment between Turbines 22 and 34. Within this area heart-leaved foamflower was relatively common and widespread. This species occurred in several vegetation types including rich hardwood stands (both mature and immature), recent clear-cuts on rich sites and along seepage tracks. Highest densities were generally found along seepage tracks while populations in forested areas populations tended to be more diffuse. Given the wide distribution of heart-leaved foamflower in the surveyed areas of the northwestern portion of the Project Study Area, it is likely that this species is abundant both inside and outside of areas potentially affected by turbine installation. In the current turbine array, the most westerly turbines (S-32, S-33 and S-34) have been eliminated which will reduce the number of patches of heart-leaved foamflower that could potentially be affected by construction activities from 87 to 19 patches.

Climbing false buckwheat was encountered at one location in the Project Study Area. A single plant was recorded in an open thicket in deciduous forest near Turbine 21. This species is typically found in low alluvial thickets along river intervales. This species is similar in appearance to fringed black bindweed (*Polygonum cilinode*) which was frequently encountered in recent clear-cuts and roadsides in the Project Study Area. It is possible that other populations of climbing false buckwheat may have been overlooked in some of the richer harvested areas at the northern end of the Project Study Area. This plant will not be directly affected by construction activities.

Squashberry was found at one location outside of the Project Study Area during the 2007 surveys. A small patch of squashberry was found in a coniferous treed swamp approximately 3 km from the nearest portion of the Project Study Area.

Black ash is typically found in deciduous and mixedwood treed swamps in Nova Scotia both in rich and impoverished sites. This species was encountered at one location in the Project Study Area. A single black ash sapling was found in a mixedwood treed swamp near the entrance to the Weeks Construction Ltd. Quarry off Highway 4. This sapling was in poor condition as a result of being struck by a fallen tree. The sapling was still vigorous but was deformed by the fallen tree leaning on it. Other suitable wetlands were present in the Project Study Area; however, this was the only location where black ash was found. This is the typical distribution pattern for this species in Nova Scotia with small numbers of individuals spread thinly over the landscape. The turbine array has been modified such that this black ash at this location will not be affected by wind farm construction activities.

Blood milkwort was also encountered at the southern end of the Project Study Area. One population comprising seven plants was found at the edge of a seldom used woods road near Bezansons Lake. Blood milkwort prefers areas of exposed mineral soil with high light levels and low competition from other plant species. It is typically found in areas that have been heavily disturbed but are not subject to frequent trampling damage. Infrequently traveled woods roads are a typical habitat for this species in Nova Scotia. The turbine array has been altered such that this species will not be affected by wind farm construction activities.

Long-leaved stitchwort was found in a wet grassy area near the outflow of a tall shrub dominated stream swamp near Turbine 32 at the northern end of the Project Study Area. A small patch of this species was found in association with sensitive fern (*Onoclea sensibilis*), purple-stemmed aster (*Symphyotrichum puniceum*), American golden saxifrage (*Chrysosplenium americanum*) and rough bedstraw (*Galium asprellum*). Turbine 32 has been eliminated from the turbine array and as such this patch of long-leaved stitchwort will not be adversely affected by wind farm construction activities.

Two rare species not identified as potentially being present in the Project Study Area by the rare plant modeling exercise were encountered during the 2011 field surveys. These included alpine rush (*Juncus alpinoarticulatus*) and wavy-leaved aster (*Symphyotrichum undulatum*).

Alpine rush is listed as May be at Risk in Nova Scotia by NSDNR and the Nova Scotia population is listed as S1S2 by ACCDC indicating that it is considered to be very rare to rare in the province. Alpine rush was found in a wetland complex located between Turbines S-13 and S-14. At this location it was found in open treed bog and was associated with three-leaved false Solomon's seal (*Maianthemum canadense*), white beakrush (*Rhyncospora alba*), cinnamon fern (*Osmunda cinnamomea*), and club spur orchid (*Platanthera clavellata*). Several hundred shoots were present at this location. The access road between S-13 and S-14 will not pass through the distribution of alpine rush in the wetland. However, there is potential for road construction activities at this location and along the access road between S-14 and S-16 to adversely affect this species either through hydrological alteration of the wetland or through inputs of silt that could alter the trophic state of the wetland.

Wavy-leaved aster is listed as a Sensitive species by NSDNR and ACCDC considers the Nova Scotia population to be rare (S2). A single wavy-leaved aster was found in a small wet area in a forest clearing at the S-21 turbine site. It was associated with soft rush (*Juncus effusus*), spotted jewelweed (*Impatiens capensis*), rough-stemmed goldenrod (*Solidago rugosa*), and common lady fern (*Athyrium filix-femina*).

Seven species were encountered during the field surveys that are listed as uncommon by ACCDC but are considered to be secure (Green listed) in Nova Scotia by NSDNR. These include panicled hawkweed (*Hieracium paniculatum*), small round-leaved orchid (*Platanthera orbiculata*), large purple-fringed Orchid (*Platanthera grandiflora),* meadow willow (*Salix petiolaris*), rosy sedge (*Carex rosea*), blunt broom sedge (*Carex tribuloides*), and red trillium (*Trillium erectum*).

Panicled hawkweed generally grows in mixed or dry deciduous forest. It is most frequently associated with oak. In the Project Study Area it was found at seven locations including tracks through recent clear-cuts, along woods roads and in old fields. The total number of plants present at these locations is difficult to determine since this species is difficult to distinguish from the more common Canada hawkweed which was common in the Project Study Area. This species was found near turbines S-6, S-7, and S-19. S-6 and S-7 are no longer part of the turbine array so the panicled hawkweed plants found at this location will not be affected by wind farm construction activities. The plants present at S-19 will be affected by construction activities.

Small round-leaved orchid is typically found in damp forest under deep shade. It was found at three locations in the Project Study Area. Eighteen plants were found in small stand of American beech (*Fagus grandifolia*) near turbine S-35. Two plants were found in a dense young spruce stand near turbine S-18. This species was also encountered during the 2007 field surveys conducted for the Dalhousie Mountain Wind Farm EA. One plant was found in a young yellow birch-balsam fir stand near turbine S-40. S-35 and S-40 have been eliminated from the turbine array leaving only the two plants present at S-18 affected by construction activities.

Large purple-fringed orchid is typically found in poorly drained meadows and along streams. In the Project Study Area this species was observed at 13 locations with a total of 62 plants recorded. It was patchily distributed in the Project Study Area with clusters of occurrences near turbines S-7, S-22, S-29, and S-37. In the Project Study Area large purple-fringed orchid was typically found in rich wetland habitat, particularly in areas where groundwater seeps were present. Turbines S-7 and S-37 have been eliminated from the turbine array so only the plants near S-22 and S-29 will be affected by construction activities. A total of seven plants affected.

Meadow willow was found at one location during the field surveys. Two meadow willows were found in a mixedwood treed swamp near turbine S-1. It was associated with white meadowsweet (*Spiraea alba*), speckled alder (*Alnus incana*), sensitive fern (*Onoclea sensibilis*), and gray birch (*Betula populifolia*). This population of meadow willow will not be adversely affected by wind farm construction activities.

Rosy sedge is typically found in dry deciduous forest and thickets. In the Project Study Area it was found in a red pine (*Pinus resinosa*) plantation near turbine S-8. Virtually all of the red pine in the plantation had died and the stand was reverting to a hardwood stand. One rosy sedge was found at this location. S-8 has been dropped from the turbine array consequently, this species will not be affected by construction activities.

Blunt broom sedge is typically found in swales and wet woods. This species was found in a seepage track wetland in a clear-cut between turbines S-29 and S-30. At this location, blunt broom sedge was associated with soft rush, sensitive fern and white meadowsweet. The number of blunt broom sedge present at this location is not known since this species can only be reliably identified in the laboratory making it not practical to do counts in the field. The access road between S-29 and S-30 does not come near the blunt broom sedge population so this population will not be affected by construction activities.

Red trillium is typically found on rich hardwood slopes. This species was not encountered during the 2011 field surveys but was recorded during the 2007 surveys in the vicinity of turbine S-43. Red trillium was scattered in sugar maple forest at several sites in this area. It is not known if red trillium is present within the footprint of S-43 or the proposed access roads leading to it. Follow-up rare plant surveys will have to be conducted in this area to determine whether or not this species is present.

Three species that have been listed by NSDNR as status Undetermined were encountered during the field survey including Appalachian polypody (*Polypodium appalachianum*), glandulose dewberry (*Rubus adenocaulis*) and showy blackberry (*Rubus elegantulus*). Status Undetermined indicates that there is insufficient information available to assess the population status of a particular species. For all three of these species the uncertainty regarding the population status of the species in Nova Scotia derives from confusion regarding the taxonomy of these species.

Until recently, Appalachian polypody was considered to be a variety of a common species, rock polypody (*Polypodium virginianum*). These new species are difficult to distinguish from each other making it more difficult to assess the population statuses of the new species. Until a sufficient number of new records of these species have been compiled or old specimens have been re-examined, the general status rank of this species will remain as Undetermined. Showy blackberry and glandulose dewberry are listed as status Undetermined due to the fact that *Rubus* species hybridize frequently making it difficult to assign specimens to species. In addition, the taxonomy of the genus *Rubus* has undergone substantial changes in recent years creating considerable confusion regarding the population statuses of many species in this genus.

Appalachian polypody was found at one location in the Project Study Area near turbine S-20. A small population of this species was found growing on an exposed boulder at the edge of a stream. Cliff faces and boulders are the typical habitats for this species. S-20 has been relocated and as such, Appalachian polypody will not be affected by construction.

Showy blackberry was found growing in small clearings in a young mixedwood stand dominated by yellow birch and white spruce located between turbines S-32 and S-33. This species is typically found in clearings on poorly drained soils. S-32 and S-33 have been dropped from the turbine array so this species will not be affected by construction activities.

Glandulose dewberry typically grows on rough ground, thickets and the edges of forested areas. In the Project Study Area it was found at two locations in gaps in young mixedwood forest near turbine S-1 at the southern end of the Project Study Area. The two glandulose dewberry plants found at this location are likely to be lost as a result of construction activity.

5.3.3 Wetlands

5.3.3.1 Methods

The distribution and abundance of wetlands in the Project Study Area was determined by a combination of desktop review and field surveys. Field identification and delineation of wetlands was conducted concurrently with early and late vegetation surveys, which occurred in June and August of 2011. During field surveys, 37 proposed turbine sites were visited, which were represented by a circular plot with a 100 m diameter representing the footprint of the turbine. Field staff searched for wetlands within each proposed turbine site as they existed at the time of survey. When encountered, wetlands were noted and typically delineated to the edge of the 100 m diameter plot. Wetlands were also noted and/or delineated along proposed access roads and/or transmission lines connecting turbine sites.

Wetlands were identified and delineated following principles outlined in the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987), and the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (U.S. Army Corps of Engineers 2009), using vegetation, soil, and hydrology as wetland indicators. Data were collected using Trimble Nomad and ProXT devices. Wetland boundaries beyond the field surveyed areas were identified using aerial photo interpretations. Turbine locations were adjusted following the field surveys; therefore, not all wetlands within the most current proposed turbine sites were field delineated. However, aerial photo interpretation was completed for all current proposed turbine sites and associated infrastructure.

Aerial photo interpretation was completed for wetlands within and adjacent to the Project Study Area using stereo pairs of 1:12,500 photos taken for Pictou County in 2007, and 1:10,000 photos taken for Colchester County in 2004. Aerial photo interpretation was completed by Michael Crowell, M.Sc., a wetland ecologist familiar with the Project Study Area and experienced in delineating wetlands. Wetlands were identified using topographic location and physiognomy of the plant communities. Wetlands were interpreted conservatively, in order to capture transitional wetland habitat such as treed swamps that are often present at the edges of more open wetlands. Treed wetlands are often difficult to accurately detect on aerial photos as they are similar in appearance to adjacent upland forested habitat. This approach increases the probability of misclassifying upland habitat as wetland, but more often reduces the likelihood of missing or underestimating the size of wetlands in the Project Study Area.

Once interpreted, wetlands were classified according to the Canadian Wetland Classification System (National Wetlands Working Group 1997) to class and type, with the addition of a "wet meadow" class. Whenever possible, different class and type combinations within the same wetland (*i.e.* in a wetland complex) were interpreted separately.

Wetland functional analyses were not completed for all wetlands within the Project Study Area as this is unfeasible because of the high number of wetlands, and also because not all wetlands were visited in the field. Wetlands will be avoided to the extent possible through design of Project components, but in the event that the Project is likely to affect wetland habitat, site-specific wetland functional analyses will be conducted by a qualified wetland ecologist for the potentially affected wetlands prior to any wetland disturbance. These analyses would be used to support an Application for Water Approvals for wetland alteration. Key functions identified and evaluated for wetlands within the Project Study Area were partially based on guidelines outlined in NovaWET (Tiner 2011), and include the following: surface water detention and water flow moderation, water flow maintenance, groundwater recharge, water quality treatment, carbon sequestration and storage, and biological productivity and habitat for Species of Conservation Interest. These evaluations are based on aerial photography and site visits conducted during field surveys.

5.3.3.2 Results

Following field surveys and aerial photo interpretation, it was determined that 161 wetlands are within the Project Study Area or have portions within the Project Study Area. The following discussion reports on the portions of wetlands within the Project Study Area, unless specifically noted. Wetland types include (in decreasing order of abundance) coniferous treed swamp, mixedwood treed swamp, tall shrub swamp, low shrub swamp, treed bog, shallow water wetland, fresh marsh, wet meadow, and deciduous treed swamp (Table 1, **Appendix G**).

Wetland types and the abundance and frequency of wetlands with at least a portion located within the Project Study Area are presented in Table 5.8. Note that the total of wetland types within the Project Study Area is higher than the actual number of wetlands within the Project Study Area because there are wetland complexes that contain more than one wetland type.

Table 5.8 Summary of Wetland Types, Area, and Numbers of Wetlands and Portions of Wetlands within the Project Study Area

Wetland type	Area of Wetlands within Project Study Area (ha)	Area of Wetlands affected by existing Infrastructure (ha)	Area of Wetlands affected by proposed infrastructure (ha)	Number of Wetlands within Project Study Area (wetland or portion of wetland complex)	Number of Wetlands Affected by existing Infrastructure	Number of Wetlands Affected by Proposed Infrastructure
Coniferous treed swamp	38.65	0.72	0.10	60	16	3
Mixedwood treed swamp	23.55	0.10	0.77	61	4	15
Tall shrub swamp	12.88	0.10	0.02	21	3	1
Low shrub swamp	8.87	0.02	0	8	0	0
Treed bog	8.02	0	0.03	4	0	1
Shallow water wetland	3.64	0.02	0	2	1	0
Fresh marsh	2.34	0	0.04	10	0	2
Wet meadow	1.13	0.01	0.06	7	1	3
Deciduous treed swamp	0.94	0	0.10	4	0	3
All wetlands	100.02	0.97	1.10	177	33	28

5.3.3.3 Wetland Types

Swamps

Swamps are wetlands dominated by woody plants, and can be either peatlands or mineral wetlands (National Wetlands Working Group 1997). The water table is generally rich in dissolved nutrients and at or near the surface of the wetland, and moves through the wetland. If peat is present, it can consist of well-decomposed wood, sphagnum, and/or sedges. Five types of swamp are present in the Project Study Area including (in decreasing order of abundance): coniferous treed swamp; mixedwood treed swamp; tall shrub swamp; low shrub swamp; and deciduous treed swamp. The following wetland type descriptions refer to those wetlands within the Project Study Area but are also typical of the greater region.

Coniferous treed swamps are dominated in the tree stratum by balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). The understory is typically dominated by cinnamon fern (*Osmunda cinnamomea*), and various species of sphagnum moss (*Sphagnum* spp.). Coniferous treed swamps are common throughout the Project Study Area, and range in size from less than 0.01 ha to over 10 ha. A total of 60 coniferous treed swamps are present in the Project Study Area and together these wetlands occupy 38.7 ha of the Project Study Area. The wind farm development will affect 19 of the 60 coniferous treed swamps present in the Project Study Area. Three of these wetlands will be affected by new Project infrastructure including turbine pads, transmission lines and new road. The remaining 16 wetlands are affected by existing roads that will be upgraded for use by the wind farm development. Upgrading of the roads may include the widening of roads and or replacement of existing culverts which could result in minor infilling and potential for hydrological affects if culverts are not installed properly. In regards to the area of coniferous treed wetland affected by the Project, it is anticipated that 0.82 ha (2.1%) of the coniferous treed wetland in the Project Study Area will be affected by Project construction activities.

Mixedwood treed swamps are also dominated by balsam fir and black spruce in the tree canopy, with the addition of red maple (*Acer rubrum*), and white ash (*Fraxinus americana*). The understory of mixedwood treed swamps is often dominated by cinnamon fern, manna grasses (*Glyceria* spp.), and sensitive fern (*Onoclea sensibilis*). Mixedwood treed swamps are common throughout the Project Study Area, and range in size from approximately 0.02 ha to approximately 3 ha. There are 61 mixedwood treed swamps in the Project Study Area with a combined area of 23.6 ha. Nineteen of the mixedwood treed swamps in the Project Study Area will be affected by Project construction activities, fifteen of which will be affected by new proposed infrastructure. The total area of mixedwood treed swamp affected by construction activity is estimated to be 0.88 ha which represents 0.4% of the area of mixedwood treed swamp present in the Project Study Area.

Tall shrub swamps are composed largely of speckled alder (*Alnus incana*), but also typically contain narrow-leaved meadowsweet (*Spiraea alba*), bluejoint reed grass (*Calamagrostis canadensis*), and sphagnum mosses. Tall shrub swamps are common throughout the Project Study Area, and range in size from approximately 0.06 ha to over 7 ha. There are an estimated 21 tall shrub swamps in the Project Study Area with a combined area of 12.9 ha. Four of these wetlands may be affected by construction activities with oner affected by proposed infrastructure and three affected by upgrading of existing infrastructure. The total area of tall shrub swamp potentially affected by construction activities is estimated to be 0.11 ha which is 0.9% of the area of tall shrub swamp present in the Project Study Area. Most of the affected area will be affected by upgrading of existing roads.

Low shrub swamps are characterized by the presence of a dense low shrub canopy composed mainly of sweet gale (*Myrica gale*) and leatherleaf (*Chamaedaphne calyculata*). The ground vegetation understory typically consists of scattered patches of sphagnum mosses, but very little herbaceous vegetation. Low shrub swamps are fairly common in the central region of the Project Study Area, and range in size from approximately 0.15 ha to over 12 ha. There are an estimated 8 low shrub swamps present in the Project Study Area with a combined area of 8.9 ha. Approximately 0.19% of low shrub swamp in the Project Study Area is likely to be affected by construction activities (affected by existing infrastructure).

Deciduous treed swamps are dominated by red maple, white ash, and gray birch (*Betula populifolia*). The shrub layer is typically composed of speckled alder and common winterberry (*Ilex verticillata*). Common herbaceous species include manna grasses and bluejoint reed grass. There are only four small deciduous treed swamps in the Project Study Area, two in the northern section of the Project Study Area, and two in the south. This is the least common swamp type in the Project Study Area with four identified during the field survey and air photo interpretation exercise. The total area of deciduous treed swamp in the Project Study Area is estimated to be 0.94 ha. Three of these wetlands are likely to be affected by construction activities which will result in the loss of approximately 0.08 ha of deciduous treed swamp habitat.

Bogs

Bogs are peatlands (organic wetlands containing 40 cm or more of peat accumulation) which receive their water primarily from precipitation (National Wetlands Working Group 1997). Because the rooting zone of bogs typically does not receive nutrient rich groundwater, bogs tend to be acidic and nutrient poor, which promotes the growth of many sphagnum mosses. Sphagnum further acidifies the wetland by efficiently taking up cation nutrients and replacing them with hydrogen ions. This acidity reduces decomposition rates within bogs, which increases the accumulation of peat.

Treed bogs are the only bog type in the Project Study Area. Treed bogs are typically characterized by an open tree canopy composed of stunted black spruce and tamarack (*Larix laricina*) with occasional red maple. Common shrubs include ericaceous species such as sheep laurel (*Kalmia angustifolia*), leatherleaf, common Labrador tea (*Ledum groenlandicum*) and rhodora (*Rhododendrum canadense*), as well as common winterberry and northern wild raison (*Viburnum nudum*). The understory is typically composed of sphagnum mosses, three-leaf Solomon's-plume (*Maianthemum trifolium*) and scattered sedges (*Carex* spp.).

Only four wetlands in or partially within the Project Study Area are classified as treed bogs or complexes containing treed bogs, and they are restricted to the center of the Project Study Area. Each of these wetlands is at least 6 ha in size; relatively large for wetlands near the Project Study Area. Most of the area of these wetlands is outside of the Project Study Area. The total area of teed bog found within the Project Study Area is estimated to be 8 ha. One of the treed bogs in the Project Study Area is likely to be affected by construction activities including both proposed infrastructure and upgrading of existing roads. The area affected is estimated to be 0.02 ha which is 0.34% of the area of treed bog present in the Project Study Area.

Shallow Water Wetlands

Shallow water wetlands are mineral wetlands characterized by the near year-round presence of standing water less than 2 m deep (National Wetlands Working Group 1997). Submerged or floating aquatic plants dominate, with lesser amounts of woody or standing emergent plants present.

Shallow water wetlands are variable in their dominant species, but can often include species such as pickerelweed (*Pontedaria cordata*), fragrant water-lily (*Nymphaea odorata*), and variegated pond lily (*Nuphar lutea* ssp. *variegata*).

Shallow water wetlands are not common within the Project Study Area and are mostly associated with Bezansons Lake along the Glen Road. The total area of shallow water wetland present in the Project Study Area is estimated to be 3.64 ha, of which 0.02 ha is expected to be affected by upgrading of existing infrastructure.

Fresh Marshes

Marshes are mineral wetlands that are periodically or persistently inundated by standing or slow flowing water (National Wetlands Working Group 1997). This surface water is typically nutrient-rich, and generally fluctuates seasonally, possibly declining low enough to expose matted vegetation or mud flats during dry periods. Marshes are dominated by herbaceous species, but may contain some woody species on margins.

Fresh marshes in the Project Study Area are typically dominated by broad-leaved cattail (*Typha latifolia*), common woolly bulrush (*Scirpus cyperinus*), and bluejoint reed grass.

Fresh marshes are small (typically less than 1 ha) and scattered throughout the Project Study Area, typically in heavily disturbed areas such as road sides and in recent clear-cuts where anthropogenic activities have exposed mineral soil in existing wetlands or have altered local hydrology resulting in the establishment of wetland habitat on mineral soils. Ten fresh marshes have been identified in the Project Study Area through field surveys and air photo interpretation with a total area of 2.3 ha. Two of the fresh marshes are likely to be affected by construction activities resulting in the loss of 0.04 ha of fresh marsh habitat. All of the fresh marsh habitat lost to construction activities will be affected by new infrastructure.

Wet Meadows

Wet meadow is a Nova Scotia classification used to describe wetlands that are borderline between fresh marshes and fens. They generally contain less surface water than fresh marshes, but do not have the peat accumulation or chemistry of fens. Vegetation contains species common in fresh marshes and fens.

Wet meadows are often dominated by herbaceous species such as bluejoint reed grass, tussock sedge (*Carex stricta*), manna grasses, and also typically contain some shrub cover of species such as speckled alder and sweet gale. They are typically found in the floodplains of sluggish streams.

Wet meadows within the Project Study Area are small (typically less than 0.5 ha), and scattered throughout the northern and southern portions of the Project Study Area. Seven wet meadows were identified in the Project Study Area, with a combined area of 1.1 ha. The total area of wet meadow affected by construction activity is estimated to be 0.07 ha.

5.3.3.4 Wetland Functions

Wetlands are important environmental features that provide a number of beneficial functions, including: surface water detention and water flow moderation; water flow maintenance; groundwater recharge; shoreline erosion protection; water quality treatment; carbon sequestration and storage; and biological productivity and habitat for Species of Conservation Interest. These functions are outlined below for wetlands within the Project Study Area.

Surface Water Detention and Water Flow Moderation

Wetlands in the Project Study Area have potential to regulate stream and overland flow by slowing and temporarily detaining surface water. Many of the wetlands in the Project Study Area are located in depressions or basins downslope of moderate to steeply sloped ridges, and are likely to intercept runoff from higher elevations. Others are located along watercourses and would moderate stream flow, reducing the potential for flooding in areas downstream of the Project Study Area. This function is important for wetlands within and adjacent to the Project Study Area as there are communities downstream to the north, northwest, and southeast of the Project Study Area. Many of the wetlands that would contribute to this function are only partially located in the Project Study Area.

Water Flow Maintenance

The Project Study Area is located at high elevation, and includes portions of many wetlands that act as headwaters to watercourses. These wetlands, in particular several large wetlands near the centre of the Project Study Area, are important for maintaining water flow in their associated watercourses. Other wetlands that function to moderate water flow (discussed above) contribute to maintaining base flow by temporarily storing surface water and slowly releasing it.

Groundwater Recharge

Although this function is often difficult to assess even with field survey observations of wetlands, it is possible that smaller basin wetlands found at peaks in the southern and northern portions of the Project Study Area would contribute to groundwater recharge. The importance of this function for wetlands within the Project Study Area is likely to be low.

Shoreline Erosion Protection

Wetlands bordering large watercourses or bodies of water can provide protection from shoreline erosion, absorbing energy from waves and/or flowing water that would otherwise damage shorelines. As previously described, the Project Study Area is located at high elevation and does not contain higher order watercourses that would benefit from shoreline erosion projection. There are few bodies of water in the Project Study Area, but several of them are associated with wetlands (*e.g.* wetlands 82 and 129), and would provide shoreline erosion protection to their associated bodies of water.

Water Quality Treatment

Many wetlands improve water quality of associated surface water through a variety of processes. These processes can include degradation of organic chemicals, decreasing water energy (by way of vegetation density) to allow suspended materials to settle, uptake of nutrients by plants and microbes, and conversion of soluble metals to insoluble forms. When contaminant degradation is mediated by microbes, highly productive wetlands such as marshes and swamps often perform better than bogs and other unproductive wetlands. Various factors influence the ability of a wetland to improve water quality, including the degree of water flow through substrate, the degree of channelization of flow through the wetland, the amount of oxygen in the water, and water temperature. Wetlands within the Project Study Area have qualities that would allow them to improve water quality (*e.g.* many wetlands are swamps, are riparian, and/or have dense vegetation); however, the location of the Project Study Area is such that it is unlikely to receive water of poor quality, as it is located in a relatively uncontaminated area. There is some forest harvesting occurring in the Project Study Area and many existing woods roads which may lead to increased erosion and sediment inputs; therefore, wetlands downstream of harvesting and woods roads have the greatest potential to improve water quality.

Carbon Sequestration and Storage

Wetlands can be important sinks for greenhouse gases. Peatlands such as bogs and fens, which have slow rates of decomposition, can be important carbon sinks by storing large volumes of organic material in the form of peat. Marshes and swamps that remain saturated throughout most of the year also tend to accumulate peat and act as carbon sinks. In addition, treed swamps sequester carbon in wood produced by trees, which is typically slow to decompose after trees have died. Treed swamps (coniferous and mixedwood) are the most common wetland type within the Project Study Area, and were observed to typically contain a sphagnum moss (*Sphagnum* spp.) carpet and likely have peat accumulation. Treed bogs were also common in the central region of the Project Study Area. These treed swamps and treed bogs are expected to function highly in terms of carbon sequestration.

Biological Productivity and Habitat for Species of Conservation Interest

Many wetlands are highly productive and support high numbers of species, or high abundances of a few species. Other wetlands may be less productive, but provide uncommon habitat types that support Species of Conservation Concern with restricted ranges of tolerance that cannot survive in other habitats. Typically, larger and more fertile wetlands support larger numbers of species and are more productive, and uncommon habitat types tend to support greater numbers of Species of Conservation Interest than common habitat types.

Within the Project Study Area, wetlands provide habitat for a number of Species of Conservation Concern. Alpine rush (*Juncus alpinoarticulatus*), ranked S1S2 by ACCDC and May Be At Risk by NSDNR, was found in a wetland complex containing treed bog and coniferous treed swamp.

Heart-leaved foamflower (*Tiarella cordifolia*), ranked S2 by ACCDC and Sensitive by NSDNR, was found in many locations in the northwestern portion of the Project Study Area. Although it was found in both uplands and wetlands, it was most abundant in seepy locations near streams and the edges of wetlands where mineral rich groundwater reaches the surface, and is possibly restricted to areas rich in calcium.

Black ash (*Fraxinus nigra*), ranked S2S3 by ACCDC and Sensitive by NSDNR, was found in a mixedwood treed swamp located in the southern portion of the Project Study Area. Long-leaved starwort (*Stellaria longifolia*), ranked S3 by ACCDC and Sensitive by NSDNR, was found in a small fresh marsh located at the northern end of the Project Study Area.

Large purple fringed orchid (*Platanthera grandiflora*), ranked S3 by ACCDC and Secure by NSDNR, was primarily found in wetlands within the Project Study Area, including in nine locations in coniferous treed swamps and a tall shrub swamp in the northern portion of the Project Study Area, and also in a mixedwood treed swamp, and a fresh marsh. Meadow willow (*Salix petiolaris*), ranked S3 by ACCDC and Secure by NSDNR, was found in a mixedwood treed swamp at the southern end of the Project Study Area.

Signs of moose (*Alces americanus*) were noted in the Project Study Area. Moose, which are ranked S1 by ACCDC, At Risk by NSDNR, and Endangered under the Nova Scotia *Endangered Species Act* , typically use wetlands both as a summer food source, and as important habitat to find thermal refuge during hot weather.

5.4 BIRDS AND OTHER WILDLIFE

5.4.1 Birds

The Project Study Area contains few land features that may concentrate birds; however, the site is located in the Cobequid Hills Ecodistrict, which has a hilly topography and elevations range between 150 m and 300 m above sea level (asl) (Neily *et al*. 2003). The adjacent Dalhousie Mountain has one of the highest points in Mainland Nova Scotia, at 330 m asl. The Project Study Area itself is predominantly forested (67% of Project Study Area), although approximately 30% of the site is characterized as disturbed (*e.g.,* clear cut, agriculture, gravel pit, roads, roadside edges) (refer to Section 5.3.1 for more information on habitats in the Project Study Area).

Information on the distribution and abundance of birds in the Project Study Area was derived from field surveys, publicly available data and documents and other sources. The methodologies and results of desktop and field studies conducted in support of the Project are described in the following sections. Table 5.9 summarizes the results of all referenced studies and fieldwork.

Table 5.9 Bird Study Summary for the Proposed Clydesdale Ridge Wind Farm

								Regional Breeding Season Studies			Local Migration/Winter Studies			2011 Clydesdale Pre-Construction Surveys					Incidental Observatio	2011 Post-Construction Monitoring at Dalhousie Mtn				
CommonName	**Scientific Name**	**Species Code**	**General Status Rank**	**AC CDC SRank**	**SARA**	**MBBA Highest Breeding Status (3 squares)**	**MBBA Point Count Totals (20MR94)**	**Blaney 2005 (Fitzpatrick Mtn)**	**BLANEY 2007 (Dalhousie Mtn)**	**Vines 2008 (Dalhousie Mtn)**	**Vines 2008 spring**	**Vines 2008 fall**	**Vines 2008 Winter**	**Spring Count**	**Breeding Count (June/July)**	**Fall Count**	**Raptor Watch Count**	**Winter**	**Stantec (count)**	**Spring Count**	**Breeding Count**	**July Count**	**Fall Count**	**Raptor Watch Count**
Canada Goose	*Branta canadensis*	CAGO	Secure	SNAB,S4N		CF										12				2	0		0	
Wood Duck	*Aix sponsa*	WODU	Secure	S4S5B		PO																		
American Black Duck	*Anas rubripes*	ABDU	Secure	S5		PR										6								
Mallard	*Anas platyrhynchos*	MALL	Secure	S5		CF														1	0		0	
Blue-winged Teal	*Anas discors*	BWTE	May Be At Risk	S3B		PR																		
Green-winged Teal	*Anas crecca*	GWTE	Secure	S4S5B		PR																		
Ring-necked Duck	*Aythya collaris*	RNDU	Secure	S5B		CF								3						16	0		0	
Hooded Merganser	*Lophodytes cucullatus*	HOME	Secure	S4S5B		CF																		
Common Merganser	*Mergus merganser*	COME	Secure	S5		PR														0	6		0	
Ring-necked Pheasant	*Phasianus colchicus*	RIPH	Exotic	SNA		CF	1											1						
Ruffed Grouse	*Bonasa umbellus*	RUGR	Secure	S4S5		PR			X	X	X	X		3	3	4		2	1	4	0	1	6	
Spruce Grouse	*Falcipennis canadensis*	SPGR	Secure	S5		PR				X	X	X		1		2				3	0	1	2	
Pied-billed Grebe	*Podilymbus podiceps*	PBGR	Sensitive	S3B		PR																		
Great Blue Heron	*Ardea herodias*	GBHE	Secure	S4B		-										1								
Northern Goshawk	*Pandion haliaetus*	NOGO	Secure	S3S4		-														1	0		1	1
Bald Eagle	*Haliaeetus leucocephalus*	BAEA	Secure	S4	NAR	CF								1		1	7	5		2	0		0	5
Northern Harrier	*Circus cyaneus*	NOHA	Secure	S5B	NAR	CF									3	1			1					
Sharp-shinned Hawk	*Accipiter striatus*	SSHA	Secure	S4S5B	NAR	PO				X		X							1	0	0		1	
Osprey	*Accipiter gentilis*	OSPR	Secure	S5B		-														1	0		1	
Broad-winged Hawk	*Buteo platypterus*	BWHA	Secure	S4S5B		PO										2	1							
Red-tailed Hawk	*Buteo jamaicensis*	RTHA	Secure	S5	NAR	CF	1		X	X	X	X			3	10	2		1	7	3		2	3
Rough-legged Hawk	Buteo lagopus	RLHA	Secure	S4N	NAR									1			1							3
American Kestrel	*Falco sparverius*	AMKE	Secure	S5B		PR				X	X					3	1		1	0	0	1	2	
Sora	*Porzana carolina*	SORA	Secure	S4S5B		PO																		
Common Moorhen	*Gallinula chloropus*	COMO	Undetermined	S1B		PO																		
Killdeer	*Charadrius vociferus*	KILL	Sensitive	S3S4B		CF		X												0	1		0	
Spotted Sandpiper	*Actitis macularius*	SPSA	Sensitive	S3S4B		PO																		
Wilson's Snipe	*Gallinago delicata*	WISN	Sensitive	S3S4B		CF					X			1										
American Woodcock	*Scolopax minor*	AMWO	Secure	S4S5B		PR					X								1	1	0		1	
Ring-billed Gull	*Larus delawarensis*	RBGU	Secure	S1?B,S5N		-										1								
Herring Gull	*Larus argentatus*	HERG	Secure	S4S5		-										1								
Rock Pigeon	*Columba livia*	ROPI	Exotic	SNA		CF																		
Mourning Dove	*Zenaida macroura*	MODO	Secure	S5		PR	2	X	X	X	X			2		2				0	2		5	
Great Horned Owl	*Bubo virginianus*	GHOW	Secure	S5		PR								1						1	1		1	
Barred Owl	*Strix varia*	BDOW	Secure	S5		PR	1	X		X	X									0	0		1	
Boreal Owl	*Aegolius funereus*	BOOW	Undetermined	S1B	NAR	PR																		
Northern Saw-whet Owl	*Aegolius acadicus*	NSWO	Secure	S4		PR																		
Common Nighthawk	*Chordeiles minor*	CONI	At Risk	S3B	T	PO																		
Ruby-throated Hummingbird	*Archilochus colubris*	RTHU	Secure	S5B		PR	2			X	X	X			2	6			1	0	0		1	
Belted Kingfisher	*Ceryle alcyon*	BEKI	Secure	S5B		CF	1								2	1			1	1	0		0	
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA	Secure	S4S5B		CF	1		X	X	X													
Downy Woodpecker	*Picoides pubescens*	DOWO	Secure	S5		CF	1			X	X	X												
Hairy Woodpecker	*Picoides villosus*	HAWO	Secure	S5		CF		X	X	X	X	X		4	2	5				1	0	1	3	
Black-backed Woodpecker	*Picoides arcticus*	BBWO	Sensitive	S3S4		CF				X			X											
Northern Flicker	*Colaptes auratus*	NOFL	Secure	S5B		CF	7	X	X	X	X	X		3	9	26				8	1	2	3	
Pileated Woodpecker	*Dryocopus pileatus*	PIWO	Secure	S5		PR			X		X	X		5	3	6		3		3	0		4	
Olive-sided Flycatcher	*Contopus cooperi*	OSFL	At Risk	S3B	T	CF		X		X	X								1	0	1		0	
Eastern Wood-Pewee	*Contopus virens*	EAWP	Sensitive	S3S4B		PR	2	X		X					5	10				0	0		1	
Yellow-bellied Flycatcher	*Empidonax flaviventris*	YBFL	Sensitive	S3S4B		PR	1		X	X	X									0	0	2	1	
Alder Flycatcher	*Empidonax alnorum*	ALFL	Secure	S5B		CF	1	X	X	X	X	X		1	5	1								
Least Flycatcher	*Empidonax minimus*	LEFL	Secure	S4B		CF	2		X	X	X					5				1	0	1	0	
Eastern Phoebe	*Sayornis phoebe*	EAPH	Sensitive	S3S4B		CF									5	4				0	1		0	
Great Crested Flycatcher	*Myiarchus crinitus*	GCFL	May Be At Risk	S2B		PR																		
Eastern Kingbird	*Tyrannus tyrannus*	EAKI	Sensitive	S3S4B		PR									1									
Blue-headed Vireo	*Vireo solitarius*	BHVI	Secure	S5B		CF	18	X	X	X	X	X		1	2	2			1					
Red-eyed Vireo	*Vireo olivaceus*	REVI	Secure	S5B		CF	13	X	X	X	X	X		3	5	8				4	5	3	3	
Gray Jay	*Perisoreus canadensis*	GRAJ	Sensitive	S3S4		CF	1	X		X	X	X				4		2	1	1	0		3	
Blue Jay	*Cyanocitta cristata*	BLJA	Secure	S5		CF	1	X	X	X	X	X	X	6	6	35		5		12	1		9	
American Crow	*Corvus brachyrhynchos*	AMCR	Secure	S5		CF	4	X	X	X	X	X	X	24	7	27		18		13	1		11	
Common Raven	*Corvus corax*	CORA	Secure	S5		CF	3	X	X	X	X	X	X	4	1	12		4		2	0	1	10	
Northern Shrike	*Lanius excubitor*	NOSH	Secure	S4S5N										1						0	2		1	
Tree Swallow	*Tachycineta bicolor*	TRES	Sensitive	S4B		CF	1								3					3	0		0	
Bank Swallow	*Riparia riparia*	BANS	May Be At Risk	S3B		CF																		
Cliff Swallow	*Petrochelidon pyrrhonota*	CLSW	May Be At Risk	S3B		CF																		
Barn Swallow	*Hirundo rustica*	BARS	Sensitive	S3B	T	CF		X																
Black-capped Chickadee	*Poecile atricapillus*	BCCH	Secure	S5		CF		X	X	X	X	X	X	8	4	37		20		16	4		17	

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CommonName	**Scientific Name**	**Species Code**	**General Status Rank**	**AC CDC SRank**	**SARA**	**MBBA Highest Breeding Status (3 squares)**	**MBBA Point Count Totals (20MR94)**	**Blaney 2005 (Fitzpatrick Mtn)**	**BLANEY 2007 (Dalhousie Mtn)**	**Vines 2008 (Dalhousie Mtn)**	**Vines 2008 spring**	**Vines 2008 fall**	**Vines 2008 Winter**	**Spring Count**	**Breeding Count (June/July)**	**Fall Count**	**Raptor Watch Count**	**Winter**	**Stantec (count)**	**Spring Count**	**Breeding Count**	**July Count**	**Fall Count**	**Raptor Watch Count**
Boreal Chickadee	*Poecile hudsonica*	BOCH	Sensitive	S3		PR		X		X	X	X	X			2				2	0		4	
Red-breasted Nuthatch	*Sitta canadensis*	RBNU	Secure	S4S5		CF	1	X		X	X		X			3								
White-breasted Nuthatch	*Sitta carolinensis*	WBNU	Secure	S4		CF				X		X							1	0	0		1	
Winter Wren	*Troglodytes troglodytes*	WIWR	Secure	S5B		PR	5	X	X	X	X	X												
Golden-crowned Kinglet	*Regulus satrapa*	GCKI	Sensitive	S4		PR		X	X	X	X	X	X											
Ruby-crowned Kinglet	*Regulus calendula*	RCKI	Sensitive	S4B		CF	8	X	X	X	X	X			4					0	0	1	0	
Veery	*Catharus fuscescens*	VEER	Secure	S4B		PO														0	1		1	
Swainson's Thrush	*Catharus ustulatus*	SWTH	Secure	S4S5B		CF	5	X	X	X	X								1					
Hermit Thrush	*Catharus guttatus*	HETH	Secure	S5B		CF	4	X	X	X	X	X		2	4	3				0	3		4	
Wood Thrush	*Hylocichla mustelina*	WOTH	Undetermined	S1B		PO								1	2					1	2	1	0	
American Robin	*Turdus migratorius*	AMRO	Secure	S5B		CF	15	X	X	X	X	X		50	36	83				122	13	2	14	
Gray Catbird	*Dumetella carolinensis*	GRCA	May Be At Risk	S3B		PO					X													
European Starling	*Sturnus vulgaris*	EUST	Exotic	SNA		CF		X						3	1	4								
Cedar Waxwing	*Bombycilla cedrorum*	CEDW	Secure	S5B		CF	6	X	X	X	X	X			9	40				0	2		5	
Tennessee Warbler	*Vermivora peregrina*	TEWA	Sensitive	S3S4B		PR						X												
Nashville Warbler	*Vermivora ruficapilla*	NAWA	Secure	S5B		PR		X		X	X	X												
Northern Parula	*Parula americana*	NOPA	Secure	S5B		CF	7	X	X	X	X	X				2								
Yellow Warbler	*Dendroica petechia*	YWAR	Secure	S5B		CF						X		2	1									
Chestnut-sided Warbler	*Dendroica pensylvanica*	CSWA	Secure	S5B		CF	2		X	X		X												
Magnolia Warbler	*Dendroica magnolia*	MAWA	Secure	S5B		CF	11	X	X	X	X	X			1	7								
Black-throated Blue Warbler	*Dendroica caerulescens*	BTBW	Secure	S5B		PR				X	X	X							1					
Yellow-rumped Warbler	*Dendroica coronata*	YRWA	Secure	S5B		CF	1	X	X	X	X	X		1	5	6				4	1		6	
Black-throated Green Warbler	*Dendroica virens*	BTNW	Secure	S4S5B		CF	16	X	X	X	X	X			1	2				0	1		1	
Blackburnian Warbler	*Dendroica fusca*	BLBW	Secure	S4B		CF		X	X	X	X	X		1						0	0		4	
Palm Warbler	*Dendroica palmarum*	PAWA	Secure	S5B		CF			X	X	X	X												
Bay-breasted Warbler	*Dendroica castanea*	BBWA	Sensitive	S3S4B		PO		X		X	X													
Blackpoll Warbler	*Dendroica striata*	BLPW	Sensitive	S3S4B		PO					X	X												
Black-and-white Warbler	*Mniotilta varia*	BAWW	Secure	S4S5B		CF	6	X	X	X	X	X		5	4	2				2	2		0	
American Redstart	*Setophaga ruticilla*	AMRE	Secure	S5B		CF	7		X	X	X	X				2				1	0		1	
Ovenbird	*Seiurus aurocapilla*	OVEN	Secure	S5B		CF	12	X	X	X	X	X		2	5				1	2	1	1	4	
Northern Waterthrush	*Seiurus noveboracensis*	NOWA	Secure	S4B		PR	1																	
Mourning Warbler	*Oporornis philadelphia*	MOWA	Secure	S4B		PR	2		X	X	X									0	0		0	
Common Yellowthroat	*Geothlypis trichas*	COYE	Secure	S5B		CF	4	X	X	X	X	X			6	5			1	0	0	1	2	
Canada Warbler	*Wilsonia canadensis*	CAWA	At Risk	S3B	T	CF										1				0	0		1	
Chipping Sparrow	*Spizella passerina*	CHSP	Secure	S4S5B		CF		X			X				2				1	3	0		0	
Field Sparrow	*Spizella pusilla*	FISP	Accidental	SNA		-														0	1		0	
Vesper Sparrow	*Pooecetes gramineus*	VESP	May Be At Risk	S2S3B		CF																		
Savannah Sparrow	*Passerculus sandwichensis*	SAVS	Secure	S4B		CF	1	X			X	X				1								
Fox Sparrow	*Passerella iliaca*	FOSP	Secure	S3S4B		-																		
Song Sparrow	*Melospiza melodia*	SOSP	Secure	S5B		CF	5	X	X	X	X	X		5	8	6				17	2		3	
Lincoln's Sparrow	*Melospiza lincolnii*	LISP	Secure	S4B		CF	1	X	X	X	X				1	3				1	0		3	
Swamp Sparrow	*Melospiza georgiana*	SWSP	Secure	S5B		CF				X					1									
White-throated Sparrow	*Zonotrichia albicollis*	WTSP	Secure	S5B		CF	24	X	X	X	X	X		11	19	3				43	4		2	
Dark-eyed Junco	*Junco hyemalis*	DEJU	Secure	S4S5		CF	15	X	X	X	X	X		12	14	7				27	7	23	44	
Snow Bunting	*Plectrophenax nivalis*	SNBU	Secure	S5N		-												51		0	0		0	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	RBGR	Sensitive	S3S4B		PR																		
Bobolink	*Dolichonyx oryzivorus*	BOBO	Sensitive	S3S4B	T	PR		X																
Red-winged Blackbird	*Agelaius phoeniceus*	RWBL	Secure	S4S5B		PR								3	4					2	0		0	
Rusty Blackbird	*Euphagus carolinus*	RUBL	May Be At Risk	S2S3B	SC	CF																		
Common Grackle	*Quiscalus quiscula*	COGR	Secure	S5B		CF	2		X	X	X	X		3	2	300				2	1		0	
Pine Grosbeak	*Pinicola enucleator*	PIGR	May Be At Risk	S3?B,S5N		-																		
Purple Finch	*Carpodacus purpureus*	PUFI	Secure	S4S5		CF	2	X		X	X	X				2				9	1		1	
White-winged Crossbill	*Loxia leucoptera*	WWCR	Secure	S4S5		PR							X							1	0		0	
Common Redpoll	*Carduelis flammea*	CORE	Secure	S5N		-														1	0		0	
Pine Siskin	*Carduelis pinus*	PISI	Sensitive	S3S4B,S5N		PR										1								
American Goldfinch	*Carduelis tristis*	AMGO	Secure	S5		CF	5	X	X	X	X	X			27	40		1		8	3		17	
Evening Grosbeak	*Coccothraustes vespertinus*	EVGR	Secure	S4B,S5N		PR										7				0	2		0	
Unidentified bird		UNID												17		175	2	25						3