Shadow Flicker

Shadow flicker caused by wind turbines is defined as alternating changes in light intensity due to the moving blade shadows cast on the ground and objects (including through windows of residences). There are obstacles such as terrain and vegetation which are located between the wind turbine and a potential shadow-flicker receptor, hence shadow-flicker will be either significantly reduced or eliminated at such receptors.

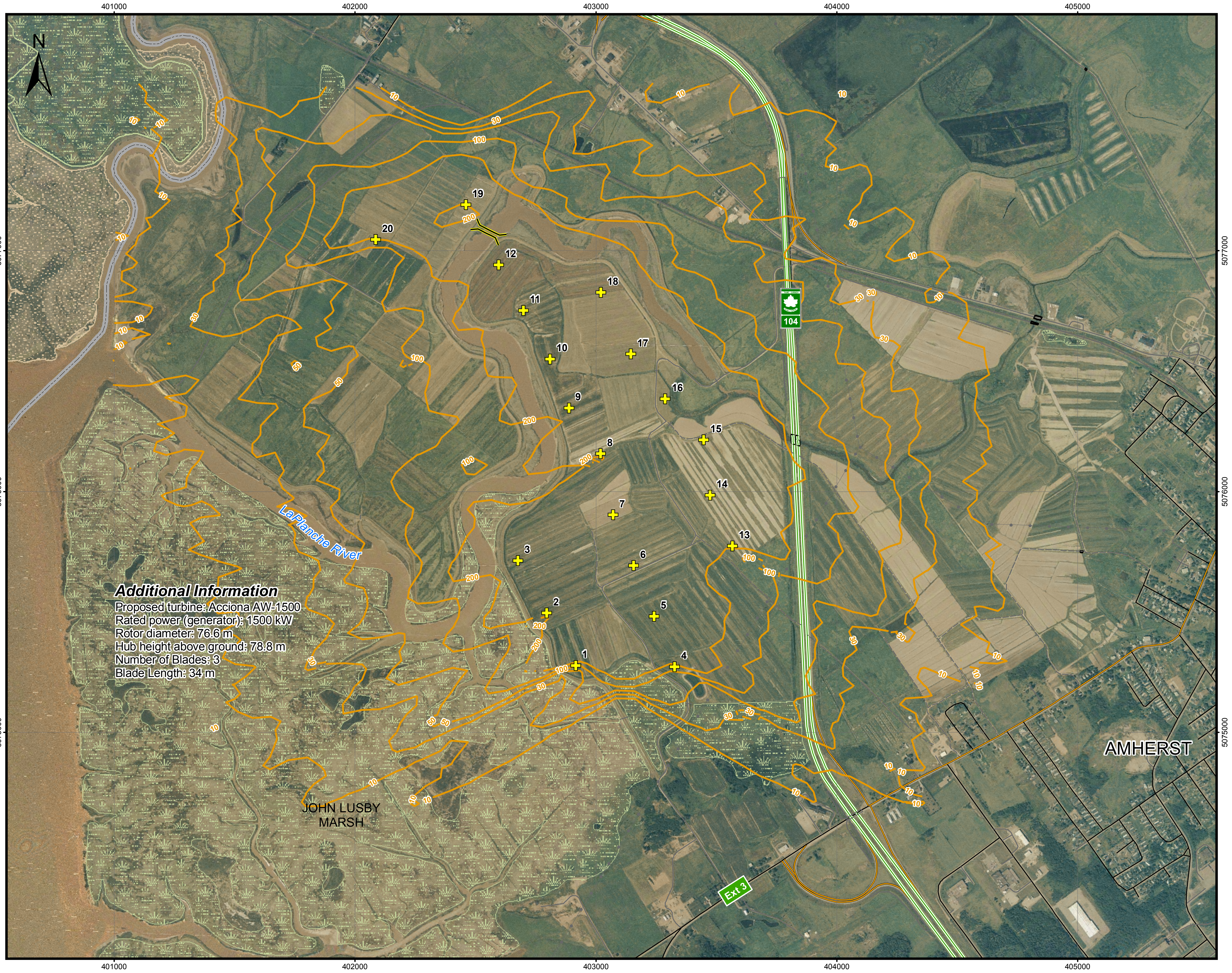
The modeling software WindPro 2 was used to model potential shadow flicker within the area. This model calculated the duration of shadow flicker various receptors receive within a year, given a number of assumptions. The sun's path calculated from the turbine was predicted based on geographic position of the project. The model also assumes a worst-case scenario, with the following conditions: the sun is fully shining all year (no clouds or fog), the rotor plane is perpendicular to the sun (biggest shadows), and the rotor is always turning (causing shadow movements).

Nova Scotia has no set regulatory limits for exposure to shadow flicker, however the industry commonly uses 30 hours per year as a limit to reduce nuisance complaints. Calculations of shadow flicker for all nearby residences, given a worst-case scenario as described above, determined that no residence will experience shadow flicker for more than 30 hours per year, thereby complying with the nuisance setting (Figure 5-5). However, as noted on Figure 5-5 two structures appear to be present within the more than 30 hours per year contour. These structures have been ground truthed and determined to be non-residential structures.

A registry will be created to document complaints of shadow flicker. When a complaint or complaints of shadow flicker are received from a receptor located within 1,000 m of the turbine, shadow flicker will be monitored from that receptor. Information collected from the shadow flicker monitoring will be used will be used to develop further mitigation, if warranted.

Shadow flicker has the potential to cause health concerns resulting from repeated exposures. In comments received from regulators on the Draft EA document, it was noted that there was concern over the potential for shadow flicker to affect cars driving on the highway. As exposures to cars on the highway will occur in isolated events and will be minimal in duration, shadow flicker is not considered an issue for local road traffic and no further consideration is warranted at this time.

No mitigation measures are required for the residential receptors evaluated for the visual impact assessment. Residences closest to the Project area, along the northern boundary of the site, could potentially experience different visual impacts than the residential receptors assessed. If these impacts require mitigation after construction of the Project, they could be addressed through mitigation measures such as tree planting. The residual effect of the Project on the area's visual aesthetics is considered to be **low** but **not significant**.



acciona Energy

Figure 5-5

Estimated Shadow Flicker

Amherst Wind Energy Project

Map Features

- Proposed Turbines
- Shadow Flicker (Hrs/Yr)
- Highway
- Major Road
- Secondary Road
- Tertiary Road
- Bridge
- Railway
- Trail/Track
- Proposed Culvert
- Utility Line
- Provincial Border
- Mud Flat
- Wetland

Spatial Data Source: Service Nova Scotia

0 200 400 800

Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1:15,000
Date: March 14, 2007
Project No.: 1005774.

Jacques Whitford

5.2.1.4 Noise Impacts

Noise can be simply defined as "unwanted sound". Sound level limits are identified on an A-weighted decibel scale (abbreviated as dBA), which is generally accepted to reflect how humans perceive sound. Conversation in close quarters is usually at a sound level of 50 to 60 dBA and an alarm clock may emit sound to levels of approximately 80 dBA. Presently, the province of Nova Scotia does not have set sound level limits specific to wind turbine operations. In response to the growth of wind energy development in Ontario, the MOE identified the need to provide guidance as to how to apply their technical documents to wind turbines, and produced their technical document "Interpretation for applying MOE Technical Publications to Wind Turbine Generators" in 2004 (available at www.ene.gov.on.ca/envision/gp/4709e.pdf). This guidance was considered during the development of a noise impact assessment for the Amherst Wind Energy Project, completed by Jacques Whitford (see Appendix E).

Wind turbine generators produce sound through a number of different mechanisms which can be categorized into mechanical and aerodynamic sound sources. The major mechanical components including the gearbox, generator and yaw motors each produce their own characteristic sounds, including sound with tonal components. Other mechanical systems such as fans and hydraulic motors can also contribute to the overall sound emissions. Mechanical sound is radiated at the surfaces of the turbine, and by openings in the nacelle casing. Mechanical issues involving yaw motor supports or power train design can result in anomalous sounds such as periodic booming or tonal sounds.

The interaction of air and the turbine blades produces aerodynamic sound through a variety of processes as air passes over and passed the blades. The sound produced by air interacting with the turbine blades tends to be broadband sound, but is amplitude modulated as the blades pass the tower, resulting in a characteristic ‘swoosh’. Generally, wind turbines radiate more sound as the wind speed increases.

The manufacturer’s predicted operational sound levels were combined with background sound data obtained from receptor locations surrounding the Project site to obtain a more accurate representation of the potential sound levels at the selected receptor locations. Sound modelling was conducted using CadadA version 3.6, which includes the calculation methodology of the International Organization for Standardization (ISO) *Standard 9613 – Attenuation of Sound during Propagation Outdoors* (ISO 9613). Local meteorology and terrain was considered in modelling. Sound resulting from construction activities was modelled. Sound power level data provided by the manufacturer were used to model operational sound at the selected receptors. Predicted sound levels at receptors increased with increasing wind speed due the fact that the sound power level of the wind turbine generators also increased with increasing wind speed, with the exception of results at a wind speed of 10 m/s. At 10 m/s the wind turbine sound power level decreases slightly, which could be a result of a reduction in inflow turbulence sound and/or separation sound, which both relate to the interaction of the blade and blade surface with atmospheric turbulence. Sound levels deemed acceptable by the MOE also change with an increase in wind speed, as outlined in the guidance document referenced above.

The study results presented in Appendix E show that sound levels at the receptor locations are primarily dominated by existing background sound levels and not by the predicted sound produced from operations of the Amherst Wind Energy Project. This is a conservative prediction, due to the assumption that receptors will always be downwind of the turbines. In reality, at any given time, some receptors would be crosswind, and in some cases upwind from the Project. Under conditions other than downwind conditions, any receptor could experience up to 5 to 10 dBA less sound compared to the worst case scenario shown in Figures B-1 to B-5 in Appendix E. Under such conditions, the wind turbine sound would be expected to be inaudible against the background sound levels. Therefore, it is not expected that the Project will have a significant impact, with respect to sound, on nearby receptors.

To reduce sound impacts resulting from Project operations, the following mitigation measures are recommended:

- adhering to the recommended setback between the Project site and receptors to maximum separation distance; and
- attending to routine maintenance of the wind turbines and associated equipment, as recommended by the manufacturer.

Provided these mitigation measures are followed, the potential residual effect of the Project on noise is considered to be **minimal** and **not significant**.

5.2.1.5 Effects to Birds

In early January 2005, the Proponent and Environment Canada (Canadian Wildlife Service) met to discuss the Project and develop a bird monitoring protocol for the site. The current Environment Canada guidelines for wind energy projects as they relate to birds were not available at this time. However, consultation was recently made with Environment Canada's "Wind Turbines and Birds – A Guidance Document for Environmental Assessment" and "Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds" (Environment Canada 2007a and 2007b), and the guideline applied to this situation.

In particular, Tables 1 to 4 of Environment Canada (2007a) were consulted to identify the sensitivity, facility size, level of concern and information expectations in the context of these guidelines. According to the criteria identified in the aforementioned tables, the facility would be considered Medium, but is considered to have an overall high sensitivity due to the presence of species with aerial flight displays (*e.g.,* Horned Larks). As a result, the level of concern for this Project would be High. Table 5-10 identifies the information that Environment Canada expects for projects with a High level of concern and thus detailed pre-construction field surveys were conducted.

TABLE 5-10 Questions to be Answered for "High" Level of Concern Projects as per Environment Canada (2007a)

Question	Answer
Identify the species that breed and winter at the site and in the surrounding area, and indicate their relative abundance.	See Section 4.3.2.1 and Appendix D.
Identify any species at risk, including species listed under the Species at Risk Act (SARA), provincially or territorially designated species, species designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), or species designated as priority species by the ACCDC, Partners in Flight (PIF) or the CWS.	See Section 4.3.3.1 and Appendix D.
Identify bird colonies (note species, size, location).	None.
Identify raptors, shorebird concentrations.	See Section 4.3.3.1 and Appendix D.

TABLE 5-10 Questions to be Answered for "High" Level of Concern Projects as per Environment Canada (2007a)

Question	Answer
Identify species that give aerial flight displays.	See below.
Identify the species that congregate at significant migration staging areas at or near the site.	See Section 4.3.3.1 and Appendix D.
Identify the species that frequently migrate through or near the area.	See Appendix D.
Identify the species that commute (*i.e.,* between breeding and foraging habitats) through or near the area, as compared to other locations within the region.	See Section 4.3.2.1.
What habitat types occur on the site and in the surrounding area?	See Section 4.3.1.
Do these habitats typically support habitat-sensitive or habitat specialist species, e.g., forest-interior species, grassland species, or shrubland species?	Hosting some species of common grassland birds (*e.g.,* Horned Lark, Snow Bunting, Savannah Sparrow, Bobolink).
What is the relative density of breeding birds in these habitats?	See Section 4.3.2.1 and below.
What breeding or migrating birds do these habitats typically support?	See Section 4.3.2.1 and Appendix D.
How much of each habitat type or function will be lost or altered as a result of this development?	The Project footprint will be primarily on actively cultivated fields, and only a very small proportion (approximately 2%) of the area within the Project area will be altered. The area is actively farmed, with no nesting observed on site during field surveys; therefore no impact on breeding birds is predicted.
What topographical features, such as islands, peninsulas, and ridges, are located on or near the site that may influence bird activity and movement?	Project site is situated adjacent to upper Bay of Fundy and on the Isthmus of Chignecto connecting NS and NB
What is the expected amount and type of human presence (vehicles, pedestrians, tourism, etc.) at the site at different times of the year, during and following construction?	See Section 2.
What are the relevant meteorological data, such as wind speed, wind direction and visibility (e.g., number of days during migration period with visibility <200 m or cloud bases <200 m) for the site?	See Section 4.4.
If a bird colony is located within 5 km of the Project area, or if a nationally recognized site occurs within 1 km, do individual birds pass through the proposed turbine locations as part of their daily movements? What proportion of the colony does this represent?	Situated adjacent to John Lusby National Wildlife Area; specific attention was given to examine bird movement from the NWA through the Project area (Section 4.3.2.1)
Do raptors breed at the site or within 1 km of the site? If so, what species are present and how close do they nest to the proposed facility?	None confirmed, but Northern Harriers are likely
If the site is recognized by local experts as having bird habitat that is locally important, how much of this habitat would be lost or altered by the proposed Project?	None.
If the site contains land features (islands, ridges, shorelines, peninsulas, areas of open water in winter, etc) that may concentrate birds on migration, while staging, or in winter: Do birds concentrate at this site during any of the seasons mentioned above?	A wide tidal river meanders through the project area and does concentrate birds (shorebirds, gulls and waterfowl) and remains partially open in winter.

TABLE 5-10 Questions to be Answered for "High" Level of Concern Projects as per Environment Canada (2007a)

Question	Answer
If the site is recognized by CWS or local experts as regionally or locally important to birds, how does the number and diversity of birds that use the site in the season of interest compare to other locations in the region or province? How much habitat would be lost or altered by the proposed Project?	No such importance has been identified for the Project area itself.
If large numbers of birds may commute through or near the area during the day, what is the height and direction of this movement, and how does this relate to the proposed Project design and turbine locations?	See Section 4.3.2.1 and below.
If large numbers of birds stage in or near (within 1 km of) the area, are there any activities taking place nearby that could potentially disturb birds (for example by causing large numbers of bird to take off and fly directly overhead), thereby resulting in collisions with wind facility structures?	Most larger concentrations of staging birds are in the tidal river and follow the course of the tidal river through the study area rather than flying overland.
What is the frequency of dense fog (visibility <200m) and low cloud bases (<200m) at the site during the spring and fall bird migration periods?	See Section 4.4.
If aerial flight display species occur at the site:	
▪ How many individuals might be affected by the proposed wind farm?	See below.
▪ How significant is the site for these species (i.e., is it one of the few sites in the region or province with this species)?	See below.
▪ What proportion of these species' local habitat would be close to the facility, and what is the likelihood that birds will be displaying in close proximity to turbine blades?	See below.

The potential environmental effects resulting from Project-related activities on birds include sensory disturbance and mortality. Section 4.3.2.1 provides detailed information on the breeding, wintering and migrating birds of the Project area and the broader regional area. Erskine and McManus (2005) summarizes observation data for 308 bird species, including 142 breeding, 70 wintering, 85 vagrants found in the Chignecto Isthmus for the years 1930 to 2000. Many of these species were not seen on the project site, because of the lack of forest habitats. Of the 59 species observed during this survey period (2005-2006), two species of concern were observed: the short eared owl and the peregrine falcon.

Sensory Disturbance

Sensory disturbance of birds may occur during all phases of the Project as a result of on-site human activities such as surveying, clearing, trenching, turbine assembly, equipment operation, site inspections and site decommissioning. A certain level of sensory disturbance to birds in the area has already resulted from ongoing agricultural and forestry activities and associated human presence. The operation of the wind turbines may also result in visual and auditory disturbance of wildlife, including birds. Breeding birds may avoid habitat within a zone surrounding the immediate Project footprint, although sensitivity is species-specific (Kingsley and Whittam 2005). Many species will not avoid habitat near rotating wind turbines, as has been noted by James (2003) and James and Coady (2003), but other species show a reduction in breeding densities near turbines (Johnson *et al*. 2000). Habitat avoidance will most likely occur during periods of construction, and may be more intermittent during periods of operation, when human presence on-site is less frequent and typically of short duration.

The flight behaviour of birds may be influenced by Project development. Operation of the turbines may affect bird movements through the partial obstruction of regular flight paths. Certain species (*e.g.,* waterfowl) appear to exhibit avoidance behaviour when flying close to an operating wind farm, while others do not appear to be influenced by the presence of a wind farm (James 2003, Kingsley and Whittam 2005). Breeding birds at Pickering, Ontario, do not appear to be disrupted by the 1.8 MW operating turbine, and birds continue to nest and move within the area as before (James 2003). Most diurnal migrants fly at low altitude, within 40 m of the ground, and are unlikely to be significantly disturbed by the wind turbines or associated facilities. At night, migrants fly well above the height of the wind turbines, typically greater than 150 m above the ground, and are thus also unlikely to be disturbed by the Project. However, visual or auditory features that cause bird avoidance may have a constructive effect in that birds will be less likely to accidentally collide with turbines.

Mortality

A possible effect of this Project on birds is an increase in mortality due to collisions with the operating wind turbines. Indeed, there is a perception that wind turbines cause a great many bird deaths, and it has been highlighted by regulatory agencies and non-governmental agencies as an issue that needs to be addressed. General information about bird-turbine collisions is presented below.

Kingsley and Whittam (2005) provide a detailed review of available information regarding turbine-related bird fatalities in North America and elsewhere. Numerous studies during the last 20+ years have been conducted to estimate bird mortality at wind farms, from a single turbine or small wind farms such as the present proposal, to larger wind farms with thousands of wind turbines (Gill *et al*. 1996, Erickson *et al*. 2001, Percival 2001). This level of study effort is principally due to the circumstances at one large site in California, Altamont Pass, which alerted industry, government and the public to potential bird mortality at wind-farms. Thousands of wind turbines installed in the early 1980s at Altamont Pass were shown to cause high raptor (hawks, eagles and falcons) mortality. Collisions with the turbine structures were the primary cause of death, although electrocution and wire collisions also played a part (Orloff and Flannery 1992). These raptor fatalities triggered an increase in scrutiny of potential wind farm developments, which has led to the development of monitoring protocols and a substantial amount of data on bird use and mortality at proposed and existing wind farms.

Despite these early studies in California, very few raptors have been found killed at other North American wind farms (Erickson *et al*. 2001, Kingsley and Whittam 2005). Songbirds are the most frequent casualties of wind farms in North America, and tend to collide with wind turbines more frequently during migration. Breeding birds appear to adapt to the presence of wind turbines near their nesting and/or foraging areas and avoid collision (Erickson *et al*. 2002, James 2003, James and Coady 2003, Kingsley and Whittam 2004). Songbirds can make up anywhere from 10% to 90% of the overall bird fatalities, depending on the location of the wind turbine site (Erickson *et al*. 2001). Excluding California, 78% of bird casualties at wind farms in the United States tend to be of migratory species (Kingsley and Whittam 2004). Many of these collisions occur at night, when individuals may be attracted to lit structures and collide with transmission wires, turbine towers or other structures in a wind farm. The recent findings at a West Virginia wind farm, where 27 birds were killed by colliding with a substation and the three wind turbines closest to the substation on a foggy night during May 2003, are probably attributable to the sodium vapour lights of the substation, which combined with the very low visibility and the presence of the wind farm on a rise in elevation to cause this rare mortality event (Kerlinger 2003). No fatalities were found at any of the other 41 wind turbines of the wind farm, located further away from the substation and its sodium vapour lights (Kerlinger 2003). Indeed, single night fatality events of this magnitude are not known to have occurred at any other North American wind farm.

Although fatalities occur at wind energy facilities, the number of fatalities is generally small. This is especially noticeable when compared to bird fatalities caused by other sources, such as communication towers, roads and buildings. Erickson *et al*. (2001) compared estimates of bird mortality caused by different human sources in the United States, and estimated that an average of 2.19 birds per turbine, or between 10,000 and 40,000 birds are killed each year. Compared to other sources, such as buildings (98-980 million birds killed each year), communication towers (4-50 million birds killed each year) and vehicles (60-80 million birds killed each year), the mortality caused by wind turbines is significantly less (Erickson *et al*. 2001). Each house in North America kills on average between 1 and 10 birds each year, and tall buildings kill many more (Dunn 1993, Kingsley and Whittam 2005). Additionally, Kingsley and Whittam (2005) indicate that the effects are small compared to the millions of birds that travel through existing wind power developments in the U.S. each year. This has been noted for two sites in Washington and one site in Minnesota, where conservative estimates of mortality, using surveillance radar and carcass surveys to determine passage rates and fatality rates, respectively, are less than 0.01% of birds passing through each wind farm (Erickson 2003). In Canada, existing wind farms in Alberta were included in a research study examining the movement of nocturnal migrant birds (and bats) using radar and sound recording technology. This research, conducted during the fall of 2004, compared the behaviour and abundance of birds and bats between operating wind farms and comparable sites without wind turbines. Millikin (2005) estimated that approximately 0.02% of the individuals (birds and bats combined) observed on radar may have resulted in a collision with a turbine. Furthermore, this research identified that these nocturnally migrating birds exhibited avoidance behaviour, with individuals reducing their speed and increasing their flight height to avoid the turbines (Millikin 2005). Nocturnal bird studies were not conducted as a part of the Project, due to information presented in the literature and the absence of significant elevation features on site (*e.g,* ridges) that may increase the likelihood of bird collisions with turbines.

Overall, the findings of the studies discussed above indicate that bird fatalities caused by wind turbines are very low in the majority of cases (Erickson *et al*. 2001, Percival 2001, Erickson *et al*. 2002, Kingsley and Whittam 2005). However, it is important to reduce or eliminate fatalities to the extent possible, and it is important to understand what factors may increase the collision risk of birds at a wind farm. A number of factors may influence the potential for bird-turbine interactions that lead to bird kills, including weather and lighting, landscape features, turbine design, facility design and bird abundance and behaviour. These are described further in the following discussion.

Weather and Lighting

When conditions are clear, there is low likelihood that birds will collide with wind turbines (Crockford 1992, Kingsley and Whittam 2005). However, low visibility (<200 m) may cause nocturnal migrants to fly at lower altitudes, and lights may attract individuals (Jones and Francis 2003, Kingsley and Whittam 2005). Birds may be attracted to red visibility beacons or other lighting associated with turbine structures. Lighting that attracts birds can increase the probability of bird-turbine collisions and result in kills. Environment Canada recommends that white strobe lights be used on towers at night and that their number and light intensity be minimized. It is also recommended that the number of flashes per minute be minimized within allowable parameters. Lighting for this Project will be based on the standards and requirements of Transport Canada, with the intent to install the minimum amount of lighting required. Medium Intensity White Flashing Omnidirectional Obstruction Lighting will be utilized at the top of turbines (CL-865), with short flash durations and the ability to emit no light during the “off phase” of the flash (*e.g.,* as allowed by strobes and modern LED lights). These lights will operate at the minimum intensity (day: 7,500 candela, night: 750 candela), minimum flash duration (0.1 – 0.25 second/flash), and the longest duration between flashes (40 flashes/minute) allowable by Transport Canada’s CAR Standard 621.19. Lighting elsewhere within the Project will be the minimum necessary for safety. Final lighting selection has been determined in consultation with Transport Canada.

Landscape Features

Siting a wind farm near landforms that concentrate birds, such as high ridges, slopes and mountaintops, may increase the risk of avian collision. The Project area does not have any of these landforms, and is sited away from shoreline. As a result, landscape features are not expected to be a factor leading to a significant number of bird fatalities.

Turbine Design

Turbine height is believed to be a strong influence on the likelihood of collision with taller structures having an increased risk of collision, while structures below 150 m cause minimal mortality (Kerlinger 2000, Crawford and Engstrom 2001, Kingsley and Whittam 2005). Migratory birds typically fly at altitudes greater than 150 m such that structures lower than 150 m in height do not usually obstruct migratory bird movements or result in bird mortality (Kingsley and Whittam 2005). The turbines of the Project will be 78-80 m in height and the rotor length will be approximately 37 m. As a result, the greatest height of the turbines will be below 150 m. At this height, the turbines are not predicted to obstruct the movements of most migratory birds that frequent the region or to increase risk of material collision. Furthermore, results from a research project in Alberta indicate that migrating birds will modify their flight paths to increase in flight height when approaching an operating wind farm (Millikin 2005).

The nature of the support structure on which the rotor blades are mounted may also influence bird-turbine collisions. Wind turbines can be mounted on either a lattice structure or tubular steel towers. Limited information is available to identify the preferred support structure although some data indicate that lattice towers encourage perching by raptors during hunting and, as a result, may put these birds at risk of collisions. As such, the turbines for this Project will be built using tubular steel towers.

Facility Design

The scale of the wind farm has a direct influence on the potential for bird-turbine collisions. Facilities of 100 turbines or more are thought to more likely have a greater effect in terms of bird mortality due to the increased number of vertical obstacles (potential collision hazards) in the landscape (Environment Canada 2005). The Project will consist of a maximum of 20 turbines and will not be of a size that should cause concern for elevated collision risk.

Bird Abundance and Behaviour

When considering the results of the avian pre-construction monitoring program, the vast majority of birds observed during the study were flying within 30 m of the ground, which roughly corresponds to the air space below the turbine blade sphere (*i.e.*, below where the turbine blades would be turning). In general, the area does not seem to be a major flight path for migrating birds or for birds traveling over the study area to get to some other location. Nearly 80% percent of the observations and individual birds were seen on the ground or at a height of less than 30 m, with only 5% observed at over 100 m. Most of the waterfowl were seen resting or foraging in the tidal river. The shorebirds used the tidal river for foraging and the central area for roosting during high tide, both of which place the birds on the ground. Obviously, the birds seen on the ground had to have occupied air space to get there. Most of the birds seen on the ground flew when disturbed, but stayed close to the ground (< 30 m) and usually flew to another similar habitat close by to land and resume feeding or resting.

As described in Section 4.3.2.1, it is important to note that the tidal section of the LaPlanche River and the salt marsh adjacent to it (including the John Lusby Salt Marsh) had 36% of the total bird sightings and 53% of the total bird numbers. Following completion of the new aboiteau structure downstream, the tidal area of the river will move further downstream from the Project site. Nearly 30% of the bird sightings and total number were seen in the large central area, but this is mainly due to the fact that the central area represents a very large percentage of the total surface area being studied. Only 2.5% of the sightings and 0.5% of the total bird numbers were seen using the 100 m wide travel corridor connecting the non tidal section of the LaPlanche River to the John Lusby Salt Marsh. Therefore, this area is not as important to birds as anticipated.

Although species of conservation concern have occurred in the regional area in the past, it is unlikely that any are at risk of collision, due to the very low use of the site by these species, the general absence of habitat suitable within the Project footprint for their breeding or staging, and the expected low number of fatalities overall, based on previous studies undertaken elsewhere in North America. As a result, no specific mitigation measures or monitoring programs have been identified to address potential effects to species of conservation concern.

Potential Impact and Mitigation

Evidence from wind farms in North America and elsewhere, as noted above, suggests that bird collisions are likely to occur but are in very low numbers, and the potential for significant bird kills is low. Within the Project area, there are no known physical features (*e.g.*, mountaintops, ridges and slopes) that would increase the risk of collision. Weather has some potential to be a factor affecting visibility and resulting in bird-turbine collisions. However, the number of days with fog is expected to be similar to other inlands areas of northern Nova Scotia, given the distance from the coast. The design of the turbines and the wind power project on the whole also reduces the risk of bird-turbine interaction, as noted above. Finally, the results of the pre-construction bird survey program and collection of existing data indicate that the bird use of the Project area does not cause any concern with regards to increasing risk of collision, disturbance or habitat alteration. However, there are further mitigation and monitoring measures that will help reduce effects to bird populations. To the extent possible given the local conditions, distribution lines within the wind farm will be buried underground. There is the possibility that sections of the distribution line will be above ground. If above ground sections are required, the visibility of pole-mounted distribution lines may be increased by adding flags or other markers, if warranted.

Additionally, construction on site will occur outside of the breeding season to the extent possible. During detailed layout surveying activities, a biologist on-site will identify nests within or immediately adjacent to work areas, and flag them for avoidance during construction.

To determine the accuracy of the predicted environmental effects and ensure all mitigation measures are successful, post-construction monitoring will be conducted and will be developed in consultation with CWS and NSDNR. Monitoring will include spring and fall avian mortality surveys, and breeding bird surveys to be conducted at a frequency to be determined though consultation with CWS. Typically searches include a 40 m radius around each turbine and will be developed as per the "Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds" (Environment Canada 2007b). Additionally, as a part of the monitoring protocol, searcher efficiency trials will be conducted and may include spring scavenger impact trials if required by Environment Canada, to correct for these potential influences on the carcass monitoring. Bat mortality surveys will be conducted in the fall in conjunction with bird mortality surveys, as required. This is to capture the timing of fall migration activities for migratory bat species and the movement of resident species to hibernacula. Two years of bird monitoring will be conducted, and then monitoring will be discontinued unless significant mortality is occurring. The detailed protocol and subsequent results of the post-construction monitoring will be used to assess the success of the mitigation measures in consultation with Environment Canada and NSDNR. In turn, this may lead to other mitigation being suggested using the available options at the time.

Taking into account the mitigation measures, there likely will be residual effects of the Project on the area's birds. In general, sensory disturbance will be infrequent, temporary in nature, reversible, small in magnitude and restricted to the Project area given the mitigation measures proposed. Residual effects of sensory disturbance are not predicted to be significant. Fatalities as a result of colliding with structures within the Project will be irreversible, but they are expected to be infrequent and minor in magnitude and in geographic extent. As a result, the residual effect of this mortality is **not** considered to be significant.

5.2.1.6 Other Wildlife

Other wildlife species of the Project area include mammals, reptiles and amphibians. Most species are year-round residents of the Project area and adjacent lands, although certain local or long-distance migrations of some species occur. Potential environmental effects of the Project on wildlife include habitat alteration, mortality and sensory disturbance.

Sensory Disturbance

Wildlife sensory disturbance may occur as a result of on-going human activity on-site as well as visual and auditory disturbance related to the operation of the turbines. Sensitivity of wildlife to disturbance varies by species and life-stage.

Human presence (noise, sight and smell) and vehicles may disturb wildlife. During operation of the wind-farm, Project-related vehicles and personnel will be in the vicinity of wind turbines on a regular basis for ongoing maintenance. It is likely that some disturbance of diurnal wildlife will occur during operation and maintenance of the Project. Bats are unlikely to be affected by human presence as they are nocturnal and the majority of human presence will occur in the Project area during the day. Although there is the potential for limited human presence induced disturbance to wildlife, significant adverse effects are not predicted for several reasons. First, the Project area has a high degree of existing human disturbance (*i.e.,* sod farm activities) and thus wildlife species have either become acclimatized to some degree of human disturbance or have already left the area. Second, disturbance will be intermittent and generated noise will be of low levels (*i.e.,* human speech and vehicle noise). Third, no rare or at-risk wildlife species were reported as breeding in the Project area. In order to further reduce the severity effects of human disturbance on wildlife, worker presence on-site should be minimized and limited to designated work areas. In addition, all Project-related vehicles will be maintained to minimize noise and no idling will be permitted. In consideration of existing conditions and suggested mitigation no significant adverse effects are predicted on wildlife due to human presence during operation and maintenance.

The operation of the wind turbines may also result in visual and auditory disturbance of wildlife. However, studies in the western United States have shown that there has been no significant effect of the construction and operation of wind farms on big game (Strickland and Erickson 2003), indicating that species are either unaffected by these developments, given their small footprint and the preservation of existing land use, or that they can readily adapt to the presence of wind turbines. At this site, habitat avoidance will most likely occur during periods of construction, and may be more intermittent during periods of operation, when human presence on-site is less frequent and would occur on a short-term basis.

Mortality

Mortality of wildlife has the potential to occur during all phases of Project development. During construction and decommissioning, there is a small chance that small mammals may be killed as a result of limited site clearing and through the use of heavy equipment for moving materials on and off the Project site. However, additional potential for mortality relates to interactions between operating wind turbines and bats. Bats have been identified as animals with the potential to be affected by wind energy facilities, as measured by numbers of carcasses found during surveys at wind farms in the United States and Canada. The remainder of this section describes the issue of bat mortality at wind farms in more detail, places the issue in the Nova Scotia context and provides background to the assessment.

Bat Turbine Collisions

Given the ability of bats to navigate in darkness, to avoid large obstacles and detect small insects in the air using echolocation, it is interesting that bats would be found to collide with wind turbines and other tall structures. However, this is indeed the case. Bat collision mortality has been identified to occur with a number of tall structures including lighthouses, buildings, power lines, communication towers and wind turbines. Bat collision with human structures appears to be an infrequent occurrence, but it has the potential to be of concern, as discussed below.

The first report of bat fatalities at a wind farm was by Hall and Richards (1972). Over four years, 22 White-striped Mastiff-Bats (*Tadarida australis*) were found at the base of turbines at an Australian wind farm. Since then, bat fatalities have been reported at several wind farms in the United States and at one wind farm in Alberta (Brown and Hamilton 2002, Erickson *et al*. 2002, Johnson *et al*. 2002). Reports prepared by Erickson *et al*. (2002) and Johnson *et al*. (2002) provide excellent summaries of data available from a number of studies in the United States. These summaries show that the majority of bat fatalities at wind farms in the United States occur in late summer and early fall, presumably during southward migration. Of the 536 bat collision fatalities included by Erickson *et al*. (2002), nearly 90% of all the fatalities occurred from mid-July through mid-September, with over 50% in August (Erickson *et al*. 2002), peaking during the first two weeks. Most fatalities were of migratory tree bats with Hoary Bats being by far the most numerous, comprising approximately 61.7% of all fatalities. Additionally, 17.2% of the fatalities were of Eastern Red Bats and 7.1% were Silver-haired Bats. Small numbers of dead Big Brown Bat, Little Brown Bat, and Eastern Pipistrelle were also found during these studies.

Studies appear to support the belief that most fatalities are of bats during fall migration. For example, relatively large populations of bats were documented breeding in close proximity to wind farms at Buffalo Ridge, Minnesota and Foote Creek Rim, Wyoming, yet very few fatalities were recorded during the summer (Erickson *et al*. 2002). The four-year study at Foote Creek Rim determined that the majority of bats were killed in August, with the remaining carcasses found between June and September. Hoary Bats made up approximately 80% of the casualties at this site, with other species consisting of Little Brown Bats, Silver-haired Bats and Big Brown Bats (Johnson *et al*. 2002). Collisions have been reported from turbines located in crop fields, pastures and prairie, away from habitat typically used by foraging bats. Instead, the timing of documented mortality coincides well with the seasonal migration of bats, and most collisions involve these migratory species rather than resident species.

Based on the timing of spring migration (Koehler and Barclay 2000), spring migrations of Hoary, Eastern Red and Silver-haired bats are most likely to occur in May. Despite these movements, very few collision fatalities have been found in the spring at wind farms in the United States. Of 536 recorded bat collision fatalities at wind farms across the United States, only two were killed in May (Erickson *et al*. 2002). Collision data collected from other types of structures also support these findings. For example, of 50 dead Eastern Red Bats collected at a building in Chicago, 48 were found in the fall and two in the spring (Timm 1989). It is not clear why spring migrants collide with wind turbines far less frequently than fall migrants. Behavioral differences between migrating hoary bats in the spring and fall may influence collision risk, as suggested by Johnson *et al*. (2002). These differences have been reported in Florida, where autumn migration occurred in waves, whereas the spatial distribution of bats during spring migration appears to be far more scattered (Zinn and Baker 1979).

With the exception of Buffalo Mountain and Mountaineer, studies from wind farms are reporting relatively small numbers of casualties in line with the Klondike study, even taking into consideration carcass removal and searcher efficiency. Table 5-11 summarizes bat fatality data at a number of wind farms in the U.S. Many facilities reported few bat fatalities. As an example, and including factors correcting for carcass removal and searcher efficiency, only 19 bat collisions were recorded at the Klondike Wind Project in Oregon, consisting of 16 turbines, during a one-year study (Johnson *et al*. 2003). The 16 turbines at this open field site are 1.5 MW turbines with a blade sweep approximately 30-100 m above the ground. The six bats actually found at the wind farm were three Hoary Bats that had collided during September, a Silver-haired Bat found in May and two decomposed *Myotis* bats found in June. Based on the estimate of 19 bat collisions at the facility during the year, the average rate of collision is 1.2 bat fatalities per turbine per year (Johnson *et al*. 2003). With the possible exception of Mountaineer (see below), there is no current evidence that suggests populations are affected by wind farm mortality, despite the low population growth rates exhibited by most bats (excluding the Hoary Bat; see Bat Conservation International 2001). The principal factors adversely affecting bat populations are predation and habitat alteration/destruction, not collision with wind turbines or any other human structure (Bat Conservation International 2001).

Table 5-11 Estimated Bat Collision Fatality Rates at United States Wind Farms

Wind Resource Area	Bat Mortalities per Turbine per Year	Correction	Reference
Klondike, Oregon (16 - 1.5 MW turbines)	1.2	Adjusted for search biases	Johnson *et al*. 2003
Buffalo Ridge, Minnesota (Phases II & III) (281 – 750 kW turbines)	2	Adjusted for search biases	Johnson *et al*. 2003
Northeastern Wisconsin (31 – 660 kW turbines)	4.3	-	Howe *et al*. 2002
Foote Creek Rim, Wyoming (72 – 600 kW and 33 – 700 kW turbines)	1.3	Adjusted for search biases	Johnson *et al*. 2000, Young *et al*. 2001, Gruver 2002
Buffalo Mountain, Tennessee (3 – 660 kW turbines)	28.5	-	Nicholson 2003
Vansycle, Oregon (38 – 660 kW turbines)	0.7	Adjusted for search biases	Erickson *et al*. 2000
Lake Benton, Minnesota (354 - 660 kW turbines)	0.1 - 2.0	Adjusted for search biases	Johnson *et al*. 2003
Mountaineer Wind Energy Centre, West Virginia (44 - 1.5 MW turbines)	9.1	-	Lindsay and Kearns 2003
Nine Canyon, Washington (37 - 1.3 MW turbines)	3.2	Adjusted for search biases	Erickson *et al*. 2003

A more recent study proves to be an exception, in that large numbers of bats have been found to collide with wind turbines. At the Mountaineer Wind Energy Centre on Backbone Mountain, West Virginia, approximately 400 bats were found killed by 44 turbines during the first year of its operation (Lindsay and Kearns 2003). Of the 232 that were identified to the species level, most of the bats killed were Eastern Red Bats and Hoary Bats (Lindsay and Kearns 2003). Taking into consideration observer effort and carcass removal by scavengers, researchers have estimated that more than 1000 bats were killed at the site during a six week period (Bat Conservation International 2001). This is the greatest number of bats reported killed at any wind farm. The reasons why so many bats have been killed at the Mountaineer site are poorly understood but may include its siting at a high elevation within the Appalachian Mountains.

Bats are being killed at wind farms, or at least some wind farms, but the factors putting them at risk of colliding with wind turbines are unknown. Without a clear understanding of what would place bats at risk of collision, it is difficult to predict the frequency of bat-turbine collisions. For example, Erickson *et al*. (2002) report on several instances where bats were observed foraging very close to turbines without being struck by the turbine blades. This is further complicated by a lack of understanding of bat ecology, especially on migration, and the paucity of data on abundance and movement of bats at multiple spatial scales (continent-wide, provincial, regional) that could provide context for pre-construction surveys. Pre-construction bat surveys at the proposed Amherst Wind Energy Project were not undertaken due to the inability to be able to evaluate the significance of the site for bat migration, due to a lack of knowledge of what numbers of bats exist in and migrate through or within Nova Scotia,