Bird Observations at the Pickering Wind Turbine

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INTRODUCTION

In September of 2001, Ontario Power Generation (OPG) installed a modern wind turbine at the west end of the Pickering Nuclear Generating Station (PNGS). The Canadian Nuclear Regulatory Commission, in granting permission to OPG for the turbine, requested a year-long monitoring program to assess avian mortality and the possible impact of that turbine on bird populations. I prepared the monitoring program for OPG and, because of security considerations, ended up doing the monitoring through 2002. Quite apart from estimating bird mortality, I was able to make observations of bird behaviour in relation to the turbine. What follows is a summary of my observations near the wind turbine.

THE STUDY SITE

The wind turbine was placed in the west landfill area at the west end of PNGS (Figure 1). To the north of the landfill is Alex Robertson Park, an area of open lawns and a number of deciduous and coniferous trees scattered about in some parts. To the west is Hydro Marsh, which has open water areas, cattail stands, mudflats, and is bordered by shrubs and trees. It connects with Frenchman's Bay farther west. To the north of Alex Robertson Park, along Kronso Creek that flows into Hydro Marsh, there is a small wooded area with trees of various ages. The creek is marshy along the edges and has mudflats much of the year. To the south of the turbine is Lake Ontario. Between Hydro Marsh and the lake is a barrier beach. The Waterfront Trail passes through the south end of the park, south and close to the turbine, and west along the barrier beach. Other paths circle most of the park. A parking lot near the northeast corner of the park provides access to visitors to the park, and there are numerous users with their dogs on most days.

This is an area relatively rich in bird life, because of the lake, wetlands, parkland, and nearby urban areas, that provide a variety of habitats. Compilations of bird life in the area were made in conjunction with environmental assessments required for the generating station (Marshall, Macklin, Monaghan 2000). These inventories indicate that during the course of a year about 140 species might regularly occur, mainly as migrants, with about 20 species nesting in surrounding habitats. An additional 100 species have been reported, but their occurrence would be expected to be sporadic and likely only in very small numbers.

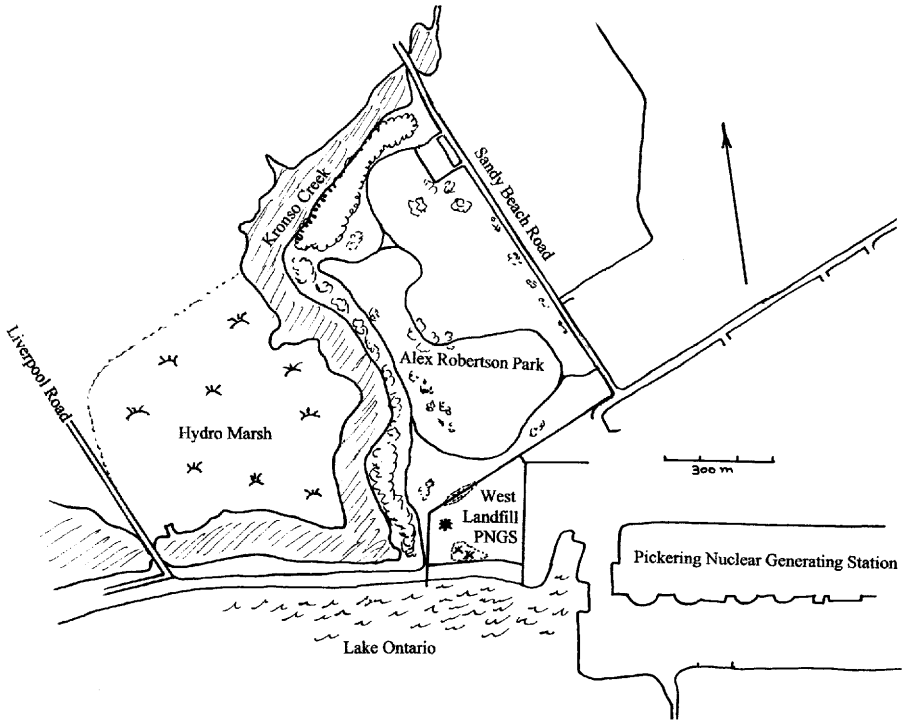

Figure 1: West end of the Pickering Nuclear Generating Station (PNGS), showing the surroundings of the wind turbine located in the west landfill.

The marsh and adjacent creek provide foraging, nesting, roosting, and shelter for cormorants, herons, waterfowl, rails, shorebirds, gulls, terns, and songbirds of many kinds. I was not able to spend the time to compile a detailed list of birds in all surrounding habitats. However, species most commonly seen from my usual cruising radius in 2002 included Double-crested Cormorant (*Phalacrocorax auritus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*), Ring-billed Gull (*Larus delawarensis*), Common Tern (*Sterna hirundo*), Downy Woodpecker (*Picoides pubescens*), Song Sparrow (*Melospiza melodia*), Swamp Sparrow (*Melospiza georgiana*), Northern Cardinal (*Cardinalis cardinalis*), Red-winged Blackbird (*Agelaius phoeniceus*), and Common Grackle (*Quiscalus quiscula*). The park provides foraging, nesting, and/or roosting for a variety of species, most notably Canada

Goose, Killdeer (*Charadrius vociferus*), Ring-billed Gull, Mourning Dove (*Zenaida macroura*), European Starling (*Sturnus vulgaris*), Common Crow (*Corvus brachyrhynchos*), House Finch (*Carpodacus mexicanus*), and American Goldfinch (*Carduelis tristis*). Numerous migrant songbirds also stopped temporarily during both spring and autumn. The waters and shores of Lake Ontario provide foraging and loafing areas for a wide variety of waterfowl, plus cormorants, gulls, and terns. A warm water discharge to the lake from the generating station maintains open water conditions all winter that is attractive to waterfowl.

The west landfill area itself is fenced off from the park. The area searched for carcasses included areas inside and outside the fence within at least 50 m of the tower. Within this 50 m radius, mowed lawn and paved trail covered about 24% of the area; bare gravel and roadway covered about 29%. Together, more than 50% could be searched thoroughly all year. There was some uncut grass (about 20% of the area) that could be easily searched, but finding small birds would have been more difficult at times once grass grew tall and until the grass died and matted down a bit. Shrubby and weedy areas (15%) could be searched fairly well through the spring migration, and again late in the year for any remains that might have been in evidence from summer. Some open portions could be searched all year, although small birds would have been missed. The marshy areas (12%) with tall cattails were the only area that could not be searched well, although I certainly scanned the edges for evidence of anything large.

THE TURBINE

The turbine is a Vestas V80, 1.8 MW, constant speed model, with a tower standing about 78 m high (Figure 2). The blades are 39 m long. The rotation is a constant 15.3 rpm. The generator is very quiet. The main audible sound, which was minimal, resulted from the sweeping of the blades through the air when the turbine was in operation. The noise was not sufficient that I noticed anyone in the park reacting to it. The wind usually made as much or more noise. The sound may have been audible to birds at close range, helping to alert them to the presence of the turbine.

PROCEDURES

Monitoring

The monitoring protocol was prepared in accordance with standard procedures recommended by Morrison (1998). Direct visual searches were concentrated mainly within 50 m of the turbine tower. However, I regularly scanned beyond that distance for anything obvious, and often extended the search for 20 to 30 m downwind, where possible, following days when winds might have carried

Figure 2: The Pickering wind turbine from the waterfront trail in Alex Robertson Park, looking southwest. Photo by *Don Chubbuck*.

something in that direction. Searches lasted about an hour each time. I walked a pattern that covered all searched area at intervals of about 5 m or less. I varied the approach and specific path somewhat in order to see things from a different perspective, or to be closer to somewhat different parts of the area. But, I was to a large extent guided by the layout of the area.

Searches were usually made on the same day or days of the week, in order to get fairly even coverage. The weather was random with respect to searches, and many different conditions were encountered. The search day was not changed because of weather, except to avoid following a snowfall, which would have buried carcasses. Searches were made about every two weeks from January until early March, and between the end of October and mid December. From 10 March to 4 May, 2 June to 17 August, and 22 September to 26 October, searches were made once per week. Search frequency was increased to three times a week from 5 May to 1 June and from 18 August to 21 September. Thus, the searches were more frequent at times when fatalities were more likely.

Study of removal by predators

This study was conducted to assess the potential for removal of dead birds by predators prior to being

found on searches. I placed out dead birds, within 50 m of the turbine, on a variety of ground covers. While I tried to avoid putting birds where they might be found by park users, I did place a number close to areas regularly passed by people and their dogs. Birds were tagged asking any person finding them to leave them. However, a dog could have consumed most before a person could intervene, or at least would have left noticeable damage. I checked each bird, on each subsequent visit, to determine how long it remained. They were removed by me after one week, when of no further interest to a predator because of the extent of decay.

RESULTS

Bird Behaviour

Canada Geese were present throughout the year, and common most of the time. They foraged regularly in the park, and foraged, loafed, or roosted along the lakeshore and in the marsh. They flew back and forth past the turbine virtually every day on a number of occasions. Typically they flew wide of the turbine by at least 75 m, moving over Hydro Marsh, or between the turbine and PNGS. They were obviously aware of the turbine, and simply avoided it most of the time. However, on some occasions I saw them fly close past the turbine even when it was in operation. When flying close, they did not make any sudden panic manoeuvres to avoid it, but continued directly on their flight, even when it brought them within 10 to 20 metres of the turning blades. They also landed on the ground and walked all about, even right beside the tower when the blades were turning above them.

Other waterfowl were present in varying numbers throughout the year, with more in migration and the nonbreeding season. Most were in Hydro Marsh or out on the lake, and regularly flew back and forth between the two. A few ducks, mainly Mallards, but also Gadwall (*Anas strepera*) and Blue-winged Teal (*Anas discors*), flew closer into the small marsh to the southeast of the tower, landing in a small bit of open water closer than 40 m from the tower. A pair of Mallards nested in this marsh, 35 m from the tower below the rotating blades. Trumpeter (*Cygnus buccinator*) and/or Mute Swans (*Cygnus olor*) were present in Hydro Marsh or on the lake through the year. I also saw them fly over the landfill within 100 m of the turbine when in operation. The turbine did not seem to inhibit waterfowl from living in close proximity to where they would be normally.

Ring-billed Gulls were common in the area all year and regularly flew from the lake to the park to forage on the grass. They also typically flew wide of the turbine by at least 75 m, but at times passed within a few metres of the turning blades without showing any apparent alarm.

Smaller numbers of Black-crowned Night-Herons were in

Hydro Marsh most of the summer and autumn, and regularly flew past the turbine to get to the outflows from PNGS. Usually, they passed more than 100 m away, but on occasion were seen flying within 50 m of the tower, below the height of the blades. They visited the small marsh southeast of the turbine also within 50 m of the tower. Great Blue Herons (*Ardea herodias*) were in Hydro Marsh on many occasions, and flying about over the park, although not seen close to the turbine. The herons' activities did not seem to be interrupted by the presence of the turbine.

Common Terns remained in Hydro Marsh through the summer, nesting on a raft there. As many as 70 birds could be seen at one time. Their nesting activities proceeded as normal, and they were seldom seen east of the marsh and closer to the turbine.

Killdeers were regular users of the gravel areas of the landfill, and flew in and out to the park every day. One pair nested within 60 m of the turbine tower. They regularly walked all about, even within a few metres of the tower below the turning blades. Spotted Sandpipers (*Actitis macularia*) visited puddles on the road and landfill, within 100 m of the tower. Migrant shorebirds of several other species certainly used Hydro Marsh, although they were not seen any closer to the turbine.

Double-crested Cormorants were regular users of Hydro Marsh and the adjacent lake most of the year. Ordinarily, they did not come close, but on one occasion, I watched one fly under a blade close to the generator when the turbine was not in operation.

Rock Doves (*Columba livia*) lived in the generating station and a flock regularly flew about the park and toward Hydro Marsh. I regularly saw them fly over the landfill area, usually well clear of the blades. On one occasion, four flew between stationary blades. Some foraged on the ground near the turbine in operation with no apparent concern.

Considering that hawk migration could have brought many hawks along the lakeshore nearby, I saw very few close to the turbine. I did see a Merlin (*Falco columbarius*) in the park, and several Sharp-shinned Hawks (*Accipiter striatus*). When the turbine was not operating, I watched one Sharp-shinned Hawk circle up right past the nacelle in front of the blades. One flew across the landfill very close to the tower when the blades were turning, but below them. I watched another chase a bird within 25 m of the turning blades. As with other birds, there was no apparent avoidance of the turbine, while keeping clear of any danger.

Summer resident songbirds of several types were regularly encountered near the turbine. Red-winged Blackbirds, Common Grackles, American Robins (*Turdus migratorius*), Mourning Doves, Song Sparrows, European

Starlings, American Goldfinches, House Finches, Barn Swallows (*Hirundo rustica*), and Yellow Warblers (*Dendroica petechia*) were the most numerous. All were seen close to the operating turbine, and carried on their daily lives seeming to pay no attention to it operating above. Their activities were largely closer to the ground below the blades, but not exclusively so. Several nested near the turbine: Red-winged Blackbird within 30 m, Song Sparrow within 50 m, Common Grackle within 50 m, and American Robin within 30 m. There were eggshells of Mourning Dove and Cedar Waxwing (*Bombycilla cedrorum*) on the ground within 50 m, suggesting they may have nested close also. A goldfinch or warbler nest (depredated and torn up) was also within 50 m of the tower.

Several other species, such as Gray Catbird (*Dumetella carolinensis*), Warbling Vireo (*Vireo gilvus*), Northern Cardinal, and Downy Woodpecker frequented the trees and shrubs below the turbine blades. Swallows of several kinds foraged over the landfill area. Numerous migrant songbirds were seen in the trees of the park, marsh edge, and landfill. Several times when the turbine was not operating, I observed small birds flying within a few metres of and between the turbine blades. Overall, these small birds, while undoubtedly well aware of the turbine, were not inhibited from normal daily activities right around it.

Predators

Typically, I arrived and searched outside the fence starting before sunrise. Occasionally, I came at other times. Most days, however, I arrived prior to any people or dogs that may have removed birds. Some dogs and people usually passed while I was there. Most dogs were running loose, and some ranged widely over the grassy areas. It was obvious from tracks that through the course of the day, and particularly on weekends, people and dogs were numerous and could be anywhere outside the fenced area.

There were numerous burrow dens in the landfill area. Some were woodchuck (*Marmota monax*) burrows, but others were used by other species. There were red fox (*Vulpes vulpes*) tracks fairly regularly, and foxes used one of the dens. Digging in the landfill area indicated that skunks (*Mephitus mephitus*) were present. There were raccoon (*Procyon lotor*) tracks regularly seen after each rain. There were at least two feral domestic cats roaming the area. Several times, half-eaten mice and snakes were found, attesting to the presence of these predators.

Common Crows were fairly regularly seen about the park and landfill areas from winter to early summer. However, when they came close to the turbine, they were usually distracted by attacks from blackbirds and grackles, and quickly departed. In summer, they were virtually absent (West Nile virus?). More were seen again after the end

of September as migrants began to move in. Gulls were present every day, but they generally avoided close approach to the turbine. Although gulls and crows were potential removers of any dead birds, they were seldom within the area most likely to have had avian casualties.

I found old bleached bones of birds and raccoons in the landfill area, on the shrubby hillside to the southwest of the turbine, and around the edge of the small marsh to the southeast. These were obviously not the result of turbine casualties, but of the activities of mammalian predators active in the area.

Removal by Predators

I placed out 42 dead birds, but am excluding seven from consideration. One was placed directly on the entrance to an active burrow, in far too obvious a place to indicate predator efficiency. The six placed out in the last week all disappeared, suggesting that a predator, perhaps a feral cat, suddenly began searching for placed birds. But, even then, four of the six were not found for at least two or three days.

Of the remaining 35 birds, most were small (20–warbler/sparrow-sized), that were the size of those most likely to have been turbine casualties, and most likely to have been completely removed by a predator, leaving no trace of their presence. Nine medium-sized birds (thrushes), and six large birds (woodcock, Rock Dove, gull) also were placed out. Fourteen were placed outside the fence and 21 inside.

I was amazed at how inefficient predators were at finding dead birds. The first few I placed were back side up and not as obvious. But, I very quickly got to the point of seeing how obvious I could make them. Birds were placed in a variety of situations, including areas of short grass, longer grass, bare gravel, and among shrubbery or under trees. However, I made no attempt to conceal the birds. When placed on longer grass, they were clearly visible from above and from one or more directions. When among shrubs, I chose spots where there was no overhead cover. When under trees, the branches were well above them so that they were easily seen from beside the tree. Thus, they were placed much as if they had fallen dead on the ground. Most were placed with the lighter coloured under surface upward, making them all the more visible. Those on bare gravel had no concealing vegetation at all.

Of the 14 birds placed outside the fence, only one disappeared. This is despite having placed one just into sparse weeds at the edge of a well-trodden path along the edge of the marsh, and another within 30 cm of the waterfront trail where dozens of people and dogs passed daily. The numerous dogs running loose in the park were certainly not adept at finding motionless birds. The one that disappeared was placed on an area of long grass.

None of those on the closely mowed grass disappeared within a week.

Of the 21 birds placed inside the fence where there were no dogs, five were found. Four of these were exposed on bare gravel, clearly visible from all directions. Only two of the six large birds were eaten, and one of those was on the roadway where predators could be expected to travel. The visibility of birds on bare gravel would seem to have been a factor in their being found, as proportionately more were taken there.

Overall, 29 of 35 birds were finally removed by me, when no longer of interest to a predator because of the state of decay. Of the six birds found by predators, three were eaten in place and remains were clearly visible. Of the six birds scavenged, four were removed within the first 48 hours, and two remained more than two days. Only three of 35 vanished without a trace (8.6%), and two of those were not found by predators for at least three days. Had I not left birds in such visible places, I doubt as many would have been found.

Avian Mortality

Over the course of the year, a total of three dead birds or their remains was found that I considered probable turbine kills. Two were nocturnal migrants, a Wood Thrush (*Hylocichla mustelina*) in spring migration, and a Philadelphia Vireo (*Vireo philadelphicus)* in autumn. Injuries were consistent with those expected of a bird striking a structure in flight. They probably died as a result of flying into the structure in darkness, but not because they were hit by rotating blades. I know the turbine was not operating when the thrush was hit in spring. In the autumn it probably was not active in the middle of the night; the bird was beside the tower.

There is some uncertainty that the third bird was a turbine casualty. It was an immature Black-crowned Night-Heron. They are fairly common all summer as visitors to the marsh and generating station outflow, but the remains were found only in late October. Remains were found in two different places about 50 m apart, so at least one part, if not both, were moved by predators. I am inclined to think the bird was hit at night, and the predators then consumed most of it at one place and dragged the rest elsewhere. Both pieces were under the extent of the turbine blades.

I also found a fourth dead bird, a European Starling, that I do not think had anything to do with the turbine. It was 50 m away, under a tree where it probably fell after dying of unknown causes. There were no broken bones or any indication of hemorrhaging in the skull.

Projected Total Mortality

The search pattern that I followed, and the ground conditions, allowed me to find even single small feathers in many places, including long

grass areas and open shrubby areas. Dozens of feathers were removed over the course of the year. These were not the results of any interaction with the turbine, but normal loss of feathers from passing birds. Most were found in late summer when many birds are molting. Thousands of feathers were also scattered through the park at that time. But, I doubt that I missed any dead birds, if they were there, in the areas that could be searched.

Searches were most frequent at the times of the year when small bird casualties were most likely to have been encountered. At other times of the year, the most likely casualties would have been large birds. If large birds had died, even if found by a predator, it is highly probable that remains would have been evident, as they were when I placed out larger birds. Smaller birds were less likely to have been found by predators before rotting, in which case, I would have found them. I was able to find individual bones and feathers in areas of uncut grass and open shrubbery until at least late June, and hence probably would have found small birds. In those areas, I could have found large birds at any time, if not all the small birds. More than 50% of the 50 m search area got a careful search throughout the year. More than 75% of the area got a careful search for all birds through the spring migration, and for medium and large birds throughout the year. Also, I searched additional area beyond the 50 m radius.

Predators proved to be rather inefficient at finding conspicuous dead birds, and with half of those few they did find, remains were left. Their efficiency was less than ten percent overall, and with the rate of removal and frequency of searches during periods of greatest nocturnal migration, it is more probable that anything would have been found before removal by a predator. Given the frequency of searching, the ease of finding even feathers in most places, and the inefficiency of the predators, I doubt that there was more than one bird, if any at all, that was missed.

DISCUSSION

Numerous studies during the past two decades and more, at virtually every new wind energy installation, have now been undertaken to estimate bird mortality at wind turbines. Studies have covered the range from one to thousands of turbines, and from mountains to offshore, across Europe and North America (Crockford 1992, Gill et al. 1996, Percival 2001, Erickson et al. 2001). These studies were initially driven largely by one situation in California where, with thousands of turbines, it was felt that the level of mortality of birds was unacceptably high. At this locality, the Altamont Pass, more extensive recent studies have found a mortality rate of about 0.23 birds per turbine per year (Thelander and Rugge 2001), but that the main concern is for rap-

tors, particularly Golden Eagles (*Aquila chrysaetos*). Similar problems have not been found at other wind energy facilities even in California (Kerlinger 2000), but the concern for Golden Eagles and other raptors is important.

Through many studies, and millions of dollars spent to find answers, the results have indicated relatively low numbers of birds killed at wind turbines, and often none have been found, especially at single turbines (Kerlinger 2000, Erickson et al. 2001). The study at Pickering also indicates that the turbine at PNGS is not going to have a significant impact on bird populations, despite there being plenty of birds flying about the area. The local resident birds soon learned of the presence of the tower and easily avoided it. I could see no indication that the turbine disrupted normal activity of the local birds. Some may have had to fly slightly farther to move safely about. This was unlikely to have seriously affected their foraging activity. Smaller birds just moved about below the turning blades as if they were not even there. Migrants continued to pass through the area, and nesting birds continued to nest as usual.

The recorded mortality at the turbine was half the number of birds that I also recorded as dead on a one kilometre section of Sandy Beach Road that runs beside and north of Alex Robertson Park, where I drove to and from the turbine. The road was likely to have experienced higher scavenging by crows and gulls, since these birds largely avoided the turbine, but were regular in the parks on either side of the road.

From all available mortality studies at wind turbines in the United States, the average outside California is about 1.83 fatalities per turbine per year (and 2.2 including California). These are considered to be accurate estimates if not slight overestimates, as detailed procedures have been followed (Erickson et al. 2001). Given that each of the free roaming house cats in North America is capable of killing more than 1000 small animals, including birds, each year (Coleman and Temple 1993), the wind turbine at Pickering is undoubtedly far less lethal than the two cats roaming the area. Each house in North America has been estimated to kill on average between 1 and 10 birds per year (Klem 1990, Dunn 1993). Wind turbines would not seem to be appreciably different than houses in the level of avian mortality reported.

The level of avian mortality at wind turbines has always been found to be absolutely insignificant when compared with tall buildings and tall communications towers that routinely kill hundreds and even thousands of birds each year (Weir 1976, Ogden 1996, Kerlinger 2000, Erickson et al. 2001). There has never been a record of a mass kill at a wind turbine. The highest mortality in one night ever record-

ed at a single turbine in North America was 14 birds at two turbines following a night of severe thunderstorms (Johnson et al. 2002). The highest I have come across for Europe at a single tower was 43, largely because there was a steady light attached to the turbine tower that night, attracting the birds; the turbine was not operating (Clausager and Nohr 1995).

The main factors that seem to determine mortality rate at towers of various types are poor weather, lights, guy wires, and height. In clear weather, even in coastal situations, the chances of a bird strike at a wind turbine are virtually zero (Crockford 1992, Winkelman 1995). Hence, raptors that migrate during the day are very unlikely to be killed. (In California, it is a population living among the turbines that is at risk.) Poor weather may bring nocturnal migrants down closer to the earth where they are more susceptible, and such weather reduces visibility. But, the occurrence of such weather, in inland situations at least, is unpredictable in time and space, such that the turbine location is not a predictor of potential mortality (Hanowski and Hawrot 2000). Even if a flock of migrants were to be low enough during bad weather, over 80% can pass right through the blades of a rapidly spinning variable speed turbine and remain unhurt (Winkelman 1992). The rate of rotation is much slower at Pickering and for any turbines in Ontario, and even less likely to cause mortality as blades are easier to see and avoid (Hodos et al. 2001). Should a bird ever get to a position of having to fly through the rotating blades, there is more time to do so if blades are moving slowly. The increased time/space between blade passes should reduce the chance of collision (Tucker 1996). Local birds soon learn the location of towers and avoid them even in darkness (Dirksen et al. 1997), hence local birds are at low risk.

Lights are known to attract birds and to disorient them, causing them to circle and fall from exhaustion, or more likely strike guy wires or glass windows where they are killed or injured (Manville 2001). But, modern turbines do not have guy wires and the lighting is minimal, and usually at least flashing, if not a strobe light. The Pickering turbine has a single strobe light by day, and a flashing red light at night. Flashing lights are generally considered to be less lethal than steady lights, although strobes apparently are even better (Ogden 1996, Larkin 2000). The lighting on wind turbines is not likely to be of significant impact in most situations.

The height of a tower is generally believed to be one of the most significant factors, with towers below 400 to 500 feet (122 to 152 metres) causing minimal mortality (Kemper 1996, Kerlinger 2000, Crawford and Engstrom 2001). The Pickering turbine and others used or to be used in Canada fall below

this height, and thus, are likely to continue to cause minimal mortality. The greatest threat to all wildlife is still loss and/or degradation of habitat (Manville 2001).

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