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Title: **ENVIRONMENTAL EFFECTS MONITORING PLAN FOR BIRDS AND BATS**

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1.0 Introduction

The HAF Wind Energy Project is located in the Township of West Lincoln, in the Niagara Region of Ontario. The Project will consist of five (5) Vestas V-100 1.8 megawatt wind turbines producing a nameplate capacity of 9.0 megawatts. Land use in the study area consists primarily of agriculture. The Natural Heritage Assessment Report, prepared for this project provides a complete description of the natural features identified within 120 metres of the project location.

This Environmental Effects Monitoring Plan for Birds and Bats has been prepared in accordance with the following Ontario Ministry of Natural Resources publications:

- "Birds and Bird Habitats: Guidelines for Wind Power Projects" dated October 2010;
- "Birds and Bat Habitats: Guidelines for Wind Power Projects" dated March 2010;

The post-construction monitoring protocol discussed in this Environmental Effects Monitoring Plan will be implemented at the HAF Wind Energy Project.

2.0 Purpose

The purpose of the Environmental Effects Monitoring Plan for the HAF Wind Energy Project is to outline post-construction monitoring survey requirements for a three year period to address potential negative environmental effects for birds and bats. Knowledge obtained from the post-construction mortality surveys will be used to identify monitoring needs for subsequent years, and will determine the success rate of proposed mitigation measures and protocols.

The Environmental Effects Monitoring plan for the HAF Wind Energy Project will ensure that any unanticipated potentially significant adverse environmental effects are detected and addressed so that they do not become significant.

3.0 Post-Construction Monitoring

Mortality Surveys

Post-construction monitoring will commence upon the operation of the turbine project. Monitoring surveys will include standardized weekly carcass searches conducted around each wind turbine location during the spring and fall migration periods. These surveys will be undertaken to assess the frequency of avian and bat mortalities, as per the Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (Environment Canada, 2007); Wind Turbine and Birds: A Guidance Document for Environmental Assessment (Environment Canada, 2007); Birds and Bird Habitats: Guideline for Wind Power Projects (Ontario Ministry of Natural Resources, 2010); and Bats and Bat Habitats: Guideline for Wind Power Projects (Ontario Ministry of Natural Resources, 2011).

Scavenger studies and searcher efficiency trials will also be implemented in accordance with the guidance provided in the Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds (Environment Canada, 2007); Birds and Bird Habitats: Guideline for Wind Power Projects (Ontario Ministry of Natural Resources, 2010); and Bats and Bat Habitats: Guideline for Wind Power Projects (Ontario Ministry of Natural Resources, 2011). Monitoring will be conducted during the core season when birds are active, from May 1st to October 31st and extend to November 30th for raptors, thus covering spring activity through fall migration.

Estimated mortality levels for birds and bats will be collected through observed mortalities per turbine, which will be modified by taking into account searcher efficiency and loss through scavenging of carcasses. Estimated annual mortalities per turbine will be calculated, and if threshold numbers are exceeded for birds and bats, mitigation measures will be implemented. The following sections outline the post-construction monitoring plan to assess impacts to bird and bat populations and provides mortality thresholds and mitigations measures to be implemented in consultation with MNR with the goal of lowering estimated mortality rates.

Timing

Bird and bat mortality monitoring will be conducted at all five turbine locations for three years following the commencement of turbine operations. Bird and bat mortality will be surveyed between May 1st and October 31st, extending to November 30th for raptors. Surveys will be conducted twice per week, at 3-4 day intervals.

If estimated annual mortality rates meet established thresholds, mitigation measures will be implemented in consultation with the MNR. Monitoring will continue on the same schedule for an additional three years for bats and birds.

Documentation and Reporting

Wherever possible, a complete 50 meter radius from each turbine base will be searched by a qualified biologist to identify and collect bird and bat carcasses. In the event of the discovery of carcasses, specimens will be photographed, and a field collection form completed. The field collection form will include information regarding the species, sex, date, time, location, and carcass condition.

The condition of each carcass collected will be recorded in one of the following categories:

- Fresh;
- Early Decomposition;
- Moderate Decomposition;
- Advanced Decomposition;
- Complete Decomposition; and
- Scavenged

Field forms will also include the searcher, injuries, distance and direction to nearest turbine, ground cover/substrate, estimated number of days since time of death and distance to plot centre.

Utilizing UTM coordinates; distance to the nearest turbine will be calculated and confirmed against field data forms. Information will be plotted cumulatively to determine whether or not selected areas of the 50 metre radius is more likely to contain carcasses. In addition, bird mortality will be plotted against weather pattern information to assess conditions which likely increase mortality probability.

All standardized methods and protocols will be used when collecting and handling carcasses. Carcasses will be labeled and stored in a freezer and used for future scavenger removal or searcher efficiency trials, assuming they are in reasonable condition (intact).

The carcasses of *Lasionycteris noctivagans*, *Lasiurus cinereus* and *Lasiurus borealis* found during bat mortality searches will be collected and frozen (later thawed) for use in carcass removal and searcher efficiency trials. The *Myotis septentrionalis*, *Myotis lucifugus*, *Myotis leibii*, *Perimyotis subflavus*, and *Eptesicus fuscus* will not be used due to white-nose syndrome (WNS) contamination risks. Instead, these species will be sent to the Canadian Cooperative Wildlife Health Center (CCWHC) in Guelph for testing for WNS. Specialized protocols will be used. These protocols include: double bagged with a copy of notes in middle layer, and frozen specimens sent by courier in ice packs in a hard bodied coolers to the CCWHC. It is important to note that searchers are able to accumulate specimens for up to three weeks prior shipping.

All searchers will have recent rabies pre-exposure vaccinations and will use proper gloves and/or tools when handling carcasses.

Permits

Searchers will obtain required permits for the collection, handling, storage and transporting injured bats and carcasses prior to commencing bat mortality surveys. The following permits will be sought as part of these works:

- A 'Wildlife Scientific Collectors Permit' will be obtained by MNR as required under the *Fish and Wildlife Conservation Act* to possess and transport wildlife.
- A 'Scientific Collector's Permit' will be obtained from Environment Canada as required by the Migratory Bird Convention Act, 1994 to collect, possess and utilize carcasses of migratory birds for use in carcass and searcher efficiency trials.

- If required, a permit from MNR under the *Endangered Species Act*, 2007 will be obtained to collect, possess and transport Species at Risk carcasses.

Injured Birds and Bats

In the event injured birds or bats are encountered, they will be transported to a licensed animal care centre.

Sample Area

Wherever possible, a complete 50 meter radius from each turbine base will be searched by a qualified biologist to identify and collect bird and bat carcasses. Carcass searches will be conducted in transects (5.0 - 6.0 meters apart), either in a rectangular or circular shape around each wind turbine.

Variability in terms of vegetation cover and terrain will be considered when estimating the total bird mortality rate for each turbine location. The habitat type present at each turbine site is comprised entirely of active agricultural fields, with relatively low vegetation cover percentage and low vegetation height resulting in an easy-moderate visibility class during the off season when no crops are grown.

The 'visibility class' will become more difficult during the growing and harvesting seasons at turbine locations. Tillage and mowing schedules will be timed to occur immediately following a carcass search to protect carcasses within the study area and to minimize mechanical impact to bats from tillage and mowing activity. Field searchers will inform the operation manager when vegetation cover requires maintenance and coordinate maintenance activities with the next field survey.

Wherever possible, ground cover around the turbines should be maintained at low levels in order to facilitate more accurate bird and bat mortality surveys. The search area of each turbine will be mapped into visibility classes according to **Table 1**, provided by MNR.

Table 1: Mortality Visibility Class (Ministry of Natural Resources, 2011)

% Vegetation Cover	Vegetation Height	Visibility Class
≥ 90% bare ground	≤ 15 cm tall	Class 1 (Easy)
≥ 25% bare ground	≤ 15 cm tall	Class 2 (Moderate)
≤ 25% bare ground	≤ 25% >30 cm tall	Class 3 (Difficult)
Little or no bare ground	≥ 25% >30 cm tall	Class 4 (Very Difficult)

Percent Area Searched

Based on post-construction data gathered to date in Ontario, most birds and bats appear to fall within 50 metres of a wind turbine base. Therefore, this area represents the maximum recommended search area. Since it may not always be possible to search the entire 50 metre radius (due to active cultivation), the actual area to be searched during the mortality surveys will be calculated at each turbine using GPS or other comparable methods as

approved by the MNR. A description of areas deemed to be unsearchable, if any, will be provided (e.g. vegetation height, type, slope, etc.) using visibility classes identified by the MNR. A map of the actual search area for each turbine will be provided in the mortality report.

The percent area searched (P_s) will be calculated as follows:

$$P_s = \frac{\text{actual area searched}}{\text{pi } r^2}$$

P_s is the percent area searched
r is the radius (50 metres)

4.0 Carcass Removal Trials

Carcass removal trials will be completed to determine the average carcass removal rate, which is a significant factor when estimating total bird and bat mortality.

Carcass removal trials for the HAF Wind Energy Project will utilize the following guidelines:

- Carcass removal trials will be conducted at least once a month;
- Five carcasses will be used for each trial;
- Carcasses will be monitored every 3-4 days in conjunction with carcass seaches;
- Carcass removal trials will be conducted in a variety of recorded weather conditions;
- Carcasses will be distributed across the range of different substrates/habitats present at the turbine locations. No more than 5 carcases are to be used at any one time for each trial;
- Carcasses will be placed before dusk using gloves and boots to avoid imparting human smell and possibly biasing trial results (e.g. attract scavengers, etc.);
- Trials will continue until all carcasses are removed or have completely decomposed (generally 2 weeks);
- To avoid confusion with turbine-related fatalities, trial carcasses will be discreetly marked using unique identification (e.g. clipping of ear, wing leg, fur; hole-punching ear; etc.), so that they can be identified as trial carcasses;
- Carcasses used will be as fresh as possible, as frozen or decomposed carcasses are less attractive to scavengers. If frozen carcasses are used, they will be thawed prior to beginning the carcass removal trials; and,
- Wherever possible, bat carcasses will be used for at least one third of the carcass removal trials. Bird carcasses will comprise the other third of the trial carcasses.

Scavenger Correction Factor

Proportions of carcasses remaining after each search interval will be pooled to calculate the overall scavenger correction factor. The scavenger correction factor (S_c), will be calculated as follows:

$$S_c = \frac{n_{visit\ 1} + n_{visit\ 2} + n_{visit\ 3}}{n_{visit\ 0} + n_{visit1} + n_{visit\ 2}}$$

S_c is the overall scavenger correction factor
$n_{visit\ 0}$ is the total number of carcasses placed
$n_{visit\ 1}$ is the total number of carcasses remaining on visit 1
$n_{visit\ 2}$ is the total number of carcasses remaining on visit 2
$n_{visit\ 3}$ is the total number of carcasses remaining on visit 3

5.0 Searcher Efficiency Trials

Searcher efficiency is a significant factor when estimating total bird and bat mortality. As such, searcher efficiency trials will be conducted for all project turbine locations. Searcher efficiency trials require a known number of discreetly marked carcasses to be planted around a wind turbine. Searchers examine the wind turbine area, and the number of carcasses found is compared to the number of carcasses planted.

Searcher efficiency trials for the HAF Wind Energy Project will utilize the following guidelines:

- Searcher efficiency trials will be conducted at least once per month during the mortality-monitoring season;
- Three carcasses per searcher per visibility class (see **Table 1**) will be used. The average efficiency per searcher across all visibility classes will be used for calculations;
- Searcher efficiency trials will be conducted for each individual searcher. To avoid potential search bias, searchers will not be notified when they are participating in an effciency trial;
- Trial carcasses will be randomly placed within the search area. A maximum of 3 carcasses will be placed at any one time. The locations of the trial carcasses will be recorded so that they can be removed and recorded if they are not found during the trial;
- Trial carcasses will be placed for one search period only. If the carcasses are not found during the trial they will be removed and recorded by the tester;
- Trial carcasses will be discreetly marked with unique identification (e.g. clipping of ear, wing, fur; hole-punch ear; etc.) so that they can be identified as a trial carcass by the tester;
- Wherever possible bat carcasses will be used for at least one third of the carcass removal trials. Bird carcasses will comprise the other third of the trial carcasses; and,
- If frozen carcasses are used, they will be thawed prior to beginning the carcass removal trials.

Searcher Efficiency Factor

A searcher efficiency factor will be calculated for each searcher. The searcher efficiency (S_e) factor will be calculated as follows:

$$S_e = \frac{\text{number of carcasses found}}{\text{number of carcasses placed - number of carcasses scavenged}}$$

S_e is the searcher efficiency

A weighted average of the overall searcher efficiency will also be calculated. The weighted average of overall searcher efficiency (S_{eo}) will be calculated as follows:

$$S_{eo} = S_{e1}(n_1/T) + S_{e2}(n_2/T) + S_{e3}(n_3/T)$$

S_{eo} is the weighted overall searcher efficiency
S_{e1} is the searcher efficiency for searcher 1
S_{e2} is the searcher efficiency for searcher 2
S_{e3} is the searcher efficiency for searcher 3
n_1 is the number of turbines searched by searcher 1
n_2 is the number of turbines searched by searcher 2
n_3 is the number of turbines searched by searcher 3
T is the total number of turbines searched by all searchers

6.0 Estimated Mortality Thresholds

Birds

The annual estimated mortality threshold for birds is:

- 14 birds per turbine per year at individual turbines
- 2 raptors across the project per year

The identified threshold for a significant single event bird mortality will be based on the following observed mortalities:

- 10 birds observed at any one turbine
- 33 birds observed within the HAF wind farm

Bats

The annual estimated mortality threshold for bats is:

- 10 bats per turbine per year (i.e. 50 bats for the HAF Wind Energy Project)

Corrected Mortality Estimates

In addition to total bird and bat mortalities observed, estimated mortality rates will also consider the results of searcher efficiency, scavenger removal trials, and percent area searched.

Corrected mortality estimates (C) will be calculated as follows:

$$C = \frac{c}{(S_e \times S_c \times P_s)}$$

C is the corrected number of bat fatalities
c is the number of carcasses found
S_e is searcher efficiency
S_c is the overall scavenger correction factor
P_s is the percent area searched

7.0 Post-Construction Mitigation and Notification

The annual post-construction monitoring report will summarize and analyze the results of the mortality monitoring. Reports will be completed within three months of the end of each year's survey period. The report will be submitted to the Ontario Ministry of Environment and copied to the Ontario Ministry of Natural Resources. These reports will remain on file and be made available from the Ontario Ministry of Environment and the Ontario Ministry of Natural Resources, upon request. Raw data gathered will be entered into a central Wind Energy Bird and Bat Monitoring Database for wind energy projects.

The reports will provide annual mortality rates expressed as the number of estimated mortalities per turbine. In addition, the results of the carcass removal and searcher efficiency trials, as well as raw data will be included. Species of significance identified in the appropriate Bird Conservation Region will be summarized as well as other species of concern such as raptors. Data results from the annual estimated mortality rates will be compared to levels indicated by other publications, if available.

The Operation Manager will be notified by the searchers if estimated mortality thresholds are reached for birds and/or bats. The Operation Manager will then implement specified operational mitigation. MNR staff will be informed immediately to discuss whether additional mitigation is warranted.

Operational Mitigation

Birds

Should estimated annual mortality rates exceed the specified thresholds for birds (14 birds/per turbine/ per year), consultation with MNR will be undertaken and the following operational mitigations will be applied:

- Temporary shutdown of one or more turbines depending on where the higher than anticipated mortalities occurred during a set period of time;
- Feathering of wind turbine blades at specific times of the year when mortality risks are high;
- An additional three years of mortality and effects monitoring will be implemented

The effectiveness of mitigation measures will be evaluated during the first two years of operation and modified as required. If required, an increase in survey frequency shall be implemented and factors which may contribute to high levels of morality (weather conditions, time of year when density of birds is particularly high) will be reviewed, as well as carry out behavioral or movement surveys. For example, if mortality rates of birds and raptors are significantly high at a particular turbine location, scoped mortality and cause and effects monitoring will be implemented. Operational mitigation in such events at individual turbines include temporary shut-down of turbine operations during a particular time of year such as migration. In the event that bird mortality thresholds continue to be exceeded after operational mitigation is applied, the Operation Manager will work with MNR to determine additional mitigation measures and a scoped monitoring plan.

Three years of mortality monitoring will be conducted at all turbines, including turbine 4 which is within 120m of a Bird Significant Wildlife Habitat feature. According to the Birds

and Bird Habitat Guidelines (MNR 2011), any turbine that is located within 120m of a Bird Significant Wildlife Habitat feature requires immediate post-construction mitigation (including operational mitigation), as outlined in the EIS, and three years of monitoring, where monitoring identifies significant annual bird mortality or disturbance effects associated with the Bird Significant Wildlife Habitat feature.

A contingency plan addressess additional mitigation measures to be implemented in the event of a significant bird morality event. A significant bird mortality event is when a single mortality monitoring survey exceeds:

a) 10 or more bird at any one turbine; or
b) 33 or more birds (including raptors) at multiple turbines

In the event of a significant bird mortality event the following will be done as the contingency plan:

- The immediate shut down of the a) turbine or b) turbines
- That the MOE and MNR will be engaged in to initiate an appropriate response plan as set out in the MNR's Bird Guidelines (2011), which may include some or all of the following mitigation measures
    - Periodic shut-down of select turbines (MNR, 2011)
    - Blade feathering at specific times of year (MNR, 2011)
    - Increased reporting frequency to identify potential threshold exceedance in a timely way
    - Additional behavioural studies to determine factors affecting mortality rates
    - An alternate plan developed and in agreement with the MOE and MNR, utilizing consideration of the seasonal abundance and species composition associated with the project/ mortality event and the best available science and information.

Bats

Should estimated annual mortality rates exceed the specified thresholds for bats (10 bats/per turbine/per year), consultation with MNR will be undertaken and the following operational mitigations will be applied:

- Mitigation measures will be implemented from sunset to sunrise from July 15th to September 30th ;
- Change the wind turbine cut-in speed to 5.5 metres per second (measured at hub height);
- An additional three years of mortality and effects monitoring will be implemented.

This operational mitigation will continue throughout the duration of the project. Should site-specific monitoring indicate a shifted peak mortality period operational mitigation may be shifted to match the peak mortality, with mitigation maintained for a minimum of 10 weeks. Any shift in the operational mitigation period to match peak mortality will be determined in coordination with and confirmed by MNR. In the event that bat mortality thresholds continue to be exceeded after operational mitigation is applied, the Operation Manager will work with MNR to determine additional mitigation measures and a scoped monitoring plan.

8.0 Candidate Significant Wildlife Habitat

8.1 Bat Maternity Colony Habitat (Mill Creek-Inverary Woods)

Should the habitat be confirmed as Significant as per the pre-construction monitoring methods outlined in the EIS, a post-construction monitoring program will be implemented for 3 years to ensure that mitigation was successful. This post-construction monitoring program will utilize the same methodology used for the pre-construction monitoring. See Appendix B. Should the post-construction monitoring program indicate a behavioural avoidance of the Significant Bat Maternity Colony, additional mitigation measures will be implemented, in consultation with MNR to address associated impacts.

This post-construction monitoring program may be carried out in addition to the post-construction monitoring program specifically designed to study the effects of turbine operations on bat mortality.

8.2 Terrestrial Crayfish Habitat

Should the habitat be confirmed as Significant as per the pre-construction monitoring methods outlined in the EIS, a post-construction monitoring program will be implemented for 3 years to ensure that mitigation was successful. This post-construction monitoring program will utilize the same methodology used for the pre-construction monitoring. **See Appendix C**. Should the post-construction monitoring program indicate a behavioural avoidance of the Significant Terrestrial Crayfish habitat, additional mitigation measures will be implemented, in consultation with MNR to address associated impacts.

Should the pre-construction monitoring determine that additional habitat beyond the original boundaries be discovered, the original habitat boundaries will be adjusted/ revised to include the additional area(s) where the species listed above or their chimneys (burrows) were found/observed. Any change to the boundaries, potential impacts and/or mitigation will be presented to MNR prior to implementation.

References

Environment Canada. 2007a. Wind Turbines and Birds: A Background Review for Environmental Assessment.

Environment Canada. 2007b. Wind Turbines and Birds: A Background Review for Environmental Assessment.

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Appendix A

Environment Canada
Recommended Protocols for Monitoring
Impacts of Wind Turbines on Birds

Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds

FINAL
February 19, 2007

Environment Canada
Canadian Wildlife Service

Recommended Protocols for Monitoring Impacts of Wind Turbines on Birds

prepared by
Canadian Wildlife Service
Environment Canada

Contents

Introduction

Uses of this document

To fulfil the requirements of a federal environmental assessment, the proponent of a wind-powered generating station (whether a large wind energy installation or a single turbine), may be required to gather baseline information on the birds that use and move through the area to be developed, and to provide follow-up information on the actual impact of the installation on the birds of the area (for more details see Environment Canada's *Wind Turbines and Birds: a Guidance Document for Environmental Assessment*, available at: http://www.cws-scf.ec.gc.ca/publications/eval/index_e.cfm).

The current document has been developed to provide proponents with information on the types of protocols likely to be useful for baseline studies and follow-up monitoring at proposed wind energy sites to evaluate impacts of wind turbines on birds.

However, proponents should not use this document on its own without consulting biologists from the Canadian Wildlife Service of Environment Canada (CWS). The most appropriate protocols for a project depend on the particular location and the risk factors at that location. Only some of the protocols in this document are likely to be required at any given site; conversely, some circumstances (e.g., offshore installations) may require protocols not covered in this document.

Pre-construction monitoring typically can be completed in one year, except in areas with particularly high uncertainty such as offshore installations. However, at any site, additional monitoring may be required if inappropriate protocols are used and inadequate data are collected in the first year. This could cause delays in approval. CWS biologists, if consulted in the early planning stages of a project, can help determine which protocols are most appropriate for a particular installation, and the appropriate level of effort to invest in each, thus greatly reducing the risk that data will not be adequate for the assessment.

While only those species of birds specified in the *Migratory Birds Convention Act, 1994* (MBCA) are under federal jurisdiction, this guide suggests study methods that are suitable for gathering information on all bird species. Some protocols, particularly post-construction mortality monitoring studies, may also be appropriate for monitoring impacts to bats. Bats have been found to be particularly vulnerable to wind energy installations in some areas. However, this document does not specifically address monitoring requirements for bats, and in particular does not address pre-construction monitoring for bats. Proponents are reminded that bats and all non-MBCA bird species are under provincial or territorial jurisdiction; the protocols suggested in this document are not meant to replace information provided by provincial or territorial authorities. Proponents are urged to contact the relevant provincial or territorial authorities to determine what requirements or expectations they may have with respect to bat monitoring pre- or post-construction.

Field data collection

It is very important that field workers hired to perform surveys outlined in this document are skilled at identifying birds by song and call and by sight. This requires knowledge of all the bird species that might be found in any particular habitat and the skill to identify individual bird songs from a chorus of mixed-species bird songs. Generally, if a person is a regular participant in the annual Breeding Bird Survey (a continental bird survey programme administered in Canada by the CWS) or any other national bird survey programme that requires an equivalent or better ability, and is familiar with birds in the region where the survey is being undertaken, then he or she is probably capable of undertaking this work. Proponents are responsible for ensuring that field staff carrying out bird surveys have adequate skills.

If a skilled field worker familiar with songs is not available, it may be possible to use electronic recording devices to record bird songs for later analysis. This approach has been adopted by a number of monitoring programs, including the Alberta Biodiversity Monitoring Program and is described in further detail under "**microphone point counts"** in Appendix 1. With present technology, this still requires a person skilled in identifying bird songs to do the final identification, but the interpretation can be done outside of the breeding season when field experts may be more readily available, and does not require the expert to travel to the field site. A field worker must still be available who is able to identify birds visually for surveys of species that are rarely detected by song, such as waterbirds or raptors, or for surveys outside of the breeding season when most birds are not singing.

Using the same field workers to carry out the pre-construction baseline studies and the follow-up surveys is recommended as a means to help standardise comparisons. Even a highly skilled observer will not manage to detect every bird that is singing at the same time, and the proportion of birds detected varies among observers. As a result, many trend analysis programs, including those for the Breeding Bird Survey, only analyse trends in data collected by the same observers. Proponents should be aware that the personnel used by a contracting company may vary from year to year, and that using the same company does not guarantee the same personnel. Furthermore, despite initial intentions, it may sometimes happen that the same personnel are not available for follow-up surveys.

For this reason, it is desirable for field work to include a means of estimating detection probabilities or observer validation in the protocols. For surveys based on bird songs (such as point counts), one way to do this is to make recordings of some or all of the point counts using appropriate equipment, and have the recordings analysed independently (see **microphone point counts** in Appendix 1). Digital copies of any recordings should be submitted with the Environmental Assessment and deposited with the monitoring data base (see next section) along with appropriate documentation on the date, time, location, weather conditions, and equipment used. These can later be interpreted by one or more additional experts if it is necessary to compare observers.

This is most likely to be a concern if the site contains habitat that supports significant numbers of breeding songbirds. CWS biologists can advise whether this is likely to be the case.

Reporting requirements

Proponents are required to include the results of pre-construction surveys in their Environmental Impact Assessments. Post construction survey and monitoring results are required to be written up and submitted to the CWS as part of follow-up.

Proponents are also asked to make available raw survey data from standardized protocols for both pre- and post-construction monitoring. The Canadian Wind Energy Association (CanWEA) and the CWS are collaborating to develop a database for the collection of bird-related data from Canadian wind energy projects, particularly for data collected using protocols recommended in this document. This national database will be used by CWS researchers to increase understanding of environmental effects of turbines on birds including the potential for cumulative effects related to habitat displacement or direct mortality. The results of these analyses will be particularly valuable for informing future monitoring requirements, in particular determining which monitoring data are most useful for predicting impacts (by comparing pre- and post-construction data), and Environment Canada will also use the results to update these protocols and the companion document *Wind Turbines and Birds: a Guidance Document for Environmental Assessment*, to make the EA process as efficient as possible. Analyses can also provide information on potential mitigation measures if significant adverse impacts are detected.

Provisions will be made to ensure that proprietary interests are protected for all data submitted. While it is desirable to provide some results for the public, this will be at a very general level, to protect the concerns of individual proponents. Any released data will not be linked to particular projects and will not provide sensitive information without the consent of the proponent.

Normally, data from pre-construction baseline studies would not be deposited into the shared database until after EA approval and the start of construction, even though the results and data are required to be a part of the information submitted through the environmental assessment process[1]. Post-construction raw data and results should be deposited annually into the shared database and thereby reported to the CWS.

During the initial development phase, provision of data to this database by proponents will be on a voluntary basis, though it is hoped that most companies will participate. Once the database is fully operational and all parties (CanWEA, CWS and industry) are satisfied that it meets their needs for information storage and security, then it may become an expectation of EA approval that all companies would submit their data.

[1] This data base is unlikely to be ready until early 2007. In the meantime, proponents should retain all their raw data so that they can be entered in the database once it is available.

Proponents may want to consider including data entry into the database as part of the contracted requirements of the company or persons hired to perform the studies.

Pre-construction (baseline) sampling methods

This section provides an overview of the types of sampling that might be expected pre-construction as part of the Environmental Impact Assessment process. For sampling methods highlighted in **bold**, further details on protocols are given in Appendix I.

Note that the amount of sampling required will vary considerably among sites, depending on the size of the site, the nature of the habitats at the site, and the numbers and species of birds expected, as reflected in the Level of Concern scores (see Environment Canada's *Wind Turbines and Birds: a Guidance Document for Environmental Assessment* for details on the Level of Concern scores). For some sites, very little sampling will be required. As noted in the introduction, proponents should consult with the CWS prior to commencing surveys to determine the appropriate choice of protocols and level of effort.

Breeding season

Breeding season surveys should be designed to determine which species regularly use the area for nesting, for foraging during the breeding season, or for raising their young, and to obtain measures of abundance of bird species using the area. Such data will be used to predict the potential impact to breeding birds of developing turbines on a site and (when combined with post-assessment monitoring) to quantify the actual impact, if construction proceeds, in order to test the predictions.

Area searches are an effective means for developing a species list for a site. This method involves visiting all of the different habitat types in an area, at various times of day and year when different species are most readily detected. A list is kept of all bird species encountered, preferably with an estimate of numbers and information on any breeding evidence found (e.g., nests, carrying food, territorial behaviour, etc.). This is essentially the same approach as is used for regional Breeding Bird Atlasses which have been used to map the distribution of breeding birds in several provinces of Canada (for example, see the Ontario Breeding Bird Atlas guide to participants available on: http://www.birdsontario.org/atlas/atlasmain.html). In its simplest form, an area search does not require standardized effort, although the amount of effort should be recorded.

Quantitative estimates of bird abundance can involve a variety of protocols. For most songbirds, the most widely used method involves **point counts**. For monitoring turbine sites, 10-minute point counts are recommended, spread through the project area. For projects with more than 10 turbines proposed, this would normally require at least 20 point counts in each major natural habitat type; this can be scaled back for small projects (< 10 turbines) or if the area of natural habitat likely to be affected is small. Point counts should be repeated twice over the course of the breeding season to ensure that both early and late breeders are detected. Some bird surveys involve shorter point counts (3 minutes or 5 minutes) but those are generally more appropriate for large scale

surveys (e.g., province-wide) rather than for specific sites of interest such as wind energy installations. Because of minimum spacing requirements between point count stations, 20 stations may not fit within either the entire project area or within a particular habitat type, in which case the sampling can be reduced accordingly. Particularly if the project involves any potentially important habitats for songbirds, it is highly recommended that at least some of the point counts be concurrently recorded using microphones and digital recorders so that later analysis of recordings can be used to adjust for variation among observers (see section on **microphone point counts** for more information on benefits and limitations of this approach).

For surveys involving birds not readily detected by song (such as waterfowl or shorebirds or birds on migration), an alternative quantitative measure is a **standardized area search.** This involves selecting a particular area (which may be the complete study area or carefully selected smaller plots) and recording all individuals of each species encountered during a standardized visit. This is most effective for species readily detected visually (such as waterfowl or shorebirds) or if the study area is relatively small. A variation on this method involves **line transects** which can be of either fixed width or variable width.

Colonial species often require special survey methods to count, or estimate, the total number of nests in the colony. However, contractors should be aware that many colonial waterbirds are quite sensitive to disturbance, and it is usually inadvisable to enter colonies during the nesting season. If a waterbird colony is present at the site (e.g., gulls, terns, herons, cormorants, seabirds) the contractor should make a rough estimate of numbers without actually entering the colony and then contact the CWS for advice on how to proceed. The appropriate advice will depend on the location of the colony, the area it covers, the species present in the colony, and the estimated number of birds in the colony.

For some secretive bird species, such as marsh birds and some raptors, especially owls, **playback methods** may be required to determine presence / absence or to estimate numbers. These involve playing recordings of the birds' territorial calls at the edge of suitable habitat during the appropriate time of day and year, and listening for a response. In most cases, such surveys can be qualitative, to determine presence or breeding evidence, unless the project area includes a large wetland or important habitat for a species at risk that is difficult to detect. In that case, a more quantitative survey may be recommended: contact the CWS for more details on designing a study to suit a particular area.

Non-breeding Season

Areas that contain habitats that may be important for migrants as stopover sites or wintering areas should be surveyed to determine whether they support large numbers of birds in these seasons. Some areas may also have high concentrations of birds flying through them, in which case there is a concern whether they may be flying at heights comparable to the blades of the wind turbines. Depending on the habitats present in an area, the geographic location of the area, and prior knowledge of when birds travel

through the general area, this may involve surveys during both spring and autumn migration as well as in winter.

Passage Migration
Birds flying through the project site on migration may be at risk of colliding with turbines. **Passage migration counts** are done to determine the number of birds flying through or over an area. Quantitative monitoring of passage migration will normally only be required if there is particular reason to believe migration will be concentrated at a site (e.g., large numbers of migrants known to pass through, wind energy installation is on a ridge top or within mountain passes, or data from similar areas elsewhere suggest migrants may be concentrated). For diurnal migrants, such as raptors, some songbirds, or some waterbirds, this can involve standing at a suitable vantage point and recording the numbers of each species passing by, taking note of whether they are flying through areas where turbines are proposed to be built. Many songbirds, as well as owls and some waterbirds, migrate mainly at night. Full quantification of nocturnal migration typically requires **radar** but an index of migration activity can often be obtained by **acoustic monitoring**.

Migration rates vary considerably from one day to the next, depending on weather conditions, so fairly intensive surveys (several days per week) are required to get a quantitative understanding of migration at a site. If daily coverage is not possible then efforts should be concentrated on days when weather conditions are favourable for large-scale migration. Information on migration volume, derived from analyses of weather radar data may help to calibrate local studies.

Migration Stopover
For quantitative surveys of stopover use, a variation on an area search called a **stopover count** is usually recommended in which one or more standardised transects are walked, and all birds seen or heard within a specified distance of the transect are recorded. The distance should be chosen such that birds can be readily identified within that distance, and will not be counted twice from different transects or different parts of the transect. In some areas or for some species (e.g., birds), it may be appropriate to also count birds beyond that distance. Transect(s) should be selected to sample all major habitats present on the site. Time of day and time of tide (for coastal areas) should be standardized to the time when birds are most readily counted. For songbirds, early morning is generally preferable, although raptors may be more readily detected later in the day.

In most cases, these surveys should be made approximately once a week throughout the spring and autumn migration season. In some circumstances, it may be necessary to modify this protocol to involve more intensive (e.g., daily) surveys during peak migration periods for particular species of concern.

If significant concentrations of birds are present (such as migrating raptors or large flocks of waterbirds), **behavioural studies** should also be undertaken to assess whether the behaviour of birds using the area leads to a risk of collision with turbines.

One approach, sometimes called a watch count, requires the observer to be stationed at a particular vantage point and to count the number of times birds move through potential turbine locations or other areas of concern.

Overwintering
Counts during the winter (e.g., November to March) should be carried out if the habitat characteristics lead to an expectation of, or if there is a history of, significant use of the area by overwintering birds (e.g., songbirds, raptors, waterfowl). **Standardized area searches** are the most effective survey method, using protocols similar to those recommended for migration stopover studies. As with migration stopover studies, if significant numbers of birds are present, searches should be complemented with **behavioural studies** to determine whether birds flying through areas will be within the future blade-swept area if turbines are built.

Winter visits should be done once or twice per month to estimate numbers of birds using an area, although more frequent visits may be needed for behavioural studies in areas with known concentrations of birds.

Offshore locations

At offshore locations, specialized survey methods may be required. Although there is some concern about direct mortality from turbines, the greatest problem, at least based on the European experience, appears to be displacement of seabirds from areas that may be important for feeding or commuting. This could potentially have population level consequences if large portions of a population are excluded from high quality habitat or forced to fly much longer distances around a site. Surveys must be designed to assess usage of the area throughout the year, for commuting, migration and foraging. In addition to monitoring bird activity, this may require monitoring of food supplies. Appropriate survey methods may include shipboard line transects, platform-based observations, and radar monitoring. The preferred combination will depend upon how much is known about the area and what risks are anticipated. Given limited knowledge about most sites, two years of pre-construction monitoring may be necessary to assess annual variation. Because offshore wind energy installations have not yet been developed in Canada, standard guidelines are not yet available on the amount of monitoring required—this will need to be determined on a case by case basis. Once further experience has been obtained, standards for these surveys will be included in future updates to this document. Whichever methods are chosen, data should be recorded in a standardized fashion for that method, as described below, to ensure the data can be compared with results from other locations, and stored in the standardized data base.

Bats

There is increasing evidence that some wind energy installation, even in agricultural settings, can intercept and kill large numbers of bats. As a result, it may be important to monitor prospective wind energy installation sites to determine whether any of the sites present an elevated risk for substantial bat mortality.

Bats fall outside of federal jurisdiction unless they are a species at risk, and proponents should contact the relevant provincial or territorial wildlife department to determine what requirements they may have for monitoring of bats or bat activity. Several provinces are in the process of developing written guidelines. Links will be provided to these documents as they become available. Alberta has completed a document:

Lausen, C. E. Baerwald, J. Gruver, R. Barclay. March 2006. Bats and Wind Turbines. Pre-siting and pre-construction survey protocols. Appendix 5 *In*: Vonhof, M. 2002. Handbook of Inventory Methods and Standard Protocols for Surveying Bats in Alberta. Alberta Sustainable Resource Development, Fish and Wildlife Division, Edmonton, Alberta. Revised 2005.

Information on obtaining this document is available at
http://www.srd.gov.ab.ca/fw/bats/ABAT.html

Some of these protocols may also be relevant in other jurisdictions, but this must be determined in consultation with the relevant authorities.

Some monitoring techniques relevant for birds will also provide information on bats, especially **radar monitoring** and post-construction **carcass searches**. These are mentioned under the respective sections outlining those techniques.

Overview of post-construction follow-up studies

This section provides an overview of the types of sampling that can be expected post-construction as part of the Environmental Impact Assessment process. The precise requirements will be determined as a condition of the approval process. For sampling methods highlighted in **bold**, further details on protocols are given in Appendix I.

Breeding season

At sites that support reasonable densities of native breeding birds (as demonstrated by pre-construction assessment), follow-up monitoring should be undertaken using the same techniques to those used during pre-construction assessment. The purpose of these surveys is to determine the consequences of the turbines to species diversity, to evaluate the predictions made during the EA process, to evaluate the cumulative effects of the industry on bird diversity and numbers, and to detect significant changes in numbers at single sites. If baseline studies indicated a very low level of native bird diversity and numbers (as might be expected of installations within industrial parks or intensive row crops) then follow-up breeding season studies are unlikely to be required. This should be determined through consultation with the CWS.

If post-construction surveys are required, then normally at least two or three years of breeding season surveys would be needed to differentiate any possible effects of the turbines from natural year-to-year variation, and to separate short-term from long-term effects. In areas of lower concern, it may be appropriate to start these surveys the second year after construction, and limit surveys to two years. If results appear to be significant, but vary substantially among years, then in some cases additional surveys

may be requested to consider longer term effects (e.g., repeat surveys 5 or 10 years later). Breeding season surveys are not especially onerous, and could be expected to require no more than 4-10 person-days of field work each year, except on very large sites.

Non-breeding Season

If baseline studies during the non-breeding season suggest that the area is important for birds at these times of the year (determined through consultation with the CWS), then similar studies to those performed in the baseline work should be repeated to gauge the consequences of the turbines' presence on birds during these times.

Carcass searches

Carcass searches are important, even on sites determined to be of a low level of concern, to evaluate the correctness of the predictions, and to test for the possibility of unexpected risk factors. For example, on some sites where pre-construction surveys suggested a low-risk area, there nevertheless was substantial unanticipated mortality observed for bats.

As a minimum standard, 6 to 8 weeks of carcass searches during the spring migration period and 8 to 10 weeks during the fall migration period should be planned for. At sites with a low level of concern, one year of data would normally be sufficient, but at sites in the highest levels of concern, two or three years of monitoring might be required. These requirements may be extended if substantial mortality is observed, particularly to evaluate any mitigation measures that may have been introduced. If turbines are in areas that support significant breeding or wintering populations of species with an elevated risk of mortality from turbines (e.g., raptors or Species at Risk with aerial displays), then carcass searches may be required during the breeding season or in winter.

Collision studies

In some areas (offshore, bogs, marshes, etc.) carcass searches are impossible or highly impracticable, and alternative methods for estimating collision mortality may be required. **Radar** has been proposed as one approach. Another approach combines microphones attached to turbines (to detect the sound of collisions) with infra-red video (to identify the species colliding). Protocols for such techniques have been developed in Europe, but have not been widely tested. As a result, an overview of these approaches is included here, but proponents requiring these approaches will need to develop an appropriate protocol, in consultation with the CWS. Proponents constructing a wind energy installation in an area that would require radar-based or other technological approaches to estimating collision rates should be aware that the costs of post-construction monitoring may be significantly higher than in areas where carcass searches are possible.

Appendix 1. Details of selected sampling protocols

This Appendix provides further details on some of the sampling protocols that are likely to be appropriate for bird monitoring in the context of wind energy environmental assessment.

Note that, whichever sampling methods are used, a complete written field protocol describing the exact sampling methods should be provided as part of the documentation and reporting. This documentation should include precise coordinates of all locations surveyed (preferably from GPS).

Area searches

- Area searches are intensive searches with the goal of finding as many bird species as possible present in an area and providing very general information on bird abundance and status.
- Area searches must be undertaken by a qualified biologist or contractor skilled at recognition by song (during the breeding season) and by sight (at all times of year) of all bird species likely to occur in an area.
- The minimum searching effort for obtaining a list of breeding species in an area would normally be a few hours for a small wind energy installation, ten or more hours for a medium wind energy installation, twenty or more for a large, and more than twenty for a very large wind energy installation (for details on what constitutes a small, medium etc. wind energy installation see Environment Canada's *Wind Turbines and Birds: a Guidance Document for Environmental Assessment*). For very large wind energy installations, a useful rule of thumb is to determine, from bird range maps or breeding bird atlas data, combined with habitat information, the number of species that might be expected in the area. Searching should continue for at least 20 hours, or until at least 80% of the expected number of species have been found (on the assumption that remaining species are probably present in very low numbers).
- For breeding season studies in areas with a variety of natural habitats, multiple visits increase the chances of detecting species that breed early or late in the season. Searches can be made more efficient by concentrating at times of peak bird activity (early morning for most songbirds, late morning or early afternoon for soaring raptors, early evening for owls and other nocturnal species).
- The procedure is to search through all the main habitat types in the area and record all birds seen and heard and to estimate the number of individuals detected on each visit. In addition, for breeding season studies, any evidence of breeding should be recorded.
- Data recorded should include:
    - The level of effort for each visit (date, start time, finish time, hours of searching, and some measure of the area searched, such as the distance covered, or a map of the area that was searched);
    - A complete list of species detected on each visit/each day;

- If possible (especially for standardized searches—see below), an estimate of the number of individuals actually detected (by sound or by sight);
- For breeding season surveys, data on any breeding evidence detected, using standard breeding bird atlas codes (Appendix 2);
- A basic description of the habitats covered;
- These data should be retained for entry into the data base.; and,
- In addition, summary data should be calculated for the EA report that indicate all species detected at each season, with estimates of peak numbers, and total sampling effort.

Standardized area searches

- Standardized area searches are a quantitative variation on an area search in which the area being searched and the search effort are strictly standardized and the number of individuals of each species detected during the sampling period is recorded to provide an index of abundance.
- For recording songbirds during the breeding season, especially in forested habitats, these are harder to standardize than **point counts**. However, they may be the best available option for counts outside the breeding season, for sampling species that are not readily detected by song, or when surveying sites that are too small to fit more than a few point counts.
- Usually these involve sampling only a portion of the study area, unless the study area or the particular habitats of concern (e.g. wetlands or tidal mudflats) can all be sampled on a single survey session. One variation on standardized area searches is a fixed width transect, in which a route (transect) is selected, and all birds within a fixed distance of the transect are recorded. The appropriate transect width depends on habitat and species of interest: for songbirds in heavily vegetated areas, few birds are detected more than 100m away; for raptors or waterbirds in open areas, birds may be detected and identified at distances of 1 km or more with good optical equipment. Square, circular or rectangular plots up to 1 km^2 have also been used in various circumstances; the area(s) to be surveyed can be any shape, provided that the shape is clearly documented, the effort is standardized, and the same areas are surveyed on each occasion.
- Data recorded should be the same as for other area searches (see above).

Line transects (distance sampling)

- A line transect is a form of distance sampling which, if assumptions are met, can be used to provide density estimates.
- The most important assumptions are that transects are placed randomly with respect to habitat, that distance between the transect line and the bird can be accurately estimated, that all birds very close to the transect are detected, that the birds do not move before being detected, and that they are not counted more than once.
- Random placement of transects is usually only possible in fairly uniform areas. In terrestrial habitats, this is most likely to be possible in grasslands or low shrub areas, but can also sometimes be done in forested areas.

- Line transect sampling can be a particularly useful technique for shipboard surveys in marine environments (but distance sampling methods can not be used to estimate density for water bird surveys conducted from a beach or shoreline, because the distribution of birds with respect to the coast is usually not random).
- Transects may be any length that can be conveniently surveyed within the optimal survey times (which would be early morning for songbirds, but may be more flexible for marine birds).
- This method involves travelling along the transect at a fairly uniform speed, and recording the shortest (perpendicular) distance from the transect to the position where each bird was first detected (note that this would normally be less than the distance between the observer and the bird).
- Data can be grouped into distance categories (e.g., 25m distance bands), but if possible, it is preferable to estimate actual distances. If necessary, these can always be grouped during data analysis. If birds are present in flocks or groups, then the distance to the centre of each flock should be recorded, along with the estimated number of birds in the flock.
- The position of birds along the transect should be recorded as well, usually by dividing the transect into segments, and recording which segment each bird was observed. Segments could be from 100 – 500m long depending on the total transect length and range of habitats traversed.
- Data recorded for each transect survey should include:
    - start location and ending location for each segment on the transect as well as the whole transect (or details, preferably in the form of a GIS shape file, of the complete path of the transect if it is not a straight line);
    - date, start time, and end time for each individual survey; and,
    - individual records for each bird (or flock) with its distance from the transect, segment number, and flock size.
        - Alternatively, records can be kept of the total number of birds of each species in each distance band for each segment along the transect.

Behavioural studies (watch counts)

- These may be required when species at risk, raptor concentrations, or flocks of other birds are present in or around a site, to determine whether their behaviour might lead to a significant risk of mortality from wind energy installations.
- Behavioural studies are intended primarily to determine how birds are using the area, especially to determine whether they are regularly flying through areas that will be swept by blades after the turbines are built, or are using sites or habitats that will be directly affected by the construction process.
- The optimal protocols depend on the species being observed as well as the topography of the site; a customized design will be required in most cases. This design should be developed by the contractor and submitted to the CWS for review before implementation. A typical study might involve finding a suitable vantage point from which birds can be observed and recording the movements of birds and the major habitats that they are using at different times throughout the day.

- Observations should only be undertaken at the appropriate season, on days when significant numbers of the species of interest are present in the area, and should typically be undertaken on multiple days to assess day-to-day variation in activity.
- Data recorded will depend on details of the sampling protocol but, as a minimum, should include information on dates and times when surveys were undertaken, as well as summary statistics on how often birds, and how many birds flew through potential turbine locations, whether they were flying within, above or below the blade height of turbines to be installed, and how often they used sites that would be disturbed by construction.

Point counts

- To be effective, point counts must be placed at well-chosen locations, carried out by experienced observers (unless microphones are being used to record them – see next section) and performed at the appropriate time of day in appropriate weather conditions.
- Point Count Placement:
  - Point count locations may be chosen either randomly or systematically (e.g., at regular intervals along a route) within the target habitats. If they are placed systematically, then the starting point of the route should be randomly chosen, if possible. Point count locations should be chosen to emphasize areas near prospective turbine sites as much as possible. Point counts should generally not be placed on roadsides, but it is acceptable to select a starting point for a route along an access road.
  - If the area consists of relatively large areas of homogeneous habitat, then point counts should be placed within each major habitat type, ideally with the centre point at least 100m from the habitat edge.
  - If the project area consists of a fragmented mosaic of habitats (e.g., small fields interspersed with hedgerows and small woodlots) such that it would be hard to place many points >100m from a habitat edge, it may be more effective to consider the whole landscape as one “habitat” and place point counts randomly or systematically within it.
  - Every major habitat type within the project area (pine forest, hardwood forest, scrub, grassland, field, etc.) likely to support significant numbers of breeding birds should be included.
  - At least 20 stations are normally required to sample a habitat adequately, spaced at least 250m apart in forest, or 500m apart in open habitat. These stations may be distributed among several different blocks of habitat.
  - The number of stations per habitat can be reduced if the total area of a particular habitat within the project site is too small to support 20 stations.
  - If the project is in the large to very large category (see Environment Canada’s *Wind Turbines and Birds: a Guidance Document for Environmental Assessment*) and is situated primarily in one major habitat type, or if the habitat is very heterogeneous, then 20 stations may be insufficient to cover the breadth of the geographic area and sample the diversity of microhabitat types; for small projects, with limited areas of

natural habitat, 20 stations per habitat type may be unnecessary – contact the CWS for guidance on sample size in all of these cases.

- Once station locations have been selected, they can be grouped into routes in a way that allows for maximum efficiency of visits – it is not necessary to visit all stations for a particular habitat type on the same day.
- Post-construction monitoring seeks to assess the impact of turbines on bird abundance and distribution.
  - Two alternative designs for point count placement can be considered:
    - One approach is to survey the exact same locations as were surveyed during pre-construction. This approach gives information on the overall, landscape-level impact of the turbines, but less information on the specific impact of the turbines.
    - Another approach is to select new point count locations in relation to the turbines (e.g., points close to turbines, 250m away from turbines and 500m away from turbines). The number of points and number of turbines sampled would depend on their configuration and on the diversity of habitats in which they are located. Stations should be selected so that some are downwind of turbines, based on prevailing wind direction, while others are upwind, as the noise impacts, and hence disturbance effects on birds may differ.
  - An ideal design would incorporate both approaches, by selecting pre-construction point count locations in relation to proposed turbine sites based on the above design. However, this may not always be possible for various reasons, including uncertainty at the time of the initial surveys in the eventual location of the turbines.
  - The appropriate design for a particular site should be determined at the time of EA approval, in consultation with the CWS.
  - The extent and intensity of monitoring expected will depend on the species richness and densities present in the site pre-construction.
- Each station must be georeferenced by GPS.
- The habitat within 100m of the station should be described in qualitative terms, unless a complete habitat map for the area has been prepared and the points can be placed on that habitat map. The habitat description should incorporate summary information on habitat structure (e.g., forest, marsh, field), dominant vegetation types within the habitat (e.g., major tree species), and, for forest or shrub habitats, an estimate of stand age and average stand height.
- The habitat coding system used by the Ontario Nest Records Scheme is recommended for coding the major structural habitat types in most parts of Canada. It is described in the Scheme's manual at http://www.birdsontario.org/onrs/instructions.html.

- Point count timing and survey conditions:

- Point counts must be performed in the early morning during the breeding season, between dawn (one half hour before sunrise) and about 4 hours after sunrise. Later in the season, singing drops off more quickly – surveys in late June and early July should usually be completed within 3 hours of sunrise.
- The peak breeding season varies geographically, but in most parts of Canada it extends from late May to early July. Consult the CWS for the optimal dates for a particular region.
- Each station should be surveyed twice, once early in the season, and once later in the season (at least 10 days after the first survey at a particular station).
- Point counts should be performed when there is as little wind as possible, because wind affects the observer's ability to hear birds. Usually, this means that wind speeds should be 3 or less on the Beaufort scale. However, in areas where the wind rarely drops below 4, even in the early morning (e.g., in some parts of the prairies or mountain ridges) this restriction may have to be relaxed.
- It is important to always begin point counts as early as possible in the morning (but not earlier than one half-hour before local sunrise), when the wind is generally calm so that windy conditions that may arise later in the morning can be avoided.
- Point counts should not be if it is raining unless precipitation is not more than a light drizzle (birds tend to stop singing in the rain).
- During post-construction point counts, in some areas, the sound of the turbines may affect the ability to hear birds. If this is a problem, it may be necessary to stop turbines near the point location while the point count is being undertaken; if wind conditions are low enough for point counts, then energy production from the turbine is likely to be minimal at that time anyway. Failure to control turbine noise during post-construction surveys may lead to under-detection of birds and over-emphasis of the impact of turbines on bird communities.
- If turbine noise is a problem and can not be adequately controlled, then the CWS should be consulted to determine whether an alternative point placement design may be feasible.

- Data recording:
  - At each station, the surveyor should listen for ten minutes, recording all species seen or heard, along with an estimate of the number of individuals of each species.
  - The surveyor should estimate the distance to each bird using a scale of 0-50m, 50-100m and further than 100m. Birds that move during the survey should be recorded in the closest distance category that they entered during the survey. Distances can often be difficult to judge when a bird is only heard singing in dense habitats, in which case the observer should provide a best estimate. This will still be valuable for differentiating birds that are close from those that are very distant.

- Data that need to be reported are the number of birds of each species detected in each distance band. It is often easiest to track individual birds if they are first mapped onto a circular diagram using a standard set of symbols, and then the number of individuals counted up afterwards.
- Birds that fly over without stopping should be recorded separately as "fly-overs"
- Additional information that should be recorded include:
  - weather conditions (temperature, wind speed (on a Beaufort scale), % cloud cover, and presence of any precipitation should be recorded)
  - date and time of day.
  - GPS coordinates of the point location
  - Name of the observer doing field work
- A sample data form is included as Appendix 3 of this document, but it is not necessary to use this form provided that all of the relevant data are recorded. Use of some sort of data form is desirable to ensure that all required data are recorded in the appropriate format, thus facilitating later computer data entry.

Microphone point counts

- Use of stereo microphones and digital recorders to record bird songs on point counts has several advantages:
  - When skilled birders able to identify all the bird songs in the region are not available, microphones can be used to record birds on the point counts, and these can later be interpreted by a skilled birder after the field season;
  - Recordings allow evaluation of observer effects, especially if there are changes in observers between pre- and post-construction monitoring. Even skilled birders differ in the proportion of birds present at a point count that they detect and it is important to calibrate among observers if the observers change; and,
  - In addition, if any bird songs are heard during a count that cannot be identified by the primary observer, the recordings can be compared with reference material or sent to another skilled birder for validation.
- Tests of these approaches are discussed in Rempel, Hobson, Holborn, Van Wilgenburg, and Elliott. 2005. Bioacoustic monitoring of forest songbirds: interpreter variability and effects of configuration and digital processing methods in the laboratory. J. Field Ornithol. 76(1):1–11.
- This approach has been adopted by a number of standardized programs, including the Alberta Biodiversity Monitoring Program (protocol details are available in their terrestrial monitoring methods document, available on their web site: http://www.abmp.arc.ab.ca/ReportsDocuments/Protocols.htm).
- For these reasons, especially in areas expected to have significant numbers of breeding birds (e.g., native habitats such as forest or prairie), it may be desirable to use recordings as a standard approach for point counts. This can either be done on a subset of points, concurrently with a skilled observer, to allow for

measuring observer variability or can be done for all point counts, in which case observers can be used who are less skilled in bird song identification.

- However, it is also important to be aware of some of the limitations of microphones. In particularly, as described below, they are very sensitive to external noise, such as wind (especially in areas with a lot of trembling aspen), vehicle noise, etc.
- If point counts must be conducted under windy or noisy conditions (e.g., there are few mornings during the breeding season with wind speeds below 3 on the Beaufort scale, or there is substantial traffic noise even in the very early morning) then microphones may not be an effective solution.
- A variety of recording units are potentially suitable for recording point counts. The key features are that the unit should have stereo microphones with sufficient sensitivity to detect birds singing at approximately the same distance that a skilled observer would be able to hear them. Each microphone should be partially directional (to enhance the stereo effect, thus facilitating counts of the number of individuals), but between them, the microphones should have an omnidirectional pickup, so that birds in all directions can be detected.
- Recordings should be made onto a digital recorder, in either high quality format (e.g., uncompressed CD quality), or in compressed formats (e.g., MP3) which seem to be generally adequate; recordings can also be made directly to computers by connecting microphones through sound cards.
- Digital recordings have the advantage that copies are readily made, and computer software for visualizing sonograms can be used to facilitate data analysis (although, unfortunately, software has not yet been developed for reliable automated identification).
- Two companies in Canada currently produce complete packages designed for field work that meet these standards (Riverforks: http://www.riverforks.com and Environment Audio Recording Systems (E.A.R.S.): http://www.earscanada.com/). Both of their systems are designed to be weather resistant.
- However, other systems could be readily designed for less cost using separately purchased components that would have suitable characteristics. Because the actual characteristics of different systems may vary, it is important that pre- and post-construction monitoring be carried out using comparable equipment.
- Record levels should be adjusted to avoid saturation (which leads to distortion). A high pass filter should be incorporated into the system to reduce noise from very low frequencies, which usually represent environmental noise rather than bird songs (only a few species such as grouse produce low frequency sounds). If possible, a standard volume calibration tone should be recorded, to allow standardization of playback volumes.
- For recording, microphones must be mounted on a tripod approximately 1-2 m above the ground in such a way that no vegetation will rub against them. The recorder should normally be positioned a few metres away from the microphones to avoid interference, and to minimize the impact of incidental noise. The operator should check that everything is properly connected by listening through headphones connected to the system prior to the start of the point count.

- At the start of each recording, the operator should announce the date, start time, and GPS coordinates of the station, followed by “start” or something similar. At the end of the 10-minute period, the operator should announce “stop” before turning off the recording (beeps from a stop watch can serve the same purpose). This will assist the analyst, and ensure that the time period of the recording matches that of the field operator, if a standard point count is being undertaken at the same time.
- The operator must minimize making any noise during the recording. Microphones are particularly sensitive to noise from crunching of gravel, leaves or other vegetation underfoot. If the operator is simultaneously conducting a point count, it is best to stand at least 5 m, and preferably 10 m away from the microphones, to minimize noise on the recording while observing birds.
- If insect noise is a major problem on the recordings, it may help to spray an insect repellent on the wind shields of the microphones.
- Microphones are generally more sensitive to environmental noise than human ears, especially at higher frequencies. Rustling of leaves, particularly trembling aspen, as well as vehicle noise can be particularly problematic. In areas with a lot of aspens, this may require conducting recordings under lower wind conditions than would be acceptable for a human listener.
- When analysing recordings from a stereo microphone setup, it is not possible to determine reliably the distance away from each bird, so it is necessary to group all birds into an unlimited distance category. Otherwise, data recorded for a microphone recording should be the same as those recorded for a regular point count.
- If point counts are conducted by an observer, as well as by recording, the data from both the observer and the recording should be entered separately into the data base. It is very important that the recordings be interpreted by somebody who does not know (or remember) what was recorded by the observer. Conversely, the observer should NOT modify what he reported on a point count in the field based on interpretation of the recordings. Otherwise, it is not possible to use the recordings to calibrate observers, and the results will not be comparable among observers. The only exception is if an observer heard a call that could not be identified in the field, and the recording was used to determine the identity, or if an observer realizes that he/she clearly mis-identified a song, in which case the identification can be corrected.
- Proponents are responsible for analysis of all recordings by a skilled analyst and for providing data on the species detected on the recording. In future, it may also be possible to store copies of the digital recordings with the data base—copies should be kept on file, on a hard drive or other storage medium (e.g., CD or DVD), for later addition to the data base, and in case they are required for re-analysis for comparison with post-construction data.

Playback counts

- Playback of recordings is used primarily to detect secretive species, such as owls or marsh birds, or to obtain more information on particular species, such as

Species at Risk, where the presence of even a few individuals of a species may be of concern.

- In many cases, it is sufficient to do this qualitatively, to detect the presence of particular species, through integration into an area search protocol.
- Quantitative surveys may be expected in some areas, such as if an area contains extensive wetlands that might contain significant numbers of marsh birds. Nationally standardized protocols for marsh bird monitoring, using playback, are currently being developed. A number of regionally appropriate standard protocols exist for nocturnal owls.
- If a Species at Risk is expected in an area, the most appropriate protocols should be discussed with the CWS before initiating surveys. Quantitative playback surveys for a Species at Risk may be required if the area is known to contain significant habitat for the species – these would need to be designed in conjunction with a CWS biologist and/or the appropriate recovery team for the species.
- Playback counts involve:
  - Playback of recordings of territorial songs or calls of target species that are of particular concern and may be expected in the habitat. Each playback should be followed by a period of silent listening to detect responses. Multiple recordings may be played (either repeats of the same species, or different species), followed by silent listening.
  - Playback must be done at the appropriate time of day:
    - Early morning for most songbirds
    - Early morning or evening for marsh birds
    - After dark for most owls
  - Playback should also be done at the appropriate time of year, depending on the species and region. The peak calling period for many owls can be one to two months earlier than the main breeding season for songbirds. Marsh birds tend to be most vocal early in the breeding season.
  - Playback can be attempted in any patches of habitat suitable for the target species. The appropriate spacing will depend on the distribution of habitats. For habitats that are difficult to enter (e.g., wetlands) it is usually acceptable to use playback from the edge of the habitat.
  - Unless following a protocol that has been previously approved specifically for a quantitative survey, playback of calls for a Species at Risk should be stopped as soon as the species presence has been confirmed, to minimize disturbance to the species.

Stopover counts

- The purpose of stopover counts is to estimate the abundance of birds using the project area as a stopover site on migration, whether for resting or for foraging. The optimal design of a stopover count will depend on the nature of the habitats in the area, and the types of species that might be expected.
- The usual sampling method will be a variation on the **standardized area search** methods.

- For large open area birds (waterfowl, shorebirds, other waterbirds, etc.), a route should be developed that provides a vantage point over all of the major habitat areas where birds might be expected.
    - In a large project area, this may involve a route of several kilometres, with driving in between observation sites.
    - The objective of this survey should be to estimate the total number of individuals of each species present in the area on a particular visit.
    - If the study area consists of several discrete patches of important habitat, then the number of individual birds of each species on each site should be recorded separately. This information may be important for turbine placement.
    - Data recorded for these surveys should include a map of the route and the major observation sites, the date, the start and end time of each visit.
    - Most waterbirds can be counted at any time during the day. However, in some areas birds may make daily movements from a roost site in one area to a foraging site in another area. Similarly, in tidal areas, birds may move among locations in response to tidal cycles. In these cases, counts should be timed to coincide with peak numbers present within the study area.
    - If significant numbers of birds are located, then **behavioural studies** (see relevant section) should be considered to determine whether the behaviour of these birds is likely to put them at risk from the wind turbines.
- For songbirds, routes should be selected that sample the major habitats likely to be used by songbirds in the region.
    - Routes can be placed along existing trails or roads. Foraging migrants are most readily detected at edges of habitats, in hedgerows, etc.
    - A good quantitative design is to set out transects approximately 500 m long along trails or roads, placing at least two per major habitat type (e.g., forests, shrubland, grassland, etc.). Individual transects may traverse multiple habitats. However, transects can be any length, provided that the same routes are visited each time.
    - Transects should be walked approximately twice a week in the early morning (sunrise to up to no more than 4 hours after sunrise) during the peak migration period for the species of interest.
    - In most cases, it is sufficient to record the total number of birds of each species detected along the transect, using **standardized area search** methodology.
    - In some habitats, it may be appropriate to use **line transect** methodology and record the distance to each bird, or the number of birds in fixed distance categories (e.g. 25m distance bands), separately counting different segments of the transect.

Passage migration counts

- Passage migration counts are used to estimate the numbers of birds flying through an area during migration periods. These will normally only be needed when there is a clear risk factor or significant unknowns.

- For most songbirds, the spring migration period runs from early April to late May, the fall period from the end of August to the middle of October, although this varies by region, latitude and altitude. Migration of waterfowl may commence in March, while migration of eagles and some northern migrants extends into November.
- For raptors and other diurnal migrating birds the following protocol is recommended:
    - Select an observation point from which a clear view is available of one or more potential turbine locations in areas that may represent migration concentration sites (e.g., ridge tops).
    - Record the species and heights of all passing birds in relation to the height of the proposed turbines. Codes can be used for incompletely identified species (e.g., *Accipiter* sp.).
    - Start at about 9 a.m. and record continuously for 6 hours, dividing the observations into one hour blocks. This will make the data comparable to most raptor monitoring stations.
    - If daily observations are not possible, then observations should be carried out for at least 10 days spread over the peak migration period for species thought to be at risk (consult local naturalists for this information). Within this period, dates should be chosen with weather conditions favourable for migration (e.g. no precipitation, light to moderate tail winds).
    - Record weather conditions (temperature, wind speed and direction, sky cover, precipitation), date, time of day, GPS coordinates of the observation point, and the approximate area and direction over which most observations were made.
- For night-migrating birds or bats, passage migration counts require technological approaches including either radar or acoustic monitoring or both. These are described in further detail in subsequent sections.

Acoustic monitoring of migrating birds

- Many species of songbirds regularly make flight calls during nocturnal migration; many calls can be identified to species. Microphones and digital recorders can be used to monitor these species during migration. However, not all species call during migration, and little is known about how often individual birds call and how much this varies from night to night or with weather conditions. To get a complete picture of the number of birds migrating through another area, acoustic monitoring may need to be combined with other techniques such as **radar**, infrared video devices, or observations with a ceilometer (a bright light pointed straight up into the sky). Nevertheless, acoustic monitoring alone may sometimes be sufficient for understanding regional variation in the concentrations of migrating birds or the heights of birds.
- A variety of systems have been used for monitoring nocturnal migrants ranging from single microphones connected to a digital recorder that provide an index of bird activity, to arrays of 4 or more microphones connected to a computer that can be used to calculate the height and position of each bird's call.

- Note that acoustic systems used for monitoring birds are not suitable for monitoring bats, because of the difference in frequency range of their calls.
- In general, systems that monitor height are likely to be more relevant to wind energy installation monitoring than systems that only provide an index of total numbers.
- National standards for have not yet been developed for acoustic monitoring. At present this technique is most likely to be required only in the context of a research project. If nocturnal flight call monitoring is required for a particular project, then a protocol should be worked out in conjunction with the CWS.

Radar monitoring

- Marine radar units can be used to monitor activity of birds and bats within a relatively large area (a few kilometres radius) from a single location.
- However, radar has the disadvantage that targets can rarely be positively identified to species. Methods for distinguishing birds from bats, based on flight patterns, are being developed, but have not been fully tested.
- A variety of systems have been developed for automated data collection and processing. This is particularly important for monitoring over longer time periods, such as a complete migration season. However, most of these automated systems are relatively expensive, and only a few consulting companies have expertise with this technology. Each company uses different approaches for automated processing of data and estimating trajectories and/or heights of flying birds and bats. Most of these approaches have not yet been compared and cross-validated; it is not yet possible to recommend one system over another.
- As such, radar is not generally being required for monitoring unless there are particular risk factors involved, such as a suspected migration corridor for bats or birds, concerns about particular Species at Risk, or concerns about waterbird movements at proposed offshore installations.
- If radar is required, the ideal sampling scheme would involve monitoring on a daily basis through the main migration period for species of concern, especially if a fully automated system can be deployed.
- If this is not possible, because of limited availability of technology or other logistic constraints, then less intensive sampling may be acceptable. Various sampling schemes can be considered, depending on logistical constraints such as the remoteness of the site and the availability of radar. If daily coverage is not possible, the next most preferred option would involve monitoring at regular intervals throughout the season (e.g. one or two nights per week, preferably concentrated on nights when weather conditions are favourable for migration—tail winds that are not too strong, no precipitation). Another option would involve sampling for a few days in a row at longer intervals, e.g. for 2-3 days every two weeks. If data are available on the likely peak migration period for species of concern, then continuous monitoring for 1 or 2 weeks during this period may also be acceptable.
- Regardless of the sampling scheme, monitoring should continue through the night, either recording continuously (preferred) or for periodic intervals such as 15-30 minutes per hour.

- Data that are recorded should include:
  - Technical information on the equipment used, including information on maximum range, minimum and maximum altitude at which targets can be detected at various distances, methods used for data analysis, etc.
  - For each bird or bat target detected, data should include information on its identity to the extent possible (e.g., bird vs. bat), its trajectory (including direction of travel and position in relation to potential turbine sites), and altitude (if known).
  - Data can then be summarized in various ways to indicate overall bird and bat activity, how this changes over the night and the season, and how it varies across the study area.
  - Summary data should be provided as part of the Environmental Impact Assessment. Raw data (i.e., information on individual tracks) should be retained for inclusion in a central data base, once appropriate data standards have been developed.
- As with acoustic monitoring, the uncertainty in protocols is such that this technique is most likely to be required only in the context of a research project. If radar monitoring is required for a particular project, then the most suitable protocol should be worked out in conjunction with the CWS.

Carcass searches

- These can be expected to be the most intensive and potentially costly part of the follow-up programme, involving many hours of work.
- To calculate total mortality associated with a turbine, in addition to searching for carcasses, it is necessary to estimate:
  - The proportion of carcasses that fell outside the search area;
  - The proportion of carcasses within the search area that are removed by scavengers between visits; and,
  - The proportion of carcasses remaining that was found by the observer.
- In most cases, carcass searches should be conducted every 3 days at a site, to minimize loss of carcasses due to scavenging, and to estimate more reliably the actual date/weather conditions when mortality took place. In some circumstances (e.g., presence of many, very efficient scavengers) it may be necessary to increase the frequency. Conversely, if carcass removal trials indicate that most carcasses persist for a week or more, then less frequent searches may be acceptable. For this reason, scavenging rate should be estimated early in the process (see below).
- The minimal duration of carcass searches for passage migrants would typically be 6 weeks during the spring migration period and 8 weeks during the fall migration period.
  - The peak period of migration varies by region, but generally most spring migration is from early April to the end of May, while the fall season extends from early August to the middle of October. Migration of waterfowl or some raptors may extend outside these seasons.
- If significant numbers of raptors, species with aerial mating displays, or other birds that during baseline behavioural studies showed a propensity for flying at

the height of the blades are present at other times of year (e.g., breeding season or over-winter), then additional carcass searching should be undertaken during the period these birds are present. For breeding season, this would normally be a 6-week period. In winter, this would depend on when birds are present in the area, and could be anywhere from 4 – 12 weeks. Optimal search intervals may vary with time of year and weather conditions.

- Carcass searching does not generally require bird experts and can usually be done by well-trained technicians, who could be locally-hired personnel.
- Trained dogs can greatly increase the efficiency of carcass searches, particularly if the search area has significant vegetation. Dogs can search a larger area more rapidly than human observers, and tend to find a higher percentage of carcasses. This will make for more accurate and more reliable estimates of total mortality. Particularly at large wind energy installations, proponents should always consider the use of dogs, if possible.
- Visual carcass searching tends to be most efficient in bright light conditions, with a light breeze (which can cause feathers to flutter), and when it has not rained recently (rain tends to flatten feathers).
- Carcass searches should focus on the area where the search is most efficient – this will usually be the gravel pad at the base of the turbine, roads extending from it, and any areas of ground nearby that are either covered with short vegetation (e.g. grasses or low forbs) or are bare. Finding carcasses in forests or scrub is extremely difficult, even with dogs.
- Once a search area has been selected, searching should be undertaken uniformly throughout the search area, so that all parts of it are searched equally intensively.
- If necessary, a stratified design can be undertaken in which searching is most intensive in areas where carcasses are most likely to be detected, with less intensive searching farther away. For a typical 80m turbine, with 40m blades, most birds seem to fall within 80m of the towers, while most bats fall within 50m; however, the intensive survey area could be smaller still, especially if this would allow increasing the numbers of turbines visited, or if the stratum near the turbine is much easier to search.
- One form of stratified design is to search a small intensive area on every visit, and to search a larger, less intensive area only on occasions when a greater-than-typical number of carcasses is discovered in the intensive area (in some cases this may mean a single carcass). This design is suitable for migrants, because most birds may be killed only under specific weather conditions, which could lead to many birds being killed on a single night.
- For smaller sites (1-10 turbines), every turbine should be searched. For larger sites, a subset of turbines should be selected to cover representative areas throughout the wind energy installation, and searched in a similar fashion.
- It is not necessary to search every turbine on the same day. For example, a third of the selected turbines could be visited each day, such that each turbine is sampled every 3 days. The order of visits should be the same each cycle, so that the sampling interval (e.g. 3 days) is the same for each turbine.

- It is generally preferable to search a larger number of turbines, but with a smaller search area at the base of each turbine, than to search intensively at only a few turbines. This is because it is possible that only a few turbines may cause problems for birds.
- In some areas, it may be appropriate to sample some turbines every 3 days, and others at longer intervals, on a rotating schedule, to ensure that mortality at selected turbines is not being overlooked.
- Whenever possible, searches should begin as soon after sunrise as practical, to minimize carcass loss from early morning scavengers.
- Regardless of the area searched, it will almost always be necessary to calculate a correction factor to allow for carcasses that fall in areas that were not searched. Statistically sound corrections must take into account the fact that the expected number of carcasses varies in relation to distance from the turbine as well as prevailing wind directions on every night since the last carcass search.
- The make these calculations, the following data must be recorded:
    - The area in which searching was undertaken at each turbine, as well as the date, start time and end time for each search (separately for each turbine). If the search area was symmetrical around the turbine, this can be easily recorded as the diameter of the circle around the turbine. If the search area was irregular in shape (e.g. the base pad plus part of an access road), then a scale diagram of the search area must be prepared. If a stratified search was undertaken, the area of each stratum must be recorded.
    - For every carcass found, record:
        - the date and time it was found;
        - the state of decomposition, to help estimate the number of days since death;
        - the extent and type of injury sustained (if identifiable);
        - the species (or the best estimate of species, if it is in too poor condition to identify completely);
        - the distance and direction from the nearest turbine as well as GPS coordinates of the carcass (to serve as a verification check); and,
        - The substrate on which the victim was found.
    - Information on average wind strength and direction on each night since the last search is also required.
- **Scavenger trials:** It is also necessary to correct for carcasses that were scavenged before the search period.
- Carcass removal experiments to estimate scavenging rates must be conducted:
    - at least twice during each season when searches are being undertaken, as the suite of scavengers is likely to change through the year; and
    - with carcasses that resemble native birds and are freshly dead or were frozen when freshly dead.
        - Examples are blackbirds and starlings from provincial control programmes, turbine victims, quails and quail chicks from farmers, and dark chicks from industrial chicken farms or breeders (the dark chicks are unsuitable as meat chickens because their skin is also

darkly coloured; the chicks may be given away or sold for a reduced price).
        - Bats are normally only available as turbine victims.
    - Carcasses should be laid out in the search area, georeferenced by GPS, and then looked for on the day of the next carcass search. Carcass persistence should be examined over various intervals, either by setting out carcasses at different intervals before the search (e.g., some immediately after the previous search, others the day before), or by setting them out the night before a search, but then leaving all carcasses in place for up to 2 weeks, checking them on each search occasion for their persistence.
    - Carcasses should be distributed at all turbines where searches are undertaken, with no more than one or two carcasses per turbine. Carcasses should be distributed across the range of different substrates being searched, roughly in proportion to their proportions in the search area (e.g. if 20% of the search area is a gravel pad and 80% is grass, then 20% of the carcasses should be placed on the gravel pad, and 80% in grass).
    - Scavenger trials should be repeated annually, as the numbers and efficiency of scavengers, especially vertebrates such as raccoons, foxes, crows, etc. may change among years.
- **Searcher efficiency trials:** All observers, even those with trained dogs, will overlook some carcasses. This percentage will vary depending on the observer, the habitat and the area being searched, etc.
- Searcher efficiency must be tested for every individual or team involved in searching for carcasses (including teams using dogs). Searcher efficiency values are not transferable to a different individual or team or to a different substrate.
    - Unknown to the searcher, another person sets out carcasses on the previous evening within the area to be searched the following day.
        - Carcasses should be placed at random locations within the search area. The location of the carcasses must be recorded, so that they can be retrieved if they were not located by the searcher.
        - If a stratified design is in use, then separate trials must be undertaken in areas being intensively searched and those with lower intensity searching.
        - If bats have been found as victims they should be included as test carcasses. Whenever possible, use carcasses of native species that may be expected at the turbine site, so that the searcher will not recognize them as being part of a trial. If they remain in good condition, carcasses may be re-used for multiple trials.
        - No more than one or two carcasses should be placed in the search area of any given turbine on a single visit.
        - Trials need not cover every turbine, but should be distributed across substrates as for scavenger trials.
    - At least 20 carcasses should be used when testing observers.

  - These should be spread over multiple visits, so that the observer does not become aware that a test is underway. The best design involves testing that is undertaken continuously, with one or a few carcasses placed prior to each visit. This is most practical if more than one observer is involved in carcass searching, in which case each observer can place one or more carcasses within the areas being searched by the other observer. This has the advantage that it keeps human searcher efficiency high, because the searcher will be "on guard" during every search session.
  - Any carcasses that were not found should be retrieved immediately after the search to determine whether they were scavenged or overlooked. Optionally, they may then be left in place as part of a scavenger efficiency trial, unless they are required for further searcher efficiency trials.
  - Data recorded for searcher efficiency trials should include, for each bird:
    - Date, time and location it was placed, along with the species; and,
    - Date and time it was searched for and whether it was found, overlooked or scavenged, along with the name of the searcher. If the carcass remained, record its condition (intact, partially scavenged or decomposed).
  - It may also be possible to develop a design that combines searcher efficiency and scavenger trials, provided that these trials involve at least some birds placed the night before (so they are still fresh) and some placed on the previous visit.
- A variety of statistical approaches have been used to estimate total mortality, incorporating all necessary correction factors. Because these are likely to improve over time, as further data are accumulated, all proponents are asked to retain all raw data to allow for flexible reanalysis in future.
- The shared database being developed by the CanWEA and the CWS will incorporate routines to estimate total mortality from each site using the best available statistical methods, provided that all raw data (not averages or lumped data) are deposited in the data base. This would include all information described in this section (information on search effort, search area, each carcass found, scavenger trials, observer efficiency trials and daily weather conditions). Proponents are strongly encouraged to deposit their data in this data base to ensure that these calculations can be adequately standardized across projects. This will also allow for simple re-analysis if better statistical techniques become available in the future.
- Provincial / territorial and federal permits are required to handle and collect dead birds or parts thereof. Please apply for these permits well before the carcass counts are to be done.
- The CWS can provide additional help with design of carcass searches.

Estimating collisions using other methods

- In some cases, where carcass searches are not practical (e.g., sites over water or wetlands), other techniques may be necessary to estimate mortality.
- Some of these techniques include radar, thermal imaging equipment, video equipment, or direct observations of birds.

- In most cases, neither radar nor thermal imaging equipment can be used to identify the species of birds involved, unless there are only a few species of concern with very different flight patterns or sizes.
- Effective use of any high tech approach requires sophisticated computer algorithms to process large amounts of data automatically, because many hundreds of hours of recordings may need to be scanned to detect collisions.
- For this same reason, visual observations are unlikely to be effective except in very unusual circumstances, or as part of a research project to understand bird behaviour around turbines.
- With radar, detecting collisions depends on following a track that disappears when it reaches the turbines – but it is not known how often tracks may disappear for other reasons, or whether all incoming birds will necessarily be detected.
- Thermal imaging methods may be able to observe collisions directly, but can only view a limited area, usually only a portion of one turbine.
- A system specifically designed to measure bird collision rates has been developed that combines microphones placed in the turbine structure (to detect the sounds of a collision) with a video camera (to record what hit the turbine). A computer is programmed to store video images from shortly before and after any unusual sounds (which may represent a collision). Tests have shown that it can effectively detect artificial collisions (e.g. tennis balls), but further testing is required to determine how well it will detect actual bird collisions (Verhoef, Westra, Korterink, and Curvers . 2003. *WT-Bird, a novel bird impact detection system*. Unpublished report. Available at: http://www.ecn.nl/docs/library/report/2002/rx02055.pdf). Replacing the video camera with a thermal imaging system may be required to detect nocturnal collisions.
- At present, none of these technologies is sufficiently developed to provide standardized protocols. These techniques would normally only be required under exceptional circumstances (e.g., offshore installations), or as part of a special research project.
- As the technologies are developed, it may be appropriate to recommend their use more widely in the future.

Appendix 2. Codes for breeding evidence

The following codes should be used for breeding evidence, in association with breeding season area searches. These codes are those used for the Ontario or Maritimes breeding bird atlases. Further details are available from their web sites:
Ontario Breeding Bird Atlas (http://www.birdsontario.org/atlas/atlasmain.html)
Maritimes Breeding Bird Atlas (http://www.mba-aom.ca/english/index.html). These were selected to allow for consistency in the national data base.

OBSERVED

X Species observed in its breeding season (no evidence of breeding). Presumed migrants should not be recorded.

POSSIBLE BREEDING

H Species observed in its breeding season in suitable nesting habitat.
S Singing male present, or breeding calls heard, in its breeding season in suitable nesting habitat.

PROBABLE BREEDING

P Pair observed in their breeding season in suitable nesting habitat.
T Permanent territory presumed through registration of territorial song on at least 2 days, a week or more apart, at the same place.
D Courtship or display between a male and a female or 2 males, including courtship feeding or copulation.
V Visiting probable nest site.
A Agitated behaviour or anxiety calls of an adult.
B Brood patch on adult female or cloacal protuberance on adult male.
N Nest-building or excavation of nest hole. (woodpeckers and wrens). Both groups may build dummy or roosting nests so nest-building alone is not enough to confirm breeding.

CONFIRMED BREEDING

NB Nest building or adult carrying nesting material (for all species except wrens and woodpeckers)
DD Distraction display or injury feigning.
NU Used nest or egg shell found (occupied or laid within the period of the study).
FY Recently fledged young or downy young, including young incapable of sustained flight.
AE Adults leaving or entering nest site in circumstances indicating occupied nest.
FS Adult carrying faecal sac.
CF Adult carrying food for young.
NE Nest containing eggs.
NY Nest with young seen or heard.

Appendix 3. Sample data sheet for ten-minute point counts

Location (Site Name): ________________________________UTM Map no.: ________

Date: ____/____/20__ Observer: ____

Wind (Beaufort scale): ____ Sky: _______ Precipitation: ____________ Temp: ____^{o}C

Comments: ____

____

Point Count Station

	1	2	3	4	5	6	7	8	9	10
UTM Easting										
UTM Northing										
Time of visit										

		First five minutes			Second five minutes			
Stn	Species Code	0-50m	51-100m	>100m	0-50m	51-100m	>100m	Total

		First five minutes			Second five minutes			
Stn	Species Code	0-50m	51-100m	>100m	0-50m	51-100m	>100m	Total

Appendix B

Post-Construction Monitoring Plan: Bat Maternity Colonies

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Project Number: **1104037.00**

Project Title: **HAF WIND ENERGY PROJECT**

Report: **007-R02-1104037**

Title: **PRE-CONSTRUCTION MONITORING WORK PLAN: CANDIDATE BAT MATERNITY COLONIES**

Client: **IPC Energy**
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Date: **February 2012**

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IPC ENERGY

Wainfleet
Clean energy for life.

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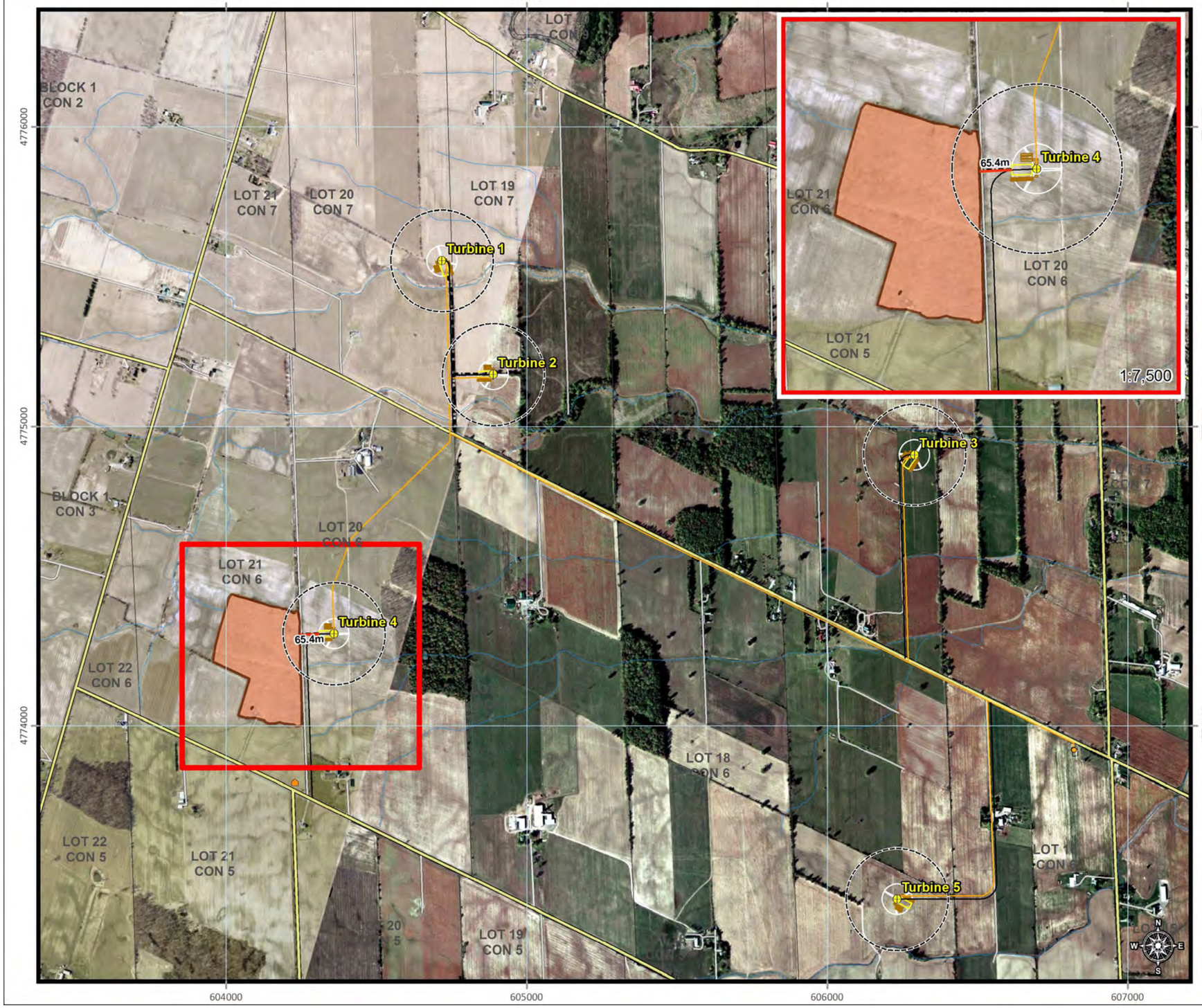
1.0 Introduction

According to the Bat and Bat Habitats: Guidelines for Wind Power Projects candidate bat maternity colonies are found in mixed or deciduous forest with ≥ 10 snags/cavity trees per hectare of trees ≥ 25cm dbh. The forests within 120 metres of the project location were surveyed for an abundance of snags and cavity trees and 1 candidate site was identified (Mill Creek-Inverary Woods). **See Figure 1.** It will be treated as significant and carried forward to the EIS. Pre-construction monitoring will be outlined in the EIS.

Candidate Bat Maternity Colony (Mill Creek-Inverary Woods)

This 4.97-hectare deciduous forest has abundant snags and cavity trees that make it suitable for a bat maternity colony site. The candidate site was investigated for bat activity (i.e. bat droppings below a hole, smell of ammonia near a hole, grease marks, urine stains or actual bats) during the day and at dusk (9:00pm) and bat activity was observed.

Feature Type/ID	Size	Significance (if known)	Attributes	Composition	Functions	Minimum distance between feature & project location	Carried forward to EOS (y/n)
Candidate Bat Maternity Colony (Mill Creek-Inverary Woods)	10 ha	Unknown	-dominated by deciduous trees with Mill Creek flowing through woodland	FOD9-2 -fresh-moist oak maple deciduous forest	-large forest for protection - abundance of snag and cavity trees suitable for bat maternity colony sites	65.4 metres from Turbine 4	No – assumed significant and carried forward to EIS (Pre-construction monitoring will be outlined in the EIS.)



Legend

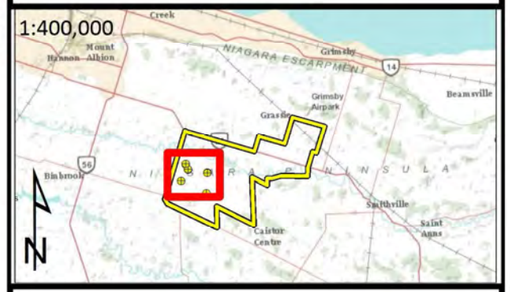
Candidate SWH
- Bat Maternity Colonies
- 120m Setbacks (Wind Turbine. Included All Related Structures)
- Distances to Natural Features

Project Infrastructure
- Wind Turbines
- Switching Station
- Maintenance Building
- Collector Line
- Turbine Access Roads (New)
- Crane Pad
- Crane Path
- Turbine Laydown Area
- Substation Fence

Existing Road Network
- Paved Road
- Unpaved Road
- Watercourses

Note:
Underground collector lines following Sixteen Rd. will be contained within the existing road network right-of-ways.

All frames: North American Datum 1983,
Universal Transverse Mercator Projection, Zone 17N.
ESRI Aerial Photography (Bing 2010)
Project location data provided by IPC Energy and AMEC.



MORRISON HERSHFIELD

Scale:
1:12,500
0 125 250 500 750 1,000 m

Project:
HAF WIND ENERGY PROJECT

Title:
**Summary of Site Investigations:
Candidate SWH (Bat Maternity Colonies)**

Project No.:	Drawing No.:
1104037	Figure No. 1
	Date: 30 Mar 2012

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2.0 Objectives of Study

This study seeks to confirm the use of the candidate bat maternity colonies. If use is confirmed, we will gather information on the abundance and species of bats using the maternity colonies.

3.0 Timing of Study

This study will be conducted in June 2012 to facilitate observations of bats exiting the candidate maternity colony roost.

4.0 Study Methods

The study will include monitoring candidate roost trees for evidence of a maternity colony through an exit survey. A minimum of 10 candidate roost trees will be identified for survey in the candidate maternity colony (Mill Creek- Inverary Woods). The trees will be selected based on the following criteria:

- tallest snag/cavity tree
- exhibits cavities or crevices most often originating as cracks, scars, knot holes or woodpecker cavities
- has the largest diameter breast height
- is within the highest density of snags/cavity trees (eg. Clusters of snags)
- has a large amount of loose, peeling ark
- cavity or crevice is high in snag/cavity tree (>10m)
- tree species that provide good cavity habitat (eg. White pine, maple, aspen, ash, oak)
- canopy is more open (to determine canopy cover, determine the percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of trees) and
- exhibits early stages of decay (decay class 1-3)

The candidate roost trees will be marked with flagging tape and their locations recorded on a GPS. Each candidate roost tree will be monitored once from 30 minutes before dusk until 60 minutes after dusk on nights without precipitation or high winds (>6m/s). Two observers will conduct a visual survey of the bat activity at the candidate roost tree, in conjunction with a broadband bat detector with a condenser microphone (Wildlife Acoustics SM2), with the acoustic monitoring device ~10m from the candidate roost tree. The number of all bats observed will be recorded and the calls will be analyzed by Erin McLachlan with CallViewer software to determine species. Erin has taken the MNR Bat Monitoring Workshop for Wind Power Projects and is familiar with identification of Ontario bat species.

5.0 Analysis of Results

The Environmental Impact Study will include a discussion of different result outcome scenarios of the study. The analysis of results will be submitted to MNR for review immediately after study completion, and prior to construction.

5.1 Significant Wildlife Habitat Technical Guide

The following numbers of bats will be considered significant at maternity colonies, as per the Significant Wildlife Habitat Technical Guide (OMNR 2000):

- 30 Big Brown Bats *(Eptesicus fuscus)*
- 100 Little Brown Bats *(Myotis lucifugus)*
- 10 Eastern Pipistrelles *(Pipistrellus subflavus)*
- 10 Silver-haired Bats *(Lasionycteris noctivagans)*
- 10 Long-eared Bats *(Myotis septentrionalis)*
- 10 Small-footed Bats *(Myotis leibii)*

5.2 Ecoregion 7E Criteria Schedule

As per the draft Ecoregion 7E Criteria Schedule (OMNR 2011), candidate bat maternity colonies are deemed significant if studies confirm the use of the feature by:

- >20 Northern Myotis *(Myotis septentrionalis)*
- >10 Big Brown Bats *(Eptesicus fuscus)*
- >20 Little Brown Myotis *(Myotis lucifugus)*
- >5 Adult Female Silver-haired Bats *(Lasionycteris noctivagans)*

If the analysis of results deems the site not significant, no further studies or mitigation are required.

If the analysis of results deems the site significant, a discussion of potential impacts to the feature will be included in the Environmental Impact Study and mitigation measures will be provided and incorporated into the Environmental Effects Monitoring Plan (EEMP) to minimize impacts.

Appendix C

Post-Construction Monitoring Plan: Terrestrial Crayfish

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Suite 600, 235 Yorkland Boulevard
Toronto, Ontario M2J 1T1
Tel: 416 499 3110
Fax: 416 499 9658
morrisonhershfield.com

Project Number: **1104036.00**

Project Title: **HAF WIND ENERGY PROJECT**

Report: **007-R02-1104036**

Title: **PRE-CONSTRUCTION MONITORING WORK PLAN: CANDIDATE TERRESTRIAL CRAYFISH HABITAT**

Client: **IPC Energy**
2550 Argentia Road Suite 105
Mississauga, Ontario
L5N 5R1

Date: **March 2012**

Morrison Hershfield Limited

Erin McLachlan
Terrestrial Ecologist and Environmental Planner

IPC ENERGY

Vineland Power
Stewards of sustainable energy.

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List of Figures

1.0 Introduction

Within Canada, terrestrial crayfish are only found within Southwestern Ontario and their habitats are very rare. They burrow in shallow marses, meadow marshes and mudflats near water.

During Site Investigations, 2 candidate sites (MAS2) were identified within 120 metres of the project location. See Figure 1.

Feature Type/ID	Size	Significance (if known)	Attributes	Composition	Functions	Minimum distance between feature & project location	Carried forward to EOS (y/n)
Candidate Terrestrial Crayfish Habitat	4.76 ha	Unknown	-wetland dominated by marsh species	MAS2 -mineral shallow marsh -dominated by reed canary grass	- suitable conditions for terrestrial crayfish habitat	0 meters Access road and underground collector line will intersect this feature	No – assumed significant and carried forward to EIS (Pre-construction monitoring will be outlined in the EIS.).

604000 605000 606000 607000

4776000 4775000 4774000 4773000

BLOCK 1 CON 2
LOT 21 CON 7
LOT 20 CON 7
LOT 37
LOT 18 CON 7
LOT 17 CON 7
BLOCK 1 CON 3
LOT 21 CON 6
LOT 18 CON 6
LOT 17 CON 6
LOT 21 CON 5
LOT 18 CON 5

Turbine 1
18.6m
Turbine 2
20.9m
Turbine 3
Turbine 4
Turbine 5

Legend

Candidate SWH
- Terrestrial Crayfish
- 120m Setback (All Project Components)
- Distances to Natural Features

Project Infrastructure
- Wind Turbines
- Switching Station
- Maintenance Building
- Collector Line
- Turbine Access Roads (New)
- Crane Pad
- Crane Path
- Turbine Laydown Area
- Substation Fence

Existing Road Network
- Paved Road
- Unpaved Road
- Watercourses

Note:
Underground collector lines following Sixteen Rd. will be contained within the existing road network right-of-ways.

All frames: North American Datum 1983,
Universal Transverse Mercator Projection, Zone 17N.
ESRI Aerial Photography (Bing 2010)
Project location data provided by IPC Energy and AMEC.

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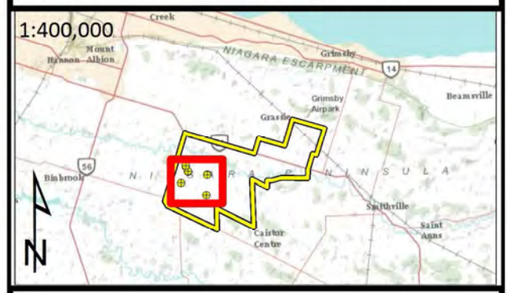

MORRISON HERSHFIELD

Scale:
1:12,500
0 125 250 500 750 1,000 m

Project:
HAF WIND ENERGY PROJECT

Title:
Summary of Site Investigations:
Candidate Terrestrial Crayfish
(Significant Wildlife Habitat)

Project No.:	Drawing No.:
1104037	Figure No. 1
	Date: 30 Mar 2012

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2.0 Objectives of Study

This study seeks to confirm the use of the candidate terrestrial crayfish habitat. If use is confirmed, we will gather information on the abundance and species of crayfish using the habitat.

3.0 Timing of Study

This study will be conducted in April 1– June 30 to include the adult breeding season. Three field visits will be scheduled.

- Site Visit #1: April
- Site Visit #2: May
- Site Visit #3: June

4.0 Study Methods

The study will include thoroughly investigating the entire candidate site on foot, looking for evidence of chimneys (burrows). Locations of all chimneys will be recorded with a GPS and notes will be made of any burrow activity observed (i.e. fresh mud pellets at burrow portals). Other observations of species using burrows (such as snakes and small mammals) will also be noted and reported. Two observers will conduct 3 surveys of 1 hour each (6 person hours of effort). Data on habitat and weather conditions (including the conditions and any precipitation events of the preceding week), start and end times of survey will also be recorded.

5.0 Analysis of Results

The Environmental Impact Study will include a discussion of different result outcome scenarios of the study. The analysis of results will be submitted to MOE and MNR immediately after study completion, and prior to construction. This analysis will include conclusions about which outcome scenarios are to be implemented from the Environmental Impact Study.

5.1 Significant Wildlife Habitat Technical Guide

As per the Significant Wildlife Habitat Technical Guide (OMNR 2000), candidate significant wildlife habitat (species/habitats of conservation concern) areas are analyzed in terms of 10 criteria:

- Degree of rarity of species found at site
- Documented significant decline in a species and/or its critical habitat
- Species whose range is solely or primarily found in Ontario
- Condition of existing habitat at site

- Size of species population at site
- Size and location of habitat
- Potential for long-term protection of the habitat
- Representation of species/habitat within the municipality
- Evidence of use of the habitat
- Species of particular interest to the planning authority

This study will provide information on the abundance and species of crayfish using the habitat to conduct an analysis on this feature.

5.2 Ecoregion 7E Criteria Schedule

As per the draft Ecoregion 7E Criteria Schedule (OMNR 2011), candidate terrestrial crayfish habitats are deemed significant if studies confirm the use of the feature by:

- Presence of 1 or more individuals of species listed or their chimneys (burrows):
    - Chimney or Digger Crayfish (*Fallicambarus fodiens*)
    - Devil Crawfish or Meadow Crayfish (*Cambarus Diogenes*)

If the analysis of results deems the site not significant, no further studies or mitigation are required.

If the analysis of results deems the site significant, a discussion of potential impacts to the feature will be included in the Environmental Impact Study and mitigation measures will be provided and incorporated into the Environmental Effects Monitoring Plan (EEMP) to minimize impacts.