

# WILD FRONTIER ECOLOGY

Bank House Farm, Pode Hole, Spalding



Post-construction Monitoring Report Year 2

June 2015

| Wild Frontier Ecology Ltd                                                    | Client details                           |
|------------------------------------------------------------------------------|------------------------------------------|
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The data which we have prepared and provided is accurate, and has been prepared and provided in accordance with the CIEEM's Code of Professional Conduct. We confirm that any opinions expressed are our best and professional bona fide opinions.

This report conforms to the British Standard 42020:2013 Biodiversity - Code of practice for planning and development.

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## 1. Non-technical Summary

A second season of vantage point observations and corpse searches was conducted at the two turbines at Bank House Farm between October 2014 and March 2015, at a reduced survey rate of 3 hours vantage point per month (18 hours in total). Low numbers of collision sensitive species were recorded within 200 metres of the turbines, and very few target species were observed within the collision risk window.

No corpses considered to relate to collision victims were located by the gun dogs on their regular walks around the base of the turbines.

Collision risk modelling produced very low mortality figures for the majority of species recorded, although relatively high numbers of woodpigeon present on a couple of occasions increased the predicted collision rates for this species to 7.24 per year at 98% avoidance rates.

No significant effects on local bird populations have been identified over the two years of the study.

## 2. Background

This report summarises the results of the second season of the post construction monitoring programme for two medium-sized wind turbines at Bank House Farm, near Pode Hole, Spalding, Lincolnshire. After the year 1 survey identified no significant effects on local bird populations<sup>1</sup>, it was agreed that a reduced programme of vantage point monitoring totalling 18 hours, would be acceptable for the 2014 - 15 survey season. This was to fulfil Condition 9 of the planning permission, quoted below.

*The site and surrounding area shall be -subject to a programme of post construction monitoring surveys, as set out in the Bird Reconnaissance Survey Report determined as part of this application, to assess the actual effects of the turbines on the wintering bird assemblage. The monitoring surveys shall be undertaken annually (each winter) for three years following the construction of the turbines. Survey reports shall be produced annually and submitted to the Local Planning Authority on a yearly basis, the first of which shall be submitted no later than 12 months from the date that the turbines first become operational. In the event that the monitoring surveys identify a significant effect {i.e. bird collisions (any species) over and above 1% of 'background' mortality rates), the applicant shall submit to and have approved in writing by the Local Planning Authority a programme for attenuating turbine activity to mitigate this impact through the most sensitive periods of operation. Such a programme shall be submitted within one month of the monitoring survey having been undertaken. Thereafter, the turbines shall only be operated in accordance with the approved details.*

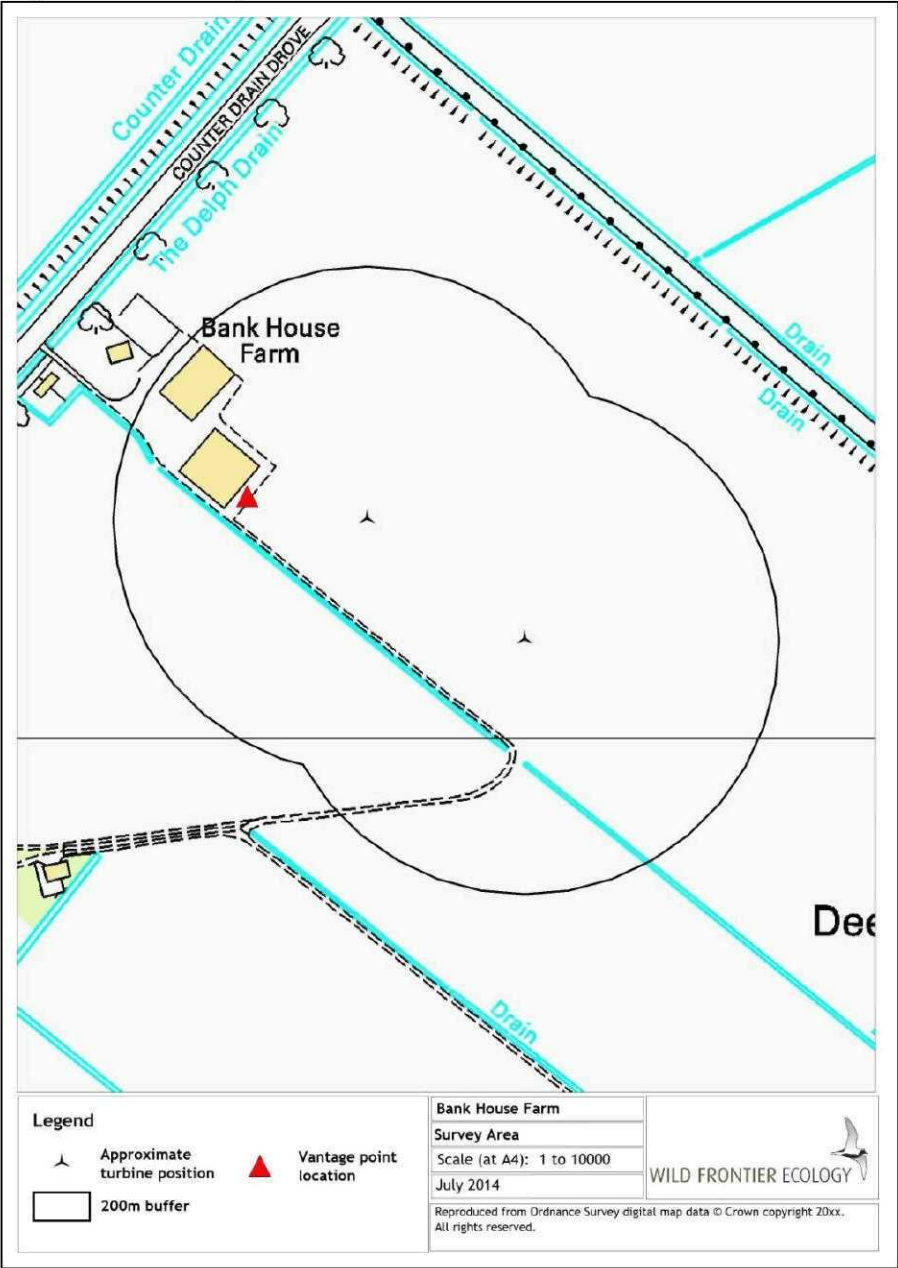
*Reason: In order to ensure that the impact of the wind turbines upon the local bird population is adequately monitored, and to provide for appropriate mitigation as necessary. This Condition is imposed in accordance with national guidance set out in Section 11 of the National Planning Policy Framework, 2012.*

A map of the site showing the two turbine positions, vantage point and survey buffer of 200 metres is given below, (same as used in year 1 of the study).

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<sup>1</sup> Riley. G. (2014) Post Construction Monitoring Report on Two Micro-turbines, Bank House Farm.

Figure 1. Site map



### 3. Methods

The survey methods were the same as in the previous year, comprising both vantage point monitoring and carcass searches, with the only deviation being the number of vantage point hours (reduced from 36 to 18, as no significant effects had been identified during the previous survey period).

Regular corpse monitoring transects were again undertaken over the same time period as the vantage point surveys, by the landowner (Mr Whitfield) accompanied by his dogs, following training by Wild Frontier Ecology using the approved TIN069 methodology.

#### 3.1 Avoidance Study

The turbines have now undergone 54 hours of observation (from a single vantage point) between October 2013 and March 2015, in order to assess whether and to what extent individual birds are physically avoiding the turbines (for dates of surveys see table 6, appended).

#### 3.2 Collision Risk Modelling

The species modelled are those considered vulnerable to collision (gull species, raptors, wading birds, stock dove and woodpigeon). The collision data are presented in table 1.

#### 3.3 Collision Study

This was again conducted by the landowner, Edward Whitfield with his 2 trained gun dogs, and the area was searched 27 times during the period October 2013 - March 2014 (see Table 5, appended, for dates). The areas around the turbine bases, and beyond to around a 70 metre radius, were worked by the dogs during each of the searches.

## 4. Results

### 4.1 Bird Avoidance Impacts

Full results of the bird surveys are appended (Tables 3-5). During vantage point sessions, all of the birds flying a course likely to collide with turbines were observed successfully taking avoidance action. A summary of observed avoidance actions are displayed in Table 6 (appended). Bird species recorded flying in the risk window during the year 2 surveys were as follows:

Black-headed Gull *Larus ridibundus*  
Common Gull *Larus canus*  
Fieldfare *Turdus pilaris*  
Grey heron *Ardea cinerea*  
Lesser black-backed gull *Larus fuscus*  
Kestrel *Falco tinnunculus*  
Skylark *Alauda arvensis*  
Starling *Sturnus vulgaris*  
Stock dove *Columba oenas*  
Woodpigeon *Columba palumbus*

### 4.2 Bird Collision Victims

As in the previous survey, no corpses considered to have died as a result of turbine collision were recovered during any of the carcass search surveys. The report from Mr Whitfield is as follows:

The field around the turbines this year at Bank House is Oilseed Rape drilled in late August and with adequate moisture the crop cover in October was good, so my visual for carcasses was not easy.

On each occasion of assessment at least one dog was with me, and often at weekends two dogs, and they combed the area around the turbines, and the dyke by the farm track.

In February I was away all month and my son only walked the area twice with both dogs, but he can't remember which days that was.

I came back in March and duly did 3 more reconnoitres.

On all of these occasions, although a few pigeons were feeding on the Oilseed Rape, no carcasses were found except for one cock pheasant. It was found roughly in between the first turbine and the farm grainstore. I couldn't determine whether it had hit a turbine or not as it looked perfectly OK, although looking at its big spurs it was obviously an older bird, and as fen pheasants only live for about 4-5 years, it is quite possible that its mortality could have been from natural causes.

During my inspections around the turbines, within the immediate vicinity of the towers, nothing was found, not even feathers, so I can only conclude that the impact of the turbines on the local wildlife has been minimal or nothing. Birds, mainly pigeons, pheasant and a few partridge do inhabit the area but as nothing has ever been seen by myself to have missed, narrowly missed, or hit the towers or rotors, then I can conclude that the risk is very minimal.

## 5. Discussion

No carcasses (apart from a single pheasant) were discovered beneath the turbines, although the ground conditions were more challenging for searches than during the previous survey period. A crop of oilseed rape sown in August was present in the field surrounding the turbines throughout the 2014 -15 survey season, covering much of the ground. However the proven ability of the gun dogs to locate corpses by scent suggests that this was not necessarily a significant constraint on the efficiency of these surveys. It is considered unlikely (though not impossible) that the pheasant died as a result of collision with one of the turbines, as it was found some distance away (c 50 metres) and showed no signs of injury.

The number of recorded instances of avoidance behaviour during the vantage point observations was low, with only 7 incidents observed (18 recorded 2013-14). Hence the rate of avoidance behaviour per hour was not dissimilar to the previous winter.

The range of species observed flying through the turbines risk window was also much reduced, down from 19 species in 2013-14 to 10 species in 2014-15. Again the reduction in survey effort is considered likely to have a major bearing on this.

The flight data collected have been combined with the 2013-14 data to give collision risk figures derived from 54 hours of observations. These largely remain very low, although the predicted collision rate for woodpigeon has risen to 7.24 per year, due to the increased numbers observed during the vantage point watches. However woodpigeons are an abundant BoCC green listed species (Birds of Conservation Concern), and any minor losses to the population (not supported by the carcass searches in any case) are considered to be of negligible significance.

No 'actual' collision rates can be calculated as a result of the negative results of the carcass study.

**Table 1. Predicted Collision Estimates using the Band Model over the 2 Years of the Study**

| Species           | Annual bird mortality at given avoidance |       |       |
|-------------------|------------------------------------------|-------|-------|
|                   | 98%                                      | 99%   | 99.9% |
| Marsh harrier     | 0.003                                    | 0.001 | 0.00  |
| Kestrel*          | 0.024<br>(95%)                           | 0.005 | 0.00  |
| Golden plover     | 1.15                                     | 0.57  | 0.05  |
| Grey heron        | 0.013                                    | 0.006 | 0.001 |
| Black-headed gull | 0.19                                     | 0.09  | 0.01  |
| Common gull       | 0.03                                     | 0.01  | 0.002 |
| Herring gull      | 0.086                                    | 0.043 | 0.004 |
| Lapwing           | 0.057                                    | 0.029 | 0.003 |
| Stock dove        | 1.70                                     | 0.85  | 0.008 |
| Woodpigeon        | 7.24                                     | 3.62  | 0.36  |

\* Modelled at 95% avoidance rate

## 5. Conclusion

The turbines continue to present a minor hazard to wintering bird species within the vicinity of Bank House Farm, although no conclusive collision victims have been discovered after two years of winter monitoring.

A lower number of species were recorded within the collision risk window during the vantage point surveys of 2014-15, which may be explained by the reduced survey effort. The numbers of observed avoidance incidents were also much reduced from the previous year.

The calculated collision risk figures continue to be very low for the majority of species, although large woodpigeon numbers observed on a couple of occasions have increased the predicted mortality for this species to a still relatively low 7.24 collisions per year at 98% avoidance levels. The collision risk figures for the remaining species recorded remain at less than 1 predicted collision per year, with the exception of golden plover and stock dove, with figures of 1.15 and 1.70 annual collisions respectively at 98% avoidance rates.

No significant effects to wintering birds have been identified following two years of ornithological monitoring work, with the lack of collision victims and low calculated collision risk figures suggesting that this remains a low risk site. No further surveys are recommended.

## Appendix 1.

**Table 2. Total of all birds observed within 200m buffer, and closest distance to turbines :2014 - 2015**

| Species                  | Total Number of Birds Within Buffer | Closest Distance to Turbine (m) |
|--------------------------|-------------------------------------|---------------------------------|
| Black-headed gull        | 220                                 | 10                              |
| Buzzard                  | 1                                   | 50-100                          |
| Carrion crow             | 16                                  | 30                              |
| Chaffinch                | 2                                   | 20                              |
| Common gull              | 7                                   | 30                              |
| Fieldfare                | 7                                   | 50                              |
| Goldfinch                | 3                                   | 60                              |
| Green woodpecker         | 1                                   | 40                              |
| Grey heron               | 2                                   | 50-100                          |
| Kestrel                  | 13                                  | 0-50                            |
| Little egret             | 2                                   | 0-50                            |
| Lesser black-backed gull | 1                                   | 50-100                          |
| Magpie                   | 3                                   | 50                              |
| Meadow pipit             | 3                                   | 50                              |
| Merlin                   | 2                                   | 0-50                            |
| Mistle thrush            | 4                                   | 40                              |
| Pheasant                 | 44                                  | 10                              |
| Pied wagtail             | 5                                   | 10                              |
| Robin                    | 1                                   | 70                              |
| Reed bunting             | 4                                   | 40                              |
| Rook                     | 1                                   | 50                              |
| Skylark                  | 12                                  | 50                              |
| Sparrowhawk              | 2                                   | 0-50                            |
| Starling                 | 58                                  | 60                              |
| Stock dove               | 52                                  | 10                              |
| Woodpigeon               | 1438                                | 5                               |
| Wren                     | 1                                   | 80                              |

**Table 3. Total of all birds observed flying within RW of turbines, and closest distance**

| Species                  | Total Number of Birds Within RW | Closest Distance to T1 |
|--------------------------|---------------------------------|------------------------|
| Black-headed Gull        | 16                              | 10                     |
| Common Gull              | 2                               | 0-50                   |
| Fieldfare                | 2                               | 150-200                |
| Grey heron               | 1                               | 50-100                 |
| Kestrel                  | 4                               | 50-100                 |
| Lesser black-backed gull | 1                               | 50-100                 |
| Skylark                  | 8                               | 0-50                   |
| Starling                 | 2                               | 100-150                |
| Stock dove               | 17                              | 0-50                   |
| Woodpigeon               | 749                             | 0-50                   |

**Table 4. Summary of described avoidance behaviour, and avoidance action within RW**

| Date       | Species           | No of Birds | Avoidance Behaviour | Distance from turbine when Avoidance Action taken (m) |
|------------|-------------------|-------------|---------------------|-------------------------------------------------------|
| 21/10/2014 | Black-headed Gull | 5           | Avoid               | 10                                                    |
| 21/10/2014 | Woodpigeon        | 1           | Avoid               | 5                                                     |
| 09/01/2015 | Stock Dove        | 1           | Avoid               | 10                                                    |
| 24/02/2015 | Common Gull       | 1           | Horizontal          | 30                                                    |
| 24/02/2015 | Stock Dove        | 1           | Horizontal          | 20                                                    |
| 25/03/2015 | Woodpigeon        | 2           | Avoid               | 5                                                     |
| 21/10/2014 | Black-headed Gull | 5           | Avoid               | 10                                                    |

**Definition of Avoidance Categories:**

**Weave** - Weaving flight-line up to maximum height of turbine

**Direct** - A direct flight-line within the turbine envelope, but clearly in a line up to the maximum turbine blade tip height, avoiding turbines

**Horiz** - A bird flying towards a wind farm site taking avoiding action by a horizontal movement (i.e. no change in height), to take it around the perimeter of the wind farm

**Vert** - As above, but bird gains altitude to take it over the top of the turbines, or underneath

**Bullet** - Flight behaviour which appears to take no avoiding action with regard to turbines (or other infrastructure)

**Hit** - A recorded collision event

**Avoid** - Avoidance behaviour near a turbine, generally taken at short notice, and is likely to appear as a sudden change in direction, or height, (or both)

**Other** - Any behaviour not easily classifiable into any of the above categories

**Table 5. Corpse Search Dates**

| Date       | Observer |
|------------|----------|
| 02/10/2014 | EW       |
| 05/10/2014 | EW       |
| 12/10/2014 | EW       |
| 18/10/2014 | EW       |
| 26/10/2014 | EW       |

|            |    |
|------------|----|
| 29/10/2014 | EW |
| 07/11/2014 | EW |
| 09/11/2014 | EW |
| 23/11/2014 | EW |
| 29/11/2014 | EW |
| 07/12/2014 | EW |
| 14/12/2014 | EW |
| 17/12/2014 | EW |
| 21/12/2014 | EW |
| 25/12/2014 | EW |
| 26/12/2014 | EW |
| 28/12/2014 | EW |
| 04/01/2015 | EW |
| 11/01/2015 | EW |
| 18/01/2015 | EW |
| 22/01/2015 | EW |
| 30/01/2015 | EW |
| ?/02/2015  | W  |
| ?/02/2015  | W  |
| 08/03/2015 | EW |
| 15/03/2015 | EW |
| 29/03/2015 | EW |

Table 6. VP Dates and Times

| Date       | Observer | Time (24hr) |        |
|------------|----------|-------------|--------|
|            |          | Start       | Finish |
| 21/10/2014 | GR       | 11:30       | 13:30  |
| 21/10/2014 | GR       | 13:40       | 14:40  |
| 20/11/2014 | GR + HE  | 11:20       | 13:20  |
| 20/11/2014 | GR + HE  | 13:30       | 14:30  |
| 16/12/2014 | GR       | 11:20       | 14:20  |
| 09/01/2015 | GR       | 11:45       | 14:45  |
| 24/02/2015 | GR + CP  | 11:35       | 13:35  |
| 24/02/2015 | GR + CP  | 13:45       | 14:45  |
| 25/03/2015 | GR       | 12:00       | 14:00  |
| 25/03/2015 | GR       | 14:10       | 15:10  |

## Appendix 3. Letter to South Holland District Council

## Bank House Farm - Post Construction Monitoring of 2 Wind Turbines

Dear Mr Crew,

We have been commissioned by Mr Whitfield to undertake a post-construction monitoring programme at the two turbines at Bank House Farm. We understand that some previous monitoring was undertaken last winter, but this did not provide sufficient detail.

Outlined below are our recommendations, based on the information with which we have been provided. We believe that the key points are as follows

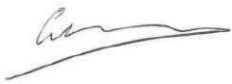
- The monitoring needs to be in line with the guidance document TIN069
- The monitoring needs to comprise both vantage point and transect survey
- The monitoring needs to be sufficient to calculate collision estimates

We suggest that 36 hours of vantage point survey over the coming winter (October 2013 - March 2014), with 6 hours of observations per month, should be sufficient for calculating collision estimates, and 18 hours in the following winter(s). This reduced effort is provisional on no significant effects being identified during the initial winter's observations. The vantage point will be located at approximately TF 185 209.

Weekly corpse monitoring transects over the same time period as the vantage point surveys will be undertaken by the landowner (Mr Whitfield) accompanied by his dogs, following training by Wild Frontier Ecology using the approved TIN069 methodology. We will present the findings of the surveys in a report to the Council at the end of the first winter period.

I hope you find the above recommended survey effort satisfactory, please get back to me if you have any questions.

Yours Sincerely



Graham Riley

## Appendix 4. Collision Risk Modelling

The collision risk is calculated by using the Band Collision Risk Model (Band et al. 2007<sup>2</sup>; SNH 2000)<sup>3</sup>. The model calculates the numbers of birds of a particular species which are estimated to collide with the wind turbines at a site per year. The model makes these calculations based on all the data recorded during the vantage point surveys. Detailed information on the dimensions of the site, turbines and birds is also required. Turbine specifications and site dimensions are provided by the wind farm developer. Average wingspans, lengths and flight speeds of birds are taken from Alerstam *et al.* (2007)<sup>4</sup>, BirdGuides Ltd. (2006)<sup>5</sup> and Bruderer & Boldt (2001)<sup>6</sup>.

Another element of collision risk modelling relates to the nature of each bird's flight event. In instances where a bird is using the site (i.e. feeding, hunting, nesting or landing on it, for example), it is considered to be following a 'less predictable' flight path, meaning flight direction, speed, altitude, and so on are likely to be highly variable. Birds not using the site and instead passing through it are considered to be following 'predictable' flight paths, in which the direction, speed and altitude tend to be more constant. Predictable flight paths would, for example, be applied to migratory species passing overhead, whereas raptors hunting over the site would be considered to be following less-predictable flight paths. This classification is necessary as the collision risk model calculates risk according to different parameters depending on whether a bird is following a predictable or less predictable flight line.

Wild Frontier Ecology uses the following definitions to calculate the collision risk for target bird species:

**Total number of flight events:** the number of flights recorded within the 500m buffer; flocks and individual birds would both be treated as single flight events.

**Total number of birds involved:** the number of birds witnessed throughout the entire duration of vantage point surveys (not necessarily indicative of actual bird numbers as repeated flights by the same bird(s) are possible).

**Total number of birds in risk window:** the number of birds recorded flying within the proposed rotor swept area, based on altitude.

**Total flight time (seconds):** the aggregate total that each species has been recorded flying within the 500m buffer.

**Risk window:** cross-sectional height at which birds are at risk from the spinning rotors (height between the floor of rotor swept area and the ceiling of rotor swept area).

**Time birds observed below the risk window:** the total time birds were recorded below the altitude of the proposed rotor sweep.

<sup>2</sup> Band W., Madders M., and Whitfield D.P. (2007). Developing field and analytical methods to assess avian collision risk at wind farms. In: de Lucas M., Janss G., and Ferrer M. (eds.), *Birds and Wind Farms Risk Assessment and Mitigation*. Quercus.

<sup>3</sup> Scottish Natural Heritage (2000). *Guidance - Wind Farms and Birds: Calculating a theoretical risk assuming no avoiding action*. SNH, Battleby.

<sup>4</sup> Alerstam T., Rosen M., Backman J., Ericson Per G.P., and Hellgren O. (2007). Flight Speeds among Bird Species: Allometric and Phylogenetic Effects. *PLoS BIOLOGY* Volume 5: Issue 8: e197

<sup>5</sup> BirdGuides Ltd. (2006). *Birds of the Western Palearctic Interactive*. DVD.

<sup>6</sup> Bruderer B. and Boldt A. (2001). Flight characteristics of birds: I. Radar measurements of speeds. *Ibis* 143: 178-204.

**Time birds observed in the risk window:** the total time birds were recorded within the altitude of the proposed rotor sweep.

**Time birds observed above the risk window:** the total time birds were recorded flying above the altitude of the proposed rotor sweep.

**Time birds observed in the risk window:** the total time birds were recorded flying within the proposed rotor swept area, based on altitude. Where birds were observed flying in and out of the risk window the proportion of time in the risk window was calculated using the height-banded data collected during the vantage point surveys.

**Flight paths:** **Predictable** flight path through the wind farm; the species flies through the wind farm in a reasonably defined direction. **Less predictable** flight path; the species occupies a recognised territory overlapping or within the 500m buffer area, in which flight paths are varied.

**Blade pitch:** pitch of blade taken at optimum output for average wind speed on site.

**Blade depth:** within this equation this is assumed to be a constant, with an estimated average depth used.

**Wind farm area:** combined 500m buffer around all the proposed turbines.

**Risk volume:** risk window multiplied by wind farm area.

**Wind farm width:** distance between the two turbines perpendicular to the predominant flight path + 100m to allow for maximum extent of turbine blades.

**Risk area:** risk window multiplied by wind farm width.

**Ratio of wind farm width to buffer width:** surveys are carried out on a buffer surrounding the proposed turbines rather than just over the area of the wind farm, in accordance with SNH and NE guidance. As the total space observed during the surveys is larger than if the wind farm area only were surveyed, more bird observations will be recorded. For predictable flight paths it is assumed that the flight events seen during surveys are evenly distributed across the whole buffer. To give an accurate representation of birds passing through the wind farm area rather than just the buffer, the total number of bird observed is multiplied by the ratio of wind farm width + 100m for turbine blades to the width of buffer.

**Flight hours:** these are estimated by taking the total hours between sunrise and sunset, and adding 25% for twilight, for each month the bird is realistically likely to be present at the site throughout the year. This provides an estimate of hours of daylight in which the bird could be flying. An additional 50% is added to daylight hours for birds that have a prolonged flight period, and often fly at night e.g. geese. Some species such as barn owl have been assumed to have a 24-hour a day flight time. Further adjustment to daylight hours is made depending on the latitude of the site.

**Estimated downtime:** estimated percentage of time the turbines will not be turning, either for periods of maintenance, cool-down or when wind speed is outside operation parameters.

## **Collision Risk Assessment**

Of all collision sensitive species, only those recorded flying in the risk window altitude zone of 40 metres to 80m (the airspace occupied by a 40m diameter rotor set on a 60m high hub) were modelled for collision risk.

### *Site and Turbine Details*

Details input to the model to calculate risk are as follows:

Number of turbines: 2

Hub height: 24m and 36m

Rotor diameter: 18m

Blade max chord: 2.50m

Blade pitch: 10°

Number of blades: 3

Average rotations per minute: 43

Blade depth: 2m

Wind farm width: 168m

Wind farm area 185,600m<sup>2</sup>

Estimated downtime: 15%

Latitudinal grid square in which wind farm proposal is located: TL

Vantage point survey hours completed: 36 over a single winter all other required information can be deduced from these figures, or is dependent on the species of bird being modelled.

## Worked Example

| <b>Woodpigeon</b>                                                                                | <b>Turbine 1</b>    |                       |
|--------------------------------------------------------------------------------------------------|---------------------|-----------------------|
| <b>Site and Turbine Details</b>                                                                  |                     |                       |
| Years of Study                                                                                   | 1                   |                       |
| Number of Turbines ( <b>N</b> )                                                                  | 2                   |                       |
| Hub Height                                                                                       | 24.0                | <b>m</b>              |
| Rotor Diameter ( <b>D</b> )                                                                      | 18.0                | <b>m</b>              |
| Rotor Radius ( <b>R</b> )                                                                        | 9.0                 | <b>m</b>              |
| Blade Max Chord ( <b>Bc</b> )                                                                    | 2.50                | <b>m</b>              |
| Blade Pitch ( <b>Bp</b> )                                                                        | 10.0                | <b>°</b>              |
| Number of Blades                                                                                 | 3                   |                       |
| Rotations Per Minute                                                                             | 15                  |                       |
| Rotor Rotation Period (1 rotation) ( <b>Rp</b> )                                                 | 4.00                | <b>sec</b>            |
| <b>Risk Window Calculation</b>                                                                   |                     |                       |
| Risk Window Ceiling Height ( <b>RWc</b> )                                                        | 33.00               | <b>m</b>              |
| Risk Window Floor Height ( <b>RWf</b> )                                                          | 15.00               | <b>m</b>              |
| Predominant Flight Path                                                                          | NA                  |                       |
| Wind Farm Width ( <b>X<sub>w</sub></b> )                                                         | 92                  | <b>m</b>              |
| Maximum Width of Buffer perpendicular to flight path                                             | 400                 |                       |
| Cross Sectional Area of Risk Window ( <b>W</b> ) = <b>X<sub>w</sub> x (RWc - RWf)</b>            | 1656                | <b>m<sup>2</sup></b>  |
| Rotor Sweep Area of Single Turbine = $\pi R^2$                                                   | 254.47              | <b>m<sup>2</sup></b>  |
| Combined Area of Turbine ( <b>A</b> ) = <b>N x <math>\pi R^2</math></b>                          | 508.94              | <b>m<sup>2</sup></b>  |
| Proportion of Risk Window Occupied by Rotors <b>Ao / W</b>                                       | 0.3073              | <b>m<sup>2</sup></b>  |
| <b>Bird Species Data</b>                                                                         |                     |                       |
| Study Period                                                                                     | <b>Nov to March</b> |                       |
| Speed of Bird Through the Rotor ( <b>v</b> )                                                     | 16.30               | <b>m/sec</b>          |
| Length of Bird ( <b>l</b> )                                                                      | 0.410               | <b>m</b>              |
| Wingspan of Bird                                                                                 | 0.775               | <b>m</b>              |
| Daily Flight Activity                                                                            | Twilight            |                       |
| Time Available for Flight Activity during the Study Period per year                              | 1755.00             | <b>hr/ yr</b>         |
| Total Available <b>Flight Hours</b> during the Study Period                                      | 1755.00             | <b>hr</b>             |
| <b>Observations</b>                                                                              |                     |                       |
| Vantage Point Hours Completed ( <b>VPh</b> )                                                     | 54.0                | <b>hr</b>             |
| Number of Birds Observed in Buffer                                                               | 788                 |                       |
| Number of Birds at Observed at Risk Height                                                       | 788                 |                       |
| <b>Collision Risk Calculation</b>                                                                |                     |                       |
| Ratio of X-Sectional Area to Buffer                                                              | 0.23                |                       |
| Number of in Risk Window ( <b>RWn</b> )                                                          | 181.240             |                       |
| Average Birds per Hour During Survey = <b>RWn / VPh</b>                                          | 3.356               |                       |
| Number of Bird Flights through Flight Risk Window ( <b>n</b> ) = <b>RWn / VPh x Flight Hours</b> | 5890.300            |                       |
| Number of Birds Passing Through Rotors per Year = <b>(n x (Ao/W))/number of study years</b>      | 1810.26             |                       |
| Estimated Down Time per year                                                                     | 15.00               | <b>%</b>              |
| <b>Chance of Collision (derived from Band 2000)</b>                                              | <b>23.54</b>        | <b>%</b>              |
| Adjusted to include Down Time                                                                    | 20.01               | <b>%</b>              |
| No Avoidance                                                                                     | 362.244             | <b>Collisions/ yr</b> |
| Adjusted for 98% Avoidance                                                                       | 7.245               | <b>Collisions/ yr</b> |
| Adjusted for 99% Avoidance                                                                       | 3.622               | <b>Collisions/ yr</b> |
| Adjusted for 99.9% Avoidance                                                                     | 0.362               | <b>Collisions/ yr</b> |



## Seymour, Sarah

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**From:** Customer Services SHDC <info@sholland.gov.uk>  
**Sent:** 30 June 2015 12:03  
**To:** \_planningadvice  
**Subject:** FW: Planning Application H03-0646-11  
**Attachments:** 20150420 Post construction monitoring report on 2 micro-turbines Bank House Farm Year 2.pdf

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**From:** bankho.freerve.co.uk [<mailto:bunny@bankho.freerve.co.uk>]  
**Sent:** 30 June 2015 09:20  
**To:** Customer Services SHDC  
**Subject:** Planning Application H03-0646-11

Dear Sirs

Please find attached Post construction monitoring report by Wild Frontier.  
As the turbines have now been monitored for 3 years, please confirm that we have now satisfied condition 9 of the planning permission.

Yours faithfully  
Edward Whitfield