Appendix 11.1 – Bat Survey Methodology and Results

1. Objectives

The aims and objectives of the bat desk study and survey work was to gather sufficient information on roosting, foraging and commuting bats within the application site to:

- Determine which species of bats are present within the zone of influence of the proposed development and in which habitats they occur;
- Determine the presence of any roosts within the vicinity of the proposed turbine location and their status (i.e. maternity, hibernation) if present;
- Determine which, if any, habitats within the vicinity of the proposed turbine location are important for bats in terms of foraging or commuting;
- Investigate any seasonal variations in bat activity;
- Describe the likely effects and identify the significance of effects on local bat populations which are likely to arise as a result of the proposed development; and,
- Aid in the design of the project to avoid negative effects on bats or to design suitable mitigation or compensation measures for adverse impacts.

2. Guidance

Guidance documents and references which were referred to when designing the bat surveys and carrying out assessments were:

- Natural England *Bat Mitigation Guidelines* (2004);
- Bat Conservation Trust *Bat Survey Good Practice Guidelines* (2007),
- Natural England Technical Information Note *TIN051: Bats and Onshore Wind Turbines* (February 2009);
- Natural England Technical Information Note *TIN059: Bats and Single Large Wind Turbines: Joint Agencies Interim Guidance* (September 2009);
- IEEM's In-Practice article written by Wray *et al. Valuing Bats in Ecological Impact Assessment* (December 2010)[1]
- Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms* (June 2011).

3. Methodology

The design of for the assessment has been continually reviewed in light of information collected during the data search and during the surveys, with reference to the objectives. The design of the surveys has been altered where it was considered that this would increase the information available for the evaluation and impact assessment. Any evolution of the survey design, along with limitations to any of the survey or assessment methods, is discussed below.

[1] Wray S, Wells D, Long E, Mitchell-Jones T (December 2010) *Valuing Bats in Ecological Impact Assessment*, IEEM In-Practice p 23-25

3.1 Desk Study

The MAGIC (Multi-Agency Geographical Information for the Countryside) website (http://magic.defra.gov.uk/) was reviewed for information on internationally and nationally designated sites (Special Areas for Conservation (SAC) or Sites of Special Scientific Interest (SSSI)), which have bats as a qualifying feature or key feature of interest within 10 km[2] of the proposed turbine location (SO668027).

Ordnance Survey plans and aerial photographs of land up to 500 m from the proposed turbine location were interrogated to identify potential bat commuting routes into the site and potential roost locations, for example, individual buildings, villages and woodland areas.

For the desk top study a radius of 5 km from the proposed turbine location was used for gathering data on bat species considered to be at low or medium risk[3] of turbine collisions. This was extended to 10 km for high risk species (including noctule, Leisler's and Nathusius pipistrelle)[4] following Bat Conservation Trust (2011) guidance.

The Gloucestershire Environmental Records Centre (GCER) was contacted for information regarding bat records within 5 km of the proposed turbine location and for records of high risk species within 10 km of the proposed turbine location. The Gloucestershire Bat Group was also contacted to obtain any additional records of bats within 5 km and 10 km respectively at which time they confirmed that all of their records are passed on to GCER.

3.2 Field Survey

3.2.1 Habitat Appraisal

A walk-over ecological survey of land within the application site and the immediate surrounds (the survey area) was undertaken on the 16th March 2010 broadly following the 'Extended Phase 1' methodology as set out in *Guidelines for Baseline Ecological Assessment* (Institute of Environmental Assessment 1995). Predominant habitats were mapped within the survey area and the intrinsic value of habitats for bats was appraised in the context of the application site and surrounding area. The survey area is shown on Figure 11.1.

The survey area includes the application site and extends approximately 50 m out from the application site boundary. This area includes all habitats within 200 m of the base of the proposed turbine[2].

During the walk-over survey trees and buildings were investigated for their potential to support roosting bats.

A preliminary assessment of the suitability of the habitats for potential commuting routes and foraging areas was also carried out during the initial walk-over survey.

The main objective of the walk-over survey with regard to bats was to identify the need for any further survey and to aid in the design of detailed bat surveys.

[2] In accordance with Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for* Onshore Wind Farms (June 2011) which states that any features with a high potential to support roosting bats within 200 m of the turbine location must be investigate.

[3] Risk categories of bats to turbine collisions follow guidance in TIN059 (Natural England, 2009)

[4] This is in accordance with the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms* (June 2011)

3.2.2 Detailed Inspections

During the extended Phase 1 walkover survey completed on 16th March 2010, four trees with the potential to support roosting bats were noted: three mature oak trees (including one which was dead) and one horse chestnut tree.

These trees were subject to a detailed daytime inspection on 22nd April 2010 in order to identify any evidence of roosting bats and/or features suitable for roosting bats to use. The inspection included visual checks of the trees for features that may be used by bats (such as rot holes, woodpecker holes, cracks or splits in limbs, cavities, loose bark, dense ivy or epicormic growth[5] and bird or bat boxes). Inspections were carried out in accordance with *Bat Surveys Good Practice Guidelines* (Bat Conservation Trust, 2007) and the *Bat Mitigation Guidelines* (English Nature, 2004) and were carried out by an ecologist with a Natural England bat licence.

Two buildings are present within 200 m of the proposed turbine location. One building (TN9) is located within the planning application boundary and was subject to a detailed inspection on the 4th October 2011 to determine its potential to support roosting bats. No access was possible to the second building, the waste transfer station (TN20), and so inspections of this structure to determine the potential to support roosting bats was undertaken from a distance, using binoculars.

Features were inspected for evidence of bats such as bat droppings and scratches or staining that could indicate bats entering and leaving. This was done by using ladders, an endoscope, a torch and inspection mirrors. Where features were too high to access using the ladders binoculars were used to identify any evidence of bat usage (e.g. staining of wood and droppings on the bark/walls). Trees were categorised as having low, medium or high potential for roosting bats based on the assessment criteria given in Table 1. Buildings were categorised as having low, medium or high potential for roosting bats based on the assessment criteria given in Table 2.

Whilst these categories attempt a standard terminology, there will be instances where an experienced bat surveyor may categorise a tree or building as having lower potential to support roosting bats than based purely on the features of the tree. For example, sources of disturbance may reduce the potential of a feature to support roosting bats, such as exterior light spillage reducing the potential for light sensitive species. The potential of a tree or building which appears to have features suitable for roosting bats but which is isolated from suitable foraging and commuting habitat may also be reduced. Conversely, good foraging and commuting habitat directly adjacent to a tree or building can enhance the potential for roosting bats.

[5] Epicormic growth is a twiggy shoot growth which appears to grow from the bark on some species of trees, notably lime and sycamore. It often grows from the base or on the stem or in the crown as a reaction to heavy pruning. It can also include growth shoot growing from a dormant or adventitious bud located on a stem and/or branches.

Table 1: Assessment of Potential to Support Roosting Bats - Categories for Trees

Category (Potential to Support Roosting Bats)	Description
Negligible potential	Tree contains no suitable features for roosting bats. These can include young trees without ivy and without loose bark and obvious cracks / fissures. Usually saplings, semi-mature specimens with a small girth or mature trees which do not tend to form fissures as readily such as sycamore.
Low potential	Tree contains limited features suitable for roosting bats. Usually young (sapling or semi-mature) trees with some ivy or some loose bark[6] but no obvious cracks or fissures. No evidence of bats found (e.g. droppings / staining).
Moderate potential	Tree contains some features suitable for roosting bats. Trees with some cracks or fissures[7] and/or large amounts of ivy / loose bark. Usually semi-mature or mature specimens. Trees tend not to have large splits, hollow trunks or woodpecker holes. No evidence of bats found.
High potential	Tree contains features that are highly desirable for roosting bats. Trees with woodpecker holes / large cracks and/or crevices. Often with a hollow trunk. May support very dense ivy. No evidence of bats found.
Confirmed roost	Bats discovered roosting within the tree, or recorded emerging / entering a tree at dusk / dawn. Trees found to contain conclusive evidence of occupation by bats, such as bat droppings. A confirmed roost record (as supplied by an established source such as the local bat group) would also fall into this category.

Table 2: Assessment of Potential to Support Roosting Bats - Categories for Buildings

Category (Potential to Support Roosting Bats)	Description
Negligible potential	Buildings with no features capable of supporting roosting bats. Often these buildings are of a 'sound' well-sealed nature, or have a single skin and no roof void. They tend to have high interior light-levels, and little or no insulation. Buildings without any roofs may also fall into this category.
Low potential	Buildings with limited features for roosting bats (e.g. shallow crevices where mortar is missing between building blocks/bricks). They may have open locations which may be subject to large temperature fluctuations and bat-access points may be constrained. No evidence of bats found (e.g. droppings / staining). Buildings may be surrounded by poor or sub-optimal bat foraging habitat. No evidence of bats found.
Moderate potential	Buildings with some features suitable for roosting bats. Buildings usually of brick or stone construction with a small number of features of potential value to roosting bats e.g. loose roof / ridge tiles, gaps in brickwork, gaps under fascia boards, and/or warm sealed roof-spaces with under-felt. These buildings may be used as occasional or transient roosts in the summer, but are unsuitable for large colonies. No evidence of bats found.
High potential	Buildings with a large number of features or extensive areas of obvious potential for roosting bats. Generally they have sheltered locations, with a stable temperature regime and suitable bat-access points. Could be suitable for a maternity roost. No evidence of bats found.

[6] In some areas loose bark can be important for species such as Barbastelle bat and, in the right geographic location, could be a feature providing high potential for this species.

[7] Crack or fissures should be sheltered from rain and wind to be of potential for roosting bats, for example a tree with a large crevice which is open at the top and becomes wet during rain would not be suitable for roosting bats.

Category (Potential to Support Roosting Bats)	Description
Confirmed roost	Bats discovered roosting within the building, or recorded emerging / entering the building at dusk / dawn. Building found to contain conclusive evidence of occupation by bats, such as bat droppings. A confirmed record (as supplied by an established source such as the local bat group) would also apply to this category.

Limitations

It was not possible to carry out a detailed inspection of the dead mature oak tree. This was due to the decay in the tree; surveyors were not convinced that the tree could withstand the ladders without damage to the tree and potential roosting sites for bats. However, an inspection of the tree was carried out from the ground (using binoculars) to identify any features with evidence of bat use. However, the results of this survey have been sufficient to assess the potential of the tree to support roosting bats and to determine the need for any further surveys of this tree.

3.2.3 Bat Activity Transect Surveys

Natural England's TIN059 (*Bats and Single Large Wind Turbines*) states that at least one dusk and dawn survey should be completed of the proposed turbine site with the aim of observing emergence at features assessed as providing high potential for roost sites and/or activity at features that provide high potential for commuting routes (hedgerows, tree lines, water courses) and/or habitat providing high potential for foraging (including lakes or larger water courses). The guidance also states that more than one survey may be required where habitats or other information indicate a high probability of use by bats. For the proposed turbine location at the Sharpness site the survey effort exceeded the minimum level of one dusk and dawn survey.

A dusk and dawn activity survey of the site was completed once a month between April 2010 and October 2010 in order to record any changes in seasonal activity across the site and to note general behaviour of bat species recorded on site throughout the active season[8]. This is in accordance with the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms* (June 2011).

The surveys completed included walking a transect of the habitats of foraging and commuting interest for bats (previously identified during the Phase 1 habitat survey in March 2010) closest to the proposed turbine location. Two Bat Box Duet (Stag Electronics) or one bat box duet and one Anabat SD1 (Titley Scientific) were used per survey. Five minute point counts were completed at key locations along the transect route to ensure the bat activity was accurately mapped within the site. Point count information allows both comparison of activity between different habitats and focussed recording of bats. The point count locations were chosen due to their proximity to a potential flight path or foraging area or at a potential commuting route into the survey area as identified from the Phase 1 habitat survey and a review of Ordnance Survey base maps and aerial photographs. The transect route and the five minute point count locations are shown on Figure 11.2.

[8] This methodology exceeded the requirements of TIN059 (the most up to date guidance at the time the surveys were completed). It should be noted that this methodology meets the minimum requirements of the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms* which were published in June 2011 (after these surveys had been completed).

The dusk transects were carried out from approximately 15 minutes before sunset until 1 hour 30 minutes after sunset (or longer where necessary if a large amount of bat activity was noted).

The dawn transects were carried out for a minimum of one hour before sunrise. If bats were still active past sunrise, dawn surveys lasted until 15 minutes after the last bat was noted following sunrise.

Natural England, Gloucestershire County Council and Stroud District Council were consulted in relation to the survey methodology. All consultees considered the methodology acceptable (see Consultation Section in Chapter 11 of the ES).

The start and end points of the transect were varied throughout the season in order to gauge activity at different times of night in all locations.

Survey dates, start times and weather conditions are given in Table 3 below.

Table 3: Bat activity survey dates and conditions

Date	Survey type (dusk or dawn)	Start time	Sunset/ sunrise	Finish time	Weather conditions	Surveyors
22/04/2010	Dusk	19.55	20.07	21.45	Clear sky, with no wind and less than 10% cloud cover. 13°C at the start, 5 °C at the end	J Girgis K Stanhope
23/04/2010	Dawn	04.50	05.52	06.15	Clear sky, cold, with no wind and less than 10% cloud cover. 2°C at start, 5°C at end	J Girgis K Stanhope
27/05/2010	Dusk	20.50	21.01	23.00	Clear sky, mild temperatures, with a light wind. Cloud cover was generally less than 10%. 10.5°C at start, 10.7°C at end	M Bowell E Harpham
28/05/2010	Dawn	03.25	04.52	05.00	Clear sky, mild temperatures, with a light wind. Cloud cover was 90%. 10°C at start, 10°C at end	D McLaughlin S Dowell
28/06/2010	Dusk	21.00	21.21	23.15	Very mild with a light wind. Cloud cover was generally more than 90%. 20°C at start, 16°C at end	C Sellars K Wilson
29/06/2010	Dawn	03.20	04.46	04.55	Very mild with a light wind. Cloud cover was generally more than 90%. Some very light rain showers occurred immediately prior to the dawn survey; 17°C at start, 15.5°C at end.	C Sellars K Wilson
22/07/2010	Dusk	20.55	21.04	22.55	Overcast, cloud cover generally around 50%. Slightly damp following rain showers earlier in the day. 15°C at start, 15°C at end	J Girgis V Lawrie
23/07/2010	Dawn	04.10	05.10	05.30	Overcast, cloud cover generally around 50%. 13.5°C at start, 13.5°C at end	J Girgis V Lawrie

Date	Survey type (dusk or dawn)	Start time	Sunset/ sunrise	Finish time	Weather conditions	Surveyors
13/08/2010	Dusk	20.25	20.48	22.35	Warm and dry with low wind speeds and little cloud cover. 18°C at start 15°C at end	V Lawrie K Wilson
14/08/2010	Dawn	04.20	05.43	05.50	Warm and dry with low wind speeds and little cloud cover. 12°C at start 13.5°C at end	V Lawrie K Wilson
09/09/2010	Dusk	19.25	19.30	21.45	Warm, dry, overcast with 100 % cloud cover. Light breeze. 6°C at start 14°C at end	V Lawrie K Wilson
10/09/2010	Dawn	05.00	06.26	06.30	Warm and overcast with 100 % cloud cover. Windy. Light rain showers overnight but dry by the start of the dawn survey. 11°C at start 11°C at end	V Lawrie K Wilson
14/10/10	Dusk	18.00	18.11	20.10	Warm, dry, overcast with 100% cloud cover. A light breeze. 13°C at start 11°C at end	J Girgis K Wilson
15/10/10	Dawn	05.45	07.23	07.30	Warm, dry, overcast with 100% cloud cover. A light breeze. 9°C at start 9°C at end	J Girgis K Wilson

Limitations

During the transect surveys completed in April 2010 the temperature dropped to 5°C at the end of the dusk survey and was 5°C and below for the entire dawn survey. Bats are less active at lower temperatures and as such this may have affected the survey results (particularly for the dawn survey).

Some observation of bat activity can be restricted by low light levels during transect surveys and it would not have been safe or practical for the surveyors to use night-vision goggles during these surveys. Therefore some bats were recorded on bat detectors but details regarding their flight direction or height of flight could not be ascertained.

Ecological surveys are limited by factors which affect the presence of plants and animals such as the time of year, migration patterns and behaviour. The absence of evidence of any particular species should not be taken as conclusive proof that the species is not present or that it will not be present in the future. Nevertheless, the results of these surveys are sufficient as they allow an assessment of bat activity in the area of the proposed wind turbine.

3.2.4 Dusk Emergence and Dawn Re-entry Surveys

A large common pipistrelle bat roost was noted warehouse building approximately 410 m south of the proposed turbine location. This roost was discovered during the dusk activity transect survey

completed on the 22nd July 2010[9]. Following the discovery of this large maternity roost advice was taken from Natural England on how to proceed at the site. It was agreed that one dusk emergence and dawn re-entry survey of this roost should be undertaken to confirm the exact number of bats and the species using it in order to have a clear understanding of the size of the roost and the species present.

One dusk emergence and dawn re-entry survey was completed on this warehouse building on the 13th August 2010. For this survey an Ecologist took a position close to the building from which any bats emerging from the roost could be seen. An ultrasonic bat detectors (Batbox Duet) was used to allow the surveyor to hear and identify bats. The dusk emergence survey was carried out from 30 minutes before sunset until 1 hour and 30 minutes after sunset. The dawn re-entry survey started approximately 1.5 hours before dawn and ended at sunrise. Any bat activity was recorded including the species of any bats entering/leaving the building, the time the bats emerged/re-entered the building and the location of the access/egress point. The survey was completed in suitable weather conditions (see Table 3 above).

3.2.5 Static Recording

In order to complement the manual bat activity transect surveys, static detectors were deployed in 2011 to enable the collection of data of bat activity across the site. These surveys were not completed in 2010 as the guidance available at the time of the 2010 surveys (i.e. Natural England's TIN059) did not specify a requirement for this level of survey. However, following the publication of the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farm* in June 2011 it was clear that this additional level of survey was required in order to adhere current guidelines.

SongMeter S2 (SM2 - Wildlife Acoustics) ultrasonic recording devices were deployed in strategic positions within the application site.

The application site is considered to require a low survey effort[10]. Based on this and the single turbine to be constructed at the site, it was determined that a minimum of five consecutive nights of ground level monitoring on static recording devices at the turbine location, per season (defined as spring, summer and autumn) was required[11].

Two SongMeters were installed at the turbine location: one a ground level (approximately 1.5 m above the ground) and one at height (on a mast approximately 10 m above the ground). The bat detectors were mounted on a wooden mast at the exact location of the proposed turbine (a GPS unit was used to locate this on site, using the following 12 figure grid reference: 366878, 202775).

For comparison, two additional SongMeters were installed in locations that had been found in 2010 to be used by commuting and/or foraging bats. The SM2's were activated for two periods of five consecutive nights: between the 11th and 15th August 2011 (summer) and between the nights of the 21st and 25th September 2011 (autumn)[12]. All four detectors were set to record simultaneously to allow a comparison of results to be made.

[9] During the point count at the known roost approximately 350 m south of the turbine location a large number of bats were observed flying from a southerly direction. One surveyor followed the route that the bats were flying from and discovered the roost. The roost was observed for a total of 20 minutes during which time the species and number of bats emerging from the building were noted.
[10] In accordance with *Table 1: Overview Of Factors To Consider When Designing Surveys And Reviewing Desk Study/Scoping Survey Results* in the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms*, June 2011
[11] In accordance with *Table 2: Minimum Survey Standards* in the Bat Conservation Trust Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms, June 2011
[12] It was not possible to complete the surveys in the spring season, see Limitations section below.

Figure 11.2 shows the locations of the static recorders and Table 4**Error! Reference source not found.** shows the deployment details of the recorders.

The deployment of the detectors followed recommendations where possible within the manufacturers manuals and following recommendations in Weller and Zabel, 2002[13]; where more bat calls were recorded on detectors placed at height (1.4 m in the experiment) rather than on the ground.

The SongMeters are weatherproof units. The data is recorded from the unit directly onto an SD card and stored in uncompressed WAC0 format.

The weather conditions for each static recording period is summarised in Table 5 below. This data is taken from the weather station on the Metmast adjacent to the application site (location shown on Figure 11.2). The weather conditions for each survey night (defined as approximately one hour before sunset until one hour after sunrise) are provided. For the August surveys, the table provides the recorded weather conditions between 7pm and 7am. For the September surveys, the table provides the recorded weather conditions between 6pm and 8am.

Table 4: Deployment details for static recorders

Date	Recorder Ref	OS grid reference[14] (and accuracy)	Height (m AGL)	Orientation[15]
11th to 15th August 2011	SM2-A	366878, 202775	Approximately 10 m	Pointing north-west
	SM2-B	366879, 202775 ±5 m	Approximately 1.5 m	Microphone pointing towards the northern hedgerow
	SM2-C	366812, 202785 ±5 m	Approximately 1.5 m	Microphone pointing towards the adjacent hedgerow
	SM2-D	366888, 202841 ±5 m	Approximately 1.5 m	Microphone pointing towards the adjacent hedgerow
21st to 25th September 2011	SM2-A	366878, 202775	Approximately 10 m	Pointing north-west
	SM2-B	366879, 202775 ±5 m	Approximately 1.5 m	Microphone pointing towards the northern hedgerow
	SM2-C	366812, 202785 ±5 m	Approximately 1.5 m	Microphone pointing towards the adjacent hedgerow
	SM2-D	366888, 202841 ±5 m	Approximately 1.5 m	Microphone pointing towards the adjacent hedgerow

Table 5: Weather conditions at Metmast (30 m height) during static recording

Date	Temperature (°C)		Wind Speed (m/s)		Relative Humidity (%)	
	Max.	Min.	Max.	Min.	Max.	Min.
11th/12th August 2011	17.8°C (at 19.10)	15.9°C (at 23.20)	9.5 m/s (at 20.00)	0.5 m/s (at 21.50)	82.7% (at 20.00)	93.3% (at 03.10)
12th/13th August 2011	17.9°C (at 19.00)	15.8°C (at 06.30)	10.7 m/s (at 05.10 and 06.50)	0.8 m/s (at 21.00)	81.5% (at 19.00)	95.8% (at 03.20)
13th/14th August 2011	17.7°C (at 19.00)	14.3°C (at 04.30)	7.7 m/s (at 19.10)	1.7 m/s (at 02.20)	68.3% (at 00.20)	89.9% (at 05.50)
14th/15th August 2011	17.6°C (at 19.20)	9.3°C (at 05.20)	6.8 m/s (at 19.30)	0.2 m/s (at 06.50)	56.3% (at 19.00)	93.3% (at 5.50)
15th/16th August 2011	15.7°C (at 19.00)	14°C (at 23.20)	11 m/s (07.00)	0.2 m/s (at 22.10)	92.5% (at 22.50)	76% (at 20.00)

[13] V*ariation in Bat Detections due to Detector Orientation in a Forest* Theodore J. Weller and Cynthia J. Zabel Wildlife Society Bulletin Vol. 30, No. 3 (Autumn, 2002), pp. 922-930

[14] OS grid references taken with a Garmin etrex, although the accuracy of the readings was variable due to the woodland canopy blocking satellite signals.

[15] The microphones are omni-directional. As such the orientation of the microphones should not have affected the recording of bat activity, and all activity within a 360° radius should have been registered.

Date	Temperature (°C)		Wind Speed (m/s)		Relative Humidity (%)	
	Max.	Min.	Max.	Min.	Max.	Min.
21st/22nd September 2011	14.8°C (at 18.00)	11.4°C (at 06.10)	16.6 m/s (at 20.20)	1.1 m/s (at 03.50)	91.9% (at 00.10)	76.2% (at 18.00)
22nd/23rd September 2011	14.7°C (at 18.00)	10.5°C (at 00.00)	8.3 m/s (at 18.40)	0.2 m/s (at 23.00)	93.6% (at 02.00)	74.7% (at 18.00)
23rd/24th September 2011	15.6°C (at 18.00)	11.5°C (at 00.20)	6.5 m/s (at 18.10)	0.5 m/s (at 18.40)	91.6% (at 05.00)	70.6% (at 18.10)
24th/25th September 2011	17.3°C (at 18.00)	14.6°C (at 07.00)	10.4 m/s (at 02.20)	0.8 m/s (at 19.10, 22.40 and 07.00)	94.2% (at 08.00)	66% (at 18.00)
25th/26th September 2011	16.9°C (at 18.00)	13.5°C (at 01.40)	12.2 m/s (at 00.10)	0.2 m/s (between 07.10 and 07.40)	96.7% (at 04.50)	68.7% (at 20.50)

Limitations

It is noted that the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for* Onshore *Wind Farms* (June 2011) state that if possible a static bat detector should be deployed within the rotor swept area of the wind turbine to assess bat activity at this altitude. It was not possible to mount a bat detector within the rotor swept area of the proposed turbine, either at the turbine location or elsewhere within the application site. Options were investigated for mounting a bat detector within the rotor swept area but for technical reasons this was not possible[16]. However, in order to attempt to identify any differences between bat activity at ground level and at height a 10 m tall pole was erected at the proposed turbine location.

The guidance also notes that five consecutive nights of recording should be completed in spring, summer and autumn for low risk sites. It was not possible to complete the required survey work for the spring season at the application site prior to the submission of the ES. This was in part due to the revised guidance being released in June 2011, after the spring survey season. The surveys completed in summer and autumn were carried out to complement the manual transect activity surveys completed in 2010, to ensure that the assessment complied with the revised guidance as far as possible prior to submission of the ES.

During the static recording in August, one of the SM2's batteries ran out after the fourth night of the survey (this is likely to be because of the large amount of bat activity recorded on the four preceding nights). As such only four nights of data were recorded for SM2-C.

During the static recording being carried out in September, one of the SM2's batteries ran out after the third night of the survey. As such only three nights of data was recorded for SM2-D.

The weather conditions recorded during the static surveys have been taken from the weather station on the Metmast located adjacent to the application site. The weather station does not record precipitation.

3.2.6 Bat Call Analysis

Analysis of recordings from the Anabat used during manual activity surveys was carried out using Analook (Titley Scientific). The frequencies of ultrasonic calls were divided by a factor of 8 and

[16] The option to deploy at a bat detector at height on the Metmast which had already been installed at the site was investigated. Due to health and safety reasons this option was not feasible (i.e. getting a Mobile Elevated Work Platform (MEWP) to the Metmast and getting a person to 40 m above ground level in the MEWP was deemed unsafe). A second option of erecting a 40 m high pole at the turbine location was also investigated. However, it was necessary to apply for planning permission to erect a pole of this size. The summer survey season would have been missed if this option had been pursued given the time it would have taken to obtain permission. As a result this option was also considered unfeasible.

stored on an SD card. The data produced were then zero-crossed using the cfcread V4.1a programme (Titley Scientific).

WAC recordings from the SongMeter during the static recordings were converted to WAV format using WACtoWAV software[17] and looked at both in their entirety through BatSound v3.1 (Pettersson Elektronik) or converted to zero-crossing files using the WACtoWAV software and analysed in Analook.

Both the Analook and BatSound software represent the recorded calls as sonograms (graphs of call frequency along the Y axis against time (duration) of the call along the X axis). The sonogram was then analysed to determine bat species.

Echolocation calls are reliably distinguishable from other sounds (e.g. wind, mechanical sounds, crickets), but the ability to distinguish species of bats varies with taxon, location, type of equipment and quality of recording, and is often difficult. Some bats are relatively easy to speciate from viewing sonograms and very little additional analysis of the sonograms may be required. Some species, such as those within the genus Myotis, can be extremely difficult, if not impossible to separate into species.

Bat echolocation calls consist of repetitive patterns commonly referred to as pulses or calls. Here, a singularly produced sound is defined as a pulse and the consecutive repetition (sequence) of pulses is defined as a call. Calls which were difficult to identify from viewing the sonogram alone were analysed in more detail by determining the mathematical parameters of the pulses that could be defined. Any noise distorting the clear definition of a pulse was excluded from analysis. The mathematical parameters measured included:

- Time between each pulse known as Inter Pulse Interval (IPI);
- Duration of call (Dur);
- Maximum frequency of call (Fmax);
- Minimum frequency of call (Fmin); and,
- Peak frequency of the call (Fpeak).

Limitations

There are inherent limitations when surveying bats using ultrasonic detectors. Ultrasound, unlike audible sound, is attenuated rapidly in air. Many echolocation calls are in the 40 KHz to 60 KHz region, where air attenuation is over 1 dB per metre. Sound absorption increases exponentially with frequency and a bat echolocating at 30 kHz is unlikely to have a range exceeding 30 m, with the range decreasing to 10 m at 100 KHz. Some bats call louder than others, notably the Noctule, which calls at the lowest frequency of any UK bat at around 20 KHz where excess attenuation is around 0.5 dB per metre. It is frequently audible at around 100 metres (Altringham, 2003).

In practice this means that bat detectors do not detect most bats calling from 30 kHZ and upwards at distances over 30 m[18]. Some species, such as brown long-eared bat, make very directional and quiet calls and can only easily be detected when the detector is facing the source of call (i.e. the bat) and at close range.

Therefore there may be some bias in the recording of bat species, caused by variations in the detectability of different species. The potential for some species of bats to be overlooked has been reduced as much as possible by the use of frequency division bat detectors (with the use of

[17] Software from Wildlife Acoustics http://www.wildlifeacoustics.com/index.php the manufacturer of the SongMeter units
[18] John D. Altrincham (2003) British Bats

headphones to cut down on background noise experienced by the surveyors), static recording, subsequent analysis of recordings and by the use of point counts during transects, where the surveyors are standing still, which reduces background noise on the detectors caused by surveyor movement. The manual surveys also used a combination of electronic detectors and observing bat behaviour where possible; the behaviour and size of bats can be used in combination with the calls to indicate species.

Table 6 indicates the maximum distances of ultrasonic detection for bat species occurring in the UK. The data has been taken from Eurobats and was collated based on a literature review and on the experience of Eurobat Intercessional Working Group members. It should be noted that this data is from surveys carried out on the continent and using a Pettersson Elektronik D980 bat detector.

Table 6: Distances of ultrasonic detection for bats occurring in the UK[19]

Species	Forages close to habitat structure	High Flight (>40 m high)	Low Flight (i.e. almost ground level)	Maximum distance of ultrasonic detection (m)
Greater horseshoe	Yes		Yes	10
Lesser horseshoe	Yes		Yes	5
Common pipistrelle	Yes	Yes	Yes	30
Soprano pipistrelle	Yes	Yes	Yes	30
Nathusius' pipistrelle	Yes	Yes	Yes	30-40
Brown long-eared	Yes	Yes	Yes	30
Grey long-eared	Yes	Yes	Yes	30
Bechstein's	Yes		Yes	25
Daubenton's bat	Yes	Yes	Yes	30
Natterers' bat	Yes		Yes	20
Whiskered bat	Yes		Yes	15
Brandt's bat	Yes	Yes	Yes	20
Noctule		Yes		100
Leisler's bat		Yes		60-80
Serotine		Yes		50
Barbastelle	Yes		Yes	30

The proposed wind turbine will have a total height of up to 122 m (with a tower/hub height of 80 m and a blade length of 41.25 m). The rotor swept area (spatial area within the arc of the turning rotor blades) would therefore be approximately 38.75 m above ground level. The location of the SongMeter 'at height' at the turbine location was approximately 28.75 m (SM2-A) below the rotor swept area (vertical distance from the SongMeters mounted position). Therefore the SongMeter will not have been in range of some bat species known to fly at height that may have been

[19] Information taken from Rodrigues, L., L. Bach, M.-J. Dubourg-Savage, J. Goodwin & C. Harbusch (2008): *Guidelines for consideration of bats in wind farm projects.* EUROBATS Publication Series No. 3 (English version). UNEP/EUROBATS Secretariat, Bonn, Germany, 51 pp. (Table 2, pp 48-49)

commuting or foraging within the rotor swept area of the proposed turbine. These include Brandt's bat (maximum distance of ultrasonic detection is 20 m). Species that may have been detected, as their maximum distance of ultrasonic detection is 30 m (falling just within the range of the static detector from the rotor swept area) include common pipistrelle, soprano pipistrelle, Nathusius' pipistrelle, brown long-eared, grey long-eared and Daubenton's bats. However, the SongMeter should have detected species such as noctule, Leisler's and serotine flying within rotor swept area (maximum distance of ultrasonic detection ranging from 50 m to 100 m). The species with the highest risk of collision with the turbine when operational (i.e. noctule, Nathusius' pipistrelle and Leisler's bat[20]) are therefore likely to have been recorded during each of the static surveys.

The ability to estimate abundance of bats by carrying out detector surveys is limited as it requires differentiation between multiple passes of a single bat and multiple bats making single passes, and is not usually possible through echolocation monitoring. However, the results can be used to indicate relative activity of bats in different habitats based on number of bat passes over time.

There are also some limitations on identification of some bats to species level, particularly those of the genera Myotis. This is due to similarities in calls of the different species and they can be difficult to identify to species level in cases where the bat pass was very brief, very distant and faint and if the bat was not seen. Due to the similarities in call parameters, species of the genera Myotis can often not be identified to species level using analysis of recorded bat calls.

Despite the inherent limitations involved in bat surveys, the methods used have made reference to best practice guidance available at the time of the surveys and used a range of survey methods on a number of visits to increase the chances of encountering bats. Bat activity surveys and static recording has been carried out within the active season (April - October), including within the periods of key bat activity (June – August), and have covered the proposed turbine location and key habitats close to the proposed turbine location. The data collected is therefore suitable for evaluation and impact assessment in relation to the proposed development.

3.3 Assessment and Evaluation

Although the IEEM (2006) *Guidelines on Ecological Impact Assessment in the UK* provide general guidance for evaluating the nature conservation value of habitats, it is extremely difficult to evaluate the value of species; species and the habitats that support them are generally considered together.

For the purpose of this project the guidance *Valuing Bats in Ecological Impact Assessment* (IEEM, 2010)[21] has been considered. This guidance is based upon the rarity of bat species (see Table 7) and gives a method for evaluating the importance of bat roosts (Table 8). The guidance also gives a method for evaluating bat commuting habitat (Table 9) and bat foraging habitat (Table 10). The scores derived from the evaluation of foraging and commuting habitat (as given in brackets in Tables 9 and 10) can be summed and used to ascribe a geographic scale of importance based on IEEM guidance (2006) (see Table 11). The limitations involved in this evaluation method are set out in IEEM (2007) and are largely related to the limited data available on bat populations in the UK.

[20] Following bat collision risk categories given in TIN059 (Natural England, 2009)

[21] Wray S, Wells D, Long E, Mitchell-Jones T (December 2010) *Valuing Bats in Ecological Impact Assessment*, IEEM In-Practice p 23-25

Table 7: Categories of bat rarity in England and Wales (adapted from IEEM, 2010)

Rarity within Range	England	Wales
Rarest (population under 10,000)	Greater horseshoe Bechstein's Greater mouse-eared Barbastelle Grey long-eared	Greater horseshoe Whiskered Brandt's Bechstein's Noctule Nathusius' pipistrelle Serotine Barbastelle
Rarer (population 10,000 to 100,000)	Lesser horseshoe Whiskered Brandt's Daubenton's Natterer's Leisler's Noctule Nathusius' pipistrelle Serotine	Lesser horseshoe Daubenton's Natterer's Brown long-eared
Common (population over 100,000)	Common pipistrelle Soprano pipistrelle Brown long-eared	Common pipistrelle Soprano pipistrelle

Table 8: Valuation of roosts

Geographic scale of importance	Roost type
District, Parish or Local	Feeding perches (common species) Individual bats (common species) Small numbers of non-breeding bats (common species) Mating sites (common species)
County	Maternity sites (common species) Small numbers of hibernating bats (common and rarer species) Feeding perches (rarer/rarest species) Individual bats (rarer/rarest species) Small numbers of non-breeding bats (rarer/rarest species)
Regional	Mating sites (rarer/rarest species) including well used swarming sites Maternity sites (rarer species) Hibernation sites (rarest species) Significant hibernation sites for rare/rarest species or all species assemblages
National/UK	Maternity sites (rarest species) Sites meeting SSSI guidelines based on bats
International	SAC sites with bats as qualifying species

Table 9: Valuing commuting habitat for bats

Species	Number of bats	Roosts/potential roosts nearby	Type and complexity of linear features
Common (**2**)	Individual bats (**5**)	None (**1**)	Absence of (other) linear features (**1**)
		Small number (**3**)	Un-vegetated fences and large field sizes (**2**)
Rarer (**5**)	Small number of bats (**10**)	Moderate number/not known (**4**)	Walls, gappy or flailed hedgerows, isolated well-grown hedgerows, and moderate field sizes (**3**)
		Large number of roosts, or close to a SSSI for the species (**5**)	Well-grown and well connected hedgerows, small field size (**4**)
Rarest (**20**)	Large number of bats (**20**)	Close to or within a SAC for the species (**20**)	Complex network of mature well established hedgerows, small fields and rivers/streams (**5**)

Table 10: Valuing foraging habitat for bats

Species	Number of bats	Roosts/potential roosts nearby	Foraging habitat characteristics
Common (**2**)	Individual bats (**5**)	None (**1**)	Industrial or other site without established vegetation (**1**)
		Small number (**3**)	Suburban areas or intensive arable land (**2**)
Rarer (**5**)	Small number of bats (**10**)	Moderate number/not known (**4**)	Isolated woodland patches, less intensive arable and/or small towns and villages (**3**)
		Large number of roosts, or close to a SSSI for the species (**5**)	Larger or connected woodland blocks, mixed agriculture, and small villages/hamlets (**4**)
Rarest (**20**)	Large number of bats (**20**)	Close to or within a SAC for the species (**20**)	Mosaic of pasture, woodlands and wetland areas (**5**)

Table 11: Scoring system for valuing habitat features (commuting and foraging habitat) for bats

Geographic Frame of Reference	Score
International	>50
National	41 – 50
Regional	31 – 40
County	21 – 30
District/ local or parish	11 – 20
Negligible importance	1 - 10

3.4 Nationally and Internationally Important Bat Sites

The designation of nationally and internationally important bat sites in the UK is based on roosts, usually maternity and hibernation roosts of the rarer and rarest bat species. The criteria for designation of these sites are outlined below for context.

The guidelines for the selection of SSSIs[22] for mammals give the following criteria which can be used to designate nationally important sites for bats (only those species of relevance to the survey area are given):

- Greater horseshoe bats - all main breeding roosts and all winter roosts containing 50 or more adult bats;
- Lesser horseshoe bats - all breeding roosts containing 100 or more adults and winter roosts containing 50 or more bats;
- Natterer's, Daubenton's, whiskered, Brandt's, serotine, noctule and Leisler's bats – only exceptionally large colonies with a long history of usage would be suitable for designation;

The SSSI selection guidelines states that the roosts of pipistrelles and brown long-eared bats should not normally be considered for national designation due to these species being more widespread and common than other bats in the UK.

SSSIs can also be designated on the basis of mixed assemblages of bats, including hibernation roosts with:

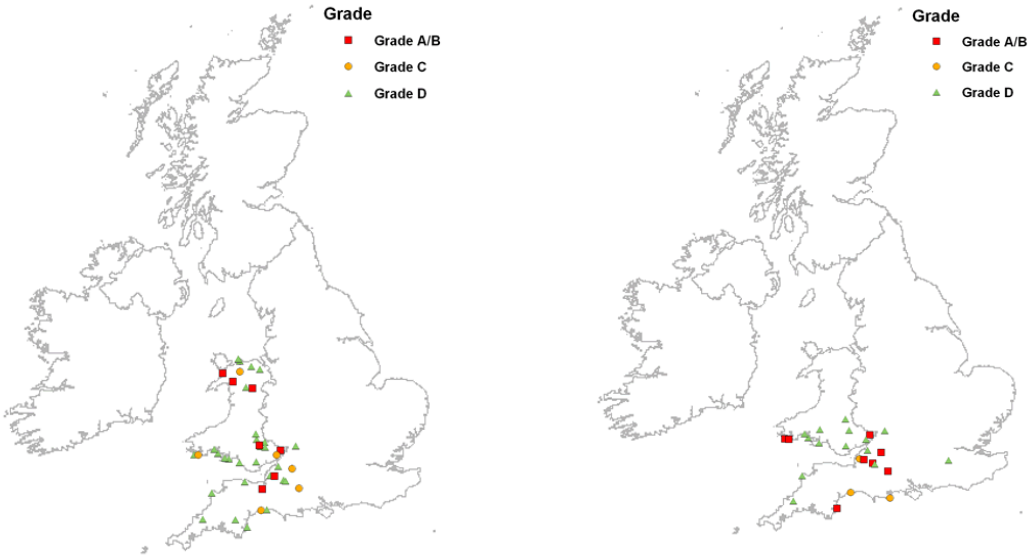
- ≥4 species and ≥50 individuals;
- 3 species and ≥100 individuals;
- 2 species and ≥150 individuals (unless in some parts of Britain where ≥30 bats of ≥2 species).

SACs of international importance can be designated for roosts supporting those bat species listed on Annex II of the Habitats Directive which includes lesser horseshoe and greater horseshoe bats. Figure 1 shows the distribution of SSSIs and SACs within the UK which are designated due to their bat interest. The grades of site shown in Figure1 are:

- A - Outstanding examples of the feature in a European context;
- B - Excellent examples of the feature, significantly above the threshold for SSSI/ASSI notification but of somewhat lower value than grade A site;
- C - Examples of the feature which are of at least national importance (i.e. usually above the threshold for SSSI notification on terrestrial sites) but not significantly above this. These features are not the primary reason for SACs being selected;
- D - Features of below SSSI quality occurring on SACs.

[22] Guidelines for the Selection of Biological SSSIs (Nature Conservancy Council, 1989)

Figure 1: Distribution of nationally and internationally designated sites for which bats are a feature[23]



Lesser horseshoe bats **Greater horseshoe bats**

3.5 Staff Experience

All surveys were undertaken by Atkins ecologists with experience in bat surveys. A brief description of the experience of the ecologists involved in the survey and assessment work is given below.

Katrena Stanhope, Principal Ecologist: Katrena has over ten years experience as a professional ecological consultant. During this time Katrena has undertaken several bat surveys and training courses in bat handling, survey and mitigation techniques and has provided bat training for other ecologists within Atkins. Katrena has held a Natural England (formally English Nature) bat survey licence (current licence no. 20081349) and a Countryside Council for Wales bat survey licence since 2004. She is a member of the Warwickshire Bat Group and has assisted Staffordshire Bat Group with hibernacula checks and harp-trapping. During these surveys Katrena has gained experience in the identification and handling of common and soprano pipistrelle bat, Daubenton's bat, whiskered and Brandt's bat, brown long-eared bat, Natterer's bat and lesser horseshoe bat. Katrena has carried out visual inspections of hibernation roosts for lesser and greater horseshoe bat in Shropshire and in Gwynedd, Wales and has surveyed known noctule tree roosts as well as conducting surveys and inspections for barbastelle bat in Gwynedd. Katrena has been the licensee or named Ecologist on eight development licences in relation to bats (Defra and Natural England) in the past five years and acted as accredited agent on a further two bat development licences. For this project Katrena reviewed the bat survey methodologies, ecological evaluation and impact assessment.

Catherine Sellars, Senior Ecologist: Catherine is an experienced bat surveyor and has eight years ecological consultancy experience. During this time she has undertaken bat surveys for numerous development projects, in particular emergence surveys, re-entry surveys and activity surveys. Catherine has undertaken surveys in a variety of habitats in various locations around England and Wales and has also completed a large number of tree and building inspections for

[23] UK distribution maps from Joint Conservation Committee's website (www.jncc.org.uk)

roosting bats. Catherine has completed assessment of impacts on bat populations from various types of development in order to support planning applications and Environmental Impact Assessments. For this project, Catherine has co-ordinated all ecology survey work, completed the Phase 1 habitat survey, consulted with statutory bodies about the bat survey methodology and written Chapter 11 – Ecology of the ES (and all of the supporting appendices).

Veronica Lawrie, Senior Ecologist: Veronica has been a professional ecological consultant for eight years and has undertaken a great number of bat activity, emergence/re-entry and daytime inspection building and tree surveys throughout this time. Her survey experience covers a range of species and areas of the UK and she has co-ordinated bat surveyors for large road schemes. Veronica has also undertaken bat sound analysis. She continues to develop her bat ecology skills and has contributed to a two day bat training workshop within Atkins in March 2011. For this project Veronica completed a number of the dusk and dawn activity transect surveys completed in 2010.

Keith Wilson, Ecologist: Keith has undertaken numerous surveys for bats including activity transect surveys, stationary monitoring and dusk and dawn emergence/re-entry surveys. He is confident at identifying groups of bats using heterodyne and frequency division bat detectors and has experience using recording equipment during a survey and setting up stationary detectors (Anabat and SongMeters) for long term monitoring. He has undertaken surveys in a variety of habitats in various locations around England and Wales. Keith has also used Analook and Batsound sonogram analysis software to analyse recordings of bats. For this project Keith completed a number of the dusk and dawn activity transect surveys completed in 2010 and analysed the data/sonograms from the SongMeters from the static recording surveys completed in 2011.

Simon Dowell, Ecologist: Simon is a Licensed bat worker in England (current Licence No. 20104249) and Wales (current Licence No. 27665:OTH:CSAB;2010), and has been carrying out bat surveys (emergence, walking transects, driving transects, roost visits, harp trapping, mist netting) for over four years with two small consultancies and with Atkins. Simon has also conducted bat surveys for the Somerset Environmental Records Centre and lead on call analysis of their results using software such as Batsound and Analook. Simon is a key member of a group of individuals carrying out mist netting and harp trapping surveys across east Devon for research on greater horseshoe bats, which involves hibernation visits in caves and mineshafts, as well as radio tracking and ringing. For this project Simon carried out one of the dusk/dawn activity transect surveys completed in 2010 and analysed the data/sonograms from the SongMeters from the static recording surveys completed in 2011.

Duncan McLaughlin, Ecologist: Duncan has five years ecological consultancy experience. He is an experienced bat surveyor, and has undertaken surveys for numerous development projects over the last five years, in particular emergence surveys, re-entry surveys, and activity surveys. Duncan has been analysing bat calls using both Batsound and Analook software for a variety of projects over the last three years. He has undertaken numerous surveys for bats, having undertaken a large number of surveys for road schemes in Pembrokeshire where impacts upon statutory designated sites (where greater and lesser horseshoe bats are qualifying species) were possible. For this project Duncan carried out one of the dusk/dawn activity transect surveys completed in 2010 and was responsible for setting out, managing and collecting the SongMeters for the static recording surveys completed in 2011.

4. Results

4.1 Desk Study Results

4.1.1 Designated Sites

The Forest of Dean and Wye Valley Woodlands SAC is present within 10 km of the application site. This is designated for its internationally important populations of greater and lesser horseshoe bats (and includes hibernation and maternity roosts). The SAC is consists of nine component parts (all SSSIs). Two of these component parts (SSSIs) are within 10 km:

- Devil's Chapel Scowles SSSI is located approximately 6 km west of the application site and supports a hibernating population of lesser horseshoe bats.
- Buckshraft Mine and Bradley Hill Railway Tunnel SSSI is located approximately 9 km north-west of the application site and support breeding and hibernating populations of greater horseshoe bats (as well as a smaller number of lesser horseshoes).

In addition Woodchester Park SSSI is present approximately 12.8 km east of the application site and supports a maternity roost of greater horseshoe bats[24]. Bats from this SSSI are known to cross the Severn Estuary to access hibernation sites within the Forest of Dean.

4.1.2 Data Search Records

Gloucestershire Bat Group

The local bat group were unable to supply records and advised that GCER were the most appropriate source of this information. However they advised that it should be assumed that **all** British bat species, except for grey long-eared bats and possibly Nathusius' pipistrelle, are present within a 10 km radius of the application site. They confirmed that both lesser and greater horseshoe species are breeding within 10 km of the application site (although they did not confirm where). They also confirmed that both noctule and Leisler's bat occur within 10 km of the application site but that it was unlikely that any roosts have been identified.

They suspect that some noctule bats from the Forest of Dean travel across the Severn Estuary to feed sometimes and confirmed that greater horseshoe bats do cross the Severn Estuary.

General

All records received from GCER within 5 km of the turbine location were dated between 1994 and 2010. As bats have a lifespan of up to thirty years and roosts are frequently used by continuous generations of bats all records provided over this timeframe are considered appropriate to be included in this assessment.

Two records of unidentified bat species with no additional information about the types of record were received within a 5 km radius of the turbine location. These records were dated 2001 and 2008. These records are at closest 3.7 km west and 1.3 km south-east from the proposed turbine location respectively.

[24] Although only designated sites within 10 km of the proposed turbine(s) are required to be identified by the current BCT guidelines for assessing the impacts of onshore wind turbines, the Woodchester SSSI has been included within this assessment at the request of Natural England (see the Consultation Section in Chapter 11 of the ES).

Locations of all bat records held within 5 km of the application site, the locations of all recorded bat roosts within 10 km of the application site and records of all high risk bat species (Leisler's bat and noctule) within 10 km of the application site are shown on Figure 11.3.

There are six species of bats known from records within the 5 km search area (or 10 km search area for high risk species) and these are summarised below. The locations of these records are shown on Figure 11.3.

Brown Long-Eared

Two records of brown long-eared bats (one roost and one 'present'[25]) were received for the search area. These are located 4.8 km north-west and 1.8 km north-east from the proposed turbine location respectively.

One record of a long-eared bat (species not given) maternity roost was also received, located in 1 km grid square SO6901 (approximately 2.2 km south-east of the application site at its closest point). Given the comments from Gloucestershire Bat Group (see above) it is likely that this is a brown long-eared bat roost.

Common Pipistrelle

Seven records of common pipistrelle (three in flight or four 'present)' were received for the search area, the closest record to the proposed turbine location is 2.2 km south-east at Sharpness Primary School. This is recorded as 'present' but as it is for a building this could be a bat roost.

Soprano Pipistrelle

One record of a soprano pipistrelle was received for the search area. This is located 2.2 km south-east at Sharpness Primary School (recorded as 'present' but this could be a bat roost).

Lesser Horseshoe

There are three records for lesser horseshoe bats within 5 km:

- One hibernation roost within Lydney golf course (approximately 2.5 km west of the turbine location);
- One lesser horseshoe bat recorded as 'present' at Berkeley Castle approximately 4 km south-east. As this record is for a building this could potentially be a lesser horseshoe roost; and,
- One roost in at Tor Cottage in Blakeney (approximately 4.5 km north-west of the turbine location).

Daubenton's

One record of a Daubenton's bat (recorded as 'present') was received for the search area. This is located 1.7 km north-east of the proposed turbine location (at Purton Timber Ponds).

Leisler's

Leisler's bat are a high risk species in terms of turbine collision. Two records of Leisler's bat (both in flight) were received for the 10 km search area. Both of these records are located 2.5 km west from the proposed turbine location.

[25] Where no details were provided to the GCER of the type of record (e.g. roost, bat droppings, bat in flight) they record that the type as 'present'.

Noctule

Noctules are a high risk species in terms of turbine collision. There are nine records of noctule (four in flight and five 'present') within the 10 km search area. The closest record to the proposed turbine location occurred 2.2 km south-east.

4.2 Habitat Appraisal

4.2.1 Foraging and Commuting Routes

The application site is located on Sharpness 'island'. The 'island' is bound to the west by the Severn Estuary and to the north, south and east by canal docks. The land uses within the island consist predominantly of industry (associated with the canal docks), with some residential housing and some areas of open space. The habitats within the areas of open space include semi-improved grassland, semi-natural broadleaved woodland, a large pond, hedgerows and large areas of tall ruderal vegetation (dominated by bramble). The combination of standing water, tall ruderals and hedgerows is likely to provide habitat for invertebrates and could therefore provide good foraging habitat for a number of bat species.

From observations within the survey area and the review of aerial photographs of the survey area the surrounding landscape (to the east of the Severn Estuary) appears to be largely comprised of industrial units, residential properties and large, irregularly shaped pastures of improved/semi-improved grassland fields and arable fields with managed hedgerow boundaries. The hedgerows for the most part appear intact and linked to several small blocks of woodland to the north, north-east and south of the survey area providing commuting routes onto the survey area for bats.

The application site is located within a semi-improved (tussocky) grassland field. The proposed turbine is located in the centre of this field. The field is bound to the north by a species-poor hedgerow with bramble scrub immediately adjacent. The field is bound to the west by an overgrown species-rich hedgerow with trees. This overgrown hedgerow is approximately 2 m to 5 m wide and large amounts of bramble are also adjacent to it.

The hedgerows and woodland edges in and around the survey area provide potential commuting routes into and across the survey area with buildings and hedgerow trees providing potential roosting sites for bats.

4.2.2 Roost Assessments

Two buildings are present within 200 m of the proposed turbine location (TN9 and TN20). These buildings were assessed as having a low potential to support roosting bats. This is due to the large age, construction and condition of the Waste Transfer Station (TN20) meaning it has very few crevices of use to roosting bats. For the single storey dilapidated brick building (TN9) this assessment is due to being open and exposed and having very little suitability to support roosting bats.

During the extended Phase 1 walkover survey completed in March 2010 at total of four trees with the potential to support roosting bats were noted within 200 m of the proposed turbine: three mature oak trees (including one which was dead) and one horse chestnut tree. These trees did not have high potential to support roosting bats. However due to their proximity to the proposed turbine (all approximately 75 m away) they were subject to further investigation in April 2010 to determine if there would be any effects on bats roosting in these trees from collision impacts.

Table 12 summarises the results of the detailed inspections of the four trees for bats.

Table 12: Daytime tree inspection survey results

Tree	Location	Inspection Results
Mature oak (dead)	Approximately 75 m north of the proposed turbine	One rot hole located approximately 4 m above the ground (within a branch facing towards the estuary on the eastern side of the tree). No evidence of bat activity was noted around this hole. Abundant peeling bark is present on the trunk and branches of this dead tree. This provides suitable habitat for summer roosting bats (e.g. bats that will roost behind the bark occasionally during warmer, dry periods of the year only). During the 2011 Phase 1 survey that amount of peeling bark had substantially reduced (with lots of bare exposed heartwood). **Conclusion:** Low potential to support small numbers of summer roosting bats.
Two mature oak	Located immediately adjacent to each other approximately 75 m north-west of the proposed turbine	**Tree 1:** Trunk split at the base. However, this split does not penetrate far into the tree and does not have any bat roosting potential. No other features with potential to support roosting bats. **Tree 2:** One rot hole located approximately 1.8 m above the ground (within the trunk). However, this is downward facing and as such is not suitable for roosting bats (as it will collect water during rainfall and bats prefer to roost in dry locations). A second rot hole is present approximately 2 m above the ground (within a branch) approximately 20 cm to 30 cm deep. No evidence of bat activity was noted in this rot hole. This rot hole has very limited potential to support roosting bat as it is full of insects (i.e. earwigs and woodlice). No other features with potential to support roosting bats. **Conclusion:** Both trees have negligible potential to support roosting bats.
Mature horse chestnut	Approximately 75 m north-west of the proposed turbine	Several small rot holes (most pointing downwards or horizontally). No evidence of bat activity was noted in any of these holes. Furthermore, these rot holes have no potential to support roosting bats as the cavities were blocked with birds' nests. **Conclusion:** Negligible potential to support roosting bats.

In order to assess whether bats were using the dead oak tree, the tree was observed for bats exiting the tree at dusk during the transect surveys completed in 2010 and for any bats showing interest in the tree at dawn. No bats were noted entering or exiting this tree at any time during these surveys.

Two blocks of broad-leaved woodland (separated by an access track) are present to the north of the wind turbine. These woodland areas comprise trees which are young and semi-mature with some trees of low or medium potential to support roosting bats. However, no trees or buildings with high potential to support roosting bats were noted in these areas (or elsewhere within 200 m of the proposed turbine location) and as such no further surveys for roosting bats was deemed necessary[26].

During the activity surveys (see below) two bat roosts were identified. One common pipistrelle roost is located within a terraced house approximately 350 m south of the proposed turbine location

[26] In accordance with the Bat Conservation Trust *Bat Surveys – Good Practice Guidelines (2nd Edition): Surveying for Onshore Wind Farms*, June 2011

(first observed during the dusk activity survey completed on 27th May 2010). The number of bats noted exiting the roost during the transect surveys completed from May to October varied from six to twelve[27]. Given the numbers present and the time of year that the numbers fluctuate, this could be a possible pre-maternity roost (with pregnant females gathering prior to giving birth and then moving on to an alternative roost site).

A second common pipistrelle maternity roost is located within a warehouse building approximately 410 m south of the proposed turbine location. A total of 85 common pipistrelles were noted leaving the roost on the 22nd July 2010. A dusk emergence and dawn re-entry survey completed on 13th August 2010 noted a total of 55 common pipistrelles leaving the large roost at dusk[28] and seven common pipistrelles were noted returning to the roost during the dawn survey[29].

4.2.3 Summary of Bat Activity Transect Survey Results

A summary of the species and number of bats observed during each of the monthly bat activity transect surveys completed in 2010 is presented in Table 13 below. The bat results have been split into four areas: the turbine location and three areas where bat activity was noted to be highest (including the hedgerow to the north of the proposed turbine, the hedgerow to the west of the proposed turbine and the mown grassland track to the south of the proposed turbine location).

Table 13: Bat Activity Transect Results

Survey Month	Bat Species and Numbers Noted			
	Turbine Location	Hedgerow to the North	Hedgerow to the West	Grassland Track to the South
April – Dusk	-	-	19 common pipistrelles (commuting and foraging approximately 3 m to 5 m height, along the edge of the hedgerow)	-
April - Dawn	No bat activity recorded			
May - Dusk	-	-	1 brown long eared bat 11 common pipistrelles 1 soprano pipistrelle	2 common pipistrelles
May - Dawn	-	-	7 common pipistrelles	-
June – Dusk	2 common pipistrelles (commuting east to west across field at 4 m height)	-	1 serotine (heard not seen) 22 common pipistrelles (commuting and	8 common pipistrelles (commuting and foraging at approximately 2 m

[27] 12 in May, 12 in June, 6 in July, 0 in August, September and October.
[28] The number of bats emerging from the roost is less than noted during the partial emergence survey completed in July 2010. This is likely to have occurred for a number of natural reasons, for example, the warm weather experienced during the summer perhaps meant that the young bats had already matured and left the roost
[29] It is possible that many bats observed emerging from the roost returned following foraging at dusk before the commencement of the dawn survey.

Survey Month	Bat Species and Numbers Noted			
	Turbine Location	Hedgerow to the North	Hedgerow to the West	Grassland Track to the South
			foraging at 2 m to 8 m height next to hedgerow)	height)
June - Dawn	1 common pipistrelle (commuting west to east across field at 4 m height)	1 brown long eared	25 common pipistrelles (commuting and foraging at 2m to 4m height along hedgerow)	1 common pipistrelle (heard not seen)
July - Dusk	-	-	1 noctule (heard not seen) 4 common pipistrelles	1 noctule (heard not seen) 4 common pipistrelles
July - Dawn	-	-	11 common pipistrelles (flying at 3 m to 4 m height along hedgerow edge)	-
August - Dusk	-	-	6 common pipistrelles (commuting and foraging)	-
August - Dawn	-	-	6 common pipistrelles (foraging along hedgerow edge at 2 m height)	1 common pipistrelle (commuting at 1.5 m height)
September – Dusk	1 common pipistrelle (flying northwards past turbine location at 2 m height)	1 common pipistrelle (foraging)	1 noctule (heard not seen) 11 common pipistrelles (foraging near hedgerow)	-
September - Dawn	-	1 common pipistrelle (foraging)	4 common pipistrelles (foraging)	
October – Dusk	-	-	1 common pipistrelle (commuting)	-
October - Dawn	-	-	1 common pipistrelle (commuting)	-

4.2.4 Summary of the Static Recording Results

A summary of the species and number of bat registrations recorded during the summer and autumn static recording surveys completed in 2011 are presented in Tables 14 and 15 below.

Table 14: Results of static recording surveys completed in August 2011[30]

Date	SM2 Device	SM2 Location	Bat Species and Number of Registrations per Night										Total Number of Bat Registrations per SM2
			Common pipistrelle	Soprano pipistrelle	Noctule	Leisler's	Serotine	Lesser Horseshoe	Greater Horseshoe	Brown Long Eared	Barbastelle	Myotis sp.	
11th/12th August 2011	SM2-A	10 m above ground level, at the turbine location	13		9								**22**
	SM2-B	1.5 m above ground level, at the turbine location	11		3								**14**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	1,331	104	15	*2*[31]						59[32]	**1,511**
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	16	2									**18**
12th/13th August 2011	SM2-A	10 m above ground level, at the turbine location	20	3	17	*1*[31]							**41**
	SM2-B	1.5 m above ground level, at the turbine location	17	2	7	*1*[31]							**27**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	130	17	19						2	6[32]	**174**
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	6	3	8							1[33]	**18**
13th/14th August	SM2-A	10 m above ground level, at the turbine location	4	2	4								**10**

[30] A single possible Nathusius' pipistrelle bat recording was made during the August survey (as the base of the sonogram call appears to be between 38 and 40 kHz for a short period, indicative of this species). However, this recording has been excluded from this assessment for the following reasons: the recording is of poor quality (meaning the file could be an inaccurate representation of the echolocation call and detailed sonogram analysis was not possible), there was only one recording of a pipistrelle call reaching these frequencies, no Nathusius' pipistrelle bats were noted during manual activity surveys and Gloucestershire Bat Group have advised that this species is unlikely to be present in the county. .

[31] It was not possible to speciate between the Leisler's and serotine bats.

[32] It was not possible to identify to species level the Myotis bat species recorded. However, the analysis indicates that the records could include Brandt's/whiskered bat and natterer's bat.

[33] It was not possible to identify to species level the Myotis bat species recorded. However, the analysis indicates that it the records could include Brandt's/whiskered bat.

Date	SM2 Device	SM2 Location	Bat Species and Number of Registrations per Night										Total Number of Bat Registrations per SM2
			Common pipistrelle	Soprano pipistrelle	Noctule	Leisler's	Serotine	Lesser Horseshoe	Greater Horseshoe	Brown Long Eared	Barbastelle	Myotis sp.	
2011	SM2-B	1.5 m above ground level, at the turbine location	4	2	2								**8**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	1,630	96	4						1	101[32]	**1,832**
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	11	4	3							3[32]	**21**
14th/15th August 2011	SM2-A	10 m above ground level, at the turbine location	3	1	12							4[34]	**20**
	SM2-B	1.5 m above ground level, at the turbine location	3	2	3							5[34]	**13**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	398	35	2							11[32]	**446[35]**
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	13	7	8							3[32]	**31**
15th/16th August 2011	SM2-A	10 m above ground level, at the turbine location	10	2	12								**24**
	SM2-B	1.5 m above ground level, at the turbine location	9	1	11								**21**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location											**-[36]**
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	10	3	9	*1*[31]						1[34]	**24**
Maximum Number of Registrations per Bat Species on Any One Recording Night			**1,649**	**108**	**51**	***2***		**0**	**0**	**0**	**2**	**104**	

[34] It was not possible to identify to species level the Myotis bat species recorded.
[35] One unidentified bat was recorded. Analysis indicated that it is possible that this was a brown long-eared.
[36] No records as battery in SM2 recorder ran out.

Table 15: Results of static recording surveys completed in September 2011

Date	SM2 Device	SM2 Location	Bat Species and Number of Registrations per Night										Total Number of Bat Registrations per SM2
			Common pipistrelle	Soprano pipistrelle	Noctule	Leisler's	Serotine	Lesser Horseshoe	Greater Horseshoe	Brown Long Eared	Barbastelle	Myotis Sp.	
21st/22nd September 2011	SM2-A	10 m above ground level, at the turbine location	2		1	1							**4**
	SM2-B	1.5 m above ground level, at the turbine location	2		2								**4**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	147	35					1		3		**186**[37]
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	5	2	1								**8**
22nd/23rd September 2011	SM2-A	10 m above ground level, at the turbine location	1		1							1[33]	**3**
	SM2-B	1.5 m above ground level, at the turbine location	4		2								**6**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	420	95	1	1		1			3		**521**[38]
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	1	2	1							1[33]	**5**
23rd/24th September 2011	SM2-A	10 m above ground level, at the turbine location	2		2	1							**5**
	SM2-B	1.5 m above ground level, at the turbine location	2		1	1				1	1		**6**

[37] In addition, a total of 81 social calls were also recorded (the analysis suggests that these are likely to be common and soprano pipistrelles.
[38] In addition, a total of 90 social calls were also recorded (the analysis suggests that these are likely to be common and soprano pipistrelles)

Date	SM2 Device	SM2 Location	Bat Species and Number of Registrations per Night										Total Number of Bat Registrations per SM2
			Common pipistrelle	Soprano pipistrelle	Noctule	Leisler's	Serotine	Lesser Horseshoe	Greater Horseshoe	Brown Long Eared	Barbastelle	Myotis Sp.	
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	136	107	1	1					6	5[33]	**256**[39]
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location	2	2	3							1[33]	**8**
24th/25th September 2011	SM2-A	10 m above ground level, at the turbine location	3		1								**4**
	SM2-B	1.5 m above ground level, at the turbine location	1	1	7							1	**10**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	95	32	1			1		2	1	4[32]	**136**[40]
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location											**-**[36]
25th/26th September 2011	SM2-A	10 m above ground level, at the turbine location		2									**2**
	SM2-B	1.5 m above ground level, at the turbine location		2						1			**3**
	SM2-C	1.5 m above ground level, next to hedgerow west of the turbine location	62	19		2				2	3	6[32]	**94**[41]
	SM2-D	1.5 m above ground level, next to hedgerow north of the turbine location											**-**[36]
Maximum Number of Registrations per Bat Species on Any One Recording Night			**426**	**109**	**9**	**3**	**0**	**1**	**1**	**3**	**7**	**6**	

[39] In addition, a total of nine social calls were also recorded (the analysis suggests that these are likely to be common and soprano pipistrelles).
[40] In addition, a total of 30 social calls were also recorded (the analysis suggests that these are likely to be common and soprano pipistrelles).
[41] In addition, a total of three social calls were also recorded (the analysis suggests that these are likely to be common and soprano pipistrelles).

4.2.5 Bat Activity at the Proposed Turbine Location

A summary of bat activity at the turbine location (taken from the manual bat activity surveys in 2010 and the static bat surveys in 2011) is provided in Table 16. Common pipistrelle was the most regularly recorded bat; peaks of activity by common pipistrelle occurred in August 2011.

No obvious commuting lines (linear features such as hedgerows and woodland edges) lie within 50 m of the rotating tip to highest tree in hedgerow (see Appendix 11.5 of the ES). The trees that these measurements have been taken from are mature and their capacity for any further increase in height is minimal. The base of the turbine is located approximately 65 m from the nearest linear habitat thought to be of value for bats 9the minimum distance required to avoid being located within 50 m of the rotating tip of the turbine is 58 m – see Appendix 11.5). The majority of bat activity was associated with the hedgerow approximately 70 m west of the turbine location.

Foraging activity, particularly by common pipistrelle and a lesser extent soprano pipistrelle, was noted along the hedgerow to the west.

Table 16: Summary of bat activity at the turbine location in 2010 and 2011

Survey Type	Manual Activity Surveys (number of bats observed)							Static Recording Surveys – at 1.5 m above ground (SM2-B) (maximum number of bat registrations on any one night)		Static Recording Surveys – at 10 m above ground (SM2-A) (maximum number of bat registrations on any one night)		Maximum Number of bats/registrations
Date	April 2010	May 2010	June 2010	July 2010	August 2010	September 2010	October 2010	August 2011	September 2011	August 2011	September 2011	
Common pipistrelle			3			1		17	4	20	3	**20**
Noctule								11	7	17	2	**17**
Soprano pipistrelle								2	2	3	2	**3**
Myotis sp.								5	1	4	1	**5**
Leisler - confirmed									1		1	**2**
Brown long-eared									1			**1**
Leisler's or serotine								1		1		**1**
Barbastelle									1			**1**
Total No. Bat Registrations			**3**			**1**		**36**	**17**	**45**	**9**	

5. Evaluation

5.1 Species Present and Conservation Status

Bat species recorded during the surveys (in order of abundance from most abundantly recorded to least recorded) together with details of the species' conservation status are given in Table 17.

The potential presence of a number of species of the genera Myotis was identified but could not be identified with certainty to species level. However, analysis of the recordings suggested that whiskered/Brandt's and natterer's bat were present. Table 17 below includes the Myotis species that could be within the geographic area.

Along with the information received from the data search, the following references were used for information on the national and local status of bat populations:

- Bat Conservation Trust, 2005: Species information leaflets (available at http://www.bats.org.uk/pages/uk_bat_species.html).
- Bat Conservation Trust, 2000: *Distribution Atlas of Bats in Britain and Ireland*;
- The National Bat Monitoring Programme. *Annual Report 2010*. Bat Conservation Trust, London. (http://www.bats.org.uk/pages/national_bat_monitoring_programme_annual_report_2010.html);
- UK Biodiversity Action Plan (http://jncc.defra.gov.uk/default.aspx?page=5155);
- Gloucestershire Biodiversity Action Plan website (http://gloucestershirebap.org.uk/actionplan/priority-species.php?sap=15);
- Harris S., Morris, P., Wray, S. & Yalden, D. (1995) *A review of British mammals: population estimates and conservation status of British mammals other than cetaceans*. JNCC, Peterborough; and,
- Harris S and Yalden D (2008) *Mammals of the British Isles Handbook*, 4th Edition. The Mammal Society.

All UK bats are listed under the following European Community Directives, Conventions or UK legislation:

- Appendix II of the Bern Convention. An agreement on the Conservation of Bats in Europe (EUROBATS) under the auspices of the Bonn Convention, also known as the Convention on Migratory Species (CMS) is in force, and all European bats are listed under Appendix II of the CMS;
- Appendix II of the Bonn Convention (and Recommendation 36 on the Conservation of Underground Habitats),
- Annexes II and IV of the EC Habitats Directive;
- Schedule 5 of The Wildlife and Countryside Act 1981 (as amended);
- Schedule 2 of The Conservation of Habitats and Species Regulations 2010,
- The Countryside and Rights of Way Act 2000;
- The Natural Environment and Rural Communities Act 2006; and,
- The Wild Mammals (Protection) Act 1996.

All of the bat species listed in Table 17 below have been recorded commuting and/or foraging within habitats in the application site. No roosts of the bat species recorded are known to be present within 200 m of the turbine location. The population of each of the bat species listed in Table 17 within Gloucestershire is unknown. However, the Gloucestershire Bat Group has confirmed that all of these species occurs within 10 km of the application site.

Table 17: Bat species recorded within the survey area and their conservation status

Bat Species	BAP and IUCN Status	UK Population Trend	Estimated UK Population size, rarity[42] and distribution
Common pipistrelle	UK BAP LBAP	Increasing	2,430,000 in UK (population size in England unknown). It is common and widely distributed across the UK.
Soprano pipistrelle	UKBAP	Increasing	Soprano pipistrelle 1,300,000 (unknown) – common and widely distributed across the UK.
Noctule bat	UK BAP	Stable	50,000 (45,000) – rarer. Relatively widespread in much of England, Wales and south-west Scotland. Absent from Ireland.
Barbastelle	UKBAP LBAP	No trend data available	Estimated at 5,000 in UK - rarest. Restricted to England and Wales (south of line between Humber and Dover) and widely but thinly spread.
Leisler's	-	No trend data available	Estimated at 10,000 in Great Britain – rare. Distribution mostly in central and southern counties, significant breeding populations in Bristol, Kent, Suffolk, Oxfordshire, Sheffield, South Yorkshire, Essex and Worcestershire. Largest colony in England in urban Bristol with up to 320 present after young fly.
Serotine	-	No significant overall trend but appears to be increasing	Population estimated at 15,000 but possibly underestimated – rare. Main range is south-east England, Dorset to Suffolk with recent records from Wales, central and north-west England.
Brown long-eared bat	UK BAP LBAP	Stable	245,000 (155,000) – common. Widely distributed across the UK.
Lesser horseshoe bat	UK BAP LBAP The 1996 IUCN Red List of Threatened Animals classifies this species as Vulnerable (VU A2c).	This species has shown a marked decline in numbers and distribution, although there is evidence of a recent increase in Wales.	27,000 (15,000 in England and Wales) - rarest. It has been estimated that some 230 summer (or all year round) roosts and about 480 hibernacula are known. Confined to Wales, western England and western Ireland with regular records as far east as Oxfordshire and Warwickshire.
Greater horseshoe bat	UK BAP LBAP The 1996 IUCN Red List of Threatened Animals classifies this species as Vulnerable (VU A2c).	It is estimated that the number of greater horseshoe bats has declined by 98% in the last 100 years. However recent national surveys suggest an increase.	The British population (England and Wales only) is thought to number over 6,600 individuals – rarest. Confined to southwest England and south Wales. Approximately 10 maternity roosts and 27 hibernation sites are designated as SSSIs within England and Wales for this species.
Other bats that could be present within the unidentified Myotis sp.			
Natterer's bat	-	Increasing	148,000 (70,000 in England) - rarer. Found throughout most of the British Isles.
Brandt's bat	-	Stable - there is a level of uncertainty of the population trend of these species, as it combines data from two species which are difficult to separate.	30,000 (22,500) – rarer. Brandt's bat is thought to be slightly less common and widespread than the whiskered bat. It is found throughout England and Wales and has only recently been recorded in Ireland.
Whiskered bat	-		64,000 (30,500) - rarer. Whiskered bat is thought to be slightly more common and widespread than Brandt's bat. It is found throughout England and Wales and even in southern Scotland and throughout Ireland.

[42] Rarity in England, based on Wray S, Wells D, Long E, Mitchell-Jones T (December 2010) *Valuing Bats in Ecological Impact Assessment*, IEEM In-Practice p 23-25. Rarest bats with populations less than 10,000 individuals, rare bats with populations between 10,000 and 100,000 and common bats with populations over 100,000 individuals.

The nature conservation importance of each bat species present within the survey area is given in Table 19 based on information regarding the national populations and the distribution of species.

Table 19: Nature conservation importance of individual bat species present within the survey area

Species	Nature Conservation Importance	Reasons for importance
Common pipistrelle	Low	This species is common[43] and widely distributed across the UK and Gloucestershire and uses a range of habitats including urban and industrial areas. No roosts are present within the survey area although roosts are known within 5 km. This is the most frequently recorded species within the 5 km desk study search area and was the most frequently registered bat species during both the manual and static bat surveys. The population using the site is unlikely to be of importance at the county level (i.e. medium importance) given their widespread distribution.
Soprano pipistrelle	Low	This species is common and widely distributed across the UK and Gloucestershire. No roosts are present within the survey area and a possible roost is recorded within 5 km. The population using the site is unlikely to be of importance at the county level (i.e. medium importance) given their widespread distribution.
Brown long-eared	Low	This species is common and widely distributed across the UK and Gloucestershire. No roosts are present within the survey area and two roosts are known to be present within 5 km. The population using the site is unlikely to be of importance at the county level (i.e. medium importance) given their widespread distribution.
Whiskered/ Brandt's	Medium	This rarer species is widespread across the UK but in low numbers (the low numbers of these species could be due to a lack of recording effort rather than them not being present). Present bat population in the county is unknown. No roosts are present within the survey area for these species and there are no records of these species within 5 km of the application site.
Natterer's	Medium	This rarer species is widespread across the UK but in low numbers. Present bat population in the county unknown. No roosts are present within the survey area and there are no records of this species within 5 km of the application site.
Noctule	Medium	This is a rarer bat species although it is relatively widespread in much of England, Wales and south-west Scotland. The species is absent from Ireland. Present but population in the county unknown. No roosts are present within the survey area and no roosts are recorded within 10 km of the site. However, this is the most recorded species within the 10 km desk study area and the third most abundant bat species recorded using the application site.
Barbastelle	Medium	This is a rarest bat species and distribution is restricted to England

[43] For definitions of categories of bat rarity see Table 7 above.

Species	Nature Conservation Importance	Reasons for importance
		and Wales (south of a line between Humber and Dover) where the species is widely but thinly spread. Present bat population in the county unknown. There are no records of this species within 5 km of the application site and no roosts have been located within the survey area. Ideal habitat for this species is not present within the application site (e.g. no large blocks of deciduous woodland or pastoral landscapes with wet meadows and water bodies).
Leisler's	Medium	This is a rarer bat species and distribution is mostly in central and southern counties (with the largest colony in England in urban Bristol). Present bat population in the county unknown. No roosts are present within the survey area and no records of roosts are present within the 10 km desk study area.
Serotine	Medium	This is a rarer bat species and distribution is mostly in south-east England (Dorset to Suffolk) with recent records from Wales, central and north-west England. Present bat population in the county unknown. No roosts are present within the survey area and there are no records of this species within 5 km of the application site.
Greater horseshoe	Medium	One of the rarest bat species in the UK confined to south-west England and south Wales. Population in the county is unknown. However, there is one SAC and one SSSI within 10 km of the application site that are designated due to their populations of greater horseshoe bats. No roosts are present within the survey area and there are no records of this species within 5 km of the application site.
Lesser horseshoe	Medium	One of the rarer bat species in the UK, although has a slighter wider distribution than greater horseshoe bat being confined to Wales, western England and western Ireland with scattered but regular records as far east as Oxfordshire and Warwickshire. Population in the county unknown but is one of the national strongholds for the species. However, there is one SAC and two SSSIs within 10 km of the application site that are designated due to their populations of lesser horseshoe bats. No roosts are present within the survey area and there are records of two roosts within 5 km of the application site.

5.2 Designated Sites

Lesser horseshoe bats prefer undisturbed hibernation sites and these must be available at a maximum distance of 30 km from the summer roosts [44]. Lesser horseshoe bats usually feed close to summer roosts (distances up to 4.2 km) and the animals spend about half of their activity time in summer within a radius of 600 m from their roosts[44]. The desk study identified a total of two lesser horseshoe roosts within 5 km of the application site (a hibernation site approximately 2.5 km west and a roost approximately 4.5 km north-west). It is possible that bats from the Devil's Chapel Scowles SSSI (a component part of the Forest of Dean and Wye Valley Bat Sites SAC) travel from this hibernation roost to summer/maternity roosts located within 10 km of the application site. It is therefore possible that lesser horseshoe bats from the SAC thus commute and forage within the survey area.

Greater horseshoe bats may use hibernation roosts up to 40 km (rarely greater than this) from the maternity colony and have been recorded travelling up to 50 km between roosts[45] although hibernation sites are generally close to maternity roosts. Greater horseshoe bats usually feed within 3 km to 4 km of a roost[46] and therefore crucial foraging areas for pregnant and lactating females and their offspring, when capable of flying, will be within 4 km of the maternity roosts[47]. Given the distance between the survey area and the Buckshraff Mine and Bradley Hill Railway Tunnel SSSI and the Woodchester Park SSSI it is possible that the greater horseshoe bats these sites are using the habitats within the survey area for commuting and/or foraging when moving to and from their maternity and hibernation roosts.

5.3 Bat Roosts

There are no bat roosts within the survey area. One dead mature oak tree present approximately 75 m north of the turbine base has a low potential to support summer roosting bats. However no bats were noted emerging or entering this tree during the 2010 surveys.

The nearest confirmed roosts are approximately 350 m and 410 m south of the proposed turbine location (a common pipistrelle (possible) pre-maternity roost and a common pipistrelle maternity roost, respectively). Following IEEM (2010) these roosts both have a county value (see Table 8).

5.4 Commuting and Foraging Routes

The key commuting and foraging routes identified within the survey area are shown on Figure 11.4.

5.4.1 Turbine Location

The walked transect surveys completed in 2010 confirmed that a small number of common pipistrelle commute over the grassland field at the turbine location (see Table 13).

The static recording surveys in 2011 confirmed that the following bat species (in order of most to least abundance) commute and/or forage over the grassland field at the turbine location: common pipistrelle, noctule, Myotis species (likely including Brandt's/whiskered and Natterer's), soprano pipistrelle, Leisler's, brown long-eared, possible serotine and barbastelle (see Table 16).

[44] UK Priority Species data collation *Rhinolophus hipposideros* version 2 updated on 15/12/2010 (http://jncc.defra.gov.uk/_speciespages/551.pdf)
[45] John D. Altrincham (2003), *British Bats The New Naturalist Library*
[46] Harris S and Yalden D (2008) *Mammals of the British Isles Handbook*, 4th Edition. The Mammal Society.
[47] UK Priority Species data collation *Rhinolophus ferrumequinum* version 2 updated on 15/12/2010 (http://jncc.defra.gov.uk/_speciespages/550.pdf)

5.4.2 Hedgerow to the West

Along the walked transects carried out in 2010, commuting and foraging was noted by common and soprano pipistrelle bats along the hedgerow to the west of the proposed turbine. This hedgerow forms a flight path for the two confirmed roost locations approximately 350 m and 415 m south of the turbine (e.g. bats were observed flying in a northerly direction from the roosts at dusk towards this hedgerow and to a lesser extent, south at dawn). This may help to explain the large amount of activity observed along this hedgerow. Brown long eared, serotine and noctule bats were also noted to be using this hedgerow.

The static recording surveys completed in 2011 confirmed that the hedgerow to the west of the proposed turbine location is a key commuting and foraging feature for a number of bat species. A maximum number of 1,832 total bat registrations were recorded on any one night during the surveys carried out in August 2011 and a maximum number of 521 total bat registrations were recorded on any one night during the surveys carried out in September 2011. The species using the hedgerow for the most part were common pipistrelles and soprano pipistrelles (likely due to the hedgerow forming a flight path from the two confirmed roost locations approximately 350 m and 415 m south of the turbine). However noctule, Myotis bats, barbastelle, Leisler's, serotines, lesser horseshoe bats and one greater horseshoe bat were identified using this hedgerow to commute and forage along.

5.4.3 Hedgerow to the North

Along the walked transects carried out in 2010, the hedgerow to the north of the proposed turbine was also used for commuting and foraging. However it was used less frequently (the number of bats recorded using this habitat was much less than along the western hedgerow) and by fewer bat species (with only common pipistrelle and brown long-eared bats identified).

The static recording surveys completed in 2011 indicate that the hedgerow to the north of the proposed turbine is also a commuting and foraging corridor. However, this hedgerow is less well used than the western hedgerow with less bat registrations recorded per survey (with a maximum of 31 total bat registrations on any one night during the August 2011 survey and a maximum of 8 total bat registrations on any one night during the September 2011 survey) and is used by a less diverse number of species (common pipistrelle, soprano pipistrelle, noctule, Myotis species and one serotine or Leisler's bat).

5.4.4 Grassland Track to the South

During the walked transects carried out in 2010 common and soprano pipistrelles were also noted foraging over the grassland field approximately 200 m south of the proposed turbine (along a mown grassland track through the semi-improved grassland field). One noctule was also observed to be using this track.

5.4.5 Value of Commuting and Foraging Habitat

Following the IEEM (2010) guidance the western hedgerow is a commuting route of regional importance as it is used by greater horseshoe and barbastelle bats (a small number of rarest species with an unknown number of roosts nearby and well connected commuting habitat within the vicinity gives a score of 38 – see Table 9 and Table 11).

Following the IEEM (2010) guidance the western hedgerow is a foraging route of regional importance as it is used by greater horseshoe and barbastelle bats (a small number of rarest species with an unknown number of roosts nearby and moderate foraging habitat within the vicinity gives a score of 37 – see Table 10 and Table 11).

Following the IEEM (2010) guidance the hedgerow to the north of the turbine location is a commuting route of county importance as it is used by noctules and serotines/Leisler's (a small number of rarer species with an unknown number of roosts nearby and well connected commuting habitat within the vicinity gives a score of 23 – see Table 9 and Table 11). Following this guidance it is also a foraging route of county importance as it is used by noctules and serotines/Leisler's bats (a small number of rarest species with an unknown number of roosts nearby and moderate foraging habitat within the vicinity gives a score of 37 – see Table 10 and Table 11).

Bats have been recorded commuting in the vicinity of the turbine location (i.e. over the grassland field within the application site) including common pipistrelle, noctule, soprano pipistrelle, Myotis species (likely including Brandt's/whiskered and Natterer's), Leisler's, brown long-eared, possible serotine and barbastelle. However, it is difficult to place a commuting value on this habitat as there is no obvious commuting feature for bats to follow within the vicinity of the turbine location. No foraging activity was noted at the turbine location. Of the bat species recorded using the habitat in the vicinity of the turbine location, one is a rarest bat species (barbastelle), four are rarer bat species (noctule, Myotis species, serotine and Leisler's) and three are common bat species (common pipistrelle, soprano pipistrelle and brown long eared). The rarest bat species, barbastelle, prefer to commute at low levels and tend to fly close to hedgerows and woodland edges (Harris and Yalden, 2008). It is unusual for this species to be recorded flying in open habitat. Only one barbastelle was recorded on the static detector at 1.5 m above the ground at the turbine location during the 10 nights of static recording completed in 2011, but no barbastelle were recorded on the static detector at 10 m, indicating that the bat was likely to be flying at low level possibly between the hedgerows to the west and north of the proposed turbine.

6. Summary

6.1 Species Present within the Survey Area

The surveys recorded the following species present within the survey area in order of most abundant to least abundant (with maximum total number of registrations in any one recording night during the 2011 surveys in parentheses): common pipistrelle (1,649), soprano pipistrelle (109), Myotis species (59 - it was not possible to identify these to species level with certainty but it is likely that whiskered/Brandt's and natterer's were recorded), noctule (51), barbastelle (7), Leisler's (3), brown long-eared (3), serotine (2), lesser horseshoe (1) and greater horseshoe (1).

Common pipistrelle and soprano pipistrelle were by far the most abundant species recorded and were recorded on each survey, with only individuals or small numbers of the other bat species recorded.

All bat populations in the UK have undergone significant declines over the last century due to habitat loss, fragmentation and roost destruction. However, of the bats recorded, the barbastelle, and greater horseshoe bats are the rarest and have a restricted distribution within south west England. The latter two species are also classified as Vulnerable (VU A2c) on the 1996 IUCN Red List of Threatened Animals. Lesser horseshoe bats, noctules, Leisler's and serotines are rarer bat species (with national populations between 10,000 and 100,000 individuals). Common pipistrelle,

soprano pipistrelle and brown long-eared bats are considered to be common (national populations over 100,000 individuals) and widespread throughout the UK.

6.2 Roosting Habitat

All buildings within 200 m of the turbine location were found to have negligible potential to support roosting bats.

There are no trees with high potential to support roosting bats within 200 m of the proposed turbine location. One tree, a mature dead oak located approximately 75 m north of the turbine, has a low potential to support summer roosting bats. However, no evidence of roosting bats were noted within this tree.

Two common pipistrelle roosts (one possible maternity roost and one maternity roost) are located in buildings approximately 350 m and 415 m south of the proposed turbine location. Following IEEM (2010) these roosts both have a county value (see Table 8).

6.3 Foraging and Commuting Habitat

Many bats prefer to commute along linear structures such as hedgerows or edge features, such as woodland edge, rather than across open spaces. There are two hedgerows in close proximity to the proposed turbine location, approximately 70 m to the north and 70 m to the west.

From observations on site and the review of aerial photographs of the survey area the surrounding landscape (to the east of the Severn estuary) appears to be largely comprised of industrial units, residential properties and large, irregularly shaped pastures of improved/semi-improved grassland fields and arable fields with managed hedgerow boundaries. The hedgerows for the most part appear intact and linked to several small blocks of woodland to the north, north-east and south of the survey area providing commuting routes onto the survey area for bats.

The 2010 and 2011 surveys confirmed that the hedgerow to the west of the turbine is well used for commuting and foraging purposes. The surveys also confirmed that the hedgerow to the north is used for commuting and foraging but to a lesser extent. A flight path from the two confirmed roosts located over 350 m from the turbine location was identified (along the western hedgerow).

The 2010 and 2011 surveys also confirmed that common pipistrelle, soprano pipistrelle and noctules (and to a lesser extent Leisler's, serotine, barbastelle, brown long-eared and Myotis species) commute across the semi-improved grassland field at the proposed location of the turbine. At this location, slightly more common pipistrelle and noctule activity was recorded at height (on SM2-A, located 10 m above the ground). Furthermore, brown long-eared and barbastelle bats were only ever recorded at ground level (on SM2-B, located 1.5 m above the ground). This is in accordance with the typical flight patterns of these species.

Of these species recorded using the area around the wind turbine the following are at high risk of flying within the collision risk zone of the turbine blades (i.e. the rotor swept area): noctule and Leisler's bats. Common pipistrelles, soprano pipistrelles, barbastelles and serotines are at medium risk of flying within the collision risk zone of the wind turbine. Brown long-eared bats and all Myotis bat species are of low risk of flying within the collision risk zone of the wind turbine.