9 IMPACTS ON BATS

This section addresses the impacts the proposed Wind Farm may have on bats. ERM appointed Natural Scientific Services to undertake the required specialist study on bats for the proposed development, which is appended to this report as *Annex G*. Potential impacts likely to arise during the construction and the operational phases of the development are summarised in *Table 9.1*, below.

The potential for impacts on bats by the proposed wind energy facility is evaluated in terms of impacts related to the three main behavioural activities of bats namely:

- Roosting impacts:
  - roosting habitat destruction or disturbance
  - attraction of bats to towers for roosting and therefore fatalities , due to collision or barotrauma.
- Foraging impacts:
  - disturbance of foraging habitats; and
  - bat fatalities due to collision or barotrauma during foraging activity.
- Migration impacts:
  - Fatalities due to collision or barotrauma during long distance seasonal migrations

Potential impacts likely to arise during the construction and the operational phases of the development are summarised in ***Table 9.1***, below.

Table 9.1 Impact characteristics: Impacts on Bats

	Construction	**Operation**
Project aspect/ activity	(i) Disturbance associated with noise and movement. (ii) Loss of foraging and roosting habitat.	(i) Disturbance and/or displacement from foraging or roosting areas by movement and/or noise of rotating turbine blades. (ii) Mortality due to collisions with turbine blades (iii) Mortality from barotrauma.
Impact type	Direct	Direct
Receptors affected	(i) Bats on site, key species being crevice and roof dwelling species.	(ii) Bats on site, key species being crevice dwelling species (iii) Migratory bat species, key species being *Miniopterus natalensis* (Natal long-fingered bat), *Myotis tricolor* (Temminck's hairy bat) and *Rousettus aegyptiacus* (Egyptian rousette).

Two of the ten potential bat species likely to occur on site were acoustically recorded during three nights in total in September and December 2010.

There are three known migratory bat species in South Africa - (*Miniopterus natalensis* (Natal long-fingered bat), *Myotis tricolour* (Temminck's myotis) and *Rousettus aegyptiacus* (Egyptian rousette). These bats regularly undertake migratory flights between bushveld caves and highveld caves. There is a possibility that migratory species pass through the wider Roggeveld area during migration between roosts, although locations of roosting caves and migration routes in South Africa are poorly known and not well documented. Further, information on bat diversity, abundance, roost sites and migratory patterns at and near the study site is not available and requires monitoring to obtain a better understanding. Therefore, the impacts presented below are difficult to evaluate with any degree of confidence at this stage, and has had to be inferred from observations of available habitat and limited sampling effort. A conservative approach should be adopted until longer term pre-construction monitoring is complete.

9.1 HABITAT LOSS – DESTRUCTION, DISTURBANCE AND DISPLACEMENT DUE TO WIND TURBINES AND ASSOCIATED INFRASTRUCTURE

9.1.1 Impact Description and Assessment

Construction Phase Impacts

The construction phase of the development inevitably incurs some temporary damage or permanent destruction of habitat which may have both direct and indirect impacts on bats. The clearance of natural vegetation and rocks during the construction phase may alter the foraging or roosting habitat available to bat species, resulting in displacement of bats. The Roggeveld Wind Energy Facility is going to be a large facility with up to 250 turbines, 12m wide roads, up to 7 sub-stations, overhead power lines and office and storage infrastructure. Each turbine will involve disturbing a minimum area of 20x20m. The cumulative disturbance of all the infrastructure required, results in several hectares of surface disturbance.

Increased noise and dust generated from machinery and other construction activities may impact bat roosting or foraging behaviour. The construction phase is expected to take up to 24 months per 200 MW.

During construction of infrastructure, disturbance to bat foraging and roosting habitat is expected.

Box 9.1 Construction Impact: Habitat Loss – Destruction, Disturbance and Displacement

Nature: Damage to and loss of vegetation and rock during site clearance in the construction phase would result in a negative impact on bats through loss of roosting and foraging habitat.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is limited to **on-site**.
- **Duration**: The duration would be **medium-term** (disturbances due to noise and dust) to **long-term** (as bat habitat will be affected until the project stops operating (i.e. over 25 years)).
- **Intensity:** Access road construction and turbine installation will result in a **medium** intensity impact. During construction of other infrastructure, disturbance of foraging areas, destruction of rocks and roosting areas is likely to be of **medium** intensity.

Likelihood – There is a **definite** likelihood that small areas of foraging and roosting habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium** since the current study did produce some results but there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

Operational and Decommissioning Phase Impacts

The operation of the Wind Farm may result in the long term disturbance to and/or displacement of bats from foraging or roosting areas across the Roggeveld site due to blade movement and noise emitted from rotating turbine blades. There is a potential that Natal long-fingered bat , Temminck's myotis and Egyptian rousette migratory routes pass through the wider study area and the presence of the turbines could result in disturbance of their typical migratory patterns. Noise and vibration generated from maintenance activities and decommissioning in the vicinity of rocky outcrops may result in temporary disturbance of bat roosts as works are undertaken, as the proposed turbines are sited in close proximity to the presumed bat roosts.

Box 9.2 Operational Impact: Habitat Loss: Destruction, Disturbance and Displacement

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Nature: Noise and vibration generated by the turbines during operation would cause displacement and disturbance of bats on and near the site and result in a **negative direct** impact on bat habitat if roost sites are present.

Impact Magnitude – Medium

- **Extent**: The extent of the impact is limited to **on-site**.
- **Duration**: The duration would be **long-term** as bat habitat will be affected until the project stops operating (i.e. over 25 years).
- **Intensity:** Any factor that causes bats to desert their roosts (i.e noise and vibration) is likely to be of **medium** intensity. Disturbance of foraging areas is likely to be of **medium** intensity given the extent likely to be disturbed.

Likelihood – It is **likely** that small areas of habitat will be lost.

IMPACT SIGNIFICANCE (PRE-MITIGATION) – MODERATE (-VE)

Degree of Confidence: The degree of confidence is **medium** since the current study did produce some results but there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

9.1.2 Mitigation of Habitat Loss- Destruction, Disturbance and Displacement

Design Phase

The objective of mitigation is to minimize the impacts on bats and their habitat and to maximize rehabilitation of disturbed areas. Pre-construction passive monitoring is required to further establish the current baseline and inform appropriate mitigation measures. Specific measures that can be implemented at the design phase include:

- Keep road development to a minimum where possible, upgrade existing roads rather than developing new road infrastructure.
- All project infrastructure, i.e. turbines, substations and mast should be located away from any areas considered to be of bat conservation importance. The following areas/ receptors should be avoided:
    - Turbines assessed as being moderate to high risk turbines in terms of bat fatalities should be avoided pending result of pre-construction monitoring.
    - To minimise risk to bat populations, it is important to maintain a minimum of a 50 m buffer around any bat roosting habitat after pre-construction monitoring (tree lines, significant rock outcrops, houses etc.

Construction and Operational Phase

- Blasting activities to be kept to the absolute minimum.
- Caution should be taken to ensure construction footprints are kept to an absolute minimum, including storage of materials, stockpiling etc.

- Construction activities should be avoided as far as possible during early to mid summer (November to February) when it is peak bat breeding season and young bats may not be able to leave the roost.

9.1.3 *Residual Impacts*

The implementation of the construction and operational phase mitigation measures listed above would contribute towards ensuring that the post mitigation impact significance decreases to **minor** during both the construction and operation phases. The pre- and post-mitigation impacts are compared in ***Table 9.2***.

Table 9.2 Pre- and Post- Mitigation Significance: Habitat loss - Destruction, Disturbance and Displacement

Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	MODERATE (-VE)	MINOR (-VE)
Operation	MODERATE (-VE)	MINOR (-VE)

9.2 COLLISIONS WITH TURBINES

9.2.1 *Impact Description and Assessment*

Operational Phase Impact

The growing concern over the potential impacts of wind farms on bat species in recent years is particularly in relation to the risk of collision with rotors or turbine towers, and barotrauma caused by rapid air-pressure reduction near moving turbine-blades (Cryan and Barcley, 2009). These impacts occur during the operational phase. The impacts associated with barotrauma are discussed below in *Section 9.3.2*.

Various hypotheses have been proposed for why bats may actually be attracted to wind turbines. A widely accepted explanation is that insects may concentrate around wind turbines, attracted by the heat radiation emitted or the colour of the paint on the turbines (Long, 2010) and in turn, bats may be attracted to these concentrations of insects (Ahlén *et al.* 2007). Given this theory, insectivorous species such as those belonging to the Molossidae Vespertilionidae, Rhinolophidae, Miniopteridae and Nycteridae families are more likely to be impacted from the turbines.

The proposed wind turbines, once operational, may impact on bat populations in the area by contributing to bat mortality through direct collisions with the turbine blades. The highest collision rates involving bats have been found in wind farms near forests but bat collisions have also been reported from turbines in open areas and even at offshore wind farms (Ecosystems Ltd, 2010). In North America, it is mostly tree-roosting migratory bats that are affected, with fatality numbers influenced by the height of towers (taller towers resulting in more fatalities), the level of bat activity at the site and the proximity of turbines to active bat hibernacula.

In South Africa, it is suspected that the bats most susceptible to collisions with wind turbines are likely to be the open foragers, such as those belonging to the families Molosidae and Vespertilionidae and the migratory cave-dwelling species, for example, Natal long-fingered Bat (*Miniopterus natalensis),* Temminck's myotis (*Myotis tricolour*) and Egyptian rousette *(Rousettus aegyptiacus*). Although undetected on site during the brief field survey, the presence of these species in the vicinity of the site is a possibility. Higher collision rates with non-migratory species are expected during periods of greater bat activity such as mating.

Box 9.3 ***Operational Impact: Collisions of bats with wind turbines***

Nature: Rotation of the turbine blades during operation could result in mortality of bats through collision, with a **negative direct** impact on the bats at the Wind Farm site.

Impact Magnitude – High

- **Extent:** The extent of the impact is **on-site**, but would likely affect bats occurring outside the development footprint.
- **Duration:** The duration would be **long-term** as the ecology of the area would be affected for the life of the wind farm.
- **Intensity:** High numbers of bats may be killed in collision incidents with a resulting intensity of **high**.

Likelihood – Based on available literature**, it** is **likely** that bats will collide with turbines.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –MAJOR (-VE)

Degree of Confidence: The degree of confidence is **low** since there is a need for research on bat populations in the study area and bat migratory patterns in the central Cape region of South Africa.

9.2.2 Mitigation for Collision Risks

Collision mitigation measures are aimed at reducing the risks of bats colliding with turbines by erecting wind turbines in places of little or no bat activity. Possible mitigation measures after pre-construction monitoring and based on input from the specialist, may include:

- Locating turbines away from High Bat Risk areas subject to pre-construction monitoring.
- Implementing pre- and post-construction monitoring (see *Section 9.6*) to provide additional detailed baseline data to help define clearer mitigation measures, and to monitor the impacts on bats once the facility is operational.
- Increasing the cut-in speed per turbine location and where applicable of the rotors or curtailment is one of the only mitigation measures successful in significantly reducing bat mortalities. Curtailment is where a turbine is kept stationary at a very low wind speed and then allowed to rotate once

the wind exceeds a specific speed. The theory behind curtailment is that there is a negative correlation between bat activity and wind speed, causing bat activity to decrease as the wind speed increases. Refer to Section 6.7 for more detail on curtailment.

- Installing ultrasonic deterrent devices on selected functional turbines to minimise risk of collision, and monitoring the results. Refer to Section 6.7 for more detail on audio deterrents. However, a leading bat expert, Dr Robert Barclay (Bat specialist for the US, involved in several bat and wind farm research programs) on 22 September 2011 in Cape Town questions the technical and economic feasibility of the devices as eight devces would be required per installed turbines to cover all direction sufficiently. it is therefore recommended that this mitigation measure be subject to progress in technology and economic feasibility.

9.2.3 *Residual Impacts*

If the mitigation measures recommended in Section 9.3.2 are adhered to, this results in the reduction to moderate impact significance during the operational phase. The pre- and post-mitigation impacts are compared in Table9.3.

9.3 *BAROTRAUMA*

9.3.1 *Impact Description and Assessment*

Operational Phase Impact

Barotrauma involves tissue damage to air-containing structures caused by rapid or excessive pressure change. Bats can suffer from pulmonary barotraumas, which is lung damage caused by expansion of air in the lungs that is not accommodated by exhalation, and this may result in mortality (Baerwald *et al*, 2008). As air moves over a turning turbine blade, an area of low pressure is created and bats flying or foraging in the vicinity of this sudden change in pressure can suffer barotrauma (Baerwald *et al*, 2009). As with the collision risks discussed above, barotrauma may impact migratory bats, bats moving through the area, or resident bats foraging in the vicinity of the wind turbine towers. Any species of bat foraging or migrating over the Roggeveld ridges may come into close proximity of the turbines and may suffer barotrauma. Migratory species susceptible to barotrauma include Natal long-fingered bat, Temminck's myotis and Egyptian rousette.

Box 9.4 *Operational Impact: Barotrauma*

Nature: Pressure differences caused by turning of turbine blades can cause death of bats through barotrauma, resulting in a **negative direct** impact on the bats found within the Roggeveld site

Impact Magnitude – High

- **Extent:** The extent of the impact is **on site**, but may affect bats beyond the development footprint.
- **Duration:** The duration would be **long-term** as the bat populations of the area would be affected for the life of the wind farm.
- **Intensity:** Barotrauma may result in an unknown number of bat fatalities and is assigned an intensity of **high**.

Likelihood – There is a **likely** likelihood that this impact will occur.

IMPACT SIGNIFICANCE (PRE-MITIGATION) –MAJOR (-VE)

Degree of Confidence: The degree of confidence is **low** since little is known about bat populations, migratory patterns and mating behaviour of bats in the study area.

9.3.2 Mitigation for Barotrauma

The mitigation measures described for mitigating impacts of collision (*Section 9.2.2* above) are also aimed at reducing the risk of bats suffering from barotraumas, and are therefore relevant here.

9.3.3 Residual Impacts

If the mitigation measures recommended in Section 9.3.2 are adhered to, this results in the reduction to a **moderate** impact significance during the operational phase. The pre- and post-mitigation impacts are compared in ***Table9.3***.

Table 9.3 *Pre- and Post- Mitigation Significance: operational*

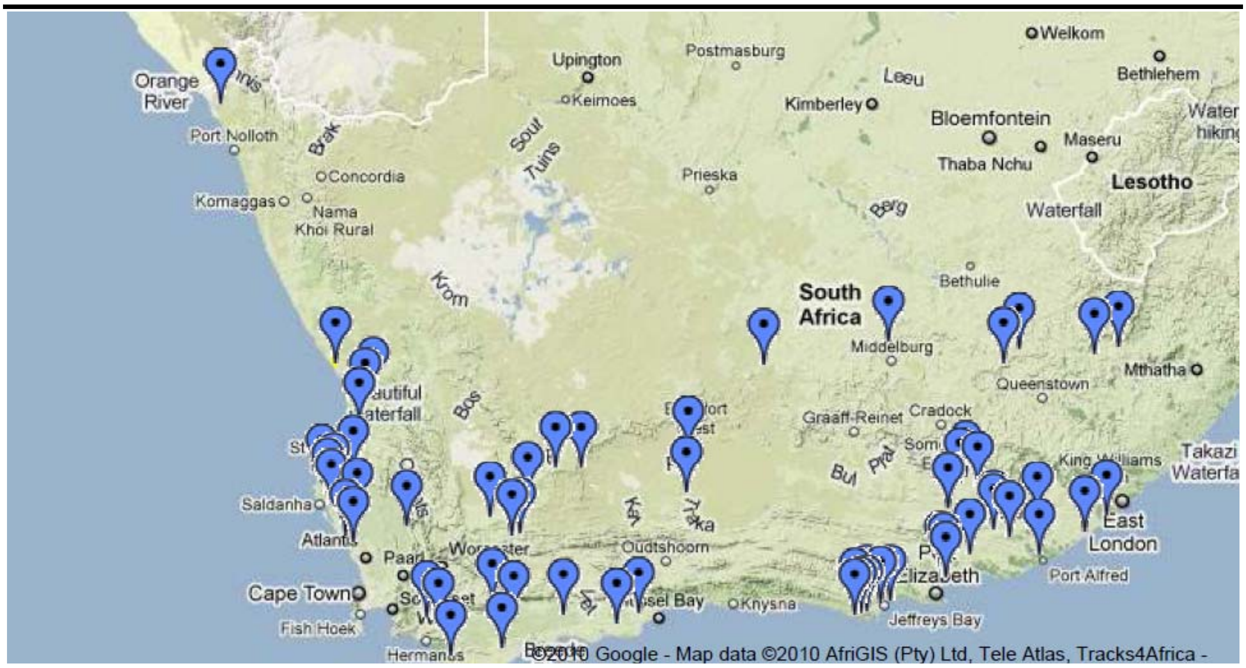
Phase	Significance (Pre-mitigation)	Residual Impact Significance
Construction	N/A	N/A
Operation	MAJOR (-VE)	MODERATE (-VE)

9.4 CUMULATIVE IMPACTS

SAWEA is the leading trade and professional body representing the wind industry in South Africa. As the voice of South Africa's wind industry, SAWEA's primary purpose is to promote the sustainable use of wind energy in South Africa, acting as a central point of contact for information for its members, and as a group promoting wind energy to government, industry, the media and the public.

Although this map is due to be updated, they had compiled a map (SAWEA, 2010) of all the applications received for wind energy farms in the country to that date (***Figure 9.1***). As can be seen, there were already over 50 proposed facilities. This is significant and definitely changes the picture in terms of impacts on bats, increasing the risks for fatalities exponentially. It also increases the risks for clashes with bat migration routes.

Figure 9.1 Proposed Wind Facilities Map for South Africa



Source: SAWEA (2010)

9.5 *ADDITIONAL MITIGATION MEASURES*

In addition to the mitigation measures discussed in Section 9.3 and 9.4 above, some mitigation recommendations are expanded on below and new ideas are explored pending result of pre-construction monitoring.

9.5.1 *Turbine Locations and Dimensions*

Site layout and turbine design can assist in reducing the impacts on bats.

The Site Reconnaissance visit and Pre-construction Monitoring will identify if there are species or areas of Conservation Importance and recommend appropriate mitigation measures. An obvious measure would be to avoid areas of sensitivity (eg bat roost sites) and apply appropriate buffer zones to these areas.

The characteristics of wind energy facilities (e.g., rotor swept area, height, support structure, lighting, number of turbines, etc.) influence bird and bat fatalities (Strickland *et al.*, 2011). A key question is whether smaller or fewer bigger turbines cause less impacts on bats. NSS's desktop review has revealed that there is evidence to suggest that larger turbines cause higher mortalities in bats; however, site specific location of turbines in terms of sensitive habitats cannot be overlooked. The following literature refers:

- In terms of turbine design, Rydell *et al* (2010) discusses how increased rotor diameter increases bat fatalities. The mortality increased with turbine tower height and rotor diameter but was independent of the distance from the ground to the lowest rotor point.
- According to NWCC (2010), early turbines were mounted on towers 18-25 metres in height and had rotors 15-18 meters in diameter that turned 60–80 revolutions per minute (rpm). Today's land-based wind turbines are mounted on towers 60-80 meters in height with rotors 45-80 meters in diameter, resulting in blade tips that can reach over 425 feet above ground level. Rotor swept areas now exceed 1 acre and are expected to reach nearly 1.5 acres within the next several years. Even though the speed of rotor revolution has significantly decreased to 11–28 rpm, blade tip speeds have remained about the same; under normal operating conditions, blade tip speeds range from 138–182 mph. Wider and longer blades produce greater vortices and turbulence in their wake as they rotate, posing a potential problem for bats in terms of barotrauma.

The long term pre-construction monitoring must advise of the spacing of the turbines in relation to bat activity patterns. However, the current brief study recommends that the Areas of Bat Conservation Importance and associated buffer areas be avoided for turbine placement. There is information available regarding bat activity patterns in relation to habitat features. The evidence in Britain is that most bat activity is in close proximity to habitat features. Activity was shown to decline when measured at fixed intervals up to 50 m away from tree lines.

To minimise risk to bat populations, it is important to maintain a minimum of a 50 m buffer around any bat roosting habitat (trees, rock outcrops, houses etc.). Should any caves be discovered, a minimum of a 3km buffer is recommended based on the foraging distance findings by Jacobs and Barclay (2009).

9.5.2 *Curtailment*

The theory behind this mitigation measure is that there is a negative correlation between bat activity and wind speed, causing bat activity to decrease as the wind speed increases.

Curtailment of operations during high risk periods may substantially reduce bat fatalities. Scientists have hypothesized that bat fatalities could be lowered substantially by reducing the amount of turbine operating hours during low wind periods when bats are most active. This can be done by increasing the minimum wind speed, known as the "cut-in" speed, at which the turbine's blades begin rotating to produce electricity. Arnett *et al.* (2010) employed three treatments at each turbine with four replicates on each night of the experiment: a) fully operational, b) cut-in speed at 5.0 m/s (C5 and c) cut-in speed at 6.5 m/s, demonstrated nightly reductions in bat fatality ranging from 53–87% with marginal annual power loss.

A test done by Baerwald *et al*. (2008b) where they altered the wind speed trigger of 15 turbines from 4 m/s to 5.5 m/s at a site with high bat fatalities in south-western Alberta, Canada, during the peak fatality period, showed a reduction of bat fatalities by 60%. Under normal circumstances the turbine would turn slowly in low wind speeds but only starts generating electricity when the wind speed reaches 4 m/s. During the experiment the Vestas V80 type turbines were kept stationary during low wind speeds and only allowed to start turning and generate electricity at a cut-in speed of 5.5 m/s. Another strategy used in the same experiment involved altering blade angles to reduce rotor speed, meaning the blades were near motionless in low wind speeds which resulted in a significant 57.5% reduction in bat fatalities.

Long term field experiments and studies done by Arnett *et al*. (2011) in Pennsylvania, USA showed a 44 – 93% reduction in bat fatalities with marginal annual power generation loss (≤ 1% per annum), when increasing cut-in speeds to 5 and 6.5 m/s respectively. Their studies concluded that curtailment can be used as an effective mitigation measure to reduce bat fatalities at wind energy facilities.

It is strongly recommended that the curtailment mitigation measure be considered if pre-construction bat monitoring indicates that it may be warranted. A cut-in speed of 6.5 m/ sec is recommended. However, all mitigation measures will be refined during the EIA Phase.

9.5.3 Ultrasonic and Radar Deterrent Devices

An ultrasonic deterrent device is a device emitting ultrasonic sound in a broad range that is not audible to humans. The concept behind such devices is to repel bats from wind turbines by creating a disorientating or irritating airspace around the turbine. Research in the field of ultrasonic deterrent devices is progressing and yielding some promising results, although controversy about the effectiveness and a lack of large scale experimental evidence exists.

Nevertheless, a study done by Szewczak and Arnett (2008), which compared bat activity using an acoustic deterrent with bat activity without the deterrent, showed that when ultrasound was broadcasted only 2.5-10.4% of the control activity rate was observed. A lab test done by Spanjer (2006) yielded promising results, and a field test of such devices done by Horn *et al*. (2008) indicated that many factors are influencing the effectiveness of the device although it did deter bats significantly from turbines.

Nicholls and Racey (2009) found that bat activity and foraging effort per unit time were significantly reduced during experimental trials when a radar antenna was fixed to produce a unidirectional signal therefore maximising exposure of foraging bats to the radar beam.

It is recommended that further research in this area be conducted in the South African context for potential application at Wind Farms throughout the country. If collaboration with local academic and research institutions is established to monitor and improve such devices during the functional stage of the wind farm, they can potentially lessen the impacts of the wind farm on bat populations significantly.

9.5.4 *Long-term Pre- and Post-construction Monitoring*

South Africa, through an initiative facilitated by the Endangered Wildlife Trust (EWT) has adopted best practise guidelines similar to existing international ones - South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments (Sowler & Stoffberg, 2011). These guidelines seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind farms, in order to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities determining applications for wind farm developments. It outlines basic standards of good practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats. The guidelines recommend that in order to assess the impacts correctly, the following information is required:

- Assemblage of species using the site;
- Relative frequency of use by different species throughout the year;
- Location and time of activity, which must include turbine locations where known;
- Locations of roosts within and close to the site;
- Details on how the surveys have been designed to determine presence of rarer species;
- Type of use of the site by bats - at and away from turbine locations, for example foraging, commuting, migrating, roosting etc.

9.5.5 *Research Collaboration Efforts*

By ensuring that bat species and population information gathered on specific sites, is shared amongst bat researchers, this knowledge base can be collaborated for future risk predictions on new applications.