juwi Renewable Energy (LTD) Pty
Garob Wind Farm Project

Northern Cape Province

Bat Impact Assessment

August 2012

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SPECIALIST DECLARATION

Professional registration

The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNASP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith."

"Only a registered person may practice in a consulting capacity" – Natural Scientific Professions Act of 2003 (20(1)-pg 14)

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Declaration of Independence

The specialist investigator declares that:

- We act as independent specialists for this project.
- We consider ourselves bound by the rules and ethics of the South African Council for Natural Scientific Professions.
- We do not have any personal or financial interest in the project except for financial compensation for specialist investigations completed in a professional capacity as specified by the Environmental Impact Assessment Regulations, 2006.
- We will not be affected by the outcome of the environmental process, of which this report forms part of.
- We do not have any influence over the decisions made by the governing authorities.
- We do not object to or endorse the proposed developments, but aim to present facts and our best scientific and professional opinion with regard to the impacts of the development.
- We undertake to disclose to the relevant authorities any information that has or may have the potential to influence its decision or the objectivity of any report, plan, or document required in terms of the Environmental Impact Assessment Regulations, 2006.

Terms and Liabilities

- This report is based on a short term investigation using the available information and data related to the site to be affected. No long term investigation or monitoring was conducted.
- The Precautionary Principle has been applied throughout this investigation.

- Additional information may become known or available during a later stage of the process for which no allowance could have been made at the time of this report.
- The specialist investigator reserves the right to amend this report, recommendations and conclusions at any stage should additional information become available.
- Information, recommendations and conclusions in this report cannot be applied to any other area without proper investigation.
- This report, in its entirety or any portion thereof, may not be altered in any manner or form or for any purpose without the specific and written consent of the specialist investigator as specified above.
- Acceptance of this report, in any physical or digital form, serves to confirm acknowledgment of these terms and liabilities.

Signed on the 20 July 2012 by Luke Strugnell in his capacity as specialist investigator

EXECUTIVE SUMMARY

Savannah Environmental (PTY) Ltd has been appointed by juwi Renewable Energies (PTY) Ltd to undertake the Environmental Impact Assessment (EIA) and associated studies for the proposed Garob Wind Farm Project. In turn The Endangered Wildlife Trust has been appointed to conduct the bat specialist study for the project.

The proposed wind energy facility will be situated on the Farm 103, portion 5 (Nelspoortjie farm), an area of approximately 5520 hectares in size. The farm lies directly north of the R357 provincial road (which runs approximately in an east to west direction). The closed Copperton copper mine and the town of Copperton lie 7.5km from the western boundary of the farm.

The proposed wind energy facility will consist of up to 58 wind turbines appropriately spaced over the site. Turbines of between 2MW and 3MW are being considered for the facility. Each turbine is estimated to have a hub height of up to 120m and a rotor diameter of up to 120m. Concrete foundations will support the turbines. Associated infrastructure for the proposed facility will include cabling between the turbines (underground where practical), an on-site substation to facilitate the connection between the facility and the grid, an 132kV overhead power line to connect to the nearby Cuprum Substation, internal access roads to each turbine (approximately 6m in diameter) linking turbines and other infrastructure on the site and a workshop area.

This report assesses the impacts this project will have on bats during construction, maintenance and operation of the wind energy facility. A site visit was undertaken between the 13th and 15th August 2012.

One Vulnerable (*Cleotis percivali)*, three Near-threatened (*Cistugo seabrae*, *Eidolon helvum, Miniopterus* and *natalensis)* seven Least Concern (*Eptesicus hottentotus*, *Myotis tricolor*, *Neoromicia capensis*, *Nycteris thebaica*, *Rhinolophus clivosus*, *Rhinolophus darlingi* and *Tadarida aegyptiaca)* and one Data Deficient (*Rhinolophus denti*) species potentially occur in the area of the study site. Four species were confirmed to occur at the study site using call identification techniques (*Neoromicia capensis, Eptesicus hottentotus, Miniopterus natalensis* and *Tadarida aegyptica*). Only *M. natalensis* is Near Threatened, the rest are considered Least Concern.

Any species that occurs in the area of the proposed wind energy facility is vulnerable to the potentially fatal impacts of wind turbines. Since only one of the species identified as potentially occurring in the area of the study site is listed as Vulnerable (*Cleotis percivali)* and only one of the recorded bats is listed at Near Threatened (*M.natalensis*) and the fact that no potential roost sites were identified on the site the overall impact of the development should be low to moderate. The uniformity of the habitat around the site also suggests that, although localized habitat destruction

and disturbance would impact on bats, the habitat is not unique or important for bats and as such the surrounding habitats would be equally available to bats to utilize.

The proposed mitigation measures and recommendations described in Section 6 should be implemented and their practicality and effectiveness researched with high priority at all turbines on this site. None of the proposed Turbines are located in area of High Bat Sensitivity and although Turbines1, 6, 9, 16, 18, 21, 28, 30, 32, 40, 41, 45, 46, 53 and 58 are located in the areas of Moderate Bat Sensitivity due to the uniformity of the habitat it is unlikely that their locations will have a signifinant impact on bat species in the area. They must, however, at least be prioritized in post-construction monitoring and implementation of mitigation measures. Gaps of at least 250m should be left between turbines. In addition, informed curtailment programmes should be adopted. Post construction monitoring of bat fatalities during the operational phase is recommended for at least four seasons at the proposed wind energy facility. Every effort should be made to mitigate the impacts on bats during this project through a construction EMP as well as by following the recommendations in this report.

With regards to this development, the following points must be stressed:

- a monitoring program is seen as critical in extending our knowledge of wind energy and bat interactions.; it is recommended that a monitoring program be planned to collect data on a host of environmental factors; his should be initiated as soon as possible to ensure robustness of data; and
- it is recommended that static monitors be placed on the meteorological mast as soon as possible so that pre-construction monitoring data can be gathered to better inform the construction and operational phases.

Table of Contents

List of Tables

List of Figures

1. INTRODUCTION & BACKGROUND

Savannah Environmental (PTY) Ltd has been appointed by juwi Renewable Energies (PTY) Ltd to undertake the Environmental Impact Assessment (EIA) and associated studies for the proposed Garob Wind Farm Project. In turn The Endangered Wildlife Trust has been appointed to conduct the bat specialist study for the project.

The proposed wind energy facility will be situated on the Farm 103, portion 5 (Nelspoortjie farm), an area of approximately 5520 hectares in size. The majority of the farm is characterized by open karoo scrub plains except in the southern portions where undulating plains and hills are found. The farm lies directly north of the R357 provincial road (which runs approximately in an east to west direction). The closed Copperton copper mine and the town of Copperton lie 7.5km from the western boundary of the farm (Figure 1). The Burchell-Cuprum 132kV distribution power line traverses the northern portion of the site.

After the proposed site was tested through a Site Screening Assessment for Wind Development was completed in September 2011 it was decided that no site alternatives would be identified for the proposed wind energy facility developments.

The proposed wind energy facility will consist of up to 58 wind turbines appropriately spaced over the site (Figure 2). Turbines of between 2MW and 3MW are being considered for the facility. Each turbine is estimated to have a hub height of up to 120m and a rotor diameter of up to 120m. Concrete foundations will support the turbines. Associated infrastructure for the proposed facility will include cabling between the turbines (underground where practical), an on-site substation to facilitate the connection between the facility and the grid, a 132kV overhead power line to connect to the nearby Cuprum Substation, internal access roads to each turbine (approximately 6m in diameter) linking turbines and other infrastructure on the site and a workshop area.

The newly completed "South African Good Practice Guidelines for Surveying Bats in Wind Farm Developments", produced by the Wildlife Energy Programme (WEP) of the Endangered Wildlife Trust (EWT), in conjunction with independent eco-consultant and trainer Sandie Sowler and Stellenbosch University postdoctoral fellow Samantha Stoffberg, and endorsed by the South African Wind Energy Association, highlights the need to assess the impact of wind farms on ecology, and the importance of bats in the South African context of the ecosystem services they provide (Sowler and Stoffberg 2012). These guidelines seek to provide consultants with guidance on assessing the need, preparing, planning and implementing bat monitoring in respect of wind farm development and to standardize the way these data are collected and provide guidance when it comes to interoperating the results. It presents basic standards of good practice and highlights specific considerations relating to the pre-construction monitoring of proposed wind farm sites for bats.

This report follows the good practice guidelines and assesses the impacts this project will have on bats during construction, maintenance and operation of the wind energy facility. A site visit was undertaken between the 13th and 15th August 2012.

1.1 Terms of reference

The terms of reference used for this project are to:

- Assess and present the current project area for bat habitat
- Conduct roost surveys
- Conduct transect surveys using a suitable bat detector to assess bat activity and identify species on site
- Rate the impact of the project against a specified set of criteria, supplied by Savannah Environmental, and provide mitigation measures to reduce any identified impacts

1.2 Description of the Project

The following aspects make up the proposed wind energy facility:

- 58 wind turbines of between 2 – 3MW in capacity (hub height of up to 120m, rotor diameter of up to 120m)
- Concrete foundations to support each turbine
- Cabling between the turbines, to be laid underground where practical, which will connect to an on-site substation
- An on-site substation to facilitate the connection between the wind energy facility and the electricity grid
- A 132kV overhead power line to connect to the Cuprum Substation
- Internal access roads to each turbine (approximately 6m in width) linking wind turbines and other infrastructure on the site (existing roads will be used as much as possible)
- Workshop area/office for control, maintenance and storage.

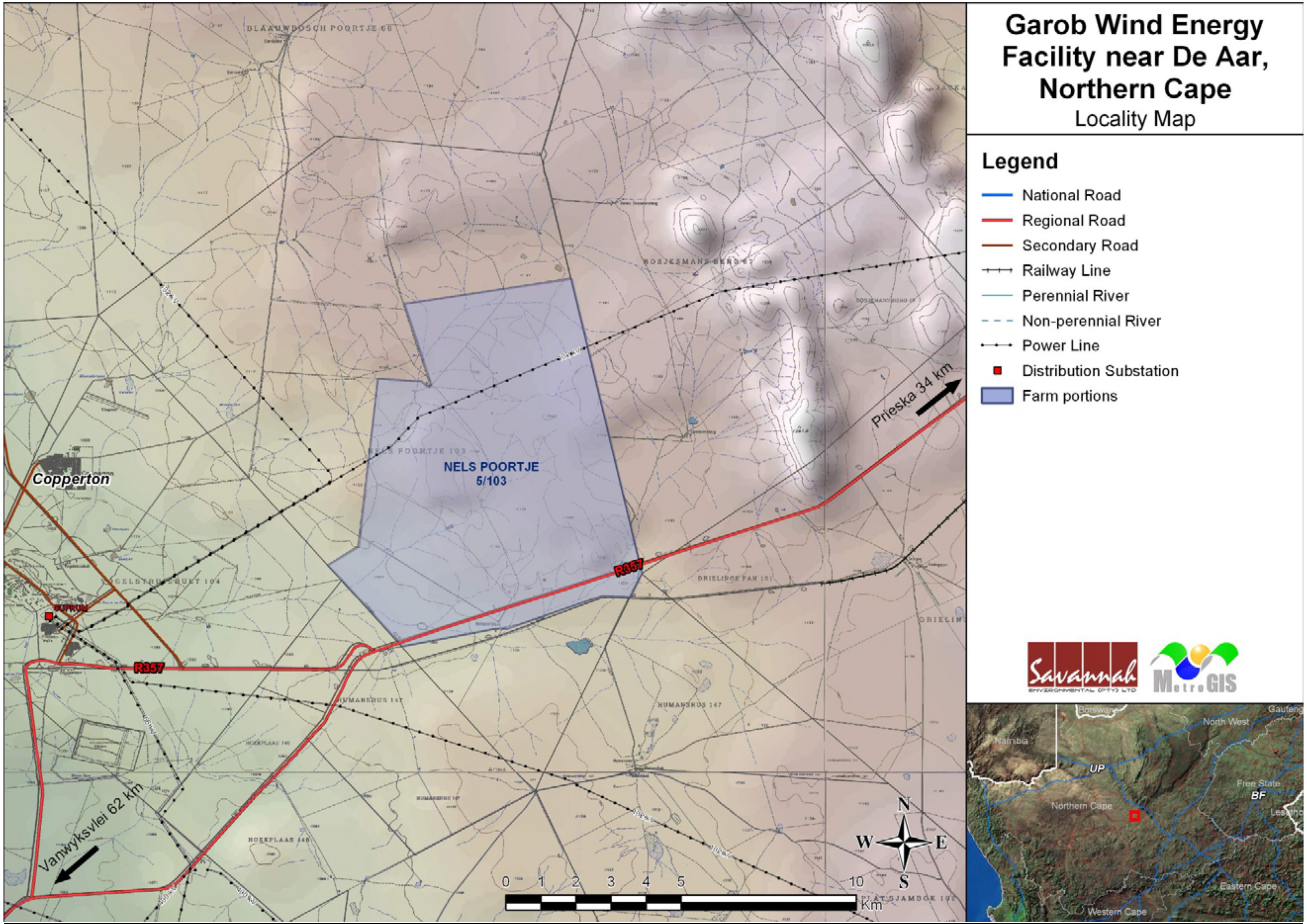


Figure 1 - Location of the proposed Garob Wind Farm Project (map provided by Savannah).

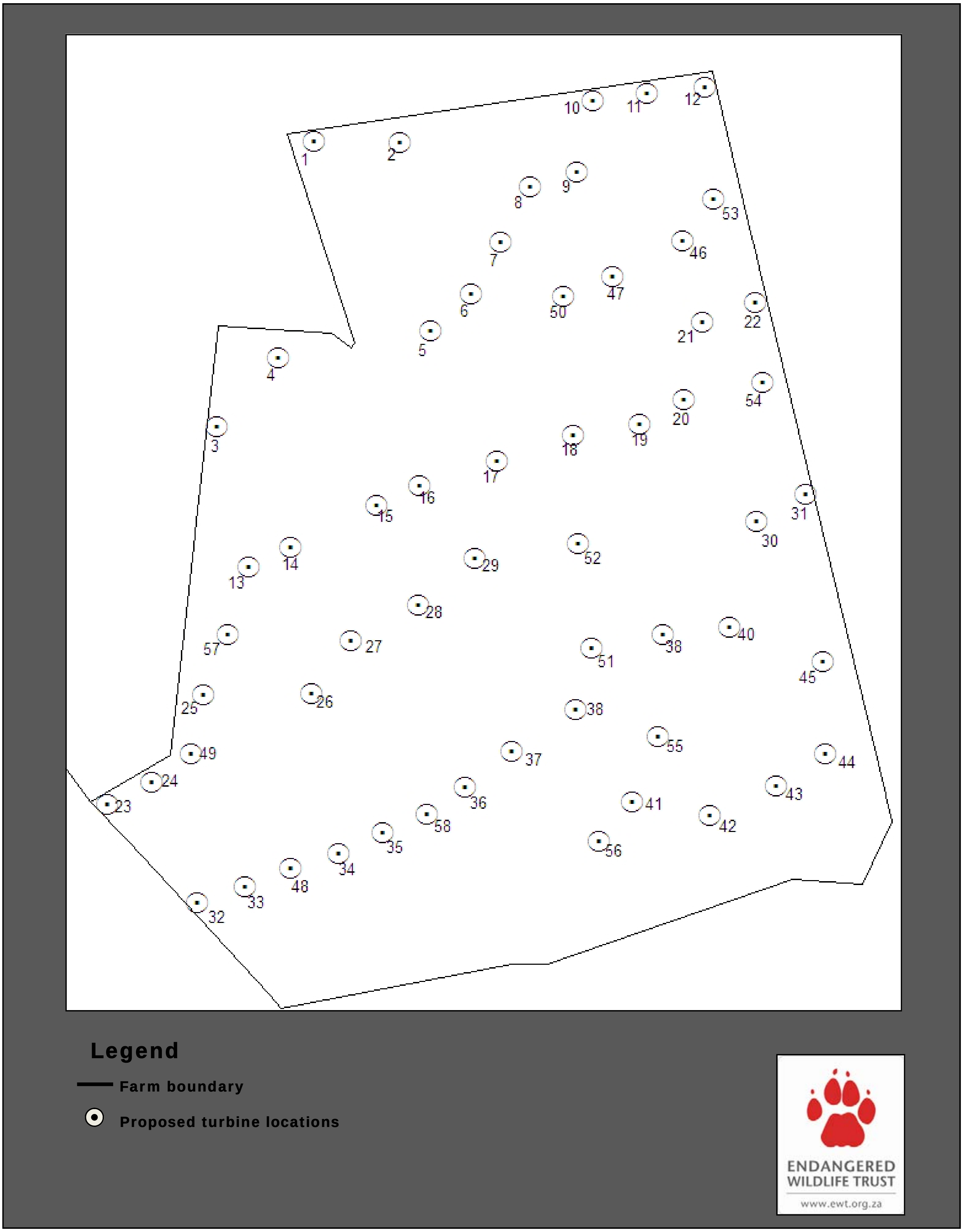


Figure 2. Location of the wind turbines within the proposed Garob Wind Farm Project.

2. BACKGROUND TO CHIROPTERA

2.1. General

Bats (Order Chiroptera) comprise one fifth of all mammalian species and are the second largest order of mammal (Simmons 2005). Bats are long-lived mammals and females often produce only one pup per year, resulting in a life-strategy characterized by slow reproduction (Barclay & Harder 2003). Because of this, bat populations are sensitive to changes in mortality rates and their populations tend to recover slowly from declines.

2.2. Role in ecosystems

Bats provide important ecosystem services (Kunz *et al.* 2011). They are major pollinators of fruiting trees, dispersers of seeds and controllers of insects, including agricultural pests. They have contributed substantially to medical research, to our understanding of radar and sonar, and their droppings are considered highly prized in some parts of the world as fertiliser. A single small North American Little Brown Bat (*Myotis lucifugus*) can consume up to 1,200 small insects in an hour; almost 5,000 mosquito-sized insects a night per bat (Taylor 2000). A small colony of bats can therefore consume over 200,000 insects in one night. In a study conducted in Sacramento USA, it was reported that the presence of sufficient numbers of bats reduced fruit crop damage to pears by the corn ear moth, by 55% (Long *et al*. 1998).

In South Africa, as in other parts of the world, the ecosystem services are equally important. Insectivorous bats provide essential pest control services to farmers and fruit-eating bats are agents of seed dispersal (thus aiding forest regeneration) and pollination services (important for baobab trees). The potential loss of these ecosystem services should be considered when assessing the environmental impact of developments. The possible loss of bat colonies could therefore potentially result in increased costs incurred by the need for pesticides and in reduced agricultural productivity.

Recent research suggests that the estimated value of bats to the United States agricultural industry is approximately US $22.9 billion/year and that the loss of bats in North America may lead to agricultural losses estimated at more than US $3.7 billion/year (Boyles *et al.* 2011).

2.3. Conservation and protection

In most countries in Western Europe over the past 20 years, support for the protection of bats and their roosts has increased and is enforced by stringent legislation. Bats and their roosts, even when not occupied, are fully protected by law and contravention may result in prosecution and consequent subjection to fines or even custodial sentences. This legislation has been put in place because of the decline in the European bat fauna, and the recognition that bats are a very important, even essential, part of our ecosystem. Bats are a group of mammals that we cannot afford to lose. In Europe, bats have been identified as indicators of the health of our environment and are now considered important indicators of biodiversity (Jones *et al.* 2009). The greater the number of bats in terms of individuals and diversity, the healthier our ecosystem is considered to be.

The conservation status of bats must be considered when looking at the potential impact of a development. There are 116 southern African bat species of which five are listed as Vulnerable, 17 as Near-threatened, 77 as Least Concern, 14 Data Deficient and 3 have not been evaluated (IUCN).

2.4. Behaviour and echolocation

Bats are divided into two groups, fruit-eating bats and insectivorous bats. The southern African fruit bats feed on the fruits, flowers, leaves and nectar of a wide range of indigenous trees as well as commercially grown fruit. The insectivorous bats (comprising the majority of southern African bat species) feed on a variety of insects, depending on the particular species' morphology and behavior. This group uses echolocation to hunt their prey and navigate. The design of the bat's wing, as well as structure of the echolocation call, determines the preferred prey of a particular species (Norberg and Reyner, 1987).

It is also necessary to understand bat roosting behavior, as it relates to the potential impacts a project of this nature may have. Bats roost in a variety of places during the day that can include: the foliage of trees, tree hollows or crevices, caves or rocky crevices and man-made structures, to name but a few (Monadjem *et al,* 2010). Safe roost sites are important to the continued survival of a group of bats as, without it reproductive success may be affected and the population may crash. Conservation of roost sites is, thus, important and must be searched for during any impact assessment.

Bats have the ability to emit sound pulses and analyse the returning echoes to detect, characterize and localize objects that reflect the pulse as an echo (Fenton 1990, Schnitzler and Kalko 2001). The frequencies used in echolocation are ultrasonic, i.e. above the range of human hearing. It must, however, be noted that not all bats echolocate and the fruit bats are an example of this. There are many different types of echolocation calls but what is useful is that the different groups and species have unique calls that can be used to identify them using specialized equipment that record and convert bat calls to audible (to humans) sounds. Since echolocation is unique to each bat species, recording of the ultrasonic pulses emitted by bats can be used to identify which bats are present in an area.

2.5. Bat migration in South Africa

Little work has been conducted in South Africa regarding the distribution and abundance of bats. Similarly the migratory habits and migration routes of South African bats are not clearly understood. Some evidence does however exist showing that some bat species do exhibit long-distance migration and seasonal movement within South Africa. *Miniopterus natalensis* (Natal Long-fingered Bat) is known to migrate up to 260km (Van der Merwe 1975) between their summer maternity caves and caves used for mating and hibernation during the winter months. *Myotis tricolor* (Temminck's Myotis) may undertake seasonal migrations similar to that of *M. natalensis* (Monadjem *et al*. 2010) although details of this are not known. One frugivorous bat species, *Rousettus aegyptiacus* (Egyptian rousette) is a gregarious cave-dweller, also thought to move distances of 50 to 500 km (Monadjem *et al*., 2010; Herselman & Norton, 1985).

2.6. Bats and wind energy

A clear understanding of the interaction between bats and wind turbines is vital before an accurate assessment of the impacts of the proposed wind energy facility on the bats of the area can be conducted. Unfortunately, since only two wind farms are currently operational in the country, the South African experience of wind energy generation has been somewhat limited (see the Darling Wind Farm in the Western Cape Province pictured in Figure 3). For this reason literature on the effects of wind farms on bats, methods for studying those effects and studies examining mitigation techniques hail primarily from the United States of America (USA), Canada and Europe where wind energy technology has been established and operational for much longer. Despite this, these observations, principles, hypotheses and studies can, to a certain extent, be applied to the South African situation. It must be noted that care should still be taken when adapting existing international experience and knowledge to local bat species and conditions. South African bat species may, for example, react to certain situations very differently to their foreign counterparts. This highlights the need for continued monitoring and research at all proposed wind farm sites in South Africa.

Concern for the impacts of wind energy facilities on bats has only been recognised as a concern in recent years. Most research has focused on bird mortalities but according to Baerwald *et al*. (2008), investigations revealed that at some wind energy facilities bat fatalities out-numbered those of birds by almost ten to one. As a result more research into what was causing their deaths, what was attracting them to the sites, which species were being affected and the environmental factors associated with the presence of bats (e.g. pressure, time of year, time of night, wind speed, wind direction and temperature) was initiated.

Figure 3: The Darling Wind Energy Facility in the Western Cape Province, South Africa

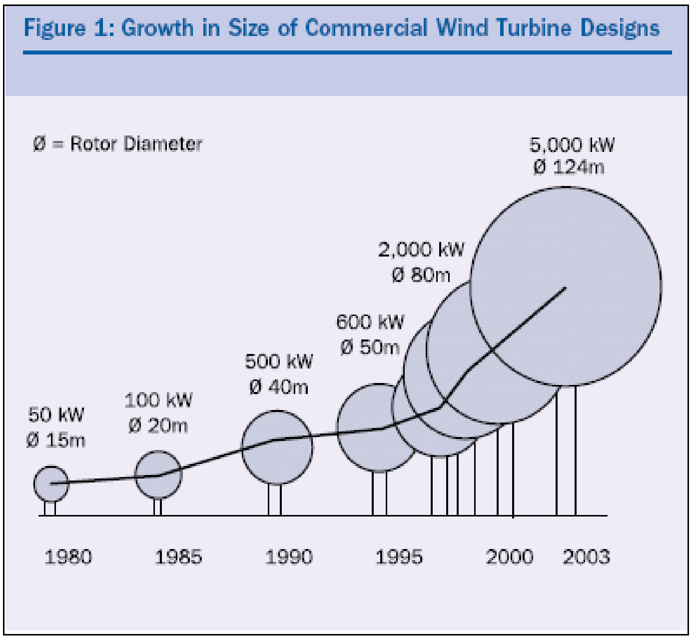
2.6.1. Factors influencing bat interactions with turbines

A number of factors influence the number of bats disturbed and/or killed at energy facilities. These can be classified into three broad groupings:

- facility related information – physical damage to the bat caused by actual collision with the turbines
- site related information – alterations to the bats' prey-base during and after construction, as well as changes in roost site availability
- bat related information – the barotrauma that operating turbines can cause to bats.

Facility related information

To date it has been shown that large turbines kill the same number of birds as smaller ones (Howell 1995; Erickson *et al.* 1999). It is not known whether this is true for bats. With newer technology and larger turbines, fewer turbines are needed for the same quantity of power generation, possibly resulting in fewer bat mortalities per KW of power produced (Erickson *et al.* 1999). Figure 4 shows the evolution of turbine size over time. More research is needed to investigate the effects of varying wind turbine styles on bat populations (Anon. 2009).



Source: European Wind Energy Association (EWEA)

Figure 4: The evolution of wind turbine size over time

Site related information

Landscape features can potentially channel or funnel bats towards a certain area. The majority of bats found in the province feed along the vegetation patch edges and not on ridge tops. Studies conducted in Indiana, USA, revealed that during summer months, bats foraged in riparian areas, bottomlands, old fields and pastures scattered with trees. Winter roosts, often used for hibernation, took bats closer to wind energy facilities as their movement patterns changed (Anon. undated). Bats are known to use topographical features such as ridges to navigate during their migrations. In addition, they may use these features as temporary roosts, foraging areas and shortcuts (Anon. undated).

Bat related information

The vast majority of wind energy facilities in North America have recorded bat deaths, some reporting thousands of deaths per year (Cryan undated). Baerwald *et al.* (2008) found that only approximately half of the dead bats found near the wind turbines in their study in Alberta, Canada showed any physical evidence of being hit by a blade. Of these 90% showed signs of internal haemorrhaging (Handwerk 2008) and damage to lung tissue. Wind turbines cause localized changes in air pressure. While bats are able to detect the relatively slow pressure changes caused by approaching storms, they are not able to detect the sudden drops in pressure caused by the turning blades of wind turbines. These sudden pressure changes cause the rapid expansion of the lungs and the bursting of the fine capillaries that surround them, leading to the death of the bat, a process known as 'barotrauma' (Handwerk 2008).

It is thought that migratory bat species are especially susceptible to negative interactions with wind farms as their annual movements may take them directly through wind energy facilities. The US National Research Council published the results of a study in May 2007 which revealed that two bat species accounted for 60% of the winged animals found dead at the studied wind energy facilities in the USA. These two species were both found to be migratory and tree roosting species (Brahic 2008). In addition, most of the deaths were recorded during the autumn migration and mating period (Cryan undated). One study even suggests that bats 'turn-off' their echolocation systems during these periods, when they aren't feeding, in order to conserve energy resources (Sagrillo 2003).

2.6.2. Potential explanations for bat mortalities at wind energy facilities

The primary hypotheses proposed for bat mortalities associated with wind energy facilities are as follows:

- **Direct collision** – a percentage of the dead bats found show signs of physical injury resulting from actual collision from the blades of wind turbines (Handwerk 2008).
- **Changes in flight patterns/Barrier effect for commuting or migrating bats** – caused by the use of topographical features to migrate, for mating behaviour and because of possibly 'turning-off' their echolocation systems (Cryan undated). Wind turbines may also form barriers to their annual migration and/or daily commutes (Cryan 2011).
- **Barotrauma** – the sudden drop in air pressure at wind farms causes a bat's lungs to rapidly expand resulting in the death of the bat (Handwerk 2008).
- **Loss of foraging habitat** – due to either wind energy facility construction or bats avoiding facilities altogether.
- **Emission of ultrasound by turbines** - probably limited

The potential impacts a development such as the Garob Wind Farm Project can have on bats therefore are mainly limited to disturbance and, depending on the importance of the specific habitat to bats, habitat destruction. As mentioned above, the large scale destruction of an important roost would have a significant impact on bats. Disturbance of bats during construction and maintenance activities could also have a detrimental effect. These two impacts will be assessed below.

3. METHODOLOGY

3.1. Desktop review

A desktop review of relevant literature and the likelihood of occurrence of specific species for the area was conducted. The assessment of likelihood of occurrence was directly informed by distribution maps and descriptions in Friedmann and Daly (2004) and Monadjem *et al.* (2010) and assigned as follows;

- if a species has been previously recorded in the area it was assigned a high likelihood of occurrence
- if the range of a species includes the area it was assigned moderate likelihood of occurrence
- if the study site is adjacent to an area where a species range extends, that species was assigned a low likelihood of occurrence
- If it is known that a species definitely does not occur within the study site it was not listed

3.2. Fieldwork

The methodology used for this study follows generally accepted principles for surveying bats and those stipulated in the good practice guidelines (Sowler and Stoffberg 2012). The field visit was used to visually assess the micro-habitats as well as to conduct surveys using a Wildlife Acoustics EM3 bat detector.

3.2.1. Driven transect surveys

Transects were driven to cover as much of the site as possible during the time available on site. As mentioned in Section 2.4 a bat detector is a handheld ultrasonic device that can be used to determine bat activity by effectively slowing their calls down sufficiently to make it audible to the human ear while still maintaining its' unique harmonics and characteristics.

An external omni-directional microphone with an extension cable was attached to a 1.5m long pole, mounted on the cab of the vehicle and connected to the EM3 bat detector. This allows one to keep the bat detector inside the vehicle, reduces noise and improves recordings. The bat detector has a GPS attached that logs co-ordinates of any recordings made. In this way every bat call recorded has an exact position corresponding to the call. This enables a map of the identified bat species, as well as the exact location it was recorded, to be created. Figure 5 shows the route of the driven transects. Driving speed was maintained consistently below 20 kilometres per hour at all times to avoid wind noise.

The EM3 calls were downloaded and analysed using Analook software after being converted to zero crossing files. Noise files were filtered out using Wildlife Acoustics' WAC to WAV converter.

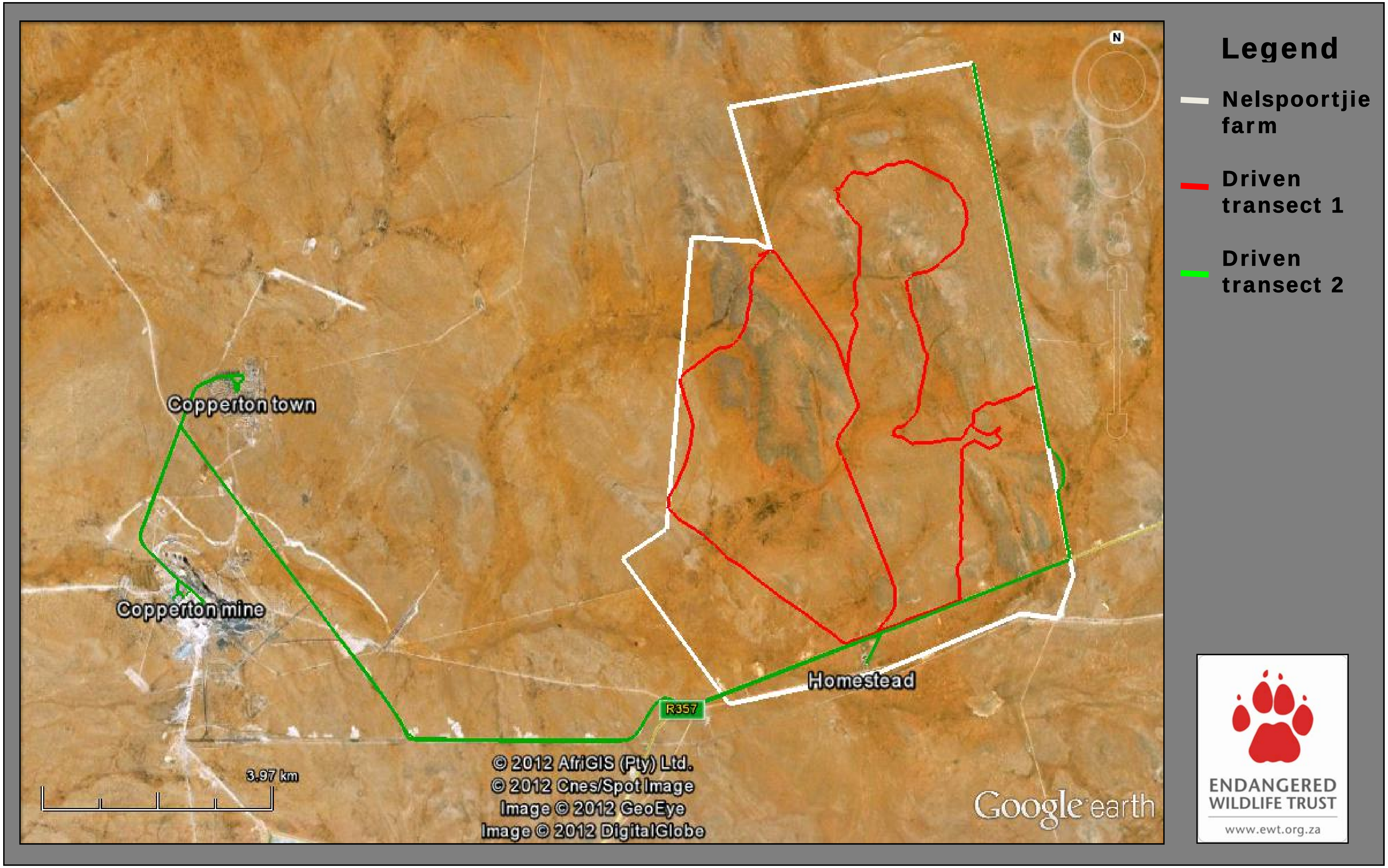


Figure 5 – Driven transects on the study site and in the surrounding relevant areas

3.2.2. Micro-habitat and roost inspection

Each site was examined for any evidence of bat roosts or attractive micro-habitats that might attract bats to a particular site both on foot and from a vehicle.

3.3. Limitations

The primary limitation to this EIA study was the timeframe in which the study had to be conducted. The impact of the development on bat populations may vary from one season to the next as bats migrate, breed or change foraging patterns. Twelve months of pre-construction monitoring is highly recommended to accurately address these issues prior to concluding the impact assessment study.

Bats emerge from their roosts and are only active during certain times of the night, meaning that only a limited period of the night is available to collect valuable data. A fully comprehensive study of the site simply cannot be conducted in only a few nights. This said, a short-term study is far better than no study at all and, as such, a thorough and comprehensive study was conducted in the time available.

In addition, although a state-of-the-art bat detector was used, the technology has not yet been commercially developed that can identify all bat species by their echolocation calls alone (a ‘bat in the hand’ would provide 100% confirmation of species occurrence but live trapping was not feasible for this study). The detection range of bat detectors is limited by the absorption of ultrasound in air. At mid-range frequencies, around 50kHz, the maximum range is only approximately 25 to 30 meters in average atmospheric conditions when bats are active. This decreases with increasing frequency. In addition the usage range of bat detectors decreases with increasing humidity and in misty conditions the maximum range can be severely reduced. Recordings are, thus, easily affected by weather conditions. Fortunately weather conditions on the nights of sampling were good. It is, however, likely that bat activity would increase in warmer months.

4. DESCRIPTION OF AFFECTED ENVIRONMENT

4.1. Land cover and vegetation of the study area

The area was assessed using CSIR's land cover data to determine what land cover is likely to be present at the site. Land cover is seen as more valuable to bat assessments than vegetation type as bats are mobile and the land cover data allows an assessment of the presence or absence of various land cover types that may attract bats. These are further discussed under micro habitats below but can be seen at a broader scale on the following map (Figure 6).

The vegetation of the area was also assessed and used to determine the presence or absence of suitable habitat for the bat species likely to occur in the area. Table 2 shows the preferred habitat of each species and this has been assessed using the vegetation map (Figure 7) to assist with determining the likelihood of occurrence.

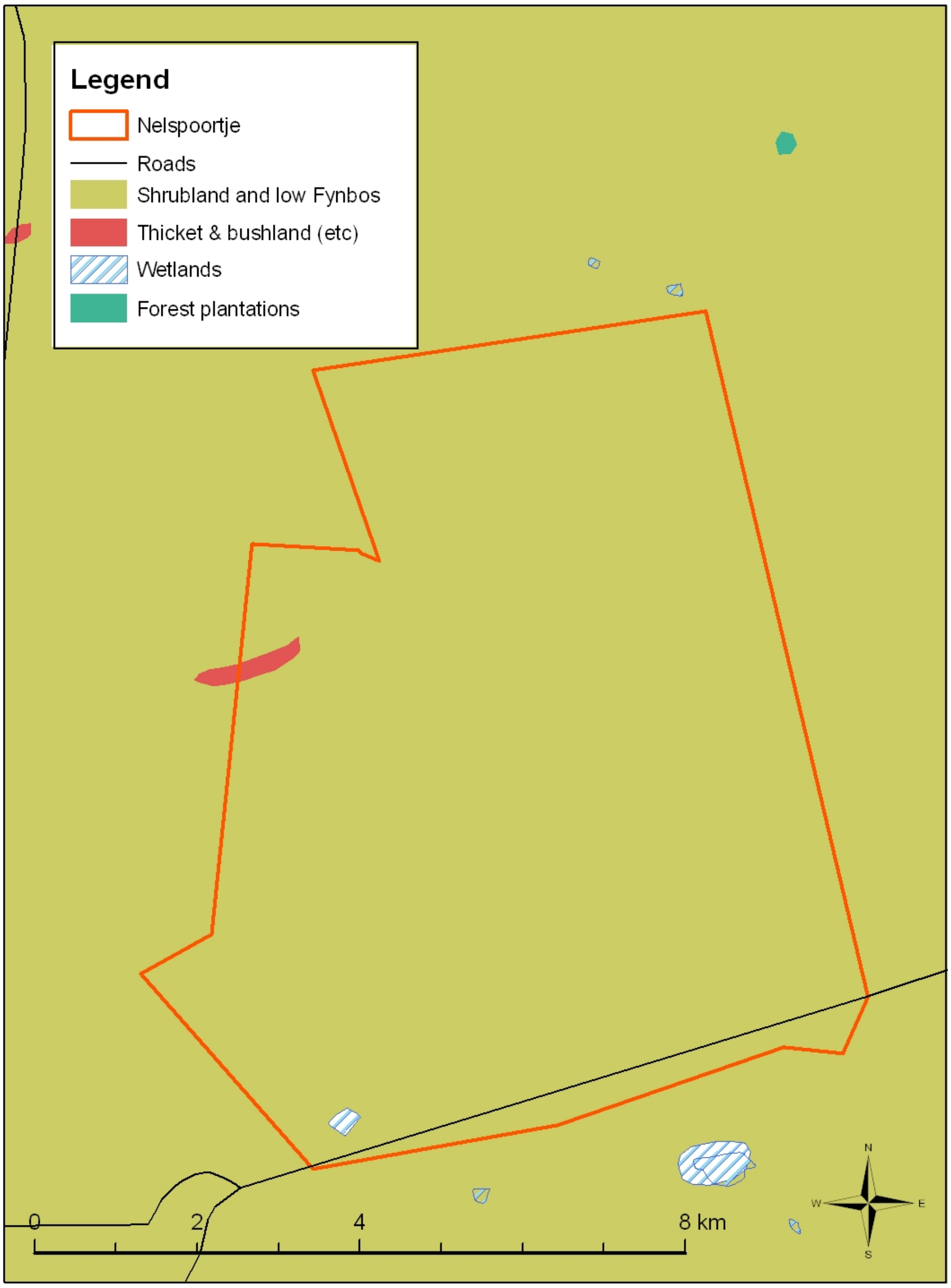


Figure 6 - Land cover data for the study area (CSIR)

Figure 7 - Vegetation classification (Mucina and Rutherford, 2006)

Figure 8 – Bosmanland Arid Grassland typical of the area

The study site is dominated by Bosmanland Arid Grassland vegetation (Figure 8) and falls into the Nama-Karoo biome. This vegetation type is considered to be Least Threatened, although it is not well conserved (currently only 0.4 % is protected). Bushmanland Arid Grassland occurs on extensive, relatively flat plains and is sparsely vegetated by tussock grasses, including *Stipagrostis ciliata*, *Aristida adscensionis*, *Aristida congesta*, *Enneapogon desvauxii*, *Eragrostis nindensis*, *Schmidtia kalahariensis* and *Stipagrostis obtuse*. There are no known endemics in this vegetation. In some years, after good rains an abundance of annual herbs in is observed in the area.

The study site has been used to graze sheep and goats as part of a successful livestock farm since the turn of the 20th century.

4.2. Potential micro-habitats

The vegetation description partially helps to describe the species likely to occur in the study area. Specific features within the landscape will further affect which species occur there. These specifics, or "micro" habitats, are formed by a combination of factors such as vegetation, land cover and man-made structures. Micro habitats will be critically important in siting the proposed turbines within the affected farms. The following micro habitats were identified during the site survey and Google Earth satellite images were used to assess areas inaccessible during the survey:

- **Wetlands:** Wetlands are characterized by slow flowing water and tall emergent vegetation. Insects such as midges and mosquitoes often breed at wetlands emerging in large numbers, creating a perfect feeding site for many bat species. There may be seasonal pans that hold water in the wet season on the study site.
- **Dams and reservoirs:** Due the standing nature of water in dams and reservoirs many insects use dams as breeding sites. The presence of these insects often attracts insect-eating bats. There are a number of small reservoirs on the site. Those examined appeared to be empty but could potentially still hold water after heavy rains.
- **Thicket:** Many of the bat species listed as possibly occurring on the site are clutter and clutter-edge feeders. The presence of thicket or bush on the site may increase the likelihood of such species being present and any alteration to this habitat may have negative effects on the presence of bats in the area, possibly even their survival.
- **Man-made structures:** Buildings favoured by many bat species as safe, dry roost sites. They will often roost in the roofs of these structures. One small structure was located in the south of the site.
- **Disused mine shafts and associated infrastructure:** Abandoned mine shafts, head-gear, equipment and associated buildings are favoured by many bat species as an appropriate substitute for natural caves. The Copperton Mine is approximately 7.5km from the study site.

It is important to note that the abandoned mine shafts, old equipment and buildings of the Copperton Mine and the town of Copperton itself are close enough to be considered part of the greater area being assessed.

Bats are broadly divided into two groups, insect- and fruit-eating bats. Fruit-eating bats are generally found in the warmer, eastern parts of the country where fruit trees, often of a commercial nature, are commonly found. A number of species do, however, occur in the Northern Cape and it is possible that some may occur at the study site (Table 1). Insect-eating bats are found across the entire country, including the study site. Therefore, anything that attracts insects is likely to, in turn, attract bats. For example, wetlands, pans, rivers, dumping sites, and animals such as cows, sheep and horses are all likely to attract both insects and bats and the presence of these features should all be taken into account when considering the siting of wind turbines.

5. Results

5.1. Desktop review

Based on historically recorded and modeled distributions by Friedmann and Daly 2004 and Monadjem *et al.* 2010 the number of bat species with the potential to occur in the study area numbers 12 species (Table 1). Of the 12 species identified as potentially occurring in the study area one is Vulnerable, three Near threatened, seven Least Concern and one Data Deficient. Seven of the identified species are considered highly likely to occur in the study area, two considered moderately likely and three are unlikely but possible to occur.

Table 1- Potential bat species in the study area

SPECIES	COMMON NAME	HABITAT	CONSERVATION STATUS	LIKELIHOOD OF OCCURRENCE
Cleotis percivali	Percival's Short-eared Trident Bat	Woodland	V	Low
Cistugo seabrae	Angolan Wing-gland Bat	Desert/semi-desert	NT	Low
Eidolon helvum	African Straw-coloured Fruit Bat	Fruit-producing woodlands	NT	Moderate
Miniopterus natalensis	Natal Long-fingered Bat	Savanna/grassland	NT	High
Eptesicus hottentotus	Long-tailed Serotine	Rocky outcrops/caves	LC	High
Myotis tricolor	Temminck's Myotis	Savanna/mountains	LC	Low
Neoromicia capensis	Cape Serotine	Wide tolerance	LC	High
Nycteris thebaica	Egyptian Slit-faced Bat	Savanna/karoo	LC	High
Rhinolophus clivosus	Geoffroy's Horseshoe	Savanna/woodland	LC	Moderate
Rhinolophus darlingi	Darling's Horseshoe Bat	Savanna/woodland	LC	High
Tadarida aegyptiaca	Egyptian Free-tailed Bat	Wide tolerance	LC	High
Rhinolophus denti	Dent's Horseshoe Bat	Rocky outcrops/caves	DD	High

* V – Vulnerable, NT – Near Threatened, LC – Least Concern, DD – Data Deficient (IUCN)

5.2. Roost surveys

No habitats favourable for fruit bat species were found in or around the study site. The fertile soils near the Orange River lie less than 50km north east of the study site and the fruit orchids there may be more likely to support fruit bat species. It is unlikely that they would move into the study area.

No obvious roost sites, such as caves, large trees or unused mine shafts were found in the uniform Bosmanland Arid Grasslands of the study site itself. A number of small man-made structures were located on the site and, although no direct evidence was found at these sites, it is possible that bats may use them seasonally as roost sites. In addition reservoirs, drinking troughs and kraals on the site may attract insectivorous bats to drink and feed.

The farm houses (and related structures) in the south of the site had some evidence of occupation by bats including bat smudges and droppings. Many suitable roost sites were identified at the nearby abandoned Copperton Mine. Buildings, mine shafts and remains of the mine's head gear were all identified as potential roost sites (Figure 9).

a. b. c.

Figure 9 – Photographs showing; a. abandoned building, b. disused and partially collapsed mine shaft and c. disused mine head gear; of the Copperton Mine.

5.3. Driven transect surveys

Two main transects were driven over two different nights, the 13th and 14th of August. The first transect traversed as much of the Nelspoortjie farm as possible, travelling in two large loops throughout the farm (Figure 5). The second transect included the Copperton Mine, Copperton town and traversed the southern and eastern boundaries of the Nelspoortjie farm (Figure 5). Four (4) species of bats were detected by the EM3 bat detector during these transects – *Neoromicia capensis, Eptesicus hottentotus, Miniopterus natalensis* and *Tadarida aegyptica.* No activity was recorded on Nelspoortjie farm itself, but preliminary results indicate high activity at the abandoned Copperton Mine and the Nelspoortjie homestead and moderate activity in the town of Copperton. The results are shown in Table 2 and Figure 10.

Table 2 – Bat passes recorded during driven transect surveys

Survey transect	**Species**	**Common name**	**Number of passes**
Transect 2	*Neoromicia capensis*	Cape Serotine	20
Transect 2	*Eptesicus hottentotus*	Long-tailed Serotine	10
Transect 2	*Miniopterus natalensis*	Natal Long-fingered Bat	6
Transect 2	*Tadarida aegyptica*	Egyptian Free-tailed Bat	1

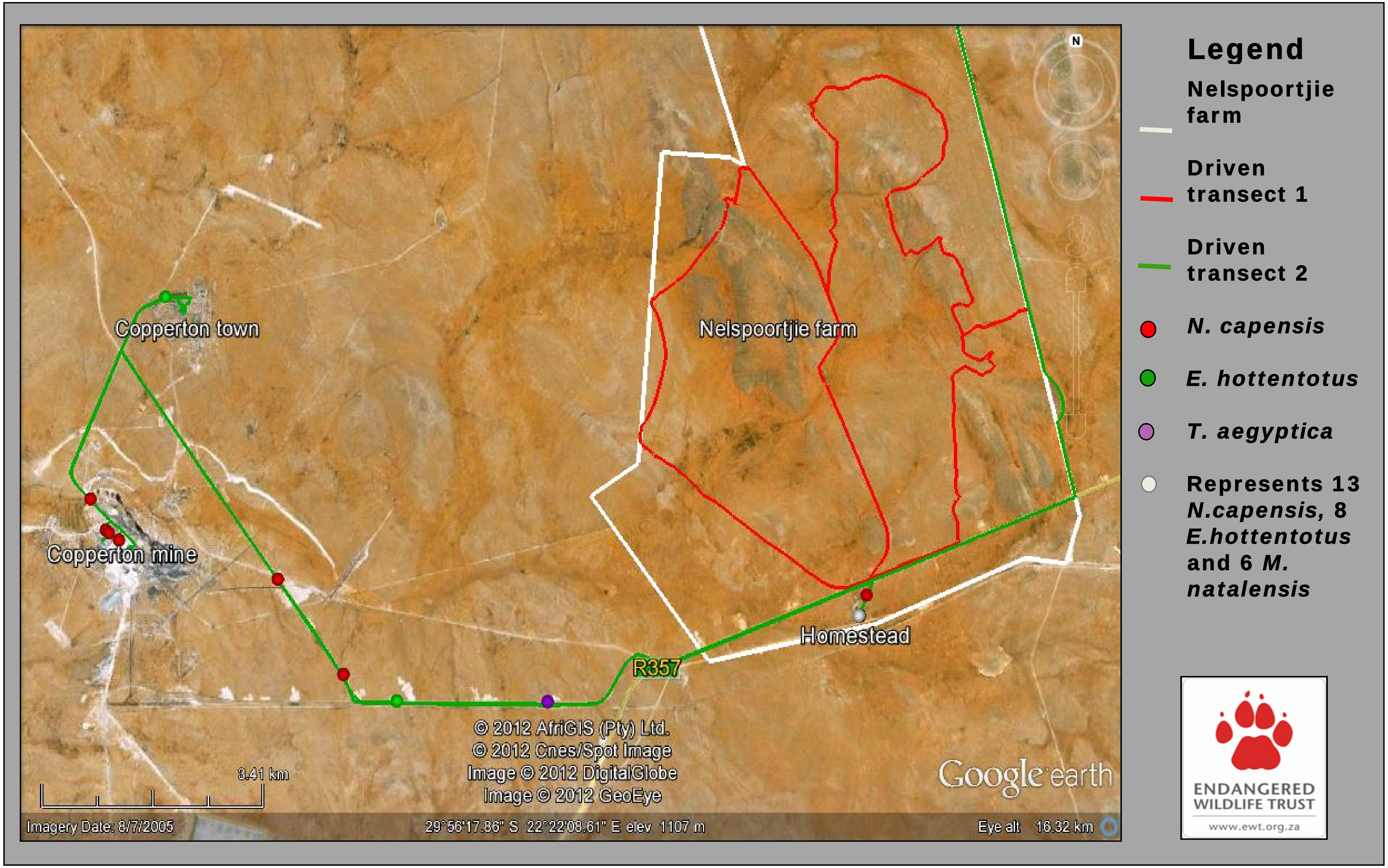


Figure 10 - Results of driven transect surveys

It must be noted that this study was conducted in winter and it is highly likely that many more species, and greater abundances, would be recorded in the summer months. It must also be noted that while it is possible to identify bats from calls, the only completely reliable method is to identify species in the hand from morphological features and measurements. This was not practical for this study as it would be very unlikely to catch a representative sample of bats over the total study area. Calls are therefore relied upon to give an idea of what species are in the area. It is also useful to get an idea of areas in which bats are congregating. Some species have very similar calls. Where there was doubt, the more sensitive species was used in the identification in keeping with the precautionary principle. That said, these data are of sufficient quality to make an assessment on the project and the impact it will have on bat species.

Neoromicia capensis was found throughout the greater area. This was expected because this species has a wide tolerance of habitat and is quite common throughout the region. This bat is a clutter edge forager and gives birth during the wet summer months. This species of bat roosts in houses, under the bark of trees and in mine shafts. The presence of the Copperton mine and the associated infrastructure there can explain their presence in the area. It is unlikely that construction of the wind energy facility will affect any *N. capensis* roosts but populations may be adversely affected through individual mortality during the operational phase.

Eptesicus hottentotus was found in the area. This species occurs widely but sparsely throughout the Northern Cape and roosts in small groups of two to four individuals in caves or rocky crevices. No reproductive information is available for this species. It is unlikely that construction of the wind energy facility will affect any *E. hottentotus* roosts but populations may be adversely affected through individual mortality during the operational phase.

Miniopterus natalensis was also found in the area but only recorded at the Nelpoortjie homestead itself. This species is a clutter edge forager and gives birth in the wet season. The females congregate in maternity roosts. These areas would be critical to avoid during the project but, given the uniformity of the site roost destruction during construction is unlikely but populations may be adversely affected through individual mortality during the operational phase.

Tadarida aegyptica was recorded only once in the area during the driven transect surveys. This species is widespread and abundant throughout most of southern Africa. It roosts communally in small to medium-sized groups which may number in the dozens. They roost in buildings, caves and under the bark of trees. This species has been recorded foraging in a wide variety of habitats and does not appear to be constrained by particular vegetation types. Females give birth to their young in November or December and only once a year. It is unlikely that construction of the wind energy facility will affect any *T. aegyptica* roosts but populations may be adversely affected through individual mortality during the operational phase.

Areas likely to be sensitive in terms of impact on bat populations are highlighted in Figure 11.

The topography of the site, along with observations made during the site visit, were used to designate the permanent water sources, riparian valleys and their slopes and the permanent man-made structures with evidence of bat occupation (identified either by bat passes recorded or bat dropping on walls) as having High Bat Sensitivity. The areas assigned Moderate Bat Sensitivity include non-riparian slopes and non-perennial riverbeds. These areas were designated based on their higher likelihood of supporting insects, and thereby attracting bats, and higher likelihood of providing suitable roost sites. Mitchell-Jones and Carlin (2009) and Rodrigies *et al.* (2008) indicate that a minimum buffer distance of 200m from features important to bats should be maintained.

None of the proposed Turbines are located in areas of High Bat Sensitivity and although Turbines 1, 6, 9, 16, 18, 21, 28, 30, 32, 40, 41, 45, 46, 53 and 58 are located in the areas of Moderate Bat Sensitivity (represented completely by dry riverbeds) due to the uniformity of the habitat and brief period these riverbeds carry water each season it is unlikely that their locations will have a significant impact on bat species in the area. They must, however, at least be prioritized in post-construction monitoring and implementation of mitigation measures.

Figure 11 – Potential bat sensitivity in the study area

6. EVALUATION OF IMPACTS AND CHOICE OF ALTERNATIVE

6.1. Evaluation of impacts

The potential for impacts on bats in the study area by the proposed Garob Wind Farm project is evaluated in terms of impacts related to the main behavioural activities of bats:

- Roosting impacts
- Foraging impacts
- Migration impact

Savannah provided the EWT with Assessment Impacts Tables to use when compiling the section below. The criteria relevant to the Impact Tables can be found in Appendix1.

6.1.1. Roost disturbance and/or destruction due to construction activities

Table 3. Assessment of the impact of the construction of the proposed wind energy facility on roosts

Nature: **Roost disturbance and/or destruction due to construction activities**		
	Without mitigation	With mitigation
Extent	1	1
Duration	5	5
Magnitude	0	0
Probability	1	0
Significance	**6 (Low)**	**0 (Low)**
Status	Neutral	Neutral
Reversibility	N/A	N/A
Irreplaceable loss of resources	No	No
Can impacts be mitigated	Yes	Yes
Mitigation: Since no active bat roosts or habitat suitable for bat roosts were found on the site the impact of the construction of the wind energy facility on roosts is expected to be low. But if any bat roosts are discovered a suitably qualified specialist must be contacted for assistance in dealing with this. Construction activity will involve site clearance, hence the removal and clearance of vegetation and possibly some out buildings for the construction of each turbine and associated infrastructure. Despite the expected impact being low the area to be disturbed by pre-construction and construction activities at the turbine localities should still be kept to a minimum.		
Cumulative impacts: Marginal – the impact of two developments of a similar nature is likely to be less than twice the impact from a single development. To reduce the possibility of impacting any bat roosts in the area it would be better to place a second development in the same environment should this be a consideration.		
Residual impacts: Low – it is unlikely that any roosts will be disturbed or destroyed		

As is clear from Table 2 it is unlikely that construction activities of the wind energy facility will have any impact on roosts in terms of disturbance or destruction.

6.1.2. Bat fatalities due to collision or barotrauma while foraging

Table 4. Assessment of the impact of the proposed wind energy facility on bats through fatalities due to collision or barotrauma while foraging.

Nature: **Bat fatalities due to collision or barotrauma while foraging**		
	Without mitigation	With mitigation
Extent	1	1
Duration	4	4
Magnitude	4	3
Probability	4	4
Significance	**36 (Medium)**	**32 (Medium)**
Status	Negative	Negative
Reversibility	Irreversible	Irreversible
Irreplaceable loss of resources	Possible loss of breeding success and population crash	Possible loss of breeding success and population crash
Can impacts be mitigated	Yes	Yes
Mitigation: Deaths caused by wind turbines are well documented. Placing turbines in areas of high bat activity and between foraging or drinking areas that may be used as flight paths should be avoided. None of the proposed Turbines are located in area of High Bat Sensitivity and although Turbines1, 6, 9, 16, 18, 21, 28, 30, 32, 40, 41, 45, 46, 53 and 58 are located in the areas of Moderate Bat Sensitivity due to the uniformity of the habitat it is unlikely that their locations will have a significant impact on bat species in the area. They must, however, at least be prioritized in post-construction monitoring and implementation of mitigation measures. Gaps of at least 250m should be left between turbines. In addition, informed curtailment programmes should be adopted. This is when a turbine is kept stationary at a very low wind speed and then allowed to rotate once the wind exceeds a specific speed. Bats are less likely to be active during nights of higher wind speeds. Since this study showed that bats occur across the entire study area assessed it is likely that the proposed development will have a high impact on bat populations though collisions and barotrauma even with appropriate mitigation measures. Long-term pre- and post-construction monitoring should be implemented to better inform such conclusions and mitigation decisions.		
Cumulative impacts: Marginal – The impact of constructing a second development in the same environment will result in higher bat mortality due to collision and/or barotrauma but splitting the two developments into separate environments may have an even larger impact.		
Residual impacts: High – permanent impact of turbines.		

Bat mortalities at wind farms due to collision with turbine blades and barotrauma has been identified globally as a serious threat to bat populations. The potential consequences of high death rates at the study site include economic losses (since insectivorous bats provide essential pest control services to farmers), social breakdown amongst gregarious colonies (Kerth *et al.* 2011) and loss of Conservation Important Species (for example the Near Threatened *M. natalensis*).

6.1.3. Disturbance to and displacement from foraging habitat due to wind turbine construction and operation

Table 5. Assessment of the impact of the proposed wind energy facility on bats through disturbance and displacement from foraging habitat

Nature: **Disturbance to and displacement from foraging habitat due to wind turbine construction and operation**		
	Without mitigation	With mitigation
Extent	1	1
Duration	4	4
Magnitude	4	3
Probability	4	3
Significance	**36 (Medium)**	**24 (Low)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources	Possible loss of breeding success	Possible loss of breeding success
Can impacts be mitigated	Yes	Yes
Mitigation: A standard construction EMP must be compiled and implemented by an on-site environmental control officer. The disturbance should decrease after construction is complete, however the use of lights (see below for an explanation) can have a more permanent disturbance or attractive impact on bats. It is advisable that the lighting needs of the project be carefully considered and minimal lighting be used if possible. Low pressure sodium lamps are recommended, or UV filters should be fitted to other types of light. This will decrease the attraction of insects and thus to bat species. There should be no large scale lines of lights as these can act as barriers to bat movement.		
Cumulative impacts: Marginal – The impact of constructing a second development in the same environment will result in higher bat mortality due to collision and/or barotrauma but splitting the two developments into separate environments may have an even larger impact.		
Residual impacts: Medium – temporary impact from construction but large impact from lighting.		

The impact of lighting on bat behavior can have two different results. It can either attract bats that prey on insects or it can disturb bats and act as a barrier to movement (Outen 1998). Therefore as mentioned above it is advisable to keep lighting to a minimum to avoid attracting certain species and to avoid disturbing others. It is not envisaged that this will have a very large impact but it is something to be aware of once operation begins. Should it become a large problem a suitably qualified bat specialist should be contacted to resolve the issue.

It must also be noted that the construction of certain structures may attract bats. Many houses are used all over the world as roost sites. This can cause distress to people as these bats may soil walls and floors with their faeces

It is therefore suggested that during construction newly constructed buildings be sealed as much as possible from bats. This will help to mitigate for this impact. This is more of a business impact as bats are unlikely to be negatively affected by this unless they are physically killed by the people on site.

It is therefore possible that the development could have a slight positive impact on certain bat species but this would need to be further studied and the exact species that would benefit would need to be assessed.

6.1.4. Bat fatalities due to collision or barotrauma during migration

Table 6. Assessment of the impact of the proposed wind energy facility on bats through fatalities during migration

Nature: **Bat fatalities due to collision or barotrauma during migration**		
	Without mitigation	With mitigation
Extent	3	3
Duration	4	4
Magnitude	5	3
Probability	4	3
Significance	**48 (Medium)**	**30 (Medium)**
Status	Negative	Negative
Reversibility	Reversible	Reversible
Irreplaceable loss of resources	Possible loss of breeding success and population crash	Possible loss of breeding success and population crash
Can impacts be mitigated	Yes	Yes

Mitigation: It has been shown that migrating bats are at higher risk of mortality through collision with turbine blades or barotrauma than non-migrating species. Little is understood about bat migration in South Africa but it is likely that bats migrate on nights of low wind speeds, temperate temperatures and no rain. Therefore, as in 5.1.2. placing turbines in areas of high bat activity and between foraging or drinking areas that may be used as flight paths should be avoided. Gaps of at least 250m should be left between turbines. In addition, informed curtailment programmes should be adopted. Long-term pre- and post-construction monitoring should be implemented to better inform such decisions.
Cumulative impacts: Compounding - The impact of constructing a second development in the same environment will result in higher bat mortality due to collision and/or barotrauma during migration.
Residual impacts: High – permanent impacts of turbines

Additional and on-going research on the migratory behavior of southern African bats is vital if we are to better understand the impacts that wind energy facilities will have on their migrations. In additional to monitoring bat activity in relations to wind speed, temperature and humidity data and to maximize the reduction of bat fatalities, wind energy facility operation plans should incorporate the response of migratory bat species to environmental variables, such as barometric pressure and fraction of moon phase, into their existing mitigation strategies.

6.2. Evaluation of alternatives

No alternatives to the wind energy facility itself have been offered.
There is no evidence to suggest that bats are affected by power lines in any way. For this reason the alternative power line options were not assessed as part of this study.

7. MEASURES FOR INCLUSION IN THE DRAFT ENVIRONMENTAL MANAGEMENT PLAN

OBJECTIVE: Bat populations foraging in, or migrating or commuting through, the development area are likely to be affected by the construction and operation of the Proposed Goereesoe Wind Farm near Swellendam through disturbance or disruption of foraging or migration and/or fatalities through collision with turbine blades or barotrauma while foraging or migrating. The objective should be to limit such impacts on bat populations by carefully choosing the location for the turbines and implementing management strategies to reduce impacts.

Project component/s	The position of the turbines; any access road over and above what is necessary that destroys vegetation; any lighting used during the construction and operational phases that may attract insects and; the curtailment programme of turbine operation.
Potential Impact	The potential impact if this objective is not met is that bat populations may be disturbed or reduced sufficiently so as to disrupt reproduction and, potentially, cause a population crash of bats in the area and possibly nationally. Ultimate localized loss of species and reduction in biodiversity may occur if this objective is not met.
Activity/risk source	Activities which could affect achieving this objective include uninformed deviation from the planned lay-out of turbines without considering the impacts on bats, not repositioning turbines which have been identified to fall into bat sensitivity areas, operating the turbines during low wind conditions and using lights that attract insects.
Mitigation: Target/Objective	Mitigation measures, as recommended, include implementing a curtailment programme, repositioning turbines that are in areas of High Bat Sensitivity and using lights that will be less likely to attract insects. A facility environmental management plan that takes cognizance of bat populations in the greater area in the event of any future extensions of any infrastructure.

Mitigation: Action/control	Responsibility	Timeframe
Provision for on-going bat monitoring plan in a facility environmental management plan which also provides guidelines on what to do in the event of any major effect on bat populations that may develop during any phase of development or operation.	Environmental management provider with an on-going monitoring role set up by the developer	To be in place before the commencement of the development
Disturbance and/or removal of vegetation should be kept to a minimum.	Developer	To be in place during planning phase and implemented during construction phase
Separation distances of at least 250m between turbines should be maintained.	Developer	To be in place during planning phase and implemented during operational phase
Curtailment programmes implemented in the operational phase.	Developer	To be in place during planning phase and implemented during construction and operational

		phases
Minimal lighting should be used, alternatively low pressure sodium lamps or UV filters should be used	Developer	To be in place during planning phase and implemented during construction and operational phases

Performance Indicator	Completed mitigation measures as recommended. Inclusion of further bat impact consideration in any future extension of infrastructural elements. Immediate reporting to relevant conservation authorities of any bat related impacts experienced during any phase of development or operation of the facility.
Monitoring	Officials from relevant environmental authorities (National and Provincial) to be permitted to inspect the operation at any time in relation to the bat component of the management plan.

8. CONCLUSIONS

Any species that occurs in the area of the proposed wind energy facility is vulnerable to the potentially fatal impacts of wind turbines. Since only one of the species identified as potentially occurring in the area of the study site is listed as Vulnerable (*Cleotis percivali)* and only one of the recorded bats is listed at Near Threatened (*M.natalensis*) and the fact that no potential roost sites were identified on the site the overall impact of the development should be low to moderate. The uniformity of the habitat around the site also suggests that, although localized habitat destruction and disturbance would impact on bats, the habitat is not unique or important for bats and as such the surrounding habitats would be equally available to bats to utilize.

The proposed mitigation measures and recommendations described in Section 6 should be implemented and their practicality and effectiveness researched with high priority at all turbines on this site. None of the proposed Turbines are located in area of High Bat Sensitivity and although Turbines1, 6, 9, 16, 18, 21, 28, 30, 32, 40, 41, 45, 46, 53 and 58 are located in the areas of Moderate Bat Sensitivity due to the uniformity of the habitat it is unlikely that their locations will have a significant impact on bat species in the area. They must, however, at least be prioritized in post-construction monitoring and implementation of mitigation measures. Gaps of at least 250m should be left between turbines. In addition, informed curtailment programmes should be adopted. Post construction monitoring of bat fatalities during the operational phase is recommended for at least four seasons at the proposed wind energy facility. Every effort should be made to mitigate the impacts on bats during this project through a construction EMP as well as by following the recommendations in this report.

With regards to this development, the following points must be stressed:

- A pre-construction monitoring program is seen as critical in extending our knowledge of wind energy and bat interactions. It is recommended that a monitoring program be planned to collect data on a host of environmental factors. This should be initiated as soon as possible to ensure robustness of data
- All future wind energy projects and plans for pre- and post-construction monitoring should consider the Sowler & Stoffberg (2012) guidelines, in conjunction with an experienced specialist, in order to understand:
    - Seasonal and diurnal bat activity rhythms at the site.
    - The abundance of bat activity and which species are utilizing the site.
    - Site specific risks/ impacts to bats associated with the proposed WEF.
    - Effective mitigation and monitoring methods that will be appropriate for the WEF.

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10. APPENDICES

10.1. Appendix 1- Criteria for assessment of the impacts

The following criteria were used to evaluate the significance of the anticipated impacts:

Extent of the impact:
The extent of the impact was assessed accordingly:

- (**1**) Limited to the site and its immediate surroundings
- (**2**) Local/Municipal extending only as far as the local community or urban area
- (**3**) Provincial/Regional
- (**4**) National i.e. South Africa
- (**5**) Across International borders

Duration of the impact:
The lifespan of the impact was assessed to be:

- (**1**) Immediate (less than 1 year)
- (**2**) Short term (1-5 years)
- (**3**) Medium term (6-15 years)
- (**4**) Long term (.15 years)
- (**5**) Permanent (no mitigation measures of natural process will reduce the impact after construction)

Magnitude of the impact:
The magnitude or severity of the impacts is indicated as either:

- (**0**) None (where the aspect will have no impact on the environment)
- (**1**) Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
- (**2**) Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
- (**3**) Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
- (**4**) High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
- (**5**) Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).

Probability of occurrence:
The likelihood of the impact actually occurring was indicated as either:

- (**0**) None (impact will not occur)
- (**1**) Improbable (the possibility of the impact materializing is very low as a result of design, historic experience or implementation of adequate mitigation measures)
- (**2**) Low probability (there is a possibility that the impact will occur)
- (**3**) Medium probability (the impact may occur)
- (**4**) High probability (it is most likely that the impact will occur)
- (**5**) Definite / do not know (the impact will occur regardless of the implementation of any prevention or corrective actions or it the specialist does not know what the probability will be based on too little published information)

Status of the Impact:
The impacts are assessed as either having a:

- Negative effect (i.e. at a cost to the environment)
- Positive effect (i.e. at a benefit to the environment)
- Neutral effect on the environment.

Accumulative Impact:
The impact of the development is considered together with additional developments of the same or similar nature and magnitude. The combined impacts may be:

- Negligible (i.e. the net effect is the same as a single development)
- Marginal (i.e. the impact of the two developments of a similar nature is less than twice the impact of a single development. This implies it is better to place the two developments in the same environment rather than in separate environments.
- Compounding (i.e. the impact of the two developments is more than twice the impact of two single developments. This implies that it is better to split the two developments into separate environments.

Significance of the Impact:
Based on a synthesis of the information contained in the points above, the potential impacts were assigned a significance weighting (S). The weighting is formulated by adding the sum of the numbers assigned to extent (E), duration (D) and magnitude (M) and multiplying this sum by the probability (P) of the impact hence S=(E+D+M)P.

- *Low (less than 30 points)*: the impact does not have a direct influence on the decision to develop the area

- *Medium (30-60 points)*: the impact could influence the decision to develop in the area unless it is effectively mitigated

- *High (above 60 points)*: where the impact must have an influence on the decision to proceed to develop in the area