PROPOSED SPREEUKLOOF WIND ENERGY FACILITY
BAT AMENDMENT REPORT

On behalf of

Spreeukloof (Pty) Ltd

July 2021

Prepared By:

Arcus Consultancy Services South Africa (Pty) Limited

Office 607 Cube Workspace
Icon Building
Cnr Long Street and Hans Strijdom Avenue
Cape Town
8001

T +27 (0) 21 412 1529 l **E** AshlinB@arcusconsulting.co.za
W www.arcusconsulting.co.za

Registered in South Africa No. 2015/416206/07

TABLE OF CONTENTS

1 INTRODUCTION

Rainmaker Energy (Pty) Ltd ('the applicant') has received environmental authorisation for the construction and operation of the 52.5 MW Spreeukloof Wind Energy Facility as well as its proposed electrical grid connection and associated infrastructure in the Eastern Cape Province. The applicant is now submitting an amendment application to the Department of Forestry, Fisheries and the Environment (DFFE) to amend the technical specifications of the WEF (Table 1), amongst other proposed amendments. The aim of this report is to consider how the relevant proposed amendments may influence the previously assessed impacts to bats. Arcus Consultancy Services South Africa (Pty) Ltd ('Arcus') was appointed to produce the bat amendment report based on previous studies done by Inkululeko Wildlife Services (IWS) and due to our familiarity with the area of development.

Table 1: Proposed Amendment to the Spreeukloof WEF

Component	Approved	Proposed Amendments
Rotor diameter	125 m	up to 176 m
Hub Height	120 m	up to 120 m
Number of Turbines	21 turbines	up to 12 turbines
132 KV Grid Connection and Substation	-	Update to the grid connection line routing and substation location.
Generation Capacity	52.5 MW	Removal of the specification of the facility capacity within the EA to reflect the number of authorised turbines as per the revised layout
Holder of Environmental Authorisation	-	Amended holder
Extension to Environmental Authorisation (EA)	November 2022	Extended validity period

2 METHODOLOGY

In carrying out this assessment, Arcus conducted a literature review on bats and wind energy impacts with a focus on the relationship between turbine size and bat fatality. The previous pre-construction bat monitoring report and impact assessment conducted by Inkululeko Wildlife Services (2017) was also reviewed.

The bat impact assessment (IWS, 2017) for the original EIA process preceded the publication of the protocols listed in Government Notice No. 43110 of gazetted on 20 March 2020: Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in terms of sections 24(5)(A) and (H) and 44 of the NEMA. While the commissioning of the original specialist assessment occurred prior to the publication of the National Gazette, No. 43110 of 20 March 2020, the original report is still aligned to the GN No. 320 - Protocol for Specialist Assessment and Minimum Report for Bat Impacts to assist the Competent Authority in the decision-making process (Appendix 6 of the EIA Regulations, 2014).

A site visit was conducted over four days at the end of autumn (18 – 21 May 2021) with the aim of assessing the revised amendment application in relation to the sensitivities identified by the DFFE Screening Tool[1] and provided in the IWS, 2017 report. The site visit had a focus on important bat features present in the development footprint and around

[1] https://screening.environment.gov.za/

proposed turbine locations, as well as the revised overhead powerline route and substation location.

A Site Sensitivity Verification Report is provided in Appendix A.

3 REVIEW OF TURBINE SIZE AND IMPACTS TO BATS

The core issue relevant to this assessment is the impact to bats due to increasing the size of the turbines and the decreasing height of the lower blade tip at the Spreeukloof WEF. All other amendments are either administrative in nature or do not significantly change impacts to bats and, as such, do not change the assessment or outcomes of this report. The proposed amendment to the turbines at the wind farm would result in a greater per turbine rotor swept area and a minimum blade tip height of 20 m, hence a potentially greater likelihood bats would collide[2] with turbine blades or experience barotrauma[3]. The total rotor swept area for the WEF will also increase, potentially further increasing the likelihood of collision overall. Currently, the maximum rotor swept area for each turbine is 12,272 m^2 and based on the amendment being applied for, this would increase to up to 24,328 m^2 (a 98% increase). The total combined rotor swept area for the currently approved turbines are 257,712 m^2 and for the proposed amendment the total combined rotor swept area would be 364,920 m^2 (ca. 42 % increase).

Numerous studies support the hypothesis that taller wind turbines are associated with higher numbers of bat fatalities. Rydell et al. (2010) found a significant positive correlation between bat mortality with both turbine tower height and rotor diameter in Germany. However, there was no significant relationship between bat mortality and the minimum distance between the rotor and the ground. The maximum tower height in their study was 98 m and data on rotor diameter were not given. In addition, there was no relationship between bat fatality and the number of turbines at a wind energy facility. However, the largest wind energy facility in this study only has 18 turbines (Rydell et al. 2010) which is significantly fewer than currently proposed for the Spreeukloof WEF.

In Greece, Georgiakakis et al. (2012) found that fatalities were significantly positively correlated with tower height but not with rotor diameter. In their study, maximum tower height and rotor diameter were 60 m and 90 m respectively. In Minnesota and Tennessee, USA, both Johnson et al. (2003) and Fiedler et al. (2007) showed that taller turbines with a greater rotor swept area killed more bats. The maximum heights of turbines in these two studies were 50 m and 78 m respectively. In Alberta, Canada, bat fatality rates differed partly due to differences in tower height, and the relationship was also influenced by bat activity (Baerwald and Barclay 2009). For example, sites with high activity but relatively short towers had low bat fatality and sites with low activity and tall towers also had low bat fatality. At sites with high bat activity, an increase in tower height increased the probability of fatality. Maximum turbine height and rotor diameter in this study was 84 m and 80 m, respectively. Despite the above support for the hypothesis that taller wind turbines kill more bats, in a review of 40 published and unpublished studies in South America, Thompson et al. (2017) found no evidence that turbine height or the number of turbines influences bat mortality. Berthinussen et al. (2014) also found no evidence of modifying turbine design to reduce bat fatalities. The relationship between bat mortality and turbine size, or number of turbines at a wind energy facility, is therefore equivocal.

Turbine size has increased since the above studies were published and no recent data of the relationship between bat fatality and turbine size is available. The maximum size of the turbines in the literature reviewed (where indicated in each study) for this assessment had towers of 98 m and blade diameters of 90 m. Some towers were as short as 44 m and

[2] Collision occurs when a bat is struck by a turbine blade while flying, either injuring or killing the bat.

[3] Barotrauma occurs when there is a large, sudden change in air pressure (such as in the air around spinning turbine blades) that causes cavitation in the lung's blood vessels.

had blade tips extending down to only 15 m above ground level. The towers and blades under consideration in this assessment are taller than in the above-mentioned studies. Currently, the approved turbine dimensions would have a maximum ground clearance of 57.5 m and a maximum tip height of 187.5 m. The amendment would result in the blade tips extending minimum of 17 m above ground level to a maximum of 208 m, based on the maximum dimensions being applied for (i.e. a turbine with 88 m blades and a 120 m hub height).

It is possible that some bats species, particularly those not adapted to use open air spaces, are being killed at a lower turbine blade sweep, thus by increasing the blade length and having a shorter distance between the ground and the lowest rotor point may have a negative impact and potentially place a greater diversity of species at risk. In South Africa, evidence of fatality for species which typically do not forage in open spaces high above the ground, is available from several wind energy facilities (Aronson et al. 2013; Doty and Martin 2012; MacEwan 2016). Although Rydell et al. (2010) did not find a significant relationship between bat mortality and the minimum distance between the rotor and the ground, data from Georgiakakis et al. (2012) suggest that as the distance between the blade tips and the ground increases, bat fatality decreases.

Given the lack of published data available on wind energy facilities with turbines of a comparative size, the impact of the proposed amendments on bats cannot be fully described. Hein and Schirmacher (2016) suggest that bat fatality could continue to increase as turbines intrude into higher airspaces since bats are known to fly at high altitudes (McCracken et al. 2008; Peurach et al. 2009; Roeleke et al. 2018). However, McCracken et al. (2008), who recorded free-tailed bats in Texas from ground level up to a maximum height of 860 m, showed that bat activity was greatest between 0 and 99 m. This height band accounted for 27% of activity of free-tailed bats, whereas the 100 m to 199 m height band only accounted for 6%.

In South Africa, simultaneous acoustic monitoring at ground level and at height is a minimum standard for environmental assessments at proposed wind energy facilities. Based on unpublished data from 16 such sites Arcus has worked at, bat activity and species diversity is greater at ground level than at height. Therefore, even though bats are recorded at heights that would put them at risk from taller turbines, the proportion of bats that would be at risk might be less. Further, the number of species that might be impacted would decrease because not all bat species use the airspace congruent with the rotor swept area of modern turbines owing to morphological adaptations related to flight and echolocation. Bats that are adapted to use open air space, such as free-tailed and sheath-tailed bats, would be at greater risk for fatality.

In the United Kingdom, both Collins and Jones (2009) and Mathews et al. (2016) showed that fewer species with lower activity, were recorded at heights between 30 m and 80 m compared to ground level. In two regions in France, Sattler and Bontadina (2005) recorded bat activity at ground level, 30 m, 50 m, 90 m and 150 m and found more species and higher activity at lower altitudes. Roemer et al. (2017) found that at 23 met masts distributed across France and Belgium, 87% of bat activity recorded was near ground level. However, the authors also showed a significant positive correlation between a species preference for flying at height and their collision susceptibility, and between the number of bat passes recorded at height and raw (i.e. unadjusted) fatality counts. In a similar study in Switzerland, majority of bat activity was recorded at lower heights for most species, but the European free-tailed bat had greater activity with increasing height (Wellig et al. 2018). These results suggest that on average, bat activity is greater at lower heights, and that there are important differences across species – those species adapted to using open air spaces are at greater risk.

4 BASELINE ENVIRONMENT

A site walkthrough was conducted by Arcus in May 2021 (autumn) to confirm and update sensitivity areas important for bats. All important features as well as potential turbine locations were visited and sensitivity rating assessed. Some features such as drainage lines and reservoirs were seen to be absent or not in use and, as such, buffers were altered or removed.

Two abandoned mines were also observed on a neighbouring farm , which could be important seasonal roosts for migratory species (such as the Natal Long-fingered bat) or night roosts. No bats were observed entering or leaving the mines although this could change throughout the year. As such, these caves have been buffered by 200 m (Appended Figure 2).

4.1 Bat Species

Seven bat species have been confirmed on the four sites initially authorised from the pre-construction monitoring study with four being present on the Spreeukloof site: The Egyptian free-tailed bat, Cape serotine, Natal Long-fingered bat, Long-tailed serotine. Three of these species are at high risk for turbine collisions or while the other one is at medium risk (Table 2).

Table 2: Bat Species Confirmed from Acoustic Monitoring within the Study Area

Species	Conservation Status[2]		Likely Risk of Impact
	National	International	
Egyptian free-tailed bat *Tadarida aegyptiaca*	Least Concern	Least Concern	High
Natal long-fingered bat *Miniopterus natalensis*	Near Threatened	Least Concern	High
Cape serotine *Neoromicia capensis*	Least Concern	Least Concern	High
Long-tailed serotine *Eptesicus hottentotus*	Least Concern	Least Concern	Medium

5 IMPACT ASSESSMENT

The amendments entail decreasing the number of turbines and using taller turbines with a greater rotor diameter and a change in location of the associated substation and overhead line. The implications of these amendments will vary for low-flying bat species and high-flying bat species. Of the impacts identified in the Final Pre-Construction Bat Monitoring Report of the authorised Spreeukloof WEF (by IWS, 2017), mortality of species due to collision with turbine blades or due to barotrauma and cumulative impacts has been reassessed. **The significance of all other identified impacts on bats associated with the development will remain the same**. The potential significance of bat mortality while foraging was rated by Inkululeko Wildlife Services (2017) as medium-high before mitigation and low after mitigation while significance of bat mortality due to migration was medium before mitigation and low after mitigation. Cumulative impacts associated with bats were rated as medium before mitigation and low after mitigation. The assessment is based on field data collected between December 2015 and December 2016 during the pre-construction monitoring. Impacts related to the change of the substation position and associated grid connection would be limited to collision with transmission lines by larger frugivorous bats. Since no evidence of any frugivorous bats were found on site and they are unlikely to occur in the area, these impacts will not significantly change.

The first key point to consider is the overall dimensions of the authorised rotor swept area vs. the new overall rotor swept area. In terms of the Environmental Authorisation received for Spreeukloof WEF, the wind farm was authorised for 21 turbines with a maximum rotor diameter of 125 m. This translates into a total authorised rotor swept area of 257,712 m^2. Taking into account the reduced number of turbines proposed for the facility in this amendment, the total rotor swept area will be 364,920 m^2. As such the new overall rotor swept area, considering the reduced number of turbines, would increase by ca. 42 %.

The increase in the rotor diameter will be negative for high flying bats species, particularly to free-tailed bats, which are present on site and have fatally collided with turbines in the Eastern Cape. This is because taller turbines are predicted to kill more bats[4]. However, unpublished data from numerous wind farms in South Africa show bat activity generally decreases with height and it is unlikely that the upper tip height increase would result in a significant difference in fatality for this group of bats. Given the lower activity recorded at height, this would not change the previous assessments findings. However, the decrease in the lower tip height will be negative for low-flying bats as the blade swept area will encroach into their lower flight zone, potentially increasing the likelihood of collisions.

As per the above findings, the overall consensus is that in the South African context, shorter blades are mostly preferred to longer ones (providing a smaller rotor swept area, and therefore a lower probability of impacts), while a higher lowest blade tip is preferred over a lower one. It would be preferential to maximize the distance between the ground and blade tips by using turbines with the shortest possible blades and/or the highest possible hub height. This would reduce the number of species potentially impacted upon by turbine blades during the operational phase. More specifically, it is recommended for the lowest blade tip height to not encroach any lower than 30 m above ground, in order to reduce the chance of bat fatalities reaching the relevant fatality thresholds sooner. It would also be preferential to use shorter blades so that they do not intrude into higher airspaces and in so doing reduces the potential impact to high flying species such as free-tailed bats. Despite the lower activity at height, increasing evidence suggests that bats actively forage around wind turbines (Cryan et al. 2014; Foo et al. 2017) so the installation of turbines in the landscape may alter bat activity patterns, either by increasing activity at height and/or increasing the diversity of species making use of higher airspaces.

Blade feathering[5] and curtailment are the remaining mitigation measures to reduce residual impacts during operation and must be continuously refined and adapted based on incoming bat fatality data. Blade feathering must be implemented as soon as operation begins (as this mitigation has no impact on energy production) and an operational bat monitoring study must also be carried out according to the latest South African Bat Assessment Association (SABAA) bat operational monitoring guidelines and an appropriately qualified bat specialist as soon as turbines become operational.

5.1 Assessment of New Layout and Sensitivities

Arcus have created a sensitivity map using the National Geo-Spatial Information Topographic dataset (2015), the National Freshwater Ecosystems Priority Areas database (2011) and the field trip conducted by Arcus in May 2021 enabled these sensitivities to be assessed and refined into an updated sensitivity map (Appended Figure 2). The updated sensitivity map shows that 2 proposed turbines fall within bat high sensitivity areas. It is recommended that these turbine positions be adjusted during the design phase in order to avoid these sensitive areas. All buffers are to blade tip. Should it not be possible to move these turbines, then more stringent mitigation measures, as set out in the original pre-construction bat impact assessment report (IWF, 2017), which would include curtailment,

[4] Smallwood, K. S. 2020. USA Wind Energy-Caused Bat Fatalities Increase with Shorter Fatality Search Intervals. Diversity 2000.

[5] Blade feathering includes facing the turbines into the wind below generation cut in speed, preventing the blades from turning unnecessarily.

would need to be implemented as soon as turbines are erected. Such curtailment would include:

1. a turbine cut-in wind speed of 8 m/s (approximately 75% of bat activity occurs below this wind speed) at hub-height is recommended for curtailment of these turbines in the following times of year and the following times of night:
2. If temp >= 9°C; AND
3. February and March from sunset to sunrise; AND
4. January, April, September, October, November and December from sunset for 2.5 hours.

Should important features, including wind pumps and water reservoirs be removed or covered, this curtailment would not apply and can be removed.

5.2 Review of Original and Updated Impact Assessment

A review of the previously assessed impacts based on the new project description was completed (Table 3). The significance rating of these impacts does not change based on the updated project description under the amended scenario.

Table 3: Summary of relevant impact assessments and indication of changes due to the proposed development

Phase	Impact	Significance with mitigation will change due to proposed development (Y/N)	Reason for No Change
Construction	Roost Disturbance	N	Construction area will not significantly impact roosts or potential roost features nearby
	Roost Destruction	N	Construction area will not significantly impact roosts or potential roost features nearby
	Fragmentation of Habitat	N	Construction footprint is not large enough to significantly change environment for bats
Operation	Light Pollution	N	New structures will not emit enough light to significantly change bat foraging behaviour
	Bat Mortality due to Collision with Transmission Lines	N	Frugivorous bats are unlikely to occur on site and collisions are unlikely to occur

Arcus is in agreement with the mitigation measures and most of the bat sensitivities in the bat sensitivity map, which contained buffers of several important bat features, identified by Inkululeko Wildlife Services (2017). In terms of impacts being identified, only mortality of species due to collision with turbine blades or barotrauma during foraging and cumulative impacts are being considered relevant for this assessment, as all other impacts and significance values remain unaffected and therefore unaltered by the proposed amendments. Mortality due to collision with turbines blades or barotrauma during migration was not assessed in the original pre-construction monitoring report, but is relevant and assessed here. The significance of the impact would be dependent on the size of the turbines chosen. The assessments here are based on the scenario where turbines of the maximum dimensions being applied for are used. This would increase risk to high flying species such as free-tailed bats and low flying species, as the turbine blades would extend higher into the air and lower to the ground.

The impact scores and criteria from the impact assessment methodology used in the original pre-construction bat monitoring report is shown in conjunction with the impact assessment methodology, scores and criteria (provided by Savannah Environmental) used in this report. The original methodology involved calculating a significance value for each impact via the criteria formula (Extent + Duration + Intensity) × Probability based on the scores given as per Figure 1. "Reversibility", "Irreplaceable loss of Resources" and "Can impacts be mitigated?" criteria were not assessed during the original pre-construction monitoring assessment (IWS 2017).

Table 2 Bat Impact ranking matrix

Parameter	Ranking				
	0	1	2	3	4
Extent	None	Localised	Study Area	Regional/National	International
Duration	None	Short-term	Medium-term	Long-term	Permanent
Intensity	None	Low	Moderate	High	Very High
Probability	None	Improbable	Probable	Highly Probable	Definite

Table 3 Significance of Negative Impact Table

	Significance of Negative Impact		
	Low-Medium	Medium	Medium-High
	Impact will not have an influence on the decision or require to be significantly accommodated in the project design.	Impact could have an influence on the environment which will require modification of the project design and/ or alternative mitigation.	Impact could have a 'no-go' implication for the project unless mitigation and/ or re-design is practically achievable.
Significance Value (Extent + Duration + Intensity) x Probability)	1-16	17-32	33-48

Figure 1: Original Bat Pre-Construction Impact Assessment Methodology

Table 4: Impact Assessment Table for Mortality of Species due to Collision with Turbine Blades or Barotrauma During Foraging at Spreeukloof WEF (under the amended scenario)

Nature of impact:
Mortality of bats due to collision with turbine blades or barotrauma caused by turbine operation while foraging.

	Authorised		Proposed amendment	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	Study Area (2)	Study Area (2)	Medium (3)	Low (2)
Duration	Permanent (4)	Permanent (4)	Long Term (4)	Long Term (3)
Magnitude	High (3)	Medium (2)	Very High (9)	Low (4)
Probability	Definite (4)	Probable (2)	Highly Probable (4)	Probable (2)
Significance	**High (36)**	**Low (16)**	**High (64)**	**Low (18)**
Status (positive or negative)	Negative	Negative	Negative	Negative
Reversibility	-	-	Irreversible	Irreversible
Irreplaceable loss of resources?	-	-	Yes	Yes
Can impacts be mitigated?	-	-	Yes	-

Mitigation:

Mitigation measures

- All currently proposed mitigation measures proposed in the Spreeukloof WEF EMPr / EA must be adhered to. This includes adhering to the updated sensitivity map (Appended Figure 2) which will require repositioning 2 turbines that intrude into high sensitivity buffers. These buffers are regarded as high sensitivity areas for turbine components only, and other infrastructure (roads, cables etc) are permissible. These areas include 500m around all cliff lines and 200m around all other important bat features and potential roosts. Should important features, including wind pumps and water reservoirs be removed or covered, these buffers would not apply and can be removed.
- Should it not be possible to move these turbines, then more stringent mitigation measures set out in the original pre-construction bat impact assessment report, which would include curtailment, would need to be implemented as soon as turbines are erected. This would include a turbine cut-in speed of 8 m/s at hub-height for these turbines in February and March from sunset to sunrise and in January, April, September, October, November and December from sunset for 2.5 hours, and only when temperatures are 9 °C or higher. The sunset and sunrise times to be adjusted each month according to the seasonal changes in these times.
- In the event that turbines can be micro-sited, then a bat specialist must map the final turbine layout before micro-siting and assess whether all turbines are appropriately sited in such a way that their blades do not encroach into any bat sensitive buffers.
- A minimum buffer **to blade tip** for all bat buffer zones is required. Additionally, a full operational phase monitoring campaign, inclusive of fatality monitoring and estimates, is to commence as soon as the wind turbines are erected, and in accordance with latest version of the bat monitoring guidelines. This is to take place for the entire Spreeukloof WEF. Based on results from this monitoring campaign, should the estimated bat fatalities for the entire Spreeukloof WEF exceed the threshold of 31 bats per annum, then strict curtailment measures will need to be implemented – to be defined and monitored by an appropriate bat specialist.
- All mitigation measures to protect bats proposed in the EMPr must be adhered to.

Additional mitigation measures

- The impacts presented can be mitigated by using turbines which maximise the ground clearance as much as possible, and by minimising the tip height (i.e. the distance between the ground and the blade tip at its highest point). The lowest tip should not encroach any lower than 30 m above ground, in order to reduce the risk of bat mortalities from reaching the specified estimated threshold limits of 31[6] bats per annum.
- Apply blade feathering to prevent unnecessary free-wheeling of blades below generation cut-in speed at operation commencement.

[6] Based on The South African Bat Assessment Association fatality threshold guidelines while assuming an area of influence of 1,532 hectares and a threshold of 0.20 bats that are not of conservation importance, or at least one frugivorous bat per hectare for the Drakensberg Montane Grassland ecoregion

Residual Risks: Residual impacts may still remain even if the high sensitivity buffers are adhered to and by using turbines of an appropriate size to limit bat fatalities. Bat fatalities are a widely occurring phenomenon having been reported across Europe, North America, Central America, Brazil, India, Australia and South Africa (Baerwald and Barclay 2011; Barros et al. 2015; Hein and Schirmacher 2016; Kumar et al. 2013; Rodríguez-Durán and Feliciano-Robles 2015; Rydell et al. 2010). Furthermore, evidence has shown that pre-construction monitoring data may not be able to adequately predict post-construction fatality risk (Hein et al. 2013), and that bats actively investigate and forge around turbines (Cryan et al. 2014; Foo et al. 2017). This suggests that there may still be fatality impacts. Residual impacts can likely be reduced if curtailment is used when appropriate and this has been shown to be one of the most effective mitigation measures (Arnett and May 2016).

Table 5: Impact Assessment Table for Mortality of Species due to Collision with Turbine Blades or Barotrauma During Migration at Spreeukloof WEF (under the amended scenario)

Nature of impact:

Mortality of bats due to collision with turbine blades or barotrauma caused by turbine operation while migrating.

	Authorised		**Proposed amendment**	
	Without mitigation	**With mitigation**	**Without mitigation**	**With mitigation**
Extent	N/A	N/A	High (3)	Low (2)
Duration	N/A	N/A	Long Term (4)	Long Term (4)
Magnitude	N/A	N/A	Moderate (6)	Minor (3)
Probability	N/A	N/A	Probable (3)	Improbable (2)
Significance	N/A	N/A	**Medium (39)**	**Low (18)**
Status (positive or negative)	N/A	N/A	Negative	Negative
Reversibility	-	-	Irreversible	Irreversible
Irreplaceable loss of resources?	-	-	Yes	Yes
Can impacts be mitigated?	-	-	Yes	-

Mitigation:

Mitigation measures

- All currently proposed mitigation measures proposed in the Spreeukloof WEF EMPr / EA must be adhered to. This includes adhering to the updated sensitivity map (Appended Figure 2) which will require repositioning 2 turbines that intrude into high sensitivity buffers. These buffers are regarded as high sensitivity areas for turbine components only, and other infrastructure (roads, cables etc) are permissible. These areas include 500m around all cliff lines and 200m around all other important bat features and potential roosts. Should important features, including (such as wind pumps andor water reservoirs) be removed or covered, these buffers would not apply and can be removed.
- Should it not be possible to move these turbines, then more stringent mitigation measures set out in the original pre-construction bat impact assessment report, which would include curtailment, would need to be implemented as soon as turbines are erected. This would include a turbine cut-in speed of 8 m/s at hub-height for these turbines in February and March from sunset to sunrise and in January, April, September, October, November and December from sunset for 2.5 hours, and only when temperatures are 9 °C or higher. The sunset and sunrise times to be adjusted each month according to the seasonal changes in these times.
- In the event that turbines can be micro-sited, then a bat specialist must map the final turbine layout before micro-siting and assess whether all turbines are appropriately sited in such a way that their blades do not encroach into any bat sensitive buffers.
- A minimum buffer **to blade tip** for all bat buffer zones is required. Additionally, a full operational phase monitoring campaign, inclusive of fatality monitoring and estimates, is to commence as soon as the wind

turbines are erected, and in accordance with latest version of the bat monitoring guidelines. This is to take place for the entire Spreeukloof WEF. Based on results from this monitoring campaign, should the estimated bat fatalities for the entire Spreeukloof WEF exceed the threshold of 31 bats per annum, then strict curtailment measures will need to be implemented – to be defined and monitored by an appropriate bat specialist. • All mitigation measures to protect bats proposed in the EMPr must be adhered to. Additional mitigation measures • The impacts presented can be mitigated by using turbines which maximise the ground clearance as much as possible, and by minimising the tip height (i.e. the distance between the ground and the blade tip at its highest point). The lowest tip should not encroach any lower than 30 m above ground, in order to reduce the risk of bat mortalities from reaching the specified estimated threshold limits of 31 bats per annum. • Apply blade feathering to prevent unnecessary free-wheeling of blades below generation cut-in speed at operation commencement.
Residual Impacts: Residual impacts may still remain even if the high sensitivity buffers are adhered to and by using turbines of an appropriate size to limit bat fatalities. Bat fatalities are a widely occurring phenomenon having been reported across Europe, North America, Central America, Brazil, India, Australia and South Africa (Baerwald and Barclay 2011; Barros et al. 2015; Hein and Schirmacher 2016; Kumar et al. 2013; Rodríguez-Durán and Feliciano-Robles 2015; Rydell et al. 2010). Furthermore, evidence has shown that pre-construction monitoring data may not be able to adequately predict post-construction fatality risk (Hein et al. 2013), and that bats actively investigate and forge around turbines (Cryan et al. 2014; Foo et al. 2017). This suggests that there may still be fatality impacts. Residual impacts can likely be reduced if curtailment is used when appropriate and this has been shown to be one of the most effective mitigation measures (Arnett and May 2016).

Cumulative impacts were rated as medium before mitigation and low after mitigation in the original bat impact assessment report in accordance with the original impact assessment methodology (Inkululeko Wildlife Sevices, 2017, Figure 1) and has been reassessed below using the impact assessment criteria provided by Savannah Environmental. Currently, there is one operational WEF within the cumulative impact area of a 50km radius (Dorper Wind Energy Facility) and at least five renewable energy facilities (all of which are for Wind Energy Facilities) planned or approved, within this area based on the Department of Environmental Affairs Renewable Energy Development Database Quarter 4, 2020.

It is important to consider cumulative impacts across the entire scale where potentially affected animals are likely to move, especially mobile animals like bats. Impacts at a local scale could have negative consequences at larger scales if the movement between distant populations is impacted (Lehnert et al. 2014; Voigt et al. 2012). For example, Lehnert et al. (2014) demonstrated that among Noctule bats collected beneath wind turbines in eastern Germany, 28 % originated from distant populations in the Northern and North-eastern parts of Europe. This is particularly relevant to bats that migrate. One migratory bat was recorded on the site but relatively seldom, so a larger cumulative impact area was not considered at this stage.

The cumulative impacts could be lower for species that do not migrate over such large distances or resident species that are not known to migrate. Three of the four species recorded during the pre-construction monitoring do not migrate over such large distances. The sphere of the cumulative impact would then likely be restricted to the home ranges and foraging distances of different species, which can range from 1 km to at least 15 km for some insectivorous bats (Jacobs and Barclay 2009; Serra-Cobo and Sanz-Trullen 1998) and up to at least 24 km for some fruit bats (Jacobsen et al. 1986).

Cumulative impacts on bats could increase as new facilities are constructed (Kunz et al. 2007) but are difficult to accurately predict or assess without baseline data on bat population size and demographics (Arnett et al. 2011; Kunz et al. 2007) and these data are lacking for many South African bat species. It is possible that cumulative impacts could be mitigated with the appropriate measures applied to wind farm design and operation. Cumulative impacts could result in declines in populations of even those species of bats currently listed as Least Concern, if they happen to be more susceptible to mortality from wind turbines (e.g. high-flying open air foragers such as free-tailed and fruit bats) even if the appropriate mitigation measures are applied. Further research into the populations and behaviour of South African bats, both in areas with and without wind turbines, is needed to better inform future assessments of the cumulative effects of WEFs on bats.

Table 6: Cumulative Impact Assessment (under the amended scenario)

Nature of impact:

Cumulative mortality of bats due to collision with turbine blades or barotrauma caused by turbine operation across multiple wind energy facilities.

The cumulative impacts will depend on the number of wind energy facilities in the region, the species involved, the levels of bat mortality and mitigation measures implemented at each wind energy facility. Bats reproduce slowly (Barclay and Harder 2003) and their populations can take long periods of time to recover from disturbances so the cumulative impacts can be high if appropriate management and mitigation is not implemented.

There are approximately 5 planned and 1 operational wind energy facilities within a 50 km radius of the Spreeukloof WEF. The assessment below assumes all facilities implement appropriate mitigation measures.

	Authorised		**Proposed amendment**	
	Without mitigation	**With mitigation**	**Overall impact of the proposed project considered in isolation**[7]	**Cumulative impact of the project and other projects in the area**
Extent	Regional (3)	Study Area (2)	High (4)	High (4)
Duration	Permanent (4)	Long Term (3)	Long Term (4)	Long term (4)
Magnitude	High (3)	Medium (2)	Minor (2)	Moderate (6)
Probability	Highly Probable (3)	Improbable (1)	Improbable (2)	Probable (3)
Significance	**Medium (30)**	**Low (7)**	**Low (20)**	**Medium (42)**
Status (positive or negative)	Negative	Negative	Negative	Negative
Reversibility	-	-	Low	Low
Irreplaceable loss of resources?	-	-	Yes	Yes
Can impacts be mitigated?	-	-	Yes	Yes, if all WEFs adhere to mitigations

Mitigation:

Mitigation measures

- All currently proposed mitigation measures proposed in the Spreeukloof WEF EMPr / EA must be adhered to. This includes adhering to the updated sensitivity map (Appended Figure 2) which will require repositioning 2 turbines that intrude into high sensitivity buffers. These buffers are regarded as high sensitivity areas for turbine components only, and other infrastructure (roads, cables etc) are permissible. These areas include 500m around all cliff lines and 200m around all other important bat features and potential roosts. Should important features, including wind pumps and water reservoirs be removed or covered, these buffers would not apply and can be removed.
- Should it not be possible to move these turbines, then more stringent mitigation measures set out in the original pre-construction bat impact assessment report, which would include curtailment, would need to be implemented as soon as turbines are erected. This would include a turbine cut-in speed of 8 m/s at hub-height

[7] Table values assume that all mitigations have been followed.

for these turbines in February and March from sunset to sunrise and in January, April, September, October, November and December from sunset for 2.5 hours, and only when temperatures are 9 °C or higher. The sunset and sunrise times to be adjusted each month according to the seasonal changes in these times. • In the event that turbines can be micro-sited, then a bat specialist must map the final turbine layout before micro-siting and assess whether all turbines are appropriately sited in such a way that their blades do not encroach into any bat sensitive buffers. • Additionally, a full operational phase monitoring campaign, inclusive of fatality monitoring and estimates, is to commence as soon as the wind turbines are erected, and in accordance with latest version of the bat monitoring guidelines. This is to take place for the entire Spreeukloof WEF. Based on results from this monitoring campaign, should the estimated bat fatalities for the entire Spreeukloof WEF exceed the threshold of 31 bats per annum, then strict curtailment measures will need to be implemented – to be defined and monitored by an appropriate bat specialist. • All mitigation measures to protect bats proposed in the Spreeukloof WEF EMPr must be adhered to. Additional mitigation measures The impacts presented can be mitigated by using turbines which maximise the ground clearance as much as possible, and by minimising the tip height (i.e. the distance between the ground and the blade tip at its highest point). The lowest tip should not encroach any lower than 30 m above ground, in order to reduce the risk of bat mortalities from reaching the specified estimated threshold limits of 31 bats per annum.
Residual Risks: Residual impacts may still remain even if the high sensitivity buffers are adhered to and by using turbines of an appropriate size to limit bat fatalities. Bat fatalities are a widely occurring phenomenon having been reported across Europe, North America, Central America, Brazil, India, Australia and South Africa (Baerwald and Barclay 2011; Barros et al. 2015; Hein and Schirmacher 2016; Hull and Cawthen 2012; Kumar et al. 2013; Rodríguez-Durán and Feliciano-Robles 2015; Rydell et al. 2010). Furthermore, evidence has shown that pre-construction monitoring data may not be able to adequately predict post-construction fatality risk (Hein et al. 2013), and that bats actively investigate and forge around turbines (Cryan et al. 2014; Foo et al. 2017). This suggests that there may still be fatality impacts. Residual impacts can likely be reduced if curtailment is used when appropriate as this has been shown to be one of the most effective mitigation measures (Arnett and May 2016)

6 ADVANTAGES AND DISADVANTAGES TO THE AMENDMENT

The advantages and disadvantages with respect to the impacts subject to change in the amendment are detailed in the table below:

Table 7: Advantages and Disadvantages of the Proposed Amendment

Advantages	Disadvantages
A reduction in the number of turbines means a smaller footprint is required and therefore less vegetation clearance and habitat loss.	It is possible that some bat species, particularly those not adapted to use open-air spaces, are being killed at the lower sweep of the turbine blades so increasing the blade length and having a shorter distance between the ground and the lowest rotor point may have a negative impact and potentially place a greater diversity of species at risk.
Most turbines are located away from highly sensitive areas.	Increasing the individual Rotor Swept Area of each turbine could increase the chances that bats will collide with turbine blades at a turbine location scale.
Bat activity and species diversity are greater at ground level than at height. Therefore, even though bats are recorded at heights that would put them at risk from taller turbines, the proportion of bats that would be at risk might be less.	Increasing the total Rotor Swept Area of the entire facility could increase the chances that bats will collide with turbine blades at a site scale.
The number of bat species that might be impacted would decrease because not all bat species use the airspace congruent with the rotor swept area of modern turbines owing to morphological adaptations related to flight and echolocation.	

7 CONCLUSION

The core issue relevant to this assessment is the impact to bats due to increasing the size of the turbines and the decreasing height of the lower blade tip at the Spreeukloof WEF. All other amendments are either administrative in nature or do not significantly change impacts to bats and, as such, do not change the assessment or outcomes of this report. Compared to the current turbine layout and dimensions of Spreeukloof WEF, it is likely that the change in turbine dimensions would (without mitigation) slightly increases mortality impacts on bats. This is primarily because of a potentially higher ground to lower tip height as well as the location of some turbines in bat sensitive areas – placing bats (particularly lower flying species using open spaces for commuting and foraging) at a higher risk. However, due to the overall lower rotor swept area these impacts will only slightly increase the risk of bat mortality. As such, the significance of bat mortality will remain **medium-high before mitigation** and **low after mitigation** for mortality during foraging, and **medium before mitigation** and **low after mitigation** for mortality during migration. Cumulative impacts are likely to be of a **medium significance before mitigation** and **low after mitigation**.

The key initial mitigation measure that should be implemented at the Spreeukloof WEF would be adherence to the latest high sensitivity and medium-high sensitivity buffer distances in this report and in the Spreeukloof WEF pre-construction bat impact report. There are currently 2 turbines that need to be relocated (Appended Figure 2). Should it not be possible to move these turbines, then more stringent mitigation measures set out in the original pre-construction bat impact assessment report, which would include curtailment, would need to be implemented as soon as turbines are erected. This would include a turbine cut-in speed of 8 m/s at hub-height for these turbines in February and March from sunset to sunrise and in January, April, September, October, November and December from sunset for 2.5 hours, and only when temperatures are 9 °C or higher. The sunset and sunrise times to be adjusted each month according to the seasonal changes in these times.

It is also recommended to maximise the ground clearance and minimise the tip height (i.e. the distance between the ground and the blade tip at its highest point) as much as possible. More specifically, it is not recommended for the lowest blade tips to encroach any lower than 30 m above ground, as turbines with a lower ground clearance run the risk of reaching the fatality thresholds sooner.

A full operational phase monitoring campaign, inclusive of fatality monitoring and estimates, is to commence as soon as the wind turbines are erected, and in accordance with latest version of the operational bat monitoring guidelines. Based on results from this operational monitoring campaign, should the estimated bat fatalities for the entire Spreeukloof WEF exceed the threshold of 31 bats per annum, then strict curtailment measures will need to be implemented – to be defined and monitored by an appropriate bat specialist. Blade feathering must also be implemented at the start of operation to prevent blade free-wheeling. This is to take place for the entire Spreeukloof WEF.

Based on the proposed amendments and the updated assessment, it is the opinion of the specialist that the amendment can be authorised, on condition that all recommendations are strictly adhered to.

8 REFERENCES

Arnett, E.B., May, R.F., 2016. Mitigating Wind Energy Impacts on Wildlife: Approaches for Multiple Taxa. Human–Wildlife Interactions: Vol. 10: Iss. 1, Article 5.

Aronson, J.B., Thomas, A.J., Jordaan, S.L., 2013. Bat fatality at a wind energy facility in the Western Cape, South Africa. African Bat Conservation News 31, 9-12.

Baerwald, E.F., Barclay, R.M.R., 2009. Geographic variation in activity and fatality of migratory bats at wind energy facilities. Journal of Mammalogy 90, 1341-1349.

Berthinussen, A., Richardson, O.C., Altringham, J.D., 2014. Bat Conservation - Global evidence for the effects of interventions. Pelagic Publishing.

Collins, J., Jones, G., 2009. Differences in bat activity in relation to bat detector height: implications for bat surveys at proposed windfarm sites. Acta Chiropterologica 11, 343-350.

Cryan, P.M., Gorresen, P.M., Hein, C.D., Schirmacher, M.R., Diehl, R.H., Huso, M.M., Hayman, D.T.S., Fricker, P.D., Bonaccorso, F.J., Johnson, D.H., Heist, K., Dalton, D.C., 2014. Behavior of bats at wind turbines. Proceedings of the National Academy of Sciences 111, 15126-15131.

Doty, A.C., Martin, A.P., 2012. Assessment of bat and avian mortality at a pilot wind turbine at Coega, Port Elizabeth, Eastern Cape, South Africa. New Zealand Journal of Zoology, 1-6.

Fiedler, J.K., Henry, T.H., Tankersley, R.D., Nicholson., C.P., 2007. Results of bat and bird mortality monitoring at the expanded Buffalo Mountain Windfarm, 2005, Tennessee Valley Authority, Knoxville, Tennessee.

Foo, C.F., Bennett, V.J., Hale, A.M., Korstian, J.M., Schildt, A.J., Williams, D.A., 2017. Increasing evidence that bats actively forage at wind turbines. PeerJ 5, e3985-e3985.

Georgiakakis, P., Kret, E., Carcamo, B., Doutau, B., Kafkaletou-Diez, A., Vasilakis, D., Papadatou, E., 2012. Bat fatalities at wind farms in north-eastern Greece. Acta Chiropterologica 14(2), 459-468.

Grodsky, S.M., Behr, M.J., Gendler, A., Drake, D., Dieterle, B.D., Rudd, R.J., Walrath, N.L., 2011. Investigating the causes of death for wind turbine-associated bat fatalities. Journal of Mammalogy 92, 917-925.

Hein, C.D., Schirmacher, M.R., 2016. Impact of wind energy on bats: a summary of our current knowledge. Human–Wildlife Interactions 10(1):19–27.

Horn, J.W., Arnett, E.B., Kunz, T.H., 2008. Behavioral responses of bats to operating wind turbines. The Journal of Wildlife Management 72, 123-132.

Jacobs, D.S., Barclay, R.M.R., 2009. Niche Differentiation in Two Sympatric Sibling Bat Species, Scotophilus dinganii and Scotophilus mhlanganii. Journal of Mammalogy 90, 879-887.

Jacobsen, N.H.G., Viljoen, P.C., Ferguson, W., 1986. Radio tracking of problem fruit bats (Rousettus aegyptiacus) in the Transvaal with notes on flight and energetics. . Zeitschrift fuer Saeugetierkunde 51, 205-208.

Johnson, G.D., Erickson, W.P., Strickland, M.D., Shepherd, M.F., Shepherd, D.A., Sarappo, S.A., 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150, 332-342.

Kunz, T.H., Arnett, E.B., Cooper, B.M., Erickson, W.P., Larkin, R.P., Mabee, T., Morrison, M.L., Strickland, M.D., Szewczak, J.M., 2007a. Assessing impacts of wind-energy development on nocturnally active birds and bats: A guidance document. The Journal of Wildlife Management 71, 2449-2486.

Lehnert, L.S., Kramer-Schadt, S., Schönborn, S., Lindecke, O., Niermann, I., Voigt, C.C., 2014. Wind farm facilities in Germany kill noctule bats from near and far. PloS one 9, e103106.

MacEwan, K., 2016. Fruit bats and wind turbine fatalities in South Africa. African Bat Conservation News 42.

MacEwan, K, 2017. Spreeukloof WEF: Final Pre-Construction Bat Monitoring Report. Inkululeko Wildlife Services

Mathews, F., Richardson, S., Lintott, P., Hosken, D., 2016. Understanding the Risk of European Protected Species (Bats) at Onshore Wind Turbine Sites to Inform Risk Management. Report by University of Exeter. pp 127.

McCracken, G.F., Gillam, E.H., Westbrook, J.K., Lee, Y.-F., Jensen, M.L., Balsley, B.B., 2008. Brazilian free-tailed bats (Tadarida brasiliensis: Molossidae, Chiroptera) at high altitude: links to migratory insect populations. Integrative and Comparative Biology 48, 107-118.

Millon, L., Colin, C., Brescia, F., and Kerbiriou, C. 2018. Wind turbines impact bat activity, leading to high losses of habitat use in a biodiversity hotspot. Ecological Engineering 112:51-54.

Mitchell-Jones, T., Carlin, C., 2014. Bats and Onshore Wind Turbines Interim Guidance, In Natural England Technical Information Note TIN051. Natural England.

Peurach, S.C., Dove, C.J., Stepko, L., 2009. A decade of U.S. Air Force bat strikes. Wildlife Conflicts 3:199–207.

Roeleke, M., Bumrungsri, S., Voigt, C.C., 2018. Bats probe the aerosphere during landscape-guided altitudinal flights. Mammal Review 48, 7-11.

Roemer, C., Disca, T., Coulon, A., Bas, Y., 2017. Bat flight height monitored from wind masts predicts mortality risk at wind farms. Biological Conservation 215, 116-122.

Rollins, K.E., Meyerholz, D.K., Johnson, G.D., Capparella, A.P., Loew, S.S., 2012. A forensic investigation into the etiology of bat mortality at a wind farm: barotrauma or traumatic injury? Veterinary Pathology Online 49, 362-371.

Rydell, J., Bach, L., Dubourg-Savage, M.-J., Green, M., Rodrigues, L., Hedenström, A., 2010. Bat mortality at wind turbines in northwestern Europe. Acta Chiropterologica 12, 261-274.

Sattler, T., Bontadina, F., 2005. Grundlagen zur ökologischen Bewertung von zwei Windkraftgebieten in Frankreich aufgrund der Diversität und Aktivität von Fledermäusen. Unveröffentlichter Kurzbericht. SWILD, Zürich im Auftrag von Megawatt Eole, Stuttgart, 23 Seiten.

Serra-Cobo, J., Sanz-Trullen, J.P., 1998. Migratory movements of Miniopterus schreibersii in the north-east of Spain. Acta Theriologica 43, 271-283.

Thompson, M., Beston, J.A., Etterson, M., Diffendorfer, J.E., Loss, S.R., 2017. Factors associated with bat mortality at wind energy facilities in the United States. Biological Conservation 215, 241-245.

Voigt, C.C., Popa-Lisseanu, A.G., Niermann, I., Kramer-Schadt, S., 2012. The catchment area of wind farms for European bats: A plea for international regulations. Biological Conservation 153, 80-86.

Wellig, S.D., Nusslé, S., Miltner, D., Kohle, O., Glaizot, O., Braunisch, V., Obrist, M.K., Arlettaz, R., 2018. Mitigating the negative impacts of tall wind turbines on bats: Vertical activity profiles and relationships to wind speed. PloS one 13, e0192493.

FIGURES

APPENDIX A: SITE SENSITIVITY VERIFICATION REPORT

APPENDIX B: SPECIALIST CV AND DECLARATION OF INTEREST