ARCUS

CASTLE WIND ENERGY FACILITY
EA AMENDMENT REPORT

BAT ASSESSMENT

On behalf of

CASTLE WIND FARM (PTY) LTD

June 2019

Prepared By:

Arcus Consultancy Services South Africa (Pty) Limited

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1 INTRODUCTION

Castle Wind Farm (Pty) Ltd ("the applicant") received environmental authorisation for the Castle Wind Energy Facility (WEF) on 8 May 2015 (which was subsequently amended on 30 June 2015 and 4 April 2017) (DEA ref: 14/12/16/3/3/2/278). The applicant is proposing to amend the turbine specifications for the Castle Wind Energy Facility as follows:

- Rotor Diameter increase from up to 150 m to between 110 m to 200 m
- Hub height from up to 130 m to between 90 m to 150m
- Individual turbine capacity from up to 4.5 MW to up to 7.9 MW

1.1 Terms of Reference

The report has been compiled under the following terms of reference and provides:

- An assessment of all impacts related to the proposed changes;
- Advantages and disadvantages associated with the changes;
- Comparative assessment of the impacts before the changes and after the changes; and
- Measures to ensure avoidance, management and mitigation of impacts associated with such proposed changes, and any changes to the EMPr.

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 literature review was carried out using the Web of Science® and Google Scholar using the following search terms:

bat OR fatality OR wind energy OR turbine OR wind turbine OR fatalities OR mortality OR mortalities OR kill* OR tower height OR height OR rotor swept zone OR rotor zone OR rotor swept area OR blades OR turbine blades OR influence OR increas* OR trend OR positive OR decreas* OR relation* OR wind farm OR wind energy facility OR carcass* OR chiroptera OR rotor diameter OR correlat* OR size*

In addition, the pre-construction bat monitoring report for the Castle WEF was reviewed, along with the current bat sensitivity buffers. The monitoring was conducted between July 2013 and August 2014. The bat specialist letter date 28 September 2016 submitted in support of the Part 2 Amendment was also reviewed.

3 REVIEW

The core issue relevant to this assessment is the impact to bats of amending the size of the turbines at the Castle WEF. Currently, the rotor swept area for each turbine will be up to 17,671 m^2 assuming turbines with a hub height of 130 m and blade lengths of 75 m. The amendment would result in either a decrease (to 9,503 m^2 assuming turbines with a hub height of 90 m and blade lengths of 55 m) or increase (to 31,416 m^2 assuming turbines with a hub height of 150 m and blade lengths of 100 m) in the rotor swept zone. The minimum and maximum tip heights currently approved will be 55 m and 205 m respectively. This will change to a minimum and maximum tip height of 35 m and 145 m respectively (for the 90 m hub height turbine) or minimum and maximum tip height of 50 m and 250 m respectively (for the 150 m hub height turbine).

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.

In Greece, Georgiakakis et al. (2012) found that bat 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 but 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 North 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 are 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 rotor diameters of 90 m. Some towers were as short as 44 m and had blade tips extending down to only 15 m above ground level. The towers and blades under consideration in this assessment are significantly taller than this.

It is possible that some bats species, particularly those not adapted to use open air spaces, are being killed at the lower sweep of the turbine blades so having a shorter distance between the ground and the lowest rotor tip point may have a negative impact and potentially place a greater diversity of species at risk. This is a disadvantage of the proposed amendments based on the turbine with a 90 m hub height as the associated blades will sweep down to 35 m as opposed to 55 m which is currently approved. However, a potential advantage of this turbine is that the rotor swept area will be lower. The turbine with the 150 m hub height will only sweep down an additional 5 m compared to the currently approved turbines but will extend 40 m into the air and have a much larger rotor swept area which is a disadvantage of that specific turbine. 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.

It is not known what the impact of turbines of the size proposed for the Castle WEF would be to bats because of a lack of published data from wind energy facilities with turbines of a comparative size. Hein and Schirmacher (2016) suggest that bat fatality should continue to increase as turbines intrude into higher airspaces because 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 17 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 more at risk.

In the United Kingdom, both Collins and Jones (2009) and Mathews et al. (2016) showed that fewer species, and less 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, most 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).

The 12 month pre-construction bat monitoring study conducted by Animalia (2014) showed that three species of bats were present at the site. The Cape Serotine *(Neromicia capensis)* and Egyptian free-tailed bat *(Tadarida aegyptiaca)* are common throughout site while the Natal long-fingered bat *(Miniopterus natalensis)* only accounts for 1% of total bat passes.

Based on literature reviewed by Animalia (2014), other species that can potentially occur at the site include the Long-tailed Serotine *(Eptesicus hottentotus),* Temminck's myotis *(Myotis tricolor),* Egyptian slit-faced bat *(Nycertris thebaica),* Geoffroy's horseshoe bat *(Rhinolophus clivosus)* and Darling's Horseshoe bat *(Rhinolophus darling).*

During the pre-construction bat monitoring at the Castle WEF, greater bat activity was recorded at 10 m compared to 50 m. These results suggest that on average, bat activity is greater at lower heights but that there are important differences across species – those species adapted to using open air spaces are at greater risk.

4 IMPACT ASSESSMENT

Of the impacts identified in the EIA, only mortality of species due to collision with turbine blades or due to barotrauma are relevant to this amendment. The significance of all other identified impacts on bats associated with the development will remain the same as per the EIA. The potential collision impact to bats are currently rated as high before, and low after mitigation. The primary mitigation measures are avoiding sensitive areas for bats and curtailment (with the need for the later based on results of the operational monitoring). However, even though changes to the turbine dimensions are proposed which may impact bats, the impact ratings will not change from high before mitigation, and low after mitigation. The only change required is to update the sensitivity map based on the new turbines dimensions.

In the pre-construction bat monitoring report sensitive areas were defined as either high (with a 150 m buffer) or moderate (with a 100 m buffer). The current turbine layout adheres to these buffers, with no turbines located within them. While not explicitly stated in the pre-construction monitoring report, these buffers must be to blade tip. To determine the buffer distances required to ensure that no turbine blades enter the bat buffers, the following formula should be used (Mitchell-Jones and Carlin 2014):

$$b = \sqrt{(bd + bl)^2 - (hh - fh)^2}$$

Where: bd = buffer distance, bl = blade length, hh = hub height and fh = feature height (zero in this instance)

Thus, based on the above, the 150 m high sensitivity buffer would need to be either 184 m or 200 m to blade tip. The 100 m moderate sensitivity buffer would need to be either 126 m or 132 m to blade tip. This results in some turbines being located in bat sensitive buffers (Table 1). The original assessment stipulated a buffer of either 100 m or 150 m. That assessment was done in accordance with the guidelines available at the time (Sowler and Stoffberg, 2012). This document did not provide guidance on the buffer distances that should be applied to important bat features. The current guidelines (Sowler et al. 2017) do provide such guidance and recommend a minimum buffer of 200 m to blade tip for important bat features. Therefore, to be compliant with current best practice the 150 m high sensitivity buffer should be increased to 200 m. Based on the bat activity at the site, the moderate sensitivity buffer should be sufficient at 100 m. The increase in the high sensitivity buffer from 150 m to 200 m results in some turbines being located in buffer zones (Table 1 and Figure 1) and these will need to be relocated during micro-siting. With these changes, page 2 of the EMPr is no longer correct and must be updated to reflect that there are turbines located in bat sensitive areas, or these turbines need to be relocated in which case no changes will be needed to the EMPr.

Table 1: Number of Turbines within Bat Buffers for Each Turbine Size being applied for

Unchanged 100m Moderate Sensitivity Buffer (to blade tip)	**90 m hub height, 55 m blade (126 m to turbine base)**	**150 m hub height, 100 m blade (135 m to turbine base)**
Moderate Sensitivity	1 (T2)	2 (T2, T9)
Previous 150 m High Sensitivity Buffer (to blade tip)	**90 m hub height, 55 m blade (184 m to turbine base)**	**150 m hub height, 100 m blade (200 m to turbine base)**
High Sensitivity	1 (T28)	3 (T1, T24, T28)
Current 200 m High Sensitivity Buffer (to blade tip)	**90 m hub height, 55 m blade (239 m to turbine base)**	**150 m hub height, 100 m blade (260 m to turbine base)**
High Sensitivity	4 (T1, T20, T24, T28)	6 (T1, T6, T18, T20, T24, T28)

The pre-construction monitoring data showed that bat activity at 50 m is lower than at 10 m, thus it would be preferential to maximise the distance between the ground and blade tips by using turbines with the shortest possible blades and the highest possible hub height. This would reduce the number of species, and individual bats, potentially impacted upon by turbine blades during the operation phase. 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. Therefore, even though the rotor swept area of the 150 m hub height turbine is larger, the blades of these turbines will sweep to 50 m whereas the blades of the 90 m hub height turbine will sweep down to 35 m, making them likely to impact a greater number of bats. Therefore, the 90 m hub height turbine may have a greater impact to bats although based on the equivocal evidence presented in this report the confidence in this assessment is medium.

5 CONCLUSION

Compared to the previous impact assessment undertaken by Animalia, it is unlikely that the amendments to the turbine dimensions proposed for the Castle WEF would change (i.e. increase or decrease) the current rated impacts to bats. This is because they are already high before mitigation and low after mitigation. This is assuming that the mitigation measures proposed in the pre-construction bat monitoring report, and which are included in the EMPr, are adhered to.

These mitigation measures include firstly adhering to the sensitivity map and secondly implementing operational bat monitoring and assessing the need for curtailment. However, the buffer zones need to be updated to account for hub height and blade length which they did not previously. Provided this is achieved, no additional mitigation measures are required and no changes to the EMPr are required either. Bat activity was lower closer to the ground during the pre-construction monitoring, therefore the 150 m hub height turbine is the preferred option.

The amendment will not change the findings of the EIA report and no additional mitigation measures will be required.. The amendment is considered to be acceptable from a bats perspective, given that during micro-siting all turbines be located outside of the bat sensitivity buffer zones calculated according to the below formula.

$$b = \sqrt{(bd + bl)^2 - (hh - fh)^2}$$

Where: bd = buffer distance, bl = blade length, hh = hub height and fh = feature height (zero in this instance)

6 REFERENCES

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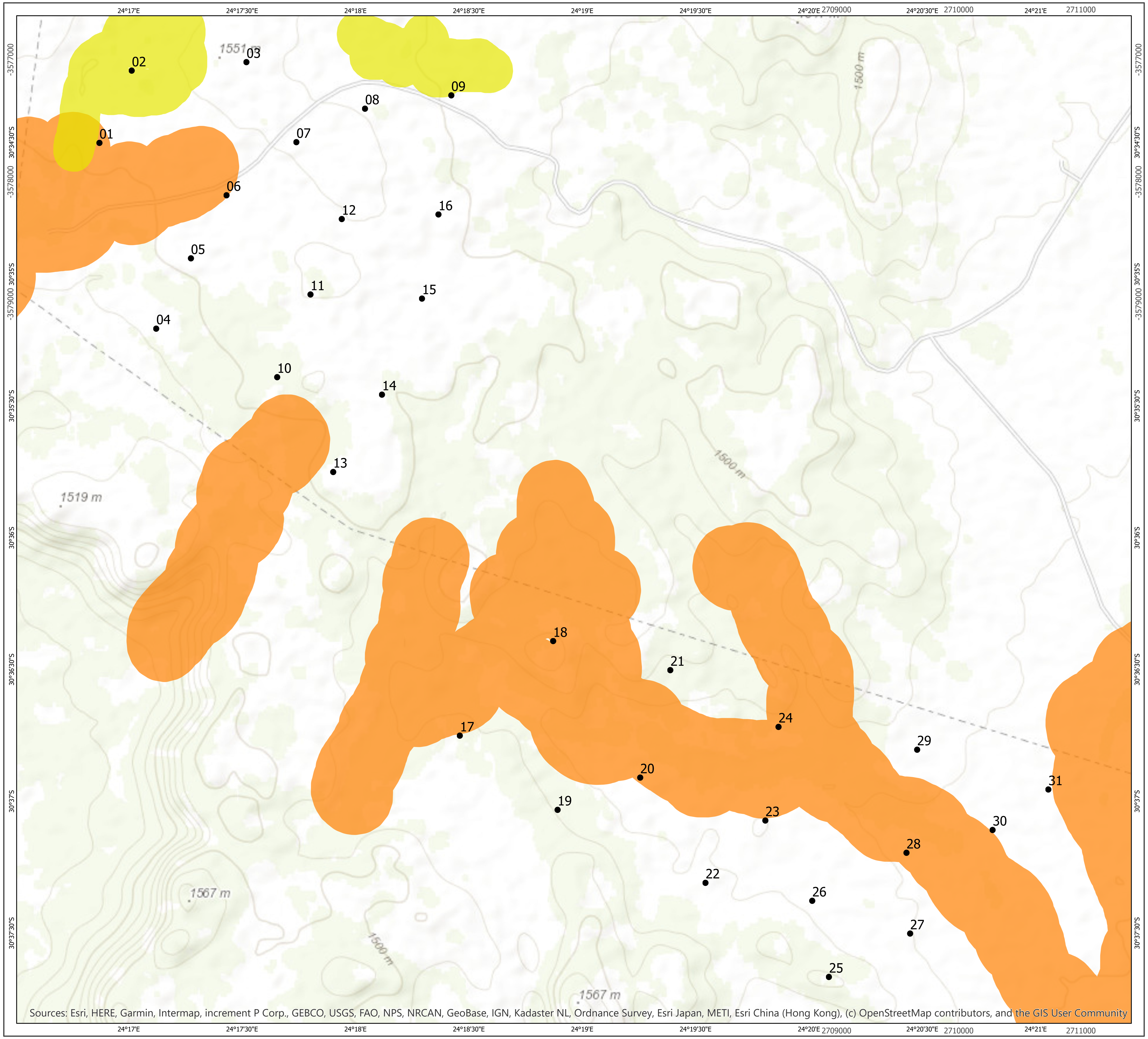

ARCUS

- Turbine Layout
- Moderate Bat Sensitivity 135m buffer
- High Bat Sensitivity 260m buffer

1:30 000 Scale @ A3

0 1 1 km

NORTH

Produced By: MB	Ref: 3324-REP-001
Checked By: JA	Date: 14/Jun/2019

Bat Sensitivity Map
Figure 1

Castle Wind Farm Amendment

Specialist Declaration

I, …Jonathan Aronson.................., as the appointed independent specialist, in terms of the 2014 EIA Regulations (as amended), hereby declare that I:

- I act as the independent specialist in this application;
- I perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I have no vested interest in the proposed activity proceeding;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- I have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- all the particulars furnished by me in this specialist input/study are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Name of Specialist: _Jonathan Aronson____

Date: _28 June 2019______________

CURRICULUM VITAE

Jonathan Aronson MSc Pr.Sci.Nat

Ecologist

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Specialisms

- Ecological Impact Assessments
- Pre-construction and Operational monitoring at wind energy developments
- Data analysis and statistical assessment of ecological data
- GIS mapping and Analysis

Summary of Experience

Jonathan has 12 years of experience studying and researching bats and has presented at the International Bat Research Conference and local bat workshops. He has been at the forefront of bats and wind energy research in South Africa and has worked on more than 40 WEF projects in South Africa, Kenya, Mozambique, Zambia and the UK undertaking pre-construction monitoring, operational monitoring, impact assessments and mitigation strategy design. He is a co-author of the Good Practise Guidelines for Surveying Bats at Wind Energy Facilities in South Africa, is the lead author on the operational monitoring guidelines for bats and is a founding member of the South African Bat Assessment Advisory Panel (SABAAP). He has experience managing wind energy facility projects including developing survey strategies, implementing field surveys, data analysis and report writing. He has provided extensive input to Environmental Impact Assessments (EIA) and post-construction Environmental Management Plans (EMP) for bats.

Professional History

2013 to current - Ecology Specialist, Arcus Consultancy Services Ltd, Cape Town
2011 to 2013 - Director, Gaia Environmental Services Pty (Ltd), Cape Town
2008 to 2008 - Research Assistant, Percy Fitzpatrick Inst. of African Ornithology, Cape Town

Qualifications and Professional Interests

- **University of Cape Town, 2009-2010**
  Msc Zoology
- **University of Cape Town, 2007**
  BSc (Hons) Freshwater Biology
- **University of Cape Town, 2003-2006**
  BSc Zoology
- Member of Society for Conservation Biology (2011 to present)
- South African Bat Assessment Advisory Panel (2013 to present)
- Professional Natural Scientist (Ecological Science) – SACNASP Registration #400238/14

Project Experience

<u>Bat Monitoring and Environmental Impact Assessments</u>

- Banna Ba Phifu Wind Energy Facility. Bat Monitoring (WKN Windcurrent SA (Pty) Ltd).
- Choje Wind Farm. Pre-construction bat monitoring (Wind Relic (Pty) Ltd).
- Kwagga Wind Energy Facility. Pre-construction bat monitoring (ABO Wind renewable energies (Pty) Ltd).
- Wind Farm in Zambia. Pre-construction bat monitoring (SLR Consulting).
- Namaacha Wind Farm. Pre-construction bat monitoring and EIA services in Mozambique (Consultec).
- West Coast One Wind Energy Facility. Post-construction Monitoring (Aurora Wind Power (RF) (Pty) Ltd).
- Beck Burn Wind Farm. Post-construction Monitoring. (EDF Energy).
- Fazakerly Waste Water Treatment Works. Post-construction Monitoring. (United Utilities).
- Paulputs Wind Energy Facility. 12 months pre-construction bat monitoring study (WKN Windcurrent SA (Pty) Ltd).
- Putsonderwater Wind Energy Facility. 12 months pre-construction bat monitoring study (WKN Windcurrent SA (Pty) Ltd).
- Zingesele Wind Energy Facility. 12 months pre-construction bat monitoring study (juwi Renewable Energies (Pty) Ltd).
- Highlands Wind Energy Facility. 12 months pre-construction bat monitoring study (WKN Windcurrent SA (Pty) Ltd).
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- Universal and Sonop Wind Energy Faculties. Pre-construction bat monitoring (JG Afrika).
- Kolkies and Karee Wind Energy Facility. 12 months pre-construction bat monitoring study (Mainstream Renewable Power South Africa).
- Komsberg East and West Wind Energy Facility. 12 months pre-construction bat monitoring study (African Clean Energy Developments Pty Ltd).

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- Gouda Wind Energy Facility. 24 months of operational monitoring for bats including activity and fatality surveys. (Blue Falcon 140 (Rf) Pty Ltd) and fatality surveys.
- Pofadder Wind Energy Facility. 12 months pre-construction bat monitoring study (Mainstream Renewable Power South Africa).
- Elliot Wind Energy Facility. Pre-construction bat monitoring study. (Rainmaker Energy).
- Hopefield Wind Farm. 12 months of operational monitoring for bats including activity (Umoya Energy).
- Spitskop West Wind Energy Facility. 12 months pre-construction bat monitoring study (RES Southern Africa/Gestamp).
- Spitskop East Wind Energy Facility. Analysis of 12 months of pre-construction bat monitoring data (RES Southern Africa).
- Patryshoogte Wind Energy Facility. Pre-construction bat monitoring study (RES Southern Africa).
- Swartberg Wind Energy Facility. 12 months pre-construction monitoring and surveys for the presence of bats roosting in farm buildings (CSIR).
- Clover Valley and Groene Kloof Wing Energy Facility. Arcus staff undertook 12 months of pre-construction bat monitoring which included acoustic surveys and mist-netting to catch bats. (Western Wind Energy).
- Spitskopvlakte Wind Energy Project. Arcus staff assisted with the implementation of a survey of bat activity on this site located near Laingsburg in the Western Cape. This work included acoustic monitoring at several locations including monitoring at height.

Ecological Surveys

- Killean Wind Farm. Bat acoustic surveys including a driven transect and commissioning of bat detectors for this proposed site in Scotland, UK. (Renewable Energy Systems Ltd).
- Maple Road, Tankersely. Bat acoustic surveys including a walked transect for this proposed site near Barnsley, UK (Rula Developments).

Due Diligence

- Due Diligence of Bat Monitoring at the Copperton Wind Enery Facility (SLR Consulting).
- Due Diligence of Bat Monitoring at the Kangas, Excelsior and Golden Valley Wind Farms (ERM).
- Due Diligence of Bat Monitoring at the Roggeveld Wind Farm (IBIS Consulting).

Amendment Applications

- Review and impact assessment for amendment to turbine dimensions for the Great Karoo Wind Energy Facility (Savannah Environmental (Pty) Ltd).
- Review and impact assessment for amendment to turbine dimensions for the Gunstfontein Wind Energy Facility (Savannah Environmental (Pty) Ltd).
- Review and impact assessment for amendment to turbine dimensions for the Komserberg East and West Wind Energy Facilities (Aurecon South Africa (Pty) Ltd).
- Review and impact assessment for amendment to turbine dimensions for the Soetwater Wind Energy Facility (Savannah Environmental (Pty) Ltd).
- Review and impact assessment for amendment to turbine dimensions for the Karusa Wind Energy Facility (Savannah Environmental (Pty) Ltd).
- Review and impact assessment for amendment to turbine dimensions for the Zen Wind Energy Facility (Savannah Environmental (Pty) Ltd).

Peer Review

- Peer Review for Three Bat Monitoring Reports for the Bokpoort II Solar Developments (Golder Associates)
- Peer Review of Operational Monitoring at the Jeffreys Bay Wind Farm, including updating the operational mitigation strategy for bats (Globeleq South Africa Management Services (Pty) Ltd).
- Oyster Bay Wind Energy Facility. Reviewing a pre-construction bat monitoring study and providing input into a stand-alone study (RES Southern Africa).
- Review and design mitigation strategies for bats at the Kinangop Wind Park, Kenya (African Infrastructure Investment Managers).

CURRICULUM VITAE

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Feasibility Studies

- Feasibility assessment for four potential wind farms in the Northern Cape (ABO Wind renewable energies (Pty) Ltd).
- Feasibility assessment for four potential wind farms in Mozambique (Ibis Consulting (Pty) Ltd).
- Assessment of the Feasibility of a Wind Farm in the Northern Cape (juwi Renewable Energies (Pty) Ltd).
- Assessment of the Feasibility of a Wind Farm in the Eastern Cape (WKN Windcurrent SA (Pty) Ltd).

Research Projects

- Darling National Demonstration Wind Farm Project. Designed and implemented a research project investigating bat fatality in the Western Cape.

Publications

- MacEwan, K., **Aronson, J.**, Richardson, E., Taylor, P., Coverdale, B., Jacobs, D., Leeuwner, L., Marais, W., Richards, L. South African Bat Fatality Threshold Guidelines for Operational Wind Energy Facilities – South African Bat Assessment Association (1st Edition).
- **Aronson, J.B.** and Sowler, S. (2016). Mitigation Guidance for Bats at Wind Energy Faculties in South Africa.
- **Aronson, J.B.**, Richardson, E.K., MacEwan, K., Jacobs, D., Marais, W., Aiken, S., Taylor, P., Sowler, S. and Hein, C (2014). South African Good Practise Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (1st Edition).
- Sowler, S. and S. Stoffberg (2014). South African Good Practise Guidelines for Surveying Bats in Wind Energy Facility Developments - Pre-Construction (3rd Edition). Kath Potgieter, K., MacEwan, K., Lötter, C., Marais, M., **Aronson, J.B**., Jordaan, S., Jacobs, D.S, Richardson, K., Taylor, P., Avni, J., Diamond, M., Cohen, L., Dippenaar, S., Pierce, M., Power, J. and Ramalho, R (eds).
- **Aronson, J.B.**, Thomas, A. and Jordaan, S. 2013. Bat fatality at a Wind Energy Facility in the Western Cape, South Africa. *African Bat Conservation News* 31: 9-12.

Workshops, Seminars and Courses

- The Ecosystem Approach and Systems Thinking Course, United Nationals Environment Programme, Currently undertaking.
- Why Carbon Footprinting Makes Business Sense, African Climate and Development Initiative Seminar, September 2016.
- The Age of Sustainable Development Course, The SDG Academy, 2016.
- Planetary Boundaries and Human Opportunities Course, The SDG Academy, 2015.
- Endangered Wildlife Trust (EWT) Bats and Wind Energy Training Course, October 2013.
- Ecological Networks Course, Kirstenbosch Botanical Gardens, July 2013.
- Social and Economic Network Analysis Course, online via Stanford University, 2013.
- Social Network Analysis Course, online via University of Michigan, 2013
- Introduction to Complexity Science Course, online via Santa Fe Institute, 2013.
- Introduction to Spatial Analysis using R, Kirstenbosch Botanical Gardens, May 2013.
- Google Geo Tools for Conservation, University of Cape Town, February 2013.
- Endangered Wildlife Trust (EWT) Bats and Wind Energy Training Course, January 2012
- Statistical Modelling Workshop for Biologists, University of Cape Town, September 2010.
- ESRI Virtual Campus Online GIS Courses, 2010.
- WAYS/ScholarShip IT Workshop: Remote Sensing and GIS Course, March 2009.