Great Karoo Wind Energy Facility: Updated Bird Impact Assessment

On behalf of

Savannah Environmental (Pty) Ltd

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Prepared By:

Arcus Consultancy Services

Office 220 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

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Specialists Declarations of Independence and Qualifications

Arcus are independent and have no business, financial or personal in the activity, application or appeal in respect of which it was appointed, other than fair remuneration for work carried out. There are no circumstances that compromise the objectivity of their specialists performing such work. Two qualified specialists provided input and co-authored the report.

Andrew Pearson is an Avifauna Specialist at Arcus and has a four year BSc in Conservation Ecology, certificates in Environmental Law, as well as eight years' experience as an environmental management professional. The findings, results, observations, conclusions and recommendations given in this report are based on this author's best scientific and professional knowledge as well as available information. The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNSP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith." Andrew is a professional member of the SACNSP, as detailed below:

Specialist:	Andrew Pearson (Pr.Sci.Nat)
Qualification:	BSc (hons) Conservation Ecology
Affiliation:	SACNASP
Registration number:	400423/11
Fields of Expertise:	Ecological Science
Registration:	Professional Member

Andrew Pearson (11 March 2016)

1 INTRODUCTION

1.1 Background

It is understood that Great Karoo Wind Farm (Pty) Ltd ('the Developer') received environmental authorisation (EA) for the construction of the Great Karoo Wind Energy Facility (WEF), near Sutherland, Northern Cape (previously part of the larger Hidden Valley WEF).

Savannah Environmental Pty Ltd (Savannah) conducted the Environmental Impact Assessment (EIA) study, and had previously appointed the Endangered Wildlife Trust (EWT) to conduct the specialist avifaunal assessment. The Avifaunal Impact Assessment report (EWT, 2012) was submitted with Final Environmental Impact Report (FEIR). Following submission of the Final Environmental Impact Report (FEIR) to the Department of Environmental Affairs (DEA) in 2012, it was requested by DEA that 4 seasons of site specific bird monitoring be conducted prior to Environmental Authorisation (EA) being issued, and for the baseline data to inform the final preconstruction monitoring report containing the updated assessment. The EWT was subsequently appointed to develop and implement such a monitoring programme and produced an updated avifaunal impact assessment, informed by 12 months of monitoring, as part of their final monitoring report (EWT, 2014).

The authorised layout (and the one which EWT (2014) based their assessment) consisted of 56 wind turbines each with a 120 m rotor diameter and a hub height of up to 120 m. The Developer is proposing to amend the EA to increase the maximum rotor diameter to 140 m, as well as changing the layout to one containing 52 turbines (Figure 1), each with a maximum generating capacity of up to 3.6 MW. The maximum turbine hub height will remain the same, and will be up to 120 m, meaning that the maximum ground to blade tip height would be 190 m.

1.2 Terms of Reference

Arcus have been appointed by Savannah to review the applicable bird information relating to the assessment of impacts for the Great Karoo WEF, and then to re-assess the impacts based on a change in rotor diameter and turbine layout. The reduced number of turbines in the layout, is an indirect result of the increased rated power, as this would allow more advanced and higher generating turbines to be used, requiring less turbines for the same MW output previously authorised. More specifically the report must reflect:

- An assessment of all impacts related to the proposed change and based on current information and understanding of WEF impacts in South Africa;
- Advantages and disadvantages associated with the proposed change; and
- Mitigation measures to ensure avoidance, management and mitigation of impacts.

2 METHODOLOGY

2.1 Document and Data Review

In order to understand the baseline avifauna environment as well as avifaunal issues relating to the project, Arcus reviewed the following documents, data and sources of information applicable to the Great Karoo WEF:

- Endangered Wildlife Trust (EWT), 2012. Hidden Valley Wind Energy Facility, Northern Cape. Avifaunal Impact Assessment EIA Report: February 2012
- EWT, 2014. Three Phased Hidden Valley Wind Energy Facility. Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment. April, 2014.

- The most recent data available online from the South African Bird Atlas Project 2 (SABAP2) of the Animal Demography Unit (ADU), University of Cape Town (UCT). These data were examined to identify if any additional priority species[1] and/or raptors have been recorded in the area covering and surrounding the project site, following the completion of the abovementioned studies.

2.2 Literature Review

In order to understand the mechanism resulting in bird collisions with wind turbines, and a resultant potential change with an increased rotor diameter and a reduced number of turbines, a brief literature review on this topic was conducted.

2.3 Impact Assessment

The applicable bird impacts, as identified and rated by EWT (2014), were evaluated and, where applicable, re-rated using the same criteria (Appendix 1) used in the original assessment, based on the proposed amendment to the project description.

3 REVIEW RESULTS

3.1 Original Avifaunal Impact Assessment for the Hidden Valley WEF (EWT, 2012).

The original assessment was done in February 2012, and was based on a detailed desk-based analysis of available data, as well as a site visit by the specialist over four days in August 2011. The key findings of this study can be summarised as follows:

- Identified avifaunal micro-habitats are cultivated lands, shrublands, dams, rivers, streams, drainage lines, hills, ridges and thickets.
- SABAP1 Data considered recorded Martial Eagle, Ludwig's Bustard, Black Stork, Greater Flamingo and Black Harrier. The former two species were relatively regularly recorded and abundant in this data set.
- 39 species were recorded during the site visit including the following priority species and/or raptors: Black Stork, Black-shouldered Kite, Jackal Buzzard, Pale Chanting Goshawk, Rock Kestrel, and Southern Black Korhaan.
- A list of 'target species' was identified as being "*the most important species to be considered (for assessment)*" and these were: Ludwig's Bustard, Black Stork, Southern Black Korhaan, Martial Eagle, Jackal Buzzard, Greater Flamingo, Lesser Kestrel, and assorted waterfowl and waders.
- In general, the site was found to be moderately sensitive in terms of avifauna.
- The most important potential impacts of the proposed development will be collision of certain bird species with the turbine blades, and collision of birds with the associated power lines.
- It was concluded by EWT (2012) that "*the proposed facility has the potential to significantly impact on avifauna in the area, although our confidence in this assessment is low due to the lack of operation experience of commercial scale wind farms in South Africa. There are no fatal flaws associated with the site, and the project should proceed subject to the mitigations, recommendations and conditions contained in this report*".
- One of the main recommendations was to implement a one year pre-construction monitoring programme to advise the final turbine layout.

[1] Species with a priority score of 170 or more, as calculated by Birdlife SA in the 2014 update: Retief, E.F, Diamond, M., Anderson, M.D., Smit, Dr. H.A., Jenkins Dr. A. & Brooks, M. 2011, updated 2014. Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures Used.

3.2 Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment for the Three Phased Hidden Valley Wind Energy Facility (EWT, 2014).

This study was conducted by the Endangered Wildlife Trust (EWT, 2014) on the Hidden Valley Wind energy Facility site, which subsequently has been re-named according to its various phases, one of which is the Great Karoo WEF. When interpreting this data, in the context of the current updated assessment specific only to the Great Karoo WEF, it is important to note that this study was conducted over a larger area comprising the three-phased Hidden Valley WEF. The data was not broken down in to the different phases, and therefore it can't be determined which data (if any) is only applicable and/or not applicable to the Great Karoo WEF.

The study was conducted in line with the applicable monitoring guidelines at the time, consisted of various sampling methods including walked transects, vehicle transects, vantage points and focal sites, and included four seasonal surveys across a 12 month period.

3.2.1 General

Appendix B of the EWT (2014) report included 149[2] species, including 20 priority species (Retief, *et.al.* 2011) and 9 Regional Red Data species (Barnes, 2000).

Of the priority species recorded, nine (five of which have Red Data Status-Taylor, 2015) were not recorded in the updated SABAP2 data examined (Section 3.3 of this report), namely Black Harrier (*Endangered*), Black Stork (*Vulnerable*) Blue Crane (*Near-threatened*), Black-shouldered Kite, Lanner Falcon (*Vulnerable*), African Harrier-hawk, Cape Eagle-Owl, African Rock Pipit (*Near-threatened*), and Black Sparrowhawk. Additional non-priority species raptors recorded were Rock Kestrel, Western Barn Owl, and Gabar Goshawk.

Monitors identified no less than five separate individual Martial Eagles across the entire site, including an unusual observation of four individual adults soaring in one location, and one juvenile in another location which allows 100% certainty of five Martial Eagles. It was suspected that Martial Eagle are breeding within the WEF, however a nest location could not be confirmed There were at least three Verreaux's Eagles, two adults and a juvenile utilizing the study site, although a nest site could not be located.

3.2.2 Walked Transect Data Summary

Species that were recorded in abundance by walked transect surveys included: Blacksmith Lapwing, Cape Wagtail, Cape Sparrow, Egyptian Goose, South African Shelduck, Spur-winged Goose, Ant-eating Chat, Bokmakierie, Cape Clapper Lark, Cape Bunting, Cape Weaver, Grey-backed Cisticola, Karoo Prinia, Large-billed Lark, Karoo Scrub-robin, White-throated Canary and Yellow Canary. The small terrestrial species that were recorded during the walk transects, were generally not threatened or restricted in range. The study found "*a low IKA* (Index of Kilometric Abundance) *of 1.23 priority species per kilometre observed on site"*. It stated the "*abundance of non-priority species on site is 88.73 birds per kilometre indicating a significantly larger abundance in comparison to priority species observed on walk transects".*

3.2.3 Vehicle Transect Data Summary

Pale Chanting Goshawk, Southern Black Korhaan, Rock Kestrel and Jackal Buzzard were the most abundant species observed on vehicle transects, and the report stated "*As a result of the low number of bird individuals recorded in the drive transects and the length of the*

[2] Arcus assumes that one of these species, the Red-winged Warbler, was a misidentification or typing error and therefore the actual number recorded is 148.

total transects required on this large site, the IKA's for priority species are considered to be low with the total abundance being 0.19 birds per km".

3.2.4 Flight Activity Summary

Flight activity data reported that there were 600 flights of priority species, representing 13 species[3], recorded of which 268 were within the potential rotor swept height (RSH).

The total flight duration of all priority species flights was 22 hours, of which 11 hours and 53 minutes was deemed to be at potential RSH. The average duration of flights was 2.6 ± 3 minutes, which is long in the experience of the specialist.

The species most regularly recorded flying from VP watches was Rock Kestrel (38 % of flights) followed by Verreaux's Eagle (19%), Jackal Buzzard (16%) and Martial Eagle 7%).

These four priority species with the highest number of individual flights also had more than 50% of their flights at potential RSH as does the Ludwig's Bustard. The Booted Eagle had 100% of its recorded flights (five in total) observed at RSH. The report therefore stated that "*These species are considered to be at high risk with turbine collision should turbines be placed in their preferred flight paths*."

An analysis of flight activity data against environmental factors concluded that "*flights are affected by temperature, no significant relationship was determined on the site for wind speed and wind direction*".

3.2.5 Sensitive Zones and Exclusion Zones

Based on flight activity and landscape features, the study identified sensitivity zones as follows:

- High sensitivity: The high sensitivity zones include the Rivers and Streams in the study area buffered by 150m on either side. These areas also include high sensitivity areas based on flight activity, and were called 'Exclusion Zones', it was stated that "*These areas have been considered in the final layout of the facility when positioning the wind turbines. The developer has complied with the EWTs recommendation that turbines positioned within these zones be moved, especially those along ridge edges, which should be moved 100m (or more) back from the ridge edge*."
- Medium Sensitivity: The medium sensitivity zones identified are farm dams as well as certain low risk ridges. EWT stated "*These dams and ridges were primarily identified at a desk top level while the presence were confirmed during the site visit as being potentially important to avifauna. However, construction of infrastructure is possible, with caution, in these areas with medium likelihood*."
- Low Sensitivity: These are the remaining areas where no obvious avifaunal features or patterns could be identified during the study. EWT stated that "*some areas could be designated as Medium in the future upon availability of new data and/or after additional site analysis or pre-construction monitoring*" and that "*there is no proven reason that infrastructure should not be built in these areas. Therefore, these Low sensitivity areas are preferred for construction*".

The study then summarised the sensitivity for each phase. It is must be noted that the following comment was made regarding two ridges in the north east of the Great Karoo WEF site: "*Limited bird flight data was collected in this area (i*.e. two parallel ridges running south-west to north-east*) due to access and limited viewshed, but it is predicted to be a potentially higher risk area from the model due to its suitable habitat*".

[3] As defined by EWT, 2014, and Including Gabar Goshawk and Rock Kestrel.

3.3 South African Bird Atlas Project Data

South African Bird Atlas Project Data (SABAP2) data[4] were examined by Arcus to identify recent reporting rates for priority species and raptors recorded in five Pentads (Figure 1); one containing proposed turbine locations (3245_2040) and four from surrounding pentads (3240_2040; 3240_2045; 3250_2035; and 3240_2050).

A total of 15 priority species or raptors were recorded by the SABAP2 data considered, of which one species (Rock Kestrel) is not a priority species (Table 1). Five regional Red Data (Taylor, 2015) priority species or raptors were recorded, including two classified as *Endangered*: Ludwig's Bustard and Martial Eagle. Priority species or raptors with relatively high reporting rates and/or recorded across three or more pentads considered were the Grey-winged Francolin, Jackal Buzzard, Karoo Korhaan, Southern Black Korhaan, Martial Eagle, Verreaux's Eagle, Spotted Eagle-owl, Pale Chanting Goshawk and Rock Kestrel. Of the species identified in Table 1, Black-chested Snake-eagle, Booted Eagle, Grey-winged Francolin, Rufous-breasted Sparrowhawk, Southern Black Korhaan and Verreaux's Eagle were not listed in the SABAP1 or SABAP2 data provided by EWT, 2012.

Table 1: Priority Species and Raptors Recorded in the SABAP2 Pentad Squares (accessed 09/03/2016)

Species	Priority Species Score	Regional Red Data Status	Pentad Report Rate (%)				
			3245_2040*	3240_2040	3240_2045	3250_2035	3240_2050
Total Species			53	62	77	76	50
Number of Cards Submitted[5]			2	5	12	9	3
Black-chested Snake-eagle	230	-	-	20	-	-	-
Booted Eagle	230	-	50	-	-	-	-
Grey-winged Francolin	190	-	50	40	83.3	-	-
Jackal Buzzard	250	-	50	80	58.3	55.6	100
Karoo Korhaan	240	NT	-	-	33.3	11.1	33.3
Lesser Kestrel	214	-	-	20	-	-	-
Ludwig's Bustard	320	EN	-	-	16.7	-	-
Martial Eagle	350	EN	-	40	25	22.2	-
Pale Chanting Goshawk	200	-	-	40	41.7	22.2	Ad hoc
Rock Kestrel	-	-	50	Ad hoc	58.3	55.6	66.7
Rufous-breasted Sparrowhawk	170	-	-	20	-	22.2	-
Spotted Eagle-owl	170	-	-	-	-	100	-
Southern Black Korhaan	270	VU	50	40	33.3	-	-

[4] http://sabap2.adu.org.za/ (Accessed 09/03/2016)

[5] Each time that birds in a pentad have been counted by a citizen scientist registered with the ADU, a pentad 'card' is submitted online to the ADU. The number of cards therefore indicate the number of times a pentad has been counted.

Species	Priority Species Score	Regional Red Data Status	Pentad Report Rate (%)				
			3245_2040*	3240_2040	3240_2045	3250_2035	3240_2050
Steppe Buzzard	210	-	-	60	16.7	-	-
Verreaux's Eagle	360	VU	50	-	8.3	-	66.7

** Pentads containing proposed Great Karoo WEF turbines. EN=Endangered; VU=Vulnerable; NT=Near-threatened*

3.4 Literature Review

Studies in America (NWCC, 2010) have indicated that relatively low raptor (e.g., hawks, eagles) fatality rates exist at most wind energy developments with the exception of some facilities in parts of California. All developments studied have reported fewer than 14 bird (all species combined) fatalities per MW per year, and most have reported less than 4 fatalities per MW per year (NWCC, 2010). Drewitt & Langston (2006) conducted a literature review and found that where bird collisions have been recorded, the rates per turbine are highly variable with averages ranging from 0.01 to 23 bird collisions annually.

Large turbines are more efficient, therefore most modern wind developments for a given number of megawatts have fewer turbines with wider spacing. However, wider and longer blades produce greater vortices and turbulence in their wake as they rotate, posing a potential problem for bats (and some birds). NWCC, 2010 explains that larger turbines have fewer rotations per minute but have similar blade tip speeds compared to the smaller turbines commonly used in older wind facilities It is believed this difference may be partly responsible for the lower raptor collision rates observed at most wind facilities where larger turbines have been installed, but that the main reason is because fewer larger turbines are needed to produce the same energy as smaller turbines. NWCC (2010) does note though that because the transition to larger turbines has largely coincided with a number of other transitions in turbine technology and siting practice, it is difficult to separate the individual effects and thereby determine the degree to which turbine size affects raptor collision rates.

It is likely that the level of bird use at the site and the behaviour of the birds at the site are more important factors to consider (than turbine size) when assessing potential risk. For example, raptor fatalities appear to increase as raptor abundance increases (NWCC, 2010) and certain species (e.g., Red-tailed Hawks and Golden Eagles) that forage for prey in close proximity to turbines appear to have increased fatalities, while others like Common Ravens appear to avoid collisions with turbines (NWCC, 2010).

Other studies (Barrios & Rodriguez, 2004; Stewart *et al.* 2007) also found that the size and alignment of turbines and rotor speed are likely to influence collision risk; however, physical structure is probably only significant in combination with other factors, especially wind speed, with moderate winds resulting in the highest risk. In fact, Barrios & Rodriguez (2004) found tower structure to have no effect on mortality, and that mortality may be directly related to abundance for certain species (e.g. Common Kestrel). They concluded that physical structures had little effect on bird mortality unless in combination with other factors. Somewhat conversely, De Lucas *et al.* 2008 found that turbine height and higher elevations may heighten the risk (taller/higher = higher risk), but that abundance was not directly related to collision risk, at least for Eurasian Griffon Vulture. De Lucas et al. 2008 stated "*All else being equal, more lift is required by a griffon vulture over a taller turbine at a higher elevation and we found that such turbines killed more vultures compared to shorter turbines at lower elevations*".

Howell *et al.*, 1997 found that the evidence to date from the Altamont Pass did not support the hypothesis that the larger rotor swept area (RSA) results in more mortalities. On the contrary it was found that the ratio of smaller to larger turbines rather than RSA was

consistent with the mortality ratio, and that it appeared that the mortality occurred on a per-turbine basis, i.e. that each turbine simply presented an obstacle.

Barclay *et al.* 2007 states "*Our analysis of the data available from North America indicates that this has had different consequences for the fatality rates of birds and bats at wind energy facilities. It might be expected that as rotor swept area increased, more animals would be killed per turbine, but our analyses indicates that this is not the case. Rotor-swept area was not a significant factor in our analyses. In addition, there is no evidence that taller turbines are associated with increased bird fatalities. The per turbine fatality rate for birds was constant with tower height*."

Krijgsveld *et al.* 2009 found that collision risk of birds with larger multi-MW wind turbines is similar to that with smaller earlier-generation turbines, and much lower than expected based on the large rotor surface and high altitude-range of modern turbines. Smallwood *et al.* 2013 found that Red-tailed hawk and all raptor fatality rates correlated inversely with increasing wind-turbine size.

Everaert, 2014 states *"Combined with the mortality rates of several wind farms in the Netherlands (in similar European lowland conditions near wetlands or other areas with water), no significant relationship could be found between the number of collision fatalities and the rotor swept area of the turbines. In contrast to more common landscapes, Hötker (2006) also found no significant relationship between mortality rate and the size of wind turbines near wetlands and mountain ridges."*

One would initially assume that a larger RSA would mean an increase in the risk of collision. In the case of Great Karoo WEF 56 turbines with a rotor diameter of 120m have a combined RSA of approximately 633,343.2 m2 (or ~63.33 ha), while 52 turbines with a rotor diameter of 140 m have a combined RSA of approximately 800,477.6 m2 (or ~80.05 ha). Although there are four less turbines, there is an increase in total RSA of approximately 16.7 ha. However, as can be seen from the above literature survey, most published findings indicate that rotor swept area is not a key factor in the collision risk. Turbine dimensions seem to play an insignificant role in the magnitude of the collision risk in general, relative to other factors such as topography, turbine location, turbine numbers, species abundance, morphology and a species' inherent ability to avoid the turbines, and may only be relevant in combination with other factors, particularly wind strength and topography. The reduction in turbine numbers is likely to be a more critical factor in the overall significance of the collision risk of a project.

4 IMPACT ASSESSMENT

EWT (2014) updated the avifaunal impact assessment done by EWT (2012), based on the findings of their pre-construction surveys for the following impacts:

- Construction Phase: Disturbance of birds and Habitat destruction.
- Operational Phase: Collision with turbines; Collision with associated overhead power lines; Electrocution on associated overhead power lines; Disturbance during operation and maintenance; and Disruption in local bird movement patterns.

The impact assessment (EWT, 2014) was done separately for each of the Hidden Valley WEF's three phases. Arcus therefore have only updated the assessment applicable to the Great Karoo WEF (Phase 3). The evaluation and re-rerating was done in order to determine if the proposed change in rotor diameter (and related reduction in the number of proposed turbines from 56 to 52) will have any impact on the significance of the findings previously identified by EWT (2014).

Selected impacts were re-rated for both 'Without Mitigation' and 'With Mitigation' scenarios and in specific relation to the revised 52 turbine layout, after examining this layout against the exclusion zones and sensitivities defined by EWT (2014) (see Figure 1). The specialist

has only re-rated the impacts that are directly related to the application for amendment, and as such the impacts related to the transmission lines have not been assessed in this report.

It was found that the new layout adhered to the recommendations and exclusion areas given by EWT (2014). Therefore, as was done by EWT (2014) this 'embedded design mitigation' was already considered in the 'Without Mitigation' rating.

Impacts were rated considering all current information pertinent to the development of the Great Karoo WEF, including (but not limited to) the change in rotor diameter and related reduction in the number of proposed turbines from 56 to 52.

There are currently up to 13 large scale Wind Energy Facilities (WEFs) operational in South Africa, and although operational monitoring data of the impacts on birds and bats are not yet readily accessible for all projects, some information exists (e.g. Smallie, 2015; NSS, 2014; Kuyler, 2004; Doty & Martin, 2012; Pers.Com. Sam Ralston (Birdlife SA)). This, together with the specialists' experience of monitoring at the operational Hopefield WEF, were considered when re-rating the impacts.

4.1.1 Construction Phase

4.1.1.1 Disturbance of Birds

Table 2: Impact Rating for Disturbance of Birds during Construction

Nature: Disturbance of birds during construction of Great Karoo Wind Farm. For shy or sensitive species this can impact on their usual daily activities, particularly whilst breeding.		
	Without mitigation	**With mitigation**
Extent	2 (local)	1 (local)
Duration	2 (short term)	2 (short term)
Magnitude	6 (moderate)	4 (low)
Probability	4 (most likely)	3 (probable)
Significance	**40 (Medium)**	**21 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	

Mitigation:

- Strict control should be maintained over all activities during construction, in particular heavy machinery and vehicle movements, and staff.
- Sensitive zones and exclusion zones (as identified by EWT, 2014) should be avoided where possible.
- Environmental measures will be detailed in the site specific EMP and will be enforced and overseen by the ECO for the project.
- Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule (in close proximity to the applicable sensitive location/s, if any are found), including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.
- The appointed Environmental Control Officer (ECO) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a

concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species or "Focal Species" (identified by EWT, 2014) are observed to be roosting and/or breeding in the vicinity, the avifaunal specialist is to be contacted for further instruction.

- It is recommended that a ridge survey is undertaken for the identification of nesting sites before construction.

4.1.1.2 Habitat destruction

Table 3: Impact Rating for Habitat Destruction during Construction

Nature: Destruction of habitats used by birds		
	Without mitigation	**With mitigation**
Extent	2 (local)	1 (local)
Duration	4 (long term)	4 (long term)
Magnitude	4 (low)	3 (minor-low)
Probability	5 (definite)	5 (definite)
Significance	**50 (Medium)**	**40 (Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	

Mitigation:

- Strict control over contractors, to ensure only the minimum required areas is cleared.
- No off-road driving.
- Minimize footprint areas, road lengths, road widths, wherever possible during the final layout design.
- Where possible existing roads must be used and batching plants, labour camps, equipment storage, etc. should be situated in areas that are already disturbed.
- A full site specific EMP must also be compiled to specify all of the impacts and mitigation measures and provide a step by step programme to follow for the ECO on site.
- Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible.
- Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded.
- Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist.
- Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within EMP.

4.1.2 Operational Phase

4.1.2.1 Collision with Turbines

Table 4: Impact Rating for Collision with Turbines during Operation.

Nature: Collision with turbines		
	Without mitigation	**With mitigation**
Extent	2 (Site- Impact will occur locally, but may have regional implications for certain species)	2 (Site- Impact will occur locally, but may have regional implications for certain species)
Duration	4 (long term)	4 (long term)
Magnitude	10 (very high)	10 (very high)
Probability	3 (probable)	3 (probable)
Significance	**48 (Medium)**	**48 (Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Possibly and only partially if the developer is willing to implement operational phase mitigation if issues are detected by monitoring.	
Mitigation:		

- The most important mitigation option is the correct positioning of turbines outside of the identified high sensitivity zones, and where possible, outside of the medium sensitivity zones. **This mitigation measure has already been undertaken and guided the final turbine layout and the high risk turbines were moved into medium/low sensitivity areas.**
- Develop and implement a carcass search programme for birds during the first two years of operation, in line with the South African monitoring guidelines.
- Develop and implement a 24 month post-construction bird activity monitoring program that mirrors the pre-construction monitoring surveys and is in line with the South African post-construction monitoring guidelines. This program must include thorough and ongoing nest searches and nest monitoring.
- Frequent and regular review of operational phase monitoring data (activity and carcass) and results by an avifaunal specialist. This review should also establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development.
- Additional available or potential mitigation options would need to be employed if operational monitoring reveals significant impacts. Some mitigation options that can be tested and employed if monitoring reveals significant numbers of collisions for particular species (in the opinion of the specialist and independent peer review), include: the installation of deterrent devices (e.g. DT Bird and ultrasonic/radar/electromagnetic deterrents for bats) to reduce collision risk; curtailment, i.e. shutting down certain turbines at certain times; and any others that may be identified as our understanding of the impacts progresses.

4.1.2.2 Disturbance during Operation and Maintenance

Table 5: Impact Rating for Disturbance during Operation and Maintenance.

Nature: Disturbance to birds during operation and maintenance		
	Without mitigation	**With mitigation**
Extent	1 (local)	1 (local)
Duration	4 (long term)	4 (long term)
Magnitude	5 (moderate-low)	4 (low)

Probability	3 (probable)	2 (improbable)
Significance	**30 (Medium)**	**18 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Medium	Medium
Irreplaceable loss of resources?	No	No
Can impacts be mitigated?	Partially	
Mitigation: • A site specific Operational Environmental Management Plan (OEMP) must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance. All contractors are to adhere to the OEMP and should apply good environmental practice during all operations. • The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possibly breeding by these species. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational Wind Farm, the nest/breeding site must not be disturbed and an avifaunal specialist must be contacted for further instruction. • Operational phase bird monitoring, in line with applicable guidelines, must be implemented and must include monitoring of all raptor nest sites for breeding success. • Strict control should be maintained over all maintenance activities, in particular heavy machinery and vehicle movements, and staff. • Operating procedures and maintenance schedules must be properly followed.		

4.1.2.3 Disruption in Local Bird Movement Patterns

Table 6: Impact Rating for Disruption in Local Bird Movement Patterns.

Nature: Disruption in local bird movement patterns		
	Without mitigation	**With mitigation**
Extent	3 (local-regional)	3 (local-regional)
Duration	4 (long term)	4 (long term)
Magnitude	5 (low-moderate)	5 (low-moderate)
Probability	3 (probable)	2 (some possibility)
Significance	**36 (Medium)**	**24 (Low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Partially, although this impact is not yet well understood, and difficult to mitigate for.	
Mitigation: • Turbines must not be constructed within any of the Exclusion zones identified by EWT (2014). • Lighting on turbines to be the minimum required, and to be of an intermittent and coloured nature rather than constant white light to reduce the possible impact on the movement patterns of nocturnal migratory species.		

4.1.3 Cumulative Impacts

EWT (2014) stated "*According to the DEA records of project applications, several of the properties surrounding and adjacent to the Hidden Valley site are currently in the process of applying or have been approved for environmental authorization for proposed*

developments. The cumulative effect of surrounding WEFs with the proposed Hidden Valley WEF will increase the significance of the following impacts: Collision with turbines; Impacts with overhead power lines; and Disruption in local bird movement patterns".

EWT (2014) only assesses the cumulative impact of these impacts and based their cumulative assessment on the assumption that 50% of the applications for the surrounding farm areas will be approved / have been approved (based on public information of applications). Since the EWT's assessment, more applications have been made and there are currently up to nine proposed large scale WEFs, in various stages of application or development, within approximately 50 km of the Great Karoo WEF. Included in these are two projects that already have preferred bidder status in the department of Energy's Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), and are due for imminent construction, namely Roggeveld Wind Farm (140 MW) and Karusa Wind Farm (140 MW), the latter of which was part of the originally proposed Hidden Valley WEF, and borders on Great Karoo WEF. Arcus have conducted a high level re-assessment of the cumulative impacts (identified by EWT (2014)), in tables 9 to 11, assuming that seven or more of the nine WEFs are constructed.

Table 7: Cumulative Impact Rating for Collision with Turbines.

Nature: Cumulative collision with turbines		
	Without mitigation	**With mitigation**
Extent	3 (regional)	3 (regional)
Duration	4 (long term)	4 (long term)
Magnitude	10 (very high)	10 (very high)
Probability	4 (highly probable)	4 (highly probable)
Significance	**68 (High)**	**68 (High)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Unknown.	
Confidence in Assessment	Low	

Although rated at a high level, and with low confidence, a detailed (and confident) significance rating of these cumulative impacts would depend largely on knowledge unavailable at the time of writing such as:

- The final turbine layouts of all facilities;
- If turbine placement was informed by adequate pre-construction monitoring and nest surveys (in line with applicable guidelines) on these facilities, and to what extent these layouts were in line with specialist recommendations;
- The density of the key species (e.g. Verreaux's Eagle, Martial Eagle, Ludwig's Bustard, Black Harrier and Blue Crane) populations on the facilities (i.e the regional population of these species), and there behaviour on the different sites.
- The species richness, abundance and behaviour of the avifaunal community within and around the various WEFs;
- Whether or not mitigation measures were recommended and implemented and are successful.

Table 8: Cumulative Impact Rating for Disruption in Local Bird Movement Patterns.

Nature: Cumulative impact of disruptions in local bird movement patterns		
	Without mitigation	**With mitigation**
Extent	3 (regional)	3 (regional)

Duration	4 (long term)	4 (long term)
Magnitude	6 (moderate)	4 (moderate)
Probability	4 (most likely)	3 (probable)
Significance	**52 (Medium)**	**33 (Medium)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Unlikely	Unlikely
Can impacts be mitigated?	Partially	
Confidence in Assessment	Low	

Conducting a detailed cumulative impact assessment of all of these facilities together on a regional scale is beyond the scope of this specialist study and would need the input of all proponents and specialists working on the above mentioned projects. Such an assessment is best undertaken and commissioned by an appropriate regional or national agency/agencies in the context of strategic planning, but is not required in the context of assessing this proposal. In the scope of this study it is therefore difficult to say with confidence at this stage what the cumulative impact of all the proposed developments will be on birds because there is no cumulative baseline to measure against. The extent of actual impacts on the region's avifauna will only become known once a few wind farms are developed in the Sutherland area and operational data becomes available, and regional population viability analysis have been conducted for key species.

If all proposed projects that are built implement appropriate mitigation measures as well as post-construction monitoring programmes (in line with applicable guidelines) and share the information gained from these, then the overall significance of the impacts in tables 7 and 8 may be reduced.

5 CONCLUSION

Arcus re-rated certain impacts and based the re-rating on all the current available information being a) the results and findings of EWT (2012) and EWT (2014); b) an examination of the updated SABAP2 data for the site; c) a literature review of the relationship between collision risk and turbine numbers and/or turbine dimensions; d) an increase of rotor diameter from 120 m to 140 m; e) a revised number of turbines, being 52 in total; f) the revised turbine positions; and g) latest information regarding actual impacts of operational WEFs in South Africa.

Although the increase in rotor diameter means a substantially larger potential risk area per turbine (known as the Rotor Swept Area- RSA), there is an indirect result of a reduced number of turbines (from 56 to 52). Published literature generally found that the number of turbines is a more important consideration when determining collision risk than the RSA or the turbine dimensions. It was also important to determine, and ensure, that the all turbines in the revised layout remained outside of the high sensitivity exclusion zones identified by EWT (2014). This was found to be the case.

We also provided more detailed mitigation measures along with those mitigation measures provided by the EWT (2014) which remain relevant. The updated mitigations, required for the project to proceed are shown in tables 2 to 6 and were considered when rating the residual impacts.

No additional impacts (i.e. that were not identified by EWT, 2014) due to the proposed changes were found.

A change in the 'With Mitigation' significance rating (i.e. the residual impact significance rating) following the updated assessment was found for the following impacts associated with the Great Karoo WEF:

- Disturbance of birds during construction changed from a score of 30 (Medium) to 21 (Low).
- Disruption of local bird movement patterns changed from a score of 36 (Medium) to 24 (Low).

It was concluded that the significance of the majority of impacts (following the re-rating) remained the same. Importantly, the predicted turbine collision impact significance score during operation remained the same at 48 (Medium).

However, while the 'With Mitigation' significance of the cumulative impact in the disruption of local bird movement patterns remained the same, the ratings increased[6] for the cumulative impacts of collisions with turbines. Cumulative impacts of collisions with turbines is now rated as High Negative, although our confidence in this cumulative rating is low.

Given the uncertainty surrounding cumulative impacts of WEFs on avifauna, and the number of proposed developments within the 'Sutherland hub' a strategic assessment of the impact that multiple projects in this area could have on key species (e.g. Verreaux's Eagle, Martial Eagle and Ludwig's Bustard) should be undertaken outside of this EIA process and should include a population analysis of the regional Verreaux's Eagle population as well as some level of collision risk modelling or predictions for this population. Such a detailed, high level study is best undertaken (or commissioned) by an appropriate regional or national agencies, as it would be applicable to a multitude of projects in the region. The Great Karoo WEF project may proceed, prior to such a study being conducted, if all the mitigations and recommendations are implemented, and monitoring data (including operational monitoring data) is made available to the relevant agencies, including Birdlife SA and the EWT, (i.e. valuable operational monitoring data collected at the Great Karoo WEF would be fed into such a strategic study if commissioned). The Specialist will, outside of the scope of this report, engage with the appropriate stakeholders in the context of strategic planning regarding the commissioning of such a study.

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[6] This is primarily due to additional projects now being proposed. It is possible that this was due to a difference in understanding of the impact rating criteria. Inconsistencies in the application of the rating criteria by EWT (2014) were noted.

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APPENDIX 1: IMPACT ASSESSMENT METHODOLOGY.

Assessment of Impacts

Direct, indirect and cumulative impacts of the issues identified through the scoping study, as well as all other issues identified in the EIA phase must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **consequences (magnitude)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- the **status**, which will be described as either positive, negative or neutral.
- the degree to which the impact can be reversed.
- the degree to which the impact may cause irreplaceable loss of resources.
- the *degree* to which the impact can be *mitigated.*

The **significance** is calculated by combining the criteria in the following formula:
S=(E+D+M)P
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),

» 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

Assessment of impacts must be summarised in the following table format. The rating values as per the above criteria must also be included. Complete a table and associated ratings for **each** impact identified during the assessment.

Example of Impact table summarising the significance of impacts (with and without mitigation)

Nature: **[Outline and describe fully the impact anticipated as per the assessment undertaken]**		
	Without mitigation	**With mitigation**
Extent	High (3)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Low (4)
Probability	Probable (3)	Probable (3)
Significance	**Medium (36)**	**Low (24)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	Yes
Mitigation: "Mitigation", means to anticipate and prevent negative impacts and risks, then to minimise them, rehabilitate or repair impacts to the extent feasible. Provide a description of how these mitigation measures will be undertaken keeping the above definition in mind.		