# AVIFAUNAL IMPACT ASSESSMENT
# Upgrades to the Modderfontein Wind Energy Facility, located in the Beaufort West REDZ - Part 2 Amendment Application

## APPLICATION FOR AMENDMENT OF ENVIRONMENTAL AUTHORISATION

Report compiled by:
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# EXECUTIVE SUMMARY

The purpose of this addendum report is to revisit the findings and recommendations of the avifaunal impact assessment for the proposed Modderfontein Wind Energy Facility (WEF) near Victoria West in the Northern and Western Cape (Avisense 2011), on the basis of a proposed amendment to the environmental authorisation via a Part 2 Amendment Application. The proposed changes are provided in **Error! Reference source not found.** below.

***Table 1: Proposed turbine dimensions***

| Aspect | Authorised | Proposed amendment |
|---|---|---|
| **Tower height** | Between 80m and 125m | Hub height: Up to 119m |
| **Rotor diameter** | Between 90m and 110m (55m blades) | Up to 162m (81m blades) |
| **Total height** | Up to 180m (55m blade plus 125m tower) | Up to 200m (81m blade plus 119m tower) |
| **Number** | 67 turbines with generating capacity of up to 3MW | 34 turbines with generating capacity of up to 5.6MW |

The turbine footprint and foundation size will remain largely unchanged.

Given the potential changes to the turbine specifications and quantity, a re-assessment of the potential turbine collision impact was carried out for purposes of the proposed amendment, to establish (i) if the original pre-mitigation risk assessment rating by Jenkins (2011) is still valid in light of a decade of subsequent experience, and (ii) if the original mitigation measures need to be revised to reduce post-mitigation impact rating to **Low,** i.e. to acceptable levels.

The Preferred Alternative amounts to a 49% reduction in the number of turbines, and a 10% increase in total rotor swept area. However, given the proximity of five (5) confirmed Verreaux's Eagles nests within 5.2km of the proposed development, and the benefit of a decade of experience gained since the original assessment was conducted in 2011, it is concluded that the original pre-mitigation impact significance rating of **Medium-High** for the collision risk that the No-Go Alternative (67 turbines) pose to avifauna was too low, and should have been **High – Very High**. The pre-mitigation rating of the Preferred Alternative (34 turbines) is still **Medium - High.**

It is further concluded that the recommendations formulated by Jenkins (2011), which are incorporated in the EA, remain valid for the Preferred Alternative, but need to be supplemented in order for the post-mitigation rating to be reduced to **Low.** The following additional mitigation measures are proposed:

1. All the turbines should have one blade painted black or red (depending on which colour is approved by the Civil Aviation Authority) for two thirds from the tip of the blade. This implies that the developer will have to engage with turbine manufacturers to come up with a design that will comply with all relevant industry and aviation standards.
2. No turbines should be constructed within a 3.7km circular buffer zone around any Verreaux's Eagle nest. This has already been implemented in the Preferred Alternative (see Figure 3).
3. Turbines in the circular 5.2km medium-risk buffer zone should be reduced to an absolute minimum. Any turbines remaining in the Verreaux's Eagle 5.2km medium-risk circular buffer zones should be

subject to pro-active mitigation in the form of a proven mitigation method such as Shutdown on Demand (SDoD), using either biomonitors or an automated system such a IdentiFlight.

## Concluding statement

The Preferred Alternative is a significant improvement on the No-Go alternative as far as impacts and avifauna is concerned and should reduce the expected pre-mitigation impacts from **High to Very High for the No-Go Alternative** to **Medium to High for the Preferred Alternative**. However, additional mitigation measures are required to reduce the post mitigation impacts of the **Preferred Alternative to Low, i.e. to acceptable levels.**

The proposed amendment is supported from an avifaunal impact perspective, provided the additional mitigation measures proposed in this report are implemented.

# Curriculum vitae: Chris van Rooyen

Profession/Specialisation : Avifaunal Specialist
Highest Qualification : BA LLB
Nationality : South African
Years of experience : 22 years

## Key Experience

Chris van Rooyen has twenty-four years' experience in the assessment of avifaunal interactions with industrial infrastructure. He was employed by the Endangered Wildlife Trust as head of the Eskom-EWT Strategic Partnership from 1996 to 2007, which has received international acclaim as a model of co-operative management between industry and natural resource conservation. He is an acknowledged global expert in this field and has consulted in South Africa, Namibia, Botswana, Lesotho, New Zealand, Texas, New Mexico and Florida. He also has extensive project management experience and he has received several management awards from Eskom for his work in the Eskom-EWT Strategic Partnership. He is the author and/or co-author of 17 conference papers, co-author of two book chapters, several research reports and the current best practice guidelines for avifaunal monitoring at wind farm sites. He has completed around 130 power line assessments; and has to date been employed as specialist avifaunal consultant on more than 50 renewable energy generation projects. He has also conducted numerous risk assessments on existing power lines infrastructure. He also works outside the electricity industry and he has done a wide range of bird impact assessment studies associated with various residential and industrial developments. He serves on the Birds and Wind Energy Specialist Group which was formed in 2011 to serve as a liaison body between the ornithological community and the wind industry.

## Key Project Experience

**Bird Impact Assessment Studies and avifaunal monitoring for wind-powered generation facilities:**

1. Eskom Klipheuwel Experimental Wind Power Facility, Western Cape
2. Mainstream Wind Facility Jeffreys Bay, Eastern Cape (EIA and monitoring)
3. Biotherm, Swellendam, (Excelsior), Western Cape (EIA and monitoring)
4. Biotherm, Napier, (Matjieskloof), Western Cape (pre-feasibility)
5. Windcurrent SA, Jeffreys Bay, Eastern Cape (2 sites) (EIA and monitoring)
6. Caledon Wind, Caledon, Western Cape (EIA)
7. Innowind (4 sites), Western Cape (EIA)
8. Renewable Energy Systems (RES) Oyster Bay, Eastern Cape (EIA and monitoring)
9. Oelsner Group (Kerriefontein), Western Cape (EIA)
10. Oelsner Group (Langefontein), Western Cape (EIA)
11. InCa Energy, Vredendal Wind Energy Facility Western Cape (EIA)
12. Mainstream Loeriesfontein Wind Energy Facility (EIA and monitoring)
13. Mainstream Noupoort Wind Energy Facility (EIA and monitoring)
14. Biotherm Port Nolloth Wind Energy Facility (Monitoring)
15. Biotherm Laingsburg Wind Energy Facility (EIA and monitoring)
16. Langhoogte Wind Energy Facility (EIA)
17. Vleesbaai Wind Energy Facility (EIA and monitoring)
18. St. Helena Bay Wind Energy Facility (EIA and monitoring)
19. Electrawind, St Helena Bay Wind Energy Facility (EIA and monitoring)
20. Electrawind, Vredendal Wind Energy Facility (EIA)
21. SAGIT, Langhoogte and Wolseley Wind Energy facilities
22. Renosterberg Wind Energy Project – 12-month preconstruction avifaunal monitoring project
23. De Aar – North (Mulilo) Wind Energy Project – 12-month preconstruction avifaunal monitoring project
24. De Aar – South (Mulilo) Wind Energy Project – 12-month bird monitoring
25. Namies – Aggenys Wind Energy Project – 12-month bird monitoring
26. Pofadder - Wind Energy Project – 12-month bird monitoring
27. Dwarsrug Loeriesfontein - Wind Energy Project – 12-month bird monitoring
28. Waaihoek – Utrecht Wind Energy Project – 12-month bird monitoring
29. Amathole – Butterworth Utrecht Wind Energy Project – 12-month bird monitoring & EIA specialist

30. Phezukomoya and San Kraal Wind Energy Projects 12-month bird monitoring & EIA specialist study (Innowind)
31. Beaufort West Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
32. Leeuwdraai Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mainstream)
33. Sutherland Wind Energy Facility 12-month bird monitoring (Mainstream)
34. Maralla Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
35. Esizayo Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
36. Humansdorp Wind Energy Facility 12-month bird monitoring & EIA specialist study (Cennergi)
37. Aletta Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
38. Eureka Wind Energy Facility 12-month bird monitoring & EIA specialist study (Biotherm)
39. Makambako Wind Energy Faclity (Tanzania) 12-month bird monitoring & EIA specialist study (Windlab)
40. R355 Wind Energy Facility 12-month bird monitoring (Mainstream)
41. Groenekloof Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
42. Tsitsikamma Wind Energy Facility 24-months post-construction monitoring (Cennergi)
43. Noupoort Wind Energy Facility 24-months post-construction monitoring (Mainstream)
44. Kokerboom Wind Energy Facility 12-month bird monitoring & EIA specialist study (Business Venture Investments)
45. Kuruman Wind Energy Facility 12-month bird monitoring & EIA specialist study (Mulilo)
46. Dassieklip Wind Energy Facility 3 years post-construction monitoring (Biotherm)
47. Loeriesfontein 2 Wind Energy Facility 2 years post-construction monitoring (Mainstream)
48. Khobab Wind Energy Facility 2 years post-construction monitoring (Mainstream)
49. Excelsior Wind Energy Facility 18 months construction phase monitoring (Biotherm)
50. Boesmansberg Wind Energy Facility 12-months pre-construction bird monitoring (juwi)
51. Mañhica Wind Energy Facility, Mozambique, 12-months pre-construction monitoring (Windlab)
52. Kwagga Wind Energy Facility, Beaufort West, 12-months pre-construction monitoring (ABO)
53. Pienaarspoort Wind Energy Facility, Touws River, Western Cape, 12-months pre-construction monitoring (ABO).
54. Koup 1 and 2 Wind Energy Facilities, Beaufort West, Western Cape, 12 months pre-construction monitoring

**Bird Impact Assessment Studies for Solar Energy Plants:**

1. Concentrated Solar Power Plant, Upington, Northern Cape.
2. Globeleq De Aar and Droogfontein Solar PV Pre- and Post-construction avifaunal monitoring
3. JUWI Kronos PV project, Copperton, Northern Cape
4. Sand Draai CSP project, Groblershoop, Northern Cape
5. Biotherm Helena PV Project, Copperton, Northern Cape
6. Biotherm Letsiao CSP Project, Aggeneys, Northern Cape
7. Biotherm Enamandla PV Project, Aggeneys, Northern Cape
8. Biotherm Sendawo PV Project, Vryburg, North-West
9. Biotherm Tlisitseng PV Project, Lichtenburg, North-West
10. JUWI Hotazel Solar Park Project, Hotazel, Northern Cape
11. Namakwa Solar Project, Aggeneys, Northern Cape
12. Brypaal Solar Power Project, Kakamas, Northern Cape
13. ABO Vryburg 1,2,3 Solar PV Project, Vryburg, North-West
14. NamPower CSP Facility near Arandis, Namibia
15. Dayson Klip PV Facility near Upington, Northern Cape
16. Geelkop PV Facility near Upington, Northern Cape

**Bird Impact Assessment Studies for the following overhead line projects:**

1. Chobe 33kV Distribution line
2. Athene - Umfolozi 400kV
3. Beta-Delphi 400kV
4. Cape Strengthening Scheme 765kV
5. Flurian-Louis-Trichardt 132kV
6. Ghanzi 132kV (Botswana)

7. Ikaros 400kV
8. Matimba-Witkop 400kV
9. Naboomspruit 132kV
10. Tabor-Flurian 132kV
11. Windhoek - Walvisbaai 220 kV (Namibia)
12. Witkop-Overyssel 132kV
13. Breyten 88kV
14. Adis-Phoebus 400kV
15. Dhuva-Janus 400kV
16. Perseus-Mercury 400kV
17. Gravelotte 132kV
18. Ikaros 400 kV
19. Khanye 132kV (Botswana)
20. Moropule – Thamaga 220 kV (Botswana)
21. Parys 132kV
22. Simplon –Everest 132kV
23. Tutuka-Alpha 400kV
24. Simplon-Der Brochen 132kV
25. Big Tree 132kV
26. Mercury-Ferrum-Garona 400kV
27. Zeus-Perseus 765kV
28. Matimba B Integration Project
29. Caprivi 350kV DC (Namibia)
30. Gerus-Mururani Gate 350kV DC (Namibia)
31. Mmamabula 220kV (Botswana)
32. Steenberg-Der Brochen 132kV
33. Venetia-Paradise T 132kV
34. Burgersfort 132kV
35. Majuba-Umfolozi 765kV
36. Delta 765kV Substation
37. Braamhoek 22kV
38. Steelpoort Merensky 400kV
39. Mmamabula Delta 400kV
40. Delta Epsilon 765kV
41. Gerus-Zambezi 350kV DC Interconnector: Review of proposed avian mitigation measures for the Okavango and Kwando River crossings
42. Giyani 22kV Distribution line
43. Liqhobong-Kao 132/11kV distribution power line, Lesotho
44. 132kV Leslie – Wildebeest distribution line
45. A proposed new 50 kV Spoornet feeder line between Sishen and Saldanha
46. Cairns 132kv substation extension and associated power lines
47. Pimlico 132kv substation extension and associated power lines
48. Gyani 22kV
49. Matafin 132kV
50. Nkomazi_Fig Tree 132kV
51. Pebble Rock 132kV
52. Reddersburg 132kV
53. Thaba Combine 132kV
54. Nkomati 132kV
55. Louis Trichardt – Musina 132kV
56. Endicot 44kV
57. Apollo Lepini 400kV
58. Tarlton-Spring Farms 132kV
59. Kuschke 132kV substation
60. Bendstore 66kV Substation and associated lines
61. Kuiseb 400kV (Namibia)
62. Gyani-Malamulele 132kV
63. Watershed 132kV
64. Bakone 132kV substation
65. Eerstegoud 132kV LILO lines
66. Kumba Iron Ore: SWEP - Relocation of Infrastructure
67. Kudu Gas Power Station: Associated power lines

68. Steenberg Booysendal 132kV
69. Toulon Pumps 33kV
70. Thabatshipi 132kV
71. Witkop-Silica 132kV
72. Bakubung 132kV
73. Nelsriver 132kV
74. Rethabiseng 132kV
75. Tilburg 132kV
76. GaKgapane 66kV
77. Knobel Gilead 132kV
78. Bochum Knobel 132kV
79. Madibeng 132kV
80. Witbank Railway Line and associated infrastructure
81. Spencer NDP phase 2 (5 lines)
82. Akanani 132kV
83. Hermes-Dominion Reefs 132kV
84. Cape Pensinsula Strengthening Project 400kV
85. Magalakwena 132kV
86. Benficosa 132kV
87. Dithabaneng 132kV
88. Taunus Diepkloof 132kV
89. Taunus Doornkop 132kV
90. Tweedracht 132kV
91. Jane Furse 132kV
92. Majeje Sub 132kV
93. Tabor Louis Trichardt 132kV
94. Riversong 88kV
95. Mamatsekele 132kV
96. Kabokweni 132kV
97. MDPP 400kV Botswana
98. Marble Hall NDP 132kV
99. Bokmakiere 132kV Substation and LILO lines
100. Styldrift 132kV
101. Taunus – Diepkloof 132kV
102. Bighorn NDP 132kV
103. Waterkloof 88kV
104. Camden – Theta 765kV
105. Dhuva – Minerva 400kV Diversion
106. Lesedi –Grootpan 132kV
107. Waterberg NDP
108. Bulgerivier – Dorset 132kV
109. Bulgerivier – Toulon 132kV
110. Nokeng-Fluorspar 132kV
111. Mantsole 132kV
112. Tshilamba 132kV
113. Thabamoopo - Tshebela – Nhlovuko 132kV
114. Arthurseat 132kV
115. Borutho 132kV MTS
116. Volspruit - Potgietersrus 132kV
117. Neotel Optic Fibre Cable Installation Project: Western Cape
118. Matla-Glockner 400kV
119. Delmas North 44kV
120. Houwhoek 11kV Refurbishment
121. Clau-Clau 132kV
122. Ngwedi-Silwerkrans 134kV
123. Nieuwehoop 400kV walk-through
124. Booysendal 132kV Switching Station
125. Tarlton 132kV
126. Medupi - Witkop 400kV walk-through
127. Germiston Industries Substation
128. Sekgame 132kV
129. Botswana – South Africa 400kV Transfrontier Interconnector

130. Syferkuil – Rampheri 132kV
131. Queens Substation and associated 132kV powerlines
132. Oranjemond 400kV Transmission line
133. Aries – Helios – Juno walk-down
134. Kuruman Phase 1 and 2 Wind Energy facilities 132kV Grid connection
135. Transnet Thaba 132kV

**Bird Impact Assessment Studies for the following residential and industrial developments:**

1. Lizard Point Golf Estate
2. Lever Creek Estates
3. Leloko Lifestyle Estates
4. Vaaloewers Residential Development
5. Clearwater Estates Grass Owl Impact Study
6. Sommerset Ext. Grass Owl Study
7. Proposed Three Diamonds Trading Mining Project (Portion 9 and 15 of the Farm Blesbokfontein)
8. N17 Section: Springs To Leandra –“Borrow Pit 12 And Access Road On (Section 9, 6 And 28 Of The Farm Winterhoek 314 Ir)
9. South African Police Services Gauteng Radio Communication System: Portion 136 Of The Farm 528 Jq, Lindley.
10. Report for the proposed upgrade and extension of the Zeekoegat Wastewater Treatment Works, Gauteng.
11. Bird Impact Assessment for Portion 265 (a portion of Portion 163) of the farm Rietfontein 189-JR, Gauteng.
12. Bird Impact Assessment Study for Portions 54 and 55 of the Farm Zwartkop 525 JQ, Gauteng.
13. Bird Impact Assessment Study Portions 8 and 36 of the Farm Nooitgedacht 534 JQ, Gauteng.
14. Shumba’s Rest Bird Impact Assessment Study
15. Randfontein Golf Estate Bird Impact Assessment Study
16. Zilkaatsnek Wildlife Estate
17. Regenstein Communications Tower (Namibia)
18. Avifaunal Input into Richards Bay Comparative Risk Assessment Study
19. Maquasa West Open Cast Coal Mine
20. Glen Erasmia Residential Development, Kempton Park, Gauteng
21. Bird Impact Assessment Study, Weltevreden Mine, Mpumalanga
22. Bird Impact Assessment Study, Olifantsvlei Cemetery, Johannesburg
23. Camden Ash Disposal Facility, Mpumalanga
24. Lindley Estate, Lanseria, Gauteng
25. Proposed open cast iron ore mine on the farm Lylyveld 545, Northern Cape
26. Avifaunal monitoring for the Sishen Mine in the Northern Cape as part of the EMPr requirements
27. Steelpoort CNC Bird Impact Assessment Study

## Professional affiliations

I work under the supervision of and in association with Albert Froneman (MSc Conservation Biology) (SACNASP Zoological Science Registration number 400177/09) as stipulated by the Natural Scientific Professions Act 27 of 2003.

Chris van Rooyen

Chris van Rooyen
06 July 2021

# 1 Background

The purpose of this addendum report is to revisit the findings and recommendations of the avifaunal impact assessment for the proposed Modderfontein Wind Energy Facility (WEF) near Victoria West in the Northern and Western Cape (Avisense 2011), on the basis of a proposed amendment to the environmental authorisation via a Part 2 Amendment Application. The proposed changes are provided in **Error! Reference source not found.** below.

***Table 2: Proposed turbine dimensions***

| Aspect | Authorised | Proposed amendment |
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| **Number** | 67 turbines with generating capacity of up to 3MW | 34 turbines with generating capacity of up to 5.6MW |

The turbine footprint and foundation size will remain largely unchanged.

# 2 Terms of Reference

Due to the proposed changes in **Error! Reference source not found.**, and in accordance with the National Environmental Management Act, 1988 (No. 107 of 1998) (NEMA), a re-assessment of potential impacts on the associated avifauna is required to be undertaken before an Amendment to Environmental Authorisation can be granted for the revised WEF development. **The impact which is specifically relevant in this instance is the risk of priority species mortality due to collisions with the turbines.**

The Terms of Reference (ToR) for this addendum report are as follows:

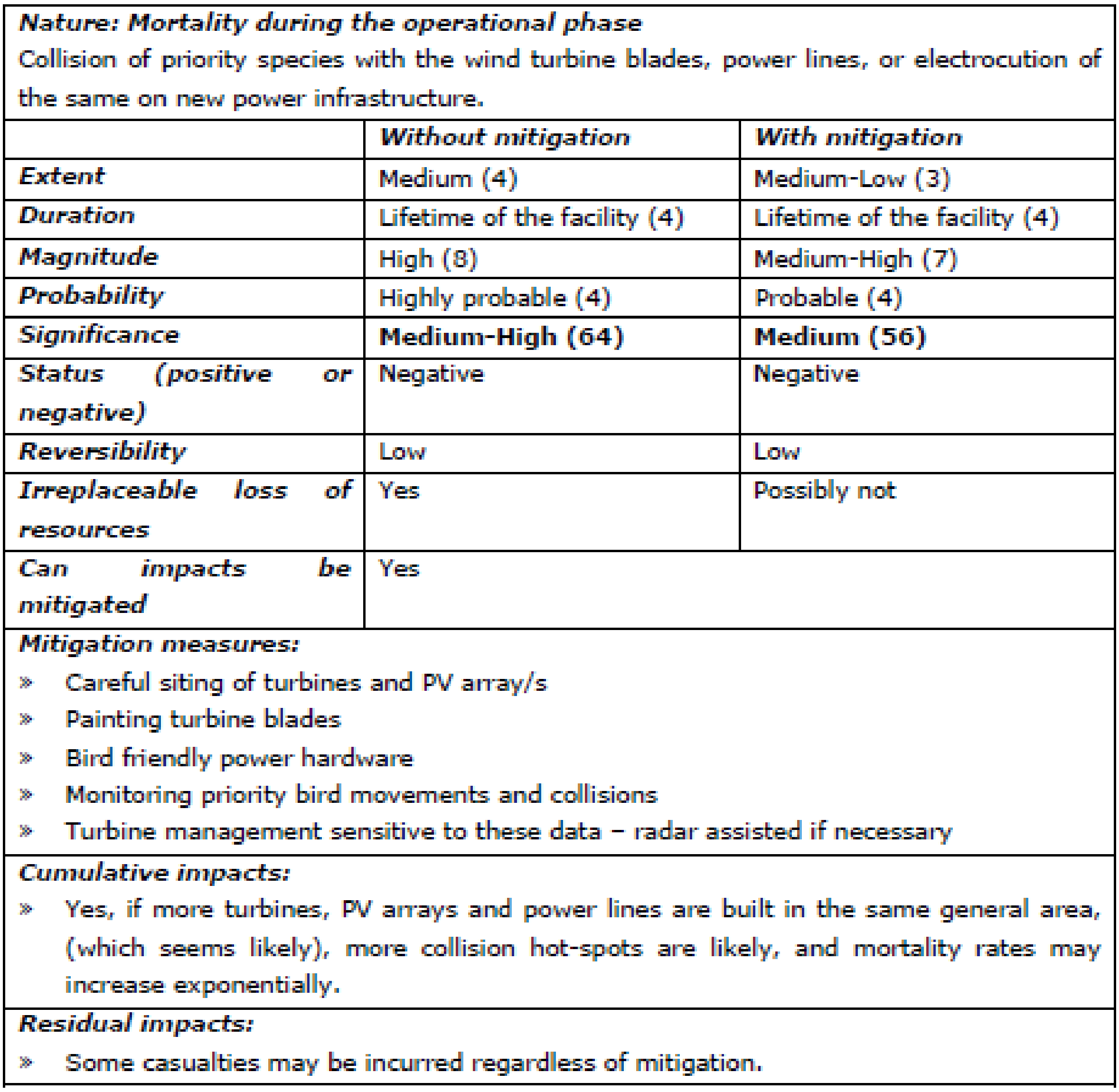
- Assess the impacts related to the proposed change from the authorised turbine specifications (if any);
- Assess advantages or disadvantages of the proposed change in turbine specifications and quantity; and
- Identify additional or changes to the mitigation measures required to avoid, manage or mitigate the impacts associated with the proposed changes in turbine specifications and quantity.

# 3 The findings of the original bird impact assessment reports

The original Bird Specialist Study (Avisense 2011) identified the risk (**Table 3**) of bird mortality due to collisions with the wind turbines and power lines, and electrocution on the new power infrastructure.

The key species identified in the original Bird Specialist Study as being most at risk of these impacts were raptors, namely Verreaux's Eagle, Martial Eagle, Tawny Eagle, Secretarybird, Lesser Kestrel and possibly Booted Eagle, Black Harrier, Peregrine Falcon and Lanner Falcon. The impacts were rated as **Medium – High** pre-mitigation, and **Medium** post mitigation (see Table 2).

***Table 3: Original bird collision risk rating***



| ***Nature: Mortality during the operational phase***<br>Collision of priority species with the wind turbine blades, power lines, or electrocution of the same on new power infrastructure. | | |
|---|---|---|
| | ***Without mitigation*** | ***With mitigation*** |
| ***Extent*** | Medium (4) | Medium-Low (3) |
| ***Duration*** | Lifetime of the facility (4) | Lifetime of the facility (4) |
| ***Magnitude*** | High (8) | Medium-High (7) |
| ***Probability*** | Highly probable (4) | Probable (4) |
| ***Significance*** | **Medium-High (64)** | **Medium (56)** |
| ***Status (positive or negative)*** | Negative | Negative |
| ***Reversibility*** | Low | Low |
| ***Irreplaceable loss of resources*** | Yes | Possibly not |
| ***Can impacts be mitigated*** | Yes | |
| ***Mitigation measures:***<br>» Careful siting of turbines and PV array/s<br>» Painting turbine blades<br>» Bird friendly power hardware<br>» Monitoring priority bird movements and collisions<br>» Turbine management sensitive to these data – radar assisted if necessary | | |
| ***Cumulative impacts:***<br>» Yes, if more turbines, PV arrays and power lines are built in the same general area, (which seems likely), more collision hot-spots are likely, and mortality rates may increase exponentially. | | |
| ***Residual impacts:***<br>» Some casualties may be incurred regardless of mitigation. | | |

# 4 The relevance of turbine numbers and dimensions in avifaunal mortality risk

Most of the studies to date found turbine dimensions to play a relatively unimportant role in the magnitude of the collision risk relative to other factors such as topography, turbine location, morphology, behaviour and a species' inherent ability to avoid the turbines and may only be relevant in combination with other factors, particularly wind strength and topography (see Howell 1997, Barrios & Rodriguez 2004; Barclay *et al.* 2007, Krijgsveld *et al.* 2009, Smallwood 2013; Everaert 2014). Three (3) studies found a correlation between hub height and mortality (De Lucas *et al.* 2008; Loss *et al.* 2013 and Thaxter *et al*. 2017), but Thaxter (2017) qualified that finding (see last bullet below).

The summary below provides a list of published findings on the topic:

- Howell *et al.* 1997 states on p.9: "*The evidence to date from the Altamont Pass does not support the hypothesis that the larger rotor swept area (RSA) of the KVS–33 turbines contributes proportionally to avian mortality, i.e. larger area results in more mortalities. On the contrary, the ratio of K-56 turbines to KVS-33 turbines rather than RSA was approximately 3.4:1 which as consistent with the 4.1:1 mortality ratio. It appears that the mortality occurred on a per-turbine basis, i.e. that each turbine simply presented an obstacle*."
- Barrios & Rodriguez 2004 states on p. 80: "*Most deaths and risk situations occurred in two rows at PESUR with little space between consecutive turbines. This windwall configuration (Orloff & Flannery 1992) might force birds that cross at the blade level to take a risk greater than in less closely spaced settings. However, little or no risk was recorded for five turbine rows at PESUR having exactly the same windwall spatial arrangement of turbines. Therefore, we conclude that physical structures had little effect on bird mortality unless in combination with other factors*."
- Barclay *et al.* 2007 states on p. 384: "*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 indicate 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*."
- De Lucas *et al.* 2008 states on p. 1702: "*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*".
- Krijgsveld *et al.* 2009 states on p. 365: "*The results reported in this paper indicate 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. Clearly, more studies of collision victims are needed before we can confidently predict the relationship between size and configuration of wind turbines and the risk for birds to collide with a turbine*."
- Smallwood *et al*. 2013 states on p.26 – 27 (see also Fig 9 on p.30): "*Red-tailed hawk (Buteo jamaicensis) and all raptor fatality rates correlated inversely with increasing wind-turbine size (Figs. 9A, B). Thousands of additional MW of capacity were planned or under construction in 2012, meaning that the annual toll on birds and bats will increase. However, the expected increase of raptor fatalities could be offset by reductions of raptor fatalities as older wind projects are repowered to new, larger wind turbines, especially if the opportunity is taken to carefully site the new wind turbines (Smallwood and Karas 2009, Smallwood et al. 2009)."*
- Loss *et al.* 2014 states on p. 208: "*The projected trend for a continued increase in turbine size coupled with our finding of greater bird collision mortality at taller turbines suggests that precaution must be taken to reduce adverse impacts to wildlife populations when making decisions about the type of wind turbines to install*."
- Everaert, 2014 states on p. 228: "*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 (Fig. 4). 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*."

- In a paper on the subject by Thaxter *et al*. (2017), the authors conducted a systematic literature review of recorded collisions between birds and wind turbines within developed countries. They related collision rate to species-level traits and turbine characteristics to quantify the potential vulnerability of 9 538 bird species globally. For birds, larger turbine capacity (megawatts) increased collision rates; however, deploying a smaller number of large turbines with greater energy output reduced total collision risk per unit energy output. In other words, although there was a positive relationship between wind turbine capacity and collision rate per turbine, the strength of this relationship was insufficient to offset the reduced number of turbines required per unit energy generation with larger turbines. *Therefore, to minimize bird collisions, wind farm electricity generation capacity should be met through deploying fewer, large turbines, rather than many, smaller ones*.

# 4 Re-assessment of collision mortality impact

In order to assess the impact of the proposed changes to the turbine dimensions and number of turbines, the No-Go Alternative (defined as the status quo i.e. the currently authorised 67 turbines) was compared with the Preferred Alternative (the proposed 34 turbines with revised dimensions).

Thaxter *et al*. (2017) analysed the relationship between the number and size of turbines, and the collision risk to birds. They found that the number of turbines is the most important factor as far as the collision risk is concerned, more so than the size of the turbine. In other words, even if the total output remains the same, by employing fewer turbines, the collision risk will still be reduced. They also found that the relationship between the total number of turbines and the collision risk is non-linear, with the collision risk exponentially higher for more, smaller turbines vs. fewer larger turbines (see Figure 1 below, taken from their 2017 paper).

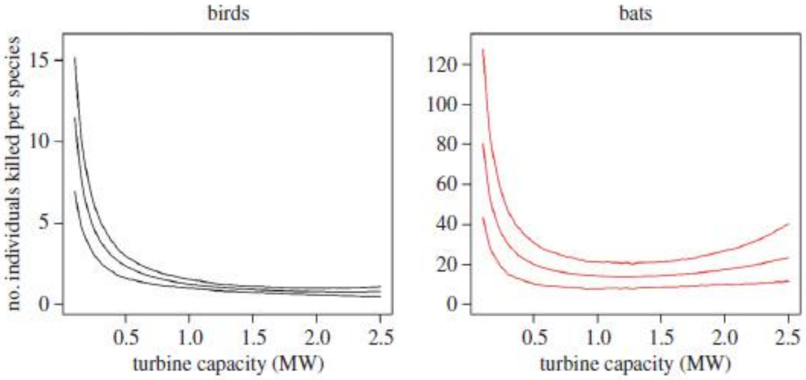


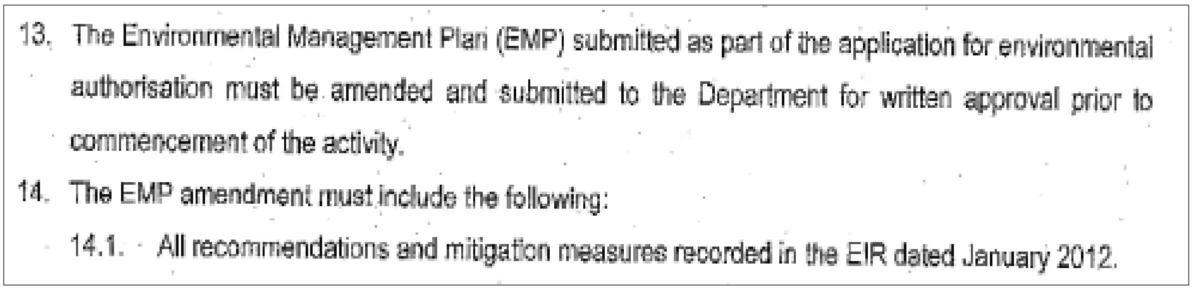
**Figure 4.** The mean total mortality rate across species for a hypothetical 10 MW wind farm, shown in relation to individual turbine capacities (which in turn require different numbers of wind turbines to meet the same capacity). Lines represent posterior means and 95% upper and lower credible intervals.

*Figure 1: Exponential curve indicating the relationship between collision mortality and number of turbines.*

The Preferred Alternative amounts to a 49% reduction in the number of turbines, and a 10% increase in total rotor swept area. However, given the proximity of five (5) confirmed Verreaux's Eagles nests within 5.2km of the proposed development (see Figure 3), and the benefit of a decade of experience gained since the original assessment was conducted in 2011, it is concluded that the original pre-mitigation impact significance rating of **Medium-High** for the collision risk that the No-Go Alternative (67 turbines) pose to avifauna was too low, and should have been **High – Very High**. The pre-mitigation rating of the Preferred Alternative (34 turbines) is still **Medium - High.**

## 5 Revised mitigation measures

The project received an Environmental Authorisation on 22 February 2012. The following condition was incorporated in the EA:

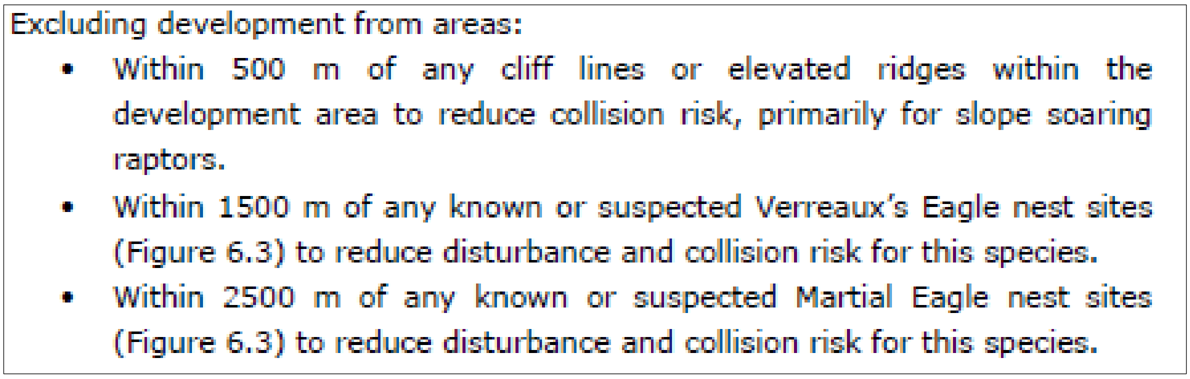


13. The Environmental Management Plan (EMP) submitted as part of the application for environmental authorisation must be amended and submitted to the Department for written approval prior to commencement of the activity.

14. The EMP amendment must include the following:

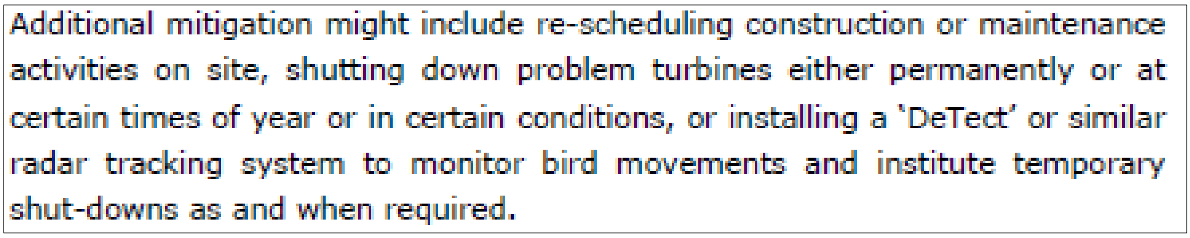
    14.1. All recommendations and mitigation measures recorded in the EIR dated January 2012.

It follows therefore that all the mitigation measures included in the original EIR (2012) remains valid. The following proposed mitigation measures by Jenkins (2011) were included in the EIR to reduce the turbine collision risk:

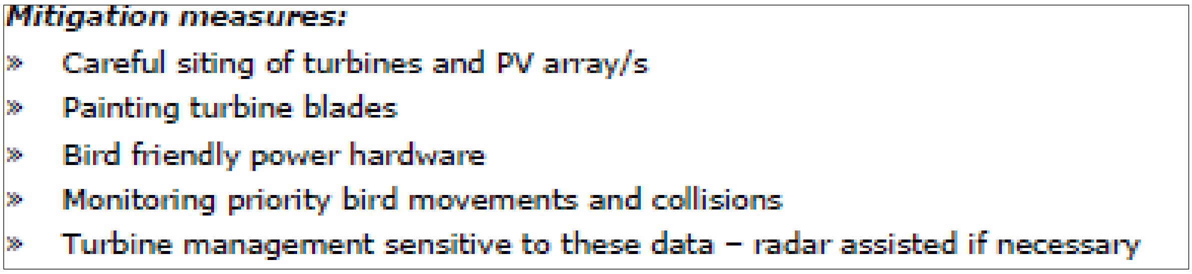


Excluding development from areas:

- Within 500 m of any cliff lines or elevated ridges within the development area to reduce collision risk, primarily for slope soaring raptors.
- Within 1500 m of any known or suspected Verreaux's Eagle nest sites (Figure 6.3) to reduce disturbance and collision risk for this species.
- Within 2500 m of any known or suspected Martial Eagle nest sites (Figure 6.3) to reduce disturbance and collision risk for this species.



Additional mitigation might include re-scheduling construction or maintenance activities on site, shutting down problem turbines either permanently or at certain times of year or in certain conditions, or installing a 'DeTect' or similar radar tracking system to monitor bird movements and institute temporary shut-downs as and when required.



***Mitigation measures:***

» Careful siting of turbines and PV array/s

» Painting turbine blades

» Bird friendly power hardware

» Monitoring priority bird movements and collisions

» Turbine management sensitive to these data – radar assisted if necessary

A re-assessment was undertaken to determine if the mitigation measures originally proposed in the EIR would be sufficient to reduce the post-mitigation impacts to an acceptable level i.e. to **Low** if the turbine dimensions and numbers are changed as proposed. In doing so, cognisance was taken of the fact that the "Best Practice Guidelines for Avian Monitoring and Impact Mitigation at Proposed Wind Energy Development Sites in Southern Africa", (Jenkins *et al*. 2011) (revised in 2015), require that either all, or part of the pre-construction monitoring should be repeated if there is a time period of three (3) years or more between the data collection and the construction of the wind farm. This re-assessment is necessary to take cognisance of any changes in the environment which may affect the risk to avifauna, and to incorporate new knowledge gained since the original assessment was conducted in 2011. To this effect nest searches were repeated in February 2021 to establish the number of large raptor nests which is present within a 12km radius around the application site. A total of twelve (12) Verreaux's Eagle nests and one (1) Martial Eagle nests were located (see Figure 3).

Since the original assessment was undertaken, a model has been developed by Dr Megan Murgatroyd of Hawk Watch, based on her PhD research on Verreaux's Eagles. This model is known by its acronym, VERA (Verreaux's Eagle Risk Assessment) and it models the likely flight patterns and high usage zones of the birds in any given area, based on the topography and the number of nests (Murgatroyd *et al.* 2020). BirdLife SA (BLSA) strongly recommends the application of the VERA model to determine high risk areas that need to be avoided by wind turbines. Should a developer choose not apply VERA, a 3.7km high risk buffer should be placed around all Verreaux's Eagle nests where no turbines should be located. In addition, all turbines in the area >3.7km up to 5.2km should be regarded as medium-risk and relocated if possible. These buffers should give more or less the equivalent protection to the eagles as the application of VERA (Murgatroyd *et al.* 2020).

The Preferred Alternative avoids all 3.7km buffer zones around Verreaux's Eagle nests around the application site. However, the applicant has indicated that the removal of all turbines from the 5.2km medium-risk buffers will not be economically feasible. If complete relocation is not a feasible option, all turbines remaining in the medium-risk zone (see Figure 3) should be subject to pro-active mitigation in the form of a proven mitigation method such as Shutdown on Demand (SDoD), using either biomonitors or an automated system such a IdentiFlight.

Avisense (2011) recommended blade painting as a mitigation measure to reduce the risk of turbine collisions, and this recommendation was incorporated into the EIR and subsequently authorised. The painting of the turbine blades is a novel method of mitigation against turbine collisions in which one of the three white blades on a wind turbine is painted black about two thirds of the blade from the tip (see Figure 2). This hypothesis is that painting would increase the visibility of the blades, and that this would reduce fatality rates. This hypothesis was tested *in situ,* at the Smøla wind-power plant in Norway which experience high fatalities of White-tailed Eagles (*Haliaeetus albicilla*), using a Before–After–Control–Impact approach employing fatality searches (May *et al.* 2020). The annual fatality rate was significantly reduced at the turbines with a painted blade by over 70%, relative to the neighbouring control (i.e., unpainted) turbines. The treatment had the largest effect on reduction of raptor fatalities; no White-tailed Eagle mortality was recorded after painting. Painting the rotor blades at operational turbines was, however, resource demanding given that they had to be painted while in-place. However, if implemented before construction, this cost will be minimized. It must be stressed that blade painting has not been experimentally tested in South Africa, therefore it should be employed as an additional mitigation measure together with other proven methods such as SDoD, and not as the sole mitigation measure.

In summary, it is concluded that the recommendations formulated by Avisense (2011), which are incorporated in the EA, remain valid for the Preferred Alternative, but need to be supplemented in order for the post-mitigation rating to be reduced to **Low.** The following additional mitigation measures are proposed:

1. All the turbines should have one blade painted black or red (depending on which colour is approved by the Civil Aviation Authority) for two thirds from the tip of the blade. This implies that the developer will have to engage with turbine manufacturers to come up with a design that will comply with all relevant industry and aviation standards.
2. No turbines should be constructed within a 3.7km circular buffer zone around any Verreaux's Eagle nest. This has already been implemented in the Preferred Alternative.
3. Turbines in the circular 5.2km medium-risk buffer zone should be reduced to an absolute minimum. Any turbines remaining in the Verreaux's Eagle 5.2km medium-risk circular buffer zones should be subject to pro-active mitigation in the form of a proven mitigation method such as Shutdown on Demand (SDoD), using either biomonitors or an automated system such a IdentiFlight.

See Figure 3 for the proposed buffer zones around eagle nests in relation to the Preferred Alternative.

*Figure 2: Turbine with painted blade in Norway (May et al. 2020)*

The implementation of the recommendations listed above should reduce the post mitigation impacts of the Preferred Alternative to **Low.**

# 6 Summary of findings

Given the potential changes to the turbine specifications and quantity, a re-assessment of the potential turbine collision impact was carried out for purposes of the proposed amendment, to establish (i) if the original pre-mitigation risk assessment rating by Avisense (2011) is still valid in light of a decade of subsequent experience, and (ii) if the original mitigation measures need to be revised to reduce post-mitigation impact rating to **Low,** i.e. to acceptable levels.

The Preferred Alternative amounts to a 49% reduction in the number of turbines, and a 10% increase in total rotor swept area. However, given the proximity of five (5) confirmed Verreaux's Eagles nests within 5.2km of the proposed development, and the benefit of a decade of experience gained since the original assessment was conducted in 2011, it is concluded that the original pre-mitigation impact significance rating of **Medium-High** for the collision risk that the No-Go Alternative (67 turbines) pose to avifauna was too low, and should have been **High – Very High**. The pre-mitigation rating of the Preferred Alternative (34 turbines) is still **Medium - High.**

It is further concluded that the recommendations formulated by Avisense (2011), which are incorporated in the EA, remain valid for the Preferred Alternative, but need to be supplemented for the post-mitigation rating to be reduced to **Low.** The following additional mitigation measures are proposed:

4. All the turbines should have one blade painted black or red (depending on which colour is approved by the Civil Aviation Authority) for two thirds from the tip of the blade. This implies that the developer will have to engage with turbine manufacturers to come up with a design that will comply with all relevant industry and aviation standards.
5. No turbines should be constructed within a 3.7km circular buffer zone around any Verreaux's Eagle nest. This has already been implemented in the Preferred Alternative (see Figure 3).
6. Turbines in the circular 5.2km medium-risk buffer zone should be reduced to an absolute minimum. Any turbines remaining in the Verreaux's Eagle 5.2km medium-risk circular buffer zones should be subject to pro-active mitigation in the form of a proven mitigation method such as Shutdown on Demand (SDoD), using either biomonitors or an automated system such a IdentiFlight.

# 7 Concluding statement

The Preferred Alternative is a significant improvement on the No-Go alternative as far as impacts and avifauna is concerned and should reduce the expected pre-mitigation impacts from **High to Very High for the No-Go Alternative** to **Medium to High for the Preferred Alternative**. However, additional mitigation measures are required to reduce the post mitigation impacts of the **Preferred Alternative to Low, i.e. to acceptable levels.**

The proposed amendment is supported from an avifaunal impact perspective, provided the additional mitigation measures proposed in this report are implemented.

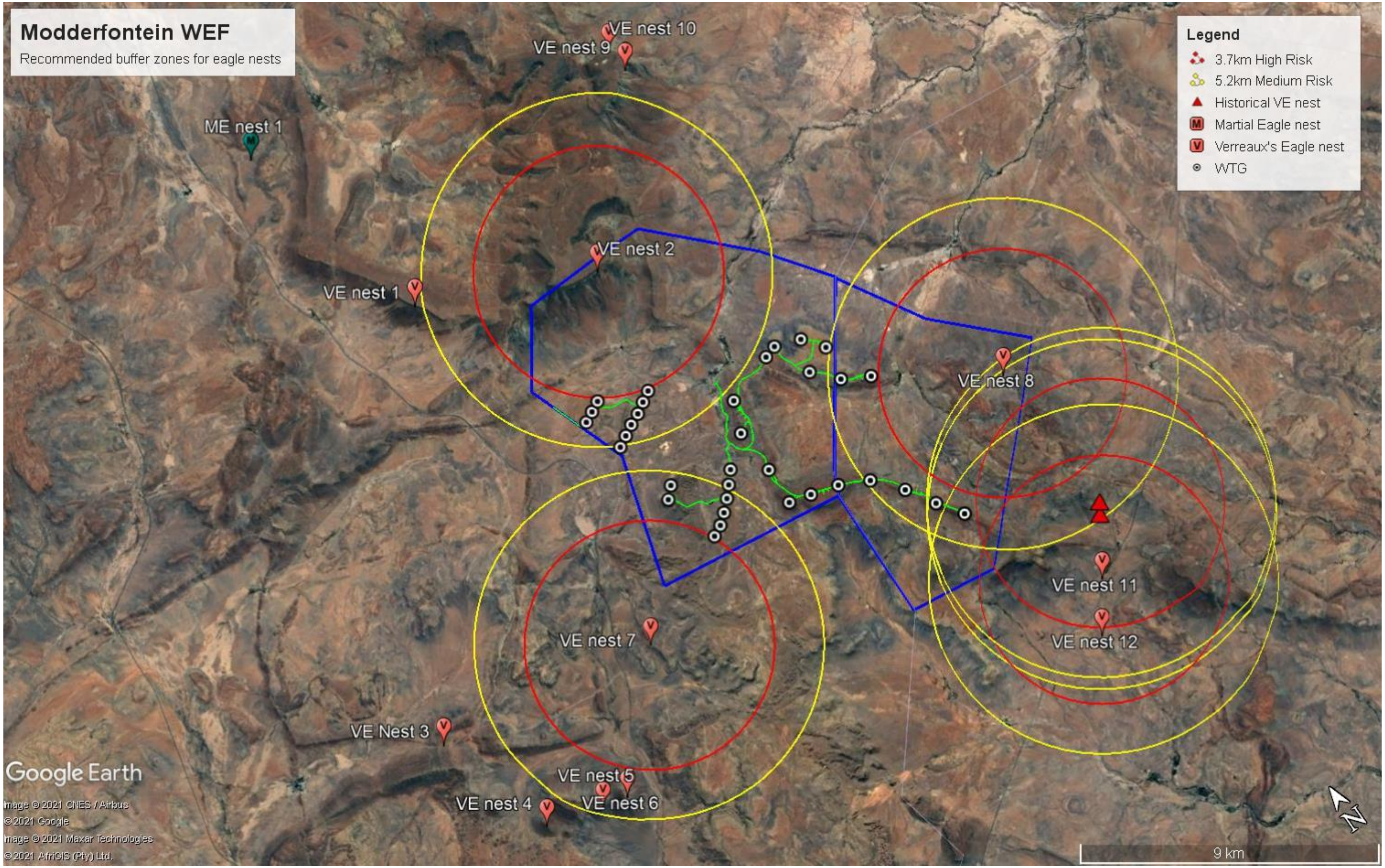


*Figure 3: Proposed buffer zones around eagle nests in relation to the Preferred Alternative.*

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