Annexure 2: Specialist Reports

Included in this Annexure are the following specialist reports:

- Bat Pre-Construction Monitoring, Arcus, February 2023.
- Bats Impact Assessment Report, Arcus, November 2023.
- Bird Monitoring Report, Chris van Rooyen Consulting, July 2023.
- Ecosystem Services Impact Assessment, August 2023.
- Environmental Acoustic Specialist Study, WSP, August 2023.
- Cultural Heritage Impact Assessment, WSP, August 2023.

Note: Critical Habitat Screening, WSP, August 2023 excluded as a revised Critical Habitat Assessment was conducted by The Biodiversity Consultancy in March 2024. This assessment is included as an annex to the Biodiversity Action Plan.

Bat Pre-Construction Monitoring Namaacha Wind Farm Mozambique

Final Report

On behalf of

Globeleq Africa Limited

February 2023
Version 3

Prepared By:

Arcus Consultancy Services South Africa (Pty) Ltd.

1st Floor Great Westerford
240 Main Road
Rondebosch
7700

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

Registered in South Africa No. 2015/416206/07

EXECUTIVE SUMMARY

Namaacha Wind Farm is a development proposed by Globeleq Africa Limited (Globeleq), and is planned to be installed approximately 12 km north of Namaacha, in the Maputo Province of Mozambique. It has a generating capacity of up to 120 MW. Arcus was appointed to conduct the bat pre-construction monitoring campaign for the proposed facility and to compile the final bat specialist monitoring report.

The project site is located on the ecotone between the Zambezian & Mopane Woodlands and the Maputaland Coastal Forest Mosaic ecoregions, which are characterised by their presence of mopane woodlands, open bushveld, savannah and grasslands. The project site exhibits some suitable habitats for bats to use when foraging, commuting or roosting. This includes linear habitats such as rivers and drainage lines (along with associated riparian vegetation), as well as roosting opportunities in trees and man-made infrastructures. The presence of a major bat roost, approximately 10.2 km south of the site is also noted, whereby several thousand *Miniopterus natalensis* and approximately 30-50 *Epomophorus wahlbergi* / *Epomophorus crypturus* bats are known to roost. As *M. natalensis* is a migratory species, this roost is considered to be of high importance for the proposed development, of which a Critical Habitat Analysis has the potential to be considered necessary, in accordance with IFC Performance Standards (under criterion 3: Migratory and Congregatory species).

Approximately forty bat species have been predicted to occur at the proposed site. Due to the large assemblage of bat species that are expected to occur on site, it was noted that a large degree of overlap in echolocating frequencies was present – not allowing for accurate acoustic identification of bats to species level. As such species were rather grouped together according to certain echolocating frequency ranges, with subsequent analysis taking these groups into consideration.

Of all species, only the short-eared trident bat (*Cloeotis percivali*) was noted to have a conservation status of concern (regionally endangered) – allowing for the potential to trigger a Critical Habitat Analysis (under criterion 1: Critically Endangered or Endangered species). Although this species was predicted to occur on site, it was not detected or observed during the full monitoring campaign. Thus, a full critical habitat assessment was not deemed necessary.

Various techniques were implemented to study the local bat community and to inform the assessment of potential risks of the proposed development, in accordance with appropriate guidance documents. Such guidance documents included South African Best Practice Guidelines for Pre-Construction Monitoring of Bats at Wind Energy Facilities, IFC Performance Standards, IFC Guidance Notes and World Bank Group EHS Guidelines for Wind Energy, among other local and international reference documents. The following techniques were applied at the proposed development area and its immediate surroundings: a desktop and bibliographic review, active acoustic detection surveys by means of vehicle-based transects, passive survey by means of installation of automatic acoustic detectors over a sampling period of 12 months, and roost searches/inspection and monitoring.

The main results of the pre-construction monitoring campaign (undertaken between 10 June 2021 and 7 June 2022) showed that a maximum of 27 insectivorous bat species were recorded on site during this period. A total of 60,681 bat passes were recorded for all species/groups. Bats from groups "MOL2" and "VES30" accounted for 93.5% of all activity. No recordings of *C. percivali* were noted, while recordings obtained from *M. natalensis* revealed that only 1.6% (990 bat passes) of all bat calls could be associated with this species. Of these 990 *M. natalensis* bat passes, only 14 were recorded from within the rotor swept area. Bat activity was low-moderate for the ecoregion, with most activity taking place in spring and summer. A total of 31 nights of substantial activity spikes were noted during

this same period, making these two seasons the most relevant in terms of potential bat impacts on site.

Roost monitoring at the known major roost (an old derelict hotel, approximately 10.2 km south of the site) yielded that the northern wing accommodates between 30-50 *E. wahlbergi / crypturus* fruit bats, while the southern wing has a confirmed presence of several thousand *M. natalensis*. Inspections during winter, spring, summer and autumn showed large abundances, with Autumn yielding marginally fewer individuals. No clear observation could be made in terms of the direction in which the bats travelled after leaving the roost at dusk.

A high-level general assessment was compiled to determine whether or not the site could be defined as critical habitat, and to determine the need for further Critical Habitat Assessments. Through the analysis of all five criterion associated with the designation of critical habitat, it was determined that although a few potential triggers exist (namely the potential presence of an endangered species [*C. percivali*] under criterion 1, and the presence of a large known bat roost [*M. natalensis* and *E. wahlbergi / crypturus*] under criterion 3, they were not deemed significant enough to meet the thresholds that would trigger critical habitat status. The habitat is thus classified as natural habitat and the relevant considerations and mitigation measures, in accordance with IFC Performance Standards would apply. No further need for critical habitat assessments were deemed necessary, as a result.

Impacts identified for the construction and operational phase of the project include roost disturbance, roost destruction, habitat modification and direct fatalities (as a result of collisions with turbine blades, and barotrauma). Cumulative impacts to bats are not presently perceived as being significant to the project, as no other known operational wind energy facilities exist in Mozambique, close to the project site. Additionally, in accordance with the South African Renewable Energy EIA Application Database, the nearest known WEF is located approximately 187 km south-west of the project, within the Republic of South Africa. Impacts for the decommissioning phase are likely to be restricted to disturbance and are expected to be low.

Recommendations have been made to mitigate potential impacts identified, mainly during design phase, but also during the operational phase. All wind turbines are to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of when turbines blades start spinning, in order to prevent free-wheeling. All turbines (including the full blade length) are to avoid high sensitive areas as a primary measure of mitigation. In the event that high sensitivity areas cannot be avoided, then minimisation techniques (turbine curtailment and/or acoustic deterrence mechanisms) must be applied at those turbines encroaching into these areas, from the start turbines being operational. Such minimisation must be in accordance with the parameters defined in Table 4. All turbines (including the full blade length) must also avoid medium sensitive areas, as far as possible. Such medium areas are associated with building/dwelling structures which were earmarked for consideration due to potential roosting habitat. However, given the absence of physical observations of bats (including guano, scratch marks or smudges) made during the relevant inspections, such features are not deemed to be significantly important for the proposed facility or local bat community on site. Turbines are therefore allowed to be placed within such buffers, if avoidance is not possible. Given the observations made, it would be beneficial if such features were removed, as far as possible, in order to avoid potential use of these structures by bats in future. If such features are not removed and found to be used by bats during the construction and/or operational phase of the project, then the appointed bat specialist must advise on appropriate management/mitigation actions for further implementation. For all wind turbines, if fatality thresholds are reached, then appropriate minimisation (turbine curtailment and/or acoustic deterrence devices) must be implemented in accordance with the parameters defined in Table 4.

The implementation of an adequate operational phase monitoring programme is recommended, as per best practice, and will contribute to the verification of the predicted impacts and to ensure any adjustments required in this regard. All recommendations must form part of an adaptive management process, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impacts are realised. Monitoring of fatalities is to occur from the outset, as soon as the first turbine is erected and starts spinning.

If the recommended mitigation measures are implemented, as well as those defined by the International Finance Corporation in terms of considerations and mitigation measures defined for natural habitats, then the development of Namaacha Wind Farm can be implemented, and it is not considered to cause irreplaceable loss to bat biodiversity.

TABLE OF CONTENTS

1 INTRODUCTION

Globeleq Africa Limited (Globeleq) is proposing to develop a wind farm approximately 12 km north of Namaacha, in the Maputo Province of Mozambique, with a generating capacity of up to 120MW.

Arcus was appointed to conduct the pre-construction bat monitoring campaign for the project, to comply with International Finance Corporation and World Bank Standards for these development types. The monitoring is based on a study area / area of interest of approximately 857 hectares.

The aim of the monitoring is to document bat activity in the area of interest and, based on this activity, assess the wind farm with regards to potential impacts to bats. This data will establish a pre-construction baseline of bat species diversity and activity and be used to inform the projects' Environmental Management Programme (EMP). The monitoring data will also assist in providing solutions to avoid and mitigate impacts, if required, by informing the final design, construction and operational management strategy of the wind farm. The baseline will also be used to compare impacts to bats during the operational phase of the project.

This final report includes the results from the bat activity monitoring undertaken between 10 June 2021 and 7 June 2022.

2 TERMS OF REFERENCE

- Conduct a full 12-month bat monitoring campaign, in accordance with international best practice, as well as the latest version of the South African best practice guidelines for monitoring bats at wind energy facilities in South Africa, to determine which bat species are present at the site, their relative risk to wind turbines, how bat activity is influenced by meteorological conditions at the site, and to understand how bats use the site;
- Assess known and potential bat roosting habitats on site to determine their significance for the proposed project; and
- Compile a final monitoring report upon completion of the monitoring campaign, summarising bat activity relative to meteorological conditions, highlighting relevant concerns or opportunities, summarising the methodology used and briefly discuss relevant impacts (where applicable) and provide an opinion, with mitigation options, on any potential impacts to bats.

3 METHODOLOGY

3.1 Desktop Review

A desktop study of available bat locality data, literature and mapping resources was undertaken to determine the likelihood of bats being present within the proposed project area. Literature was also sought to understand the current state of knowledge of wind energy and bat impacts globally. Very little published research on this regard is available for the Mozambique context. Data sources included:

- Academic sources such as research papers and published texts;
- Bat distribution records and maps; and
- A review of the habitats on the site to identify, if possible, habitats, roosts and features which may be associated with bats.

3.2 Applicable Guidance

International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability

The IFC's sustainability framework articulates the Corporation's strategic commitment to sustainable development, and is an integral part of IFC's approach to risk management. The Sustainability Framework comprises IFC's Policy and Performance Standards on Environmental and Social Sustainability, and IFC's Access to Information Policy. The performance standards are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way. IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. Eight performance standards are in place to establish standards that the client is to meet throughout the life of an investment by IFC. Performance Standard 1 "PS1" (Assessment and Management of Environmental and Social Risks and Impacts) and Performance Standard 6 "PS6" (Biodiversity Conservation and Sustainable Management of Living Natural Resources) have been identified as being the most critical for the purposes of this bat assessment. PS1 underscores the importance of managing environmental and social performance throughout the life of a project. Its objectives allow for the identification and evaluation of environmental and social risks and impacts of a project, adoption of a mitigation hierarchy, promotion of improved environmental and social performance through the use of management systems, ensuring that grievances from affected parties are managed and providing means for adequate engagement with affected communities throughout the project cycle. PS6 recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development (IFC 2012a).

International Finance Corporation (IFC) Guidance Notes: Performance Standards on Environmental and Social Sustainability

Related to the IFC Performance Standards (PS's), the respective IFC Guidance Notes (GN's) correspond to the PS's on Environmental and Social Sustainability. They offer guidance on the requirements contained within the PS's, including reference materials, and on good sustainability practices to improve project performance. As opposed to establishing policy by themselves, they explain the requirements contained within the PS's. Relevant for the proposed project itself, the following GN can be highlighted, initially: GN6 No. 25 states that numerous scientifically robust practice guidelines on integrating biodiversity into impact assessment and on biodiversity management exist. Clients should make use of such reference documents when project-related impacts on biodiversity are expected. Extensive regional and sector-specific scientifically robust guidance and case studies are widely available. Scientific, peer-reviewed journals dedicated to environmental impact assessment are another source of information (IFC 2012b). As such, as IFC performance standards and guidance do not provide specific reference to bat monitoring protocols on wind farms, it is important for other relevant guidance to be followed – to assess and integrate biodiversity into impact assessments. The ultimate aim of the IFC PS's and their guidance notes is to require developers and lenders to demonstrate, based on scientifically sound methods and surveys, that developments will lead to No Net Loss of biodiversity and will not lead to a deterioration of the globally- or regionally determined conservation status[1] of a species or ecosystem over the long term. In an event where a species or ecosystem present, which already would trigger critical habitat, be adversely impacted by a development *and* there is no feasible alternative for such development, measurable actions

[1] Conservation status is determined at a global and further regional or country-specific scale based on the criteria as published by the International Union for Conservation of Nature (IUCN).

to show Net Gain of such species and or ecosystem must be implemented by such developer. If it cannot be clearly demonstrated that there would be no feasible alternative to a said development, then any critical habitat must be avoided.

World Bank Group (WBG): Environmental, Health and Safety (EHS) Guidelines for Wind Energy

The World Bank Group EHS guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). As per IFC (2012a), IFC uses the EHS Guidelines as a technical source of information during project appraisal. The EHS Guidelines for wind energy include information relevant to environmental, health, and safety aspects of onshore and offshore wind energy facilities, and the applicability thereof is that it should be applied to wind energy facilities from the earliest feasibility assessments, as well as from the time of the environmental impact assessment, and continue to be applied throughout the construction and operational phases. IFC (2012a) and WBG (2015) clearly state that when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. Additionally, in accordance with EHS Guidelines, it is noted that other guidelines have been developed that detail the scope and extent of biodiversity surveys for onshore and offshore wind energy facilities, and that where in-country guidelines are not yet developed, international guidelines as informed by scientifically-based best practice must be used and always need to consider the requirements for surveys to be site-, species-, and season-specific (WBG 2015). In the absence of Mozambican bat monitoring guidelines, and for the purposes of this assessment, it is recommended by the specialist (based on IFC and World Bank standards) that South African bat monitoring guidelines (MacEwan et al. 2020) are followed as closely as possibly for the bat monitoring study at Namaacha Wind Farm. Regardless, a recent gap analysis was consulted for the proposed facility to assess the applicability of these guidelines and to see whether those findings were in agreement with that stated above. Further details of these findings are provided below.

ESIA and RAP Gap Analysis: Proposed 63 MW Namaacha Wind Farm Project in Namaacha, Mozambique

A gap analysis of the Environmental Pre-Feasibility Study and Scope Definition (EPDA) Report[2] and Resettlement Action Plan (RAP) was conducted and reviewed for clarity by WSP Environmental (Pty) Ltd. (WSP), with the aim of assessing the Environmental Pre-Feasibility Study and Scope Definition (EPDA). This included the review of the associated Bird and Bat Monitoring Technical Notes and Monitoring Status Report and RAP documentation, to better understand the intrinsic risks associated with the proposed Project and to identify any red flag environmental and social (E&S) issues that may not have been identified within the EPDA Report. The gap analysis was also used to identify gaps in the E&S documentation with respect to compliance with local Mozambican legislation, the IFC PS's (2012) and associated PS Guidance Notes (2019), including applicable World Bank Group (WBG) Environmental Health and Safety (EHS) Guidelines, and Good International Industry Practice (GIIP) in terms of content, approach and methodology. The findings of this gap analysis indicated that since the IFC documents do not provide detailed pre-construction bat monitoring methods and that no bat monitoring guidelines exist for Mozambique, GIIP advocates that an alternative, suitable and internationally credible regulation, guidance or standard should be sought. It states that where such GIIP standards are available from a similar geographic/ecological region, it

[2] MF&A 2019. Environmental Pre-feasibility Study and Scoping for the Namaacha Power Plant Project: Technical Report – dated July 2019.

would be appropriate for such standards to be adopted so as to ensure relevance and applicability. Furthermore, it is noted that since the proposed site is located within 3 km of the South African border, as well as being located within the Maputaland Centre for Endemism, and within 50 km of South Africa's Kruger National Park and the Lubombo Transfrontier Conservation and Resource Area, which incorporates multiple protected areas including five Ramsar sites, there is a strong case for the applicable South African bat monitoring guidelines to be applied (WSP 2020). This conclusion is therefore in agreement with the World Bank Group EHS guidelines (2015), and subsequently also IFC Performance Standards. The proposed methodology for the monitoring was based on this and therefore recommended the 12 months of monitoring. These monitoring guidelines are well aligned to IFC standards as well as other international guidelines (e.g. Collins, 2016[3]), but are specifically adapted to the Southern African environment and its bat species.

South African Best Practice Guidelines for Pre-Construction Monitoring of Bats at Wind Energy Facilities

The South African Best Practice Guidelines are based on information gathered and compiled from North America, Europe and South Africa, previous versions of these guidelines and input from South African scientists and specialists. They seek to provide technical guidance for consultants charged with carrying out impact assessments for proposed wind energy facilities (WEF's), to ensure that pre-construction monitoring surveys produce the required level of detail and answers for authorities evaluating applications for WEF developments. They outline basic requirements of best practice and highlight specific considerations relating to the pre-construction monitoring of proposed WEF sites for bats. Such guidelines would be largely applicable to the project site, due to the similar geographic/ecological region and similar bat species richness and diversity found in South Africa.

Considering the purpose and recommendations in all of the above guidance documents, it is recommended for the IFC performance standards to be used as a basis for this assessment, and subsequently based on what is contained in this, for regional or local guidelines to be considered for the purposes of the specific methodological approach for bat monitoring and updated impact assessment.

Therefore, based on Arcus' original recommendation, the South African Best Practice Guidelines are therefore the most relevant guidelines to be applied to this site, due to the absence of guidance within the borders of Mozambique, as well as the shared natural resources and close proximity of the project site to South Africa.

3.3 Field Surveys

The pre-construction monitoring was designed to monitor bat activity across the area of interest encompassed by the proposed wind farm as well as the broader study area, where relevant for potential roosting bats. Although this study is being conducted within the borders of Mozambique, the monitoring was undertaken in accordance with South African best practice guidelines[4] and supplemented by international literature and guidance, as described in the section above. Sampling of bat activity was undertaken at one (1) location using Song Meter SM4 bat detectors (Wildlife Acoustics, Inc.). At this location, a single meteorological mast has been used to accommodate the installation of the equipment. The microphones have been installed at 10 m ("ground level") and 55 m ("at height"), which is in agreement with the recommendations set out in the South African Best Practice Guidelines (MacEwan et al. 2020) and international best practice standards (Rodrigues et

[3] Collins, J. ed., 2016. Bat surveys for professional ecologists: good practice guidelines. Bat Conservation Trust.

[4] MacEwan, K., Sowler, S., Aronson, J. and Lötter, C., 2020. South African best practice guidelines for pre-construction monitoring of bats at wind energy facilities.

al. 2014), whereby activity surveys are recommended to take place at both ground level as well as at rotor height. All detectors have been configured to record every night from 30 minutes before sunset until 30 minutes after sunrise.

In addition to the static acoustic monitoring, manual transect monitoring has also been undertaken, with the aim of completing 2 nights per season, in order to provide an indication of spatial use of the site by bats. Potential roosting structures that bats could use were also searched for and investigated during the day for the presence or evidence of roosting bats (e.g. individuals, guano and culled insect remains, etc.) whenever the Arcus team were on site. These included buildings, rocky outcrops and trees.

3.4 Data Analysis

Bats emit ultrasonic echolocation calls for orientation, navigation and foraging. These calls can be recorded by bat detectors enabling bat species to be identified from various features in their calls (e.g. the frequency of the call). A sequence of bat calls is termed a bat pass, defined as two or more echolocation calls separated from other calls by more than 500 milliseconds (Hayes 1997; Thomas 1988). Quantifying the number of bat passes recorded can be used to quantify the relative abundance of bat species.

Acoustic data from each bat detector was analysed using Kaleidoscope® Pro (Version 5.4.6, Wildlife Acoustics, Inc.). Bat species were automatically identified from their echolocation calls using the embedded echolocation call library in the software. The results were vetted by random or selective (for certain species) checks through manually identifying recordings to verify the results. The total number of files was used as a proxy for the number of bat passes which is a standard approach to quantifying bat activity.

3.5 Assumptions and Limitations

The following assumptions and limitations relevant to this study are noted:

- The knowledge of certain aspects of Mozambican and South African bats including natural history, population sizes, local and regional distribution patterns, spatial and temporal movement patterns (including migration and flying heights) and how bats are impacted by wind energy developments are very limited for many species[5].
- Bat echolocation calls (i.e. ultrasound) operate over ranges of metres therefore acoustic monitoring samples only a small amount of space (Adams et al. 2012). Recording a bat using sound is influenced by the type and intensity of the echolocation call produced, the species of bat, the bat detector system used, the orientation of the signal relative to the microphone and environmental conditions such as humidity. One must therefore adopt a precautionary approach when extrapolating data from echolocation surveys over large areas due to the limited sample size (i.e. only small areas are actually sampled).
- There can be considerable variation in bat calls between different species and within species. The accuracy of the species identification is dependent on the quality of the calls used for identification. Species call parameters can often overlap, making species identification difficult.
- Bat detectors are configured to record bat activity echolocating calls within certain frequency ranges. Some bats are however able to echolocate outside of these ranges and could therefore not be detected by the monitoring equipment. As such, the results presented in this report are based solely on bat calls that echolocate between the ranges of 8 and 192 kHz.

[5] Herkt, K.M.B., Barnikel, G., Skidmore, A.K. and Fahr, J., 2016. A high-resolution model of bat diversity and endemism for continental Africa. Ecological Modelling, 320, pp.9-28.

- Bat activity recorded by bat detectors cannot be used to directly estimate abundance or population sizes because detectors cannot distinguish between a single bat flying passed a detector multiple times or between multiple bats of the same species passing a detector once each (Kunz et al. 2007a). This is interpreted using the specialists' knowledge and is presented as relative abundances.
- The potential impacts of wind energy on bats presented in this report represent the current knowledge in this field. New evidence from research and consultancy projects may become available in future, meaning that impacts and mitigation options presented and discussed in this report would need to be adjusted if the project is developed.
- While the data presented in this report provides a baseline of bat activity for the period sampled, it does not allow for an understanding of interannual variation in bat activity. It is therefore possible that during the lifespan of the facility, bat activity could be significantly different (lower or higher) compared to the baseline presented here.
- The critical habitat analysis section in this report is a high-level general assessment and has been conducted to inform and provide some level of guidance within this final monitoring report, rather than a detailed separate assessment. Such a separate critical habitat assessment was not included in the agreed scope of work. Nonetheless, based on the results of the high-level assessment made in this report, no further critical habitat assessments are deemed necessary to be undertaken for this project, with respect to bats.
- Due to the global COVID-19 pandemic, health & safety protocols adopted within the borders of Mozambique included the implementation of a strict night-time curfew, which allowed less time on site to monitor bats at night during planned manual transects. As such, this did not allow for the transects to be repeated during the August/Winter survey, and were subsequently only conducted once.
- It is possible for gaps in passive acoustic monitoring data to allow for activity levels to be reflected as lower than what they actually are, which would allow for low percentages of nights being sampled. Such gaps may be a function of data transfer issues, equipment failure and/or internal batteries depleting before being replaced.

4 BASELINE ENVIRONMENT

4.1 Habitat

The study area is located on the ecotone (boundary of overlap), between the Zambezian & Mopane Woodlands and the Maputaland Coastal Forest Mosaic ecoregions. The Zambezian & *Mopane* Woodlands are characterised by the presence of mopane woodlands, as well as open bushveld with dominant *Vachellia* and *Combretum* spp. *Themeda triandra* is the dominant grass species. The Maputaland Coastal Forest Mosaic is predominantly characterised by an intricate mosaic of many different vegetation types, from the forests of the Lebombo mountains, through savannah, woodland, palm veld, grassland, sand dunes with patches of dense sand forest, and wetland habitats. The overall study area experiences summer rainfall with dry winters (Mucina & Rutherford 2006).

For foraging bats, one of the most important ecological constraints is clutter; objects (e.g. vegetation) that have to be detected and avoided by bats during flight (Schnitzler and Kalko 2001). Clutter influences the sensory and flight behaviour or species-specific adaptations of bats. Perceptually, bats are constrained by their sensory capabilities to find prey amongst clutter (e.g. having an echolocation system adapted to find prey in dense vegetation versus in the open). Mechanically, bats are constrained by their flight ability (e.g. adaptations in wing morphology that enable flight in dense vegetation versus in the open). Habitats can therefore be defined according to clutter conditions. These include uncluttered space (open spaces, high above the ground and far from vegetation), background cluttered space (near the edges of vegetation, in vegetation gaps, and near the ground or water surfaces), and highly cluttered space (very close to surfaces such as leaves or the ground). Habitat complexity is therefore an important consideration for bats because areas that offer a variety of clutter conditions are more likely to support a greater diversity of bat species. The structural complexity of the habitat is apparent, which corresponds to a relatively higher diversity of bat species that could use the site. There are some suitable habitats for bats that can be used for roosting, foraging and commuting, and there is one known major bat roost located approximately 10.2 km south of the site (Figure 1). The structure being used as a bat roost is an old unused hotel, within the town of Namaacha. Seasonal visits to this hotel have confirmed the presence of many bats, with the northern wing housing about 30-50 (estimated) *Epomophorus wahlbergi* / *Epomophorus crypturus*, while the southern section has been seen to predominantly accommodate several thousand *Miniopterus natalensis*. This roost is an important consideration for the proposed facility, as the bats using this roost have migratory/foraging distances that could reach or exceed the distance of the proposed development area.

The availability of roosting space is a critical factor for bats (Kunz and Lumsden 2003) and a major determinant of whether bats will be present in a landscape, as well as the diversity of species that can be expected. The potential roosting features on site that are able to be used by bats include mainly buildings and trees (which are mainly associated with the farmsteads).

A number of bat species can make use of rocky crevices (Monadjem et al. 2010) and others, such as the Cape serotine and Egyptian free-tailed bat, readily make use of buildings as roosts (Monadjem et al. 2010). No large caves have been found to occur in the study area which suggests that there are not large colonies of bats, however several hundred bats can occupy building roosts, as identified above.

Water sources are important for bats as a direct resource for drinking and because these areas tend to attract insects and promote the growth of vegetation (e.g. riparian vegetation). The presence of such features within and adjacent to the site could therefore attract bats to converge or cross over the area. Therefore, besides providing drinking water, bats can also be attracted to water sources as potential foraging and roosting sites (Greif and Siemers 2010; Sirami et al. 2013). Rivers and drainage lines will be equally important for foraging and commuting. Some of these water resources are non-perennial, and therefore only available to bats during some parts of a year. This could then restrict potential impacts to bats to periods when key resources are available. Additionally, it is possible for slower moving or stagnant water to occur within such water features, and subsequently serve as suitable areas for mosquitoes to breed. As bats are known to feed largely on mosquitoes, these features could allow for suitable habitat for bats to forage along. Additionally, as the proposed development area is located within a known malaria area, the presence of bats is considered a positive occurrence, providing suitable ecosystem services within the region. Such slow moving or stagnant water would be applicable to drainage lines and rivers found on/near the site, although is expected to likely be most applicable to the well-defined rivers, as presented in Figure 6. Cultivated land for local subsistence farming is important for foraging as some species forage over agricultural fields to hunt insect pests (Noer et al. 2012; Taylor et al. 2011).

Bats are known to use linear landscape features for commuting routes to get to and from foraging sites, roost sites and to access water sources. Linear landscape elements, such as tree lines and edge habitats, provide protection to bats from predators, shelter from wind, orientation cues as well as foraging habitat (Verboom and Huitema 1997; Verboom 1998; Toffoli 2016). The primary linear landscape features are drainage lines which are typically (but not always) associated with vegetation, providing linear and edge habitats that bats can access. Rivers, tree lines, and other edge habitats might also be used as commuting routes or navigation cues. It was noted at the proposed site that drainage line features, together with their associated vegetation, is likely to be the more significant linear habitat for bats on site.

4.2 Bat Species

Approximately forty bat species have been predicted to occur at the proposed site (African Chiroptera Report 2020; Monadjem et al. 2020). It is possible that more (or fewer) species are present because the distributions of some bat species in Mozambique, particularly rarer species, are poorly known. Due to the large assemblage of bat species that are expected to occur on site, it is noted that a large degree of overlap in echolocating frequencies would occur – not allowing for accurate acoustic identification of bats to species level. For this reason, bat calls were not identified per species, for the vast majority of calls for the frequencies below ~70 kHz. Rather, bat species were grouped together according to certain echolocating frequency ranges, with subsequent analysis of these groups being conducted. Such groups are depicted below in Table 1. Analysis of the acoustic monitoring data suggests that a maximum of approximately 27 insectivorous bat species have been recorded on site during the monitoring campaign to date (Table 1). The sensitivity of each of these species to the project is a function of their conservation status and the likelihood of risk to these species from wind farm development. The likelihood of risk to impacts of wind energy was determined from the guidelines and is based on the foraging and flight ecology of bats and migratory behaviour. At present, the short-eared trident bat (*Cloeotis percivali*) is the only species that has an endangered conservation status in the area (regionally endangered). Although this species has not yet been detected during static acoustic monitoring surveys to date, it may nonetheless exhibit a potential to occur on site. In accordance with IFC Performance Standards, any area that contains important concentrations of range-restricted or nationally or regionally listed Endangered or Critically Endangered species is to be defined as a Critical Habitat (IFC 2012b). Further detail on this has therefore been provided within Section 8.1.

Table 1: Potential and Confirmed Bat Species at Namaacha WEF

Species	Species Code	Group Code	# of Bat Passes	Conservation Status[6]		Likelihood of Risk
				Regional (2016)	Global	
Large-eared giant mastiff bat *Otomops martiensseni*	OTOMAR	MOL1	1,286	Near Threatened	Near Threatened	High
Midas free-tailed bat *Mops midas*	MOPMID			Least Concern	Least Concern	High
Ansorge's free-tailed bat *Chaerephon ansorgei*	CHAANS			Least Concern	Least Concern	High
Egyptian free-tailed bat *Tadarida aegyptiaca*	TADAEG	MOL2	43,103	Least Concern	Least Concern	High
Angolan free-tailed bat *Mops condylurus*	MOPCON			Least Concern	Least Concern	High
Little free-tailed bat *Chaerephon pumilus*	CHAPUM			Least Concern	Least Concern	High
Mauritian tomb bat *Taphozous mauritianus*	TAPMAU			Least Concern	Least Concern	High
Long-tailed serotine *Eptesicus hottentotus*	EPTHOT	VES30	13,626	Least Concern	Least Concern	Medium
African Yellow bat *Scotophilus dinganii*	SCODIN			Least Concern	Least Concern	Medium - High
Welwitsch's myotis *Myotis welwitschii*	MYOWEL			Least Concern	Least Concern	Medium - High
Light-winged lesser house bat *Scotoecus albofuscus*	SCOALB			Near Threatened	Data Deficient	Medium - High
Cape serotine *Neoromicia capensis*	NEOCAP	VES40	1,570	Least Concern	Least Concern	High
Green house bat *Scotophilus viridis*	SCOVIR			Least Concern	Least Concern	Medium - High
Variegated Butterfly bat *Glauconycteris variegata*	GLAVAR			Least Concern	Least Concern	Medium - High
Schlieffen's serotine Nycticeinops schlieffeni	NYCSCH			Least Concern	Least Concern	Medium - High
Rufous mouse-eared bat *Myotis bocagii*	MYOBOC	VES50/NLB	1,004	Least Concern	Least Concern	Medium - High
Temmick's hairy bat *Myotis tricolor*	MYOTRI			Least Concern	Least Concern	Medium - High
Zulu Serotine *Neoromicia zuluensis*	NEOZUL			Least Concern	Least Concern	High
Natal long-fingered bat *Miniopterus natalensis*	MINNAT			Least Concern	Least Concern	High
African pipistrelle *Pipistrellus hesperidus*	PIPHES			Least Concern	Least Concern	Medium - High
Anchieta's pipistrelle *Neoromicia anchietae*	NEOANC			Least Concern	Least Concern	High
Rusty bat *Pipistrellus rusticus*	PIPRUS			Least Concern	Least Concern	Medium - High
Lesser long-fingered bat *Miniopterus fraterculus*	MINFRA	BB/LLB	72	Least Concern	Least Concern	High
Banana serotine *Neoromicia nana*	NEONAN			Least Concern	Least Concern	High
Egyptian slit-faced bat *Nycteris thebaica*	NYCTHE	-	-	Least Concern	Least Concern	Low
Lesser woolly bat *Kerivoula lanosa*	KERLAN	-	-	Least Concern	Least Concern	Low

[6] Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., Davies-Mostert, H.T. eds., 2016. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

Species	Species Code	Group Code	# of Bat Passes	Conservation Status[6]		Likelihood of Risk
				Regional (2016)	Global	
Short-eared trident bat *Cloeotis percivali*	CLOPER	-	-	Endangered	Least Concern	Low
Sundevall's roundleaf bat *Hipposideros caffer*	HIPCAF	-	-	Least Concern	Least Concern	Low
Cohen's horseshoe bat *Rhinolophus cohenae*	RHICOH	-	-	Vulnerable	Not Evaluated	Low
Ruppell's horseshoe bat *Rhinolophus fumigatus*	RHIFUM	-	-	Least Concern	Least Concern	Low
Bushveld horseshoe bat *Rhinolophus simulator*	RHISIM	-	6	Least Concern	Least Concern	Low
Darling's horseshoe bat *Rhinolophus darlingi*	RHIDAR	-	12	Least Concern	Least Concern	Low
Geoffroy's horseshoe bat *Rhinolophus clivosus*	RHICLI	-	2	Least Concern	Least Concern	Low
Swinny's horseshoe bat *Rhinolophus swinnyi*	RHISWI	-	-	Vulnerable	Least Concern	Low
Lander's horseshoe bat *Rhinolophus landeri*	RHILAN	-	-	Least Concern	Least Concern	Low
Smither's horseshoe bat *Rhinolophus smithersi*	RHISMI	-	-	Near Threatened	Near Threatened	Low
African straw-coloured fruit bat *Eidolon helvum*	EIDHEL	-	-	Least Concern	Near Threatened	High
Peter's epauletted fruit bat *Epomophorus crypturus*	EPOCRY	-	-	Least Concern	Least Concern	High
Wahlberg's epauletted fruit bat *Epomophorus wahlbergi*	EPOWAH	-	-	Least Concern	Least Concern	High
Egyptian fruit bat *Rousettus aegyptiacus*	ROUAEG	-	-	Least Concern	Least Concern	High

5 MONITORING RESULTS

5.1 Static Monitoring

During the sample period, a maximum possibility of up to 27 insectivorous bat species were detected, with a total of 60,681 bat passes recorded across all detectors. Percentage of nights with bat activity was high, with bats recorded between 91% and 92% of sample nights (Table 2). Bats from groups "MOL2" and "VES30" accounted for 71% and 22.5% of total activity, respectively (Table 1). Only 1.6% of activity was associated with the VES50/NLB group, which is inclusive of the Natal long-fingered bat (*Miniopterus natalensis*).

Table 2: Acoustic Monitoring Summary

Detector	Date Installed	# of Sample Nights	% of Sample Nights with Bat Activity	Mean ; Median Bat Passes/hour	Total Bat Passes
NMET_10m	10/06/2021	212	91%	5.55 ; 0.14	23,828
NMET_50m	10/06/2021	315	92%	8.49 ; 1.79	36,853

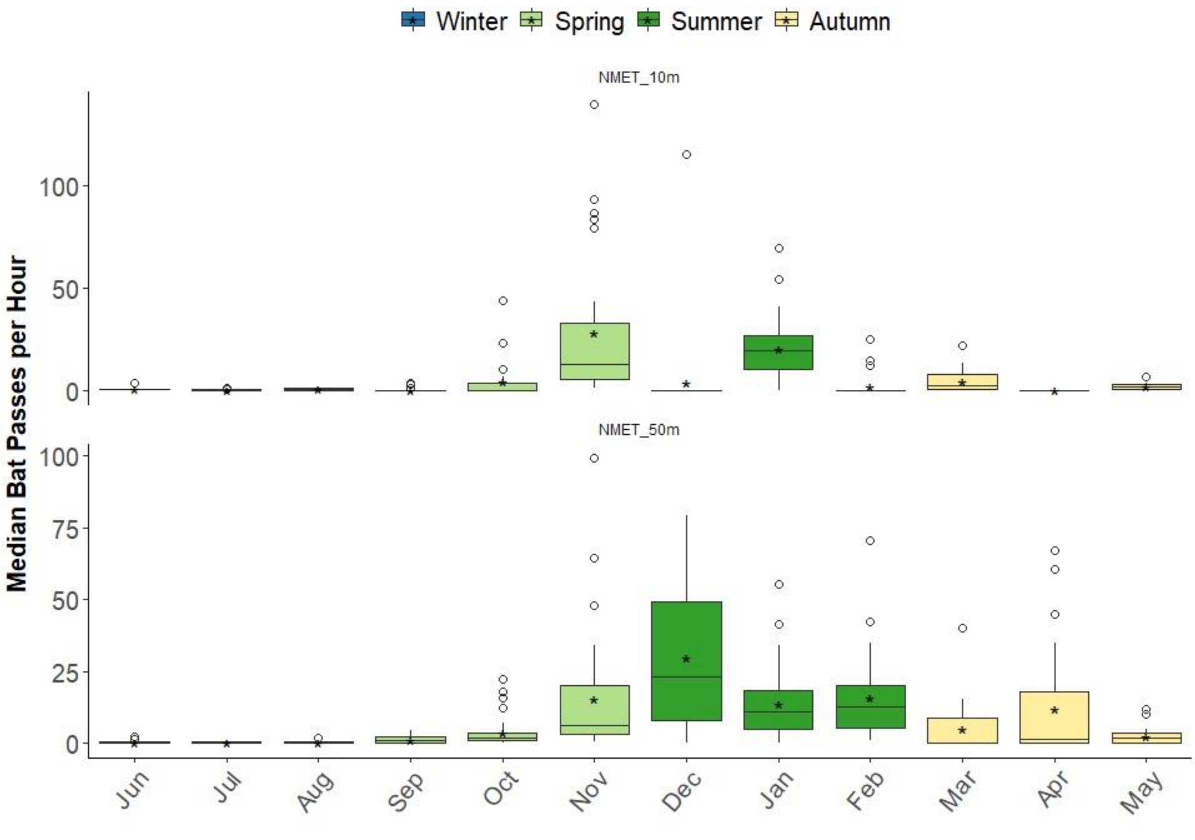
Throughout the survey period to date, the bat activity on site is considered to be low-medium, relative to its respective ecoregion (Maputaland Coastal Forest Mosaic). Bat activity is moderate near the ground during November and January (Table 3). Despite activity near ground level being moderate during months of spring and summer, it is noted that 31 nights of substantial activity spikes were recorded during this same period. These nights are considered as high-risk events and are indicating an importance for bat activity during the overall spring and summer periods.

Table 3: Median bat passes per hour per microphone per month

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
NMET_10m	0.42	0	0.58	0	0	12.79	0	19.26	0	2.32	0	1.71
NMET_50m	0.42	0.07	0.07	1.11	1.83	5.97	23.34	11.05	12.90	0	1.46	2.03

*Green cells indicate Low Risk and Orange cells indicate Moderate Risk for the Maputaland Coastal Forest Mosaic ecoregion.

Bat activity was low during the winter period between June and August, at both monitoring heights. Median activity of bat passes per month peaked at 0.58 near ground level, while activity within the rotor sweep ranged from 0.07 to 0.42 passes per month. Activity then gradually increased during spring where it eventually peaked during the late spring and summer months. During this time, the highest number of bat passes per hour recorded on a single night was 139 near ground level and 99 passes at rotor swept height (Graph 1).



Graph 1: Boxplot of median number of bat passes per hour.

Of all the species groups observed, the MOL2 group was recorded the most, overall, across the site – both near ground level and within the rotor sweep. These calls account for approximately 71% of all bat calls on site (Graph 2). The species included in this group is the Egyptian free-tailed bat, Angolan free-tailed bat, Little free-tailed bat and Mauritian tomb bat. All such species have a 'Least Concern' conservation status, but a high risk of suffering impacts due to wind turbine infrastructures, largely due to their unique foraging behaviours. All of these species are open air foragers and are subsequently susceptible to wind turbine blade collisions or mortality as a result of barotrauma[7].

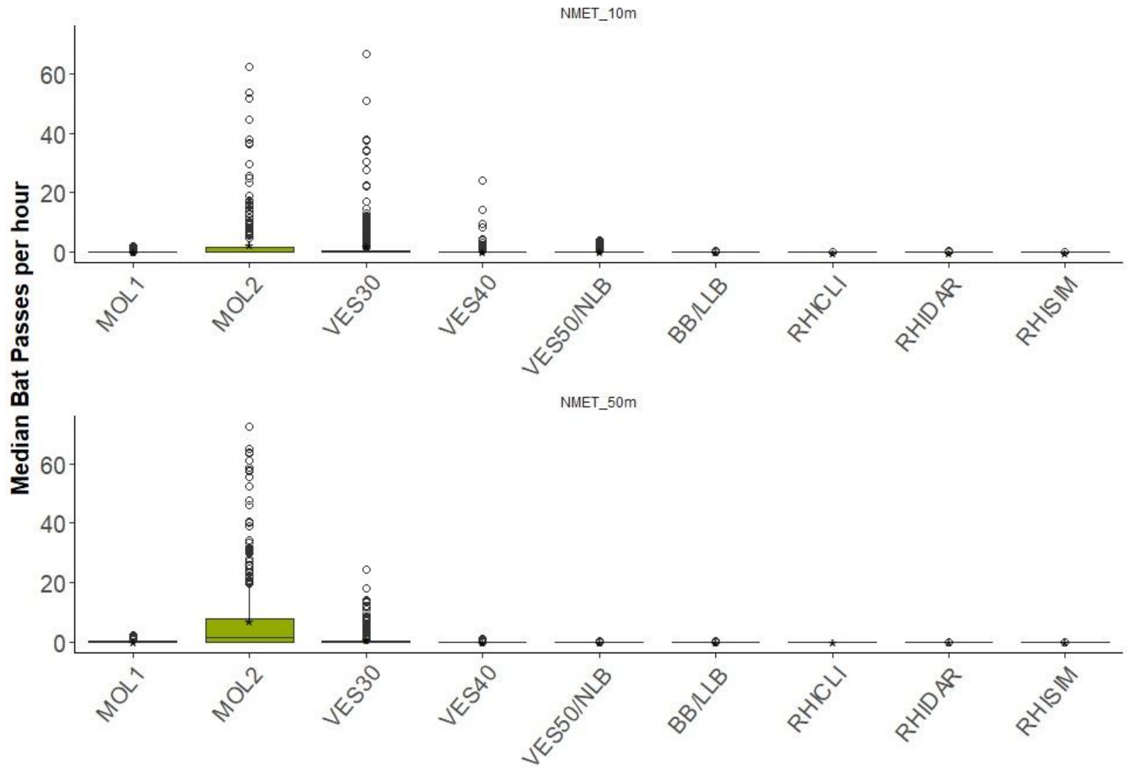
The VES30 group accounts for the second highest activity levels on site, making up a total of 22% of all bat calls (Graph 2). The species included in this group is the Long-tailed serotine, African yellow bat, Welwitsch's myotis and Light-winged lesser house bat. Most of these species have a 'Least Concern' conservation status, apart from the Light-winged lesser house bat – which is classified as 'Near Threatened' on a regional level. These species largely have a medium-high risk of suffering impacts due to wind turbine infrastructures. This is mostly because they are classified as clutter-edge foragers, where they use the lower air spaces to forage for prey. This may subsequently put them at risk to suffering wind turbine infrastructure impacts when the lower rotor swept areas overlap with these foraging airspaces.

Thereafter, activity levels were observed to decline substantially for the remainder of the groups/species. The third highest group belonged to that of the VES40 bats, inclusive of the Cape serotine, Green house bat, Variegated butterfly bat and Schlieffren's serotine – making up a total of 2.5% of all bat calls. Following this, 2.1% of all bat activity was associated with the MOL1 group, inclusive of the Large-eared giant mastiff bat, Midas free-tailed bat and Ansorge's free-tailed bat.

The fifth highest recorded group on site is the VES50/NLB group. This group is made up of the Rufous mouse-eared bat, Temmick's hairy bat, Zulu serotine, Natal long-fingered bat, African pipistrelle, Anchieta's pipistrelle and the Rusty bat. All of these species have a 'Least Concern' conservation status and are largely classified to have a medium-high or high risk of suffering impacts to wind turbine infrastructures. This group is important, as it includes the Natal long-fingered bat – which has been found to occupy a large roost approximately 10.2 km south of the site (Figure 1). Previous estimations of occupancy within this roost is noted to be relatively large (n = 14,000 – 16,000) (MF&A 2021), with recent site visits (winter, spring, summer and autumn) showing similar results, although with autumn being marginally lower. Activity levels of this group on site appear to be relatively low and make up approximately only 1.6% of all bat calls – being substantially lower than that of the first two groups, in particular (Graph 2). Of this activity, only 1.4 % of recordings were noted to occur within the rotor swept zone (approximately 14 bat passes over the monitoring period).

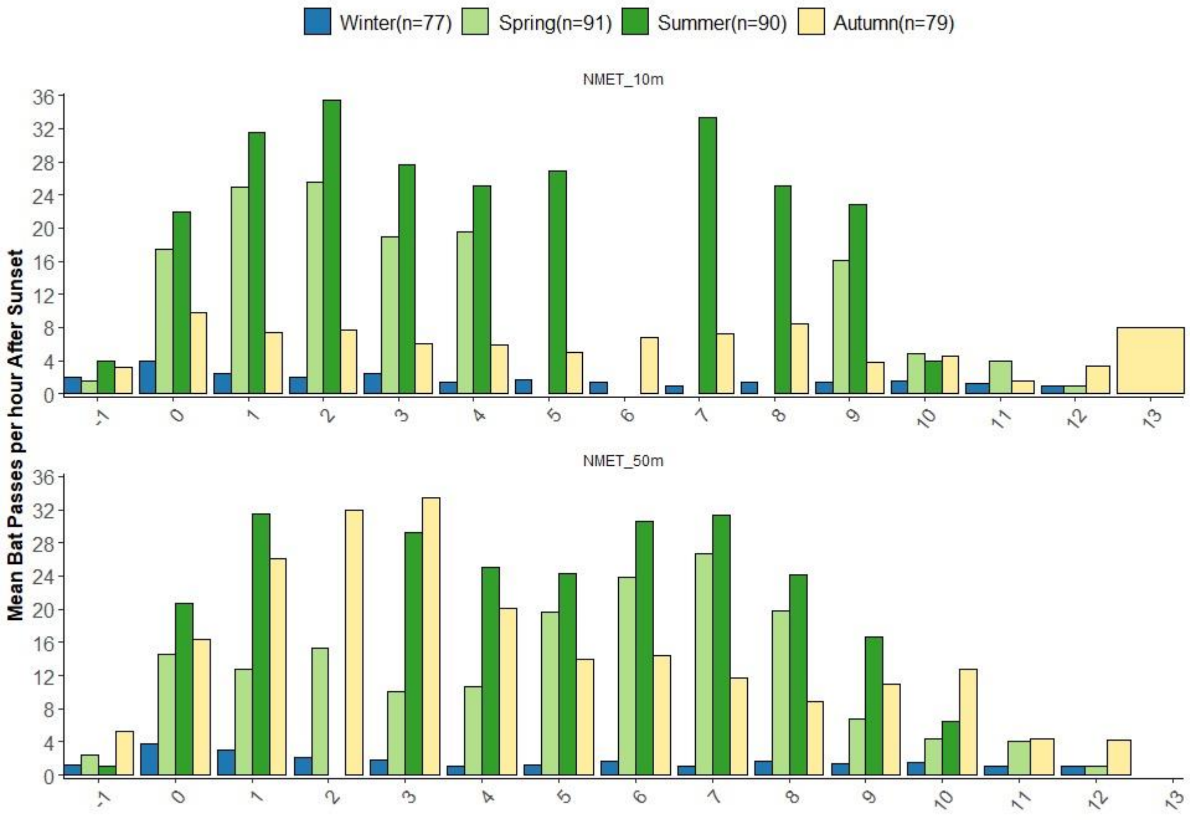
The remainder of the species that were acoustically detected on site make up less than 1% of all bat calls (each), inclusive of the Banana serotine, Lesser long-fingered bat, Bushveld horseshoe bat, Darling's horseshoe bat and Geoffroy's horseshoe bat (Graph 2).

[7] Barotrauma in a 'bats and wind energy' context refers to tissue damage caused by rapid excessive changes in air pressure near turbine blades.



Graph 2: Box and Whisker plot showing the distribution of median bat passes per hour, per group / species.

Bats were recorded from 30 minutes before sunset to 30 minutes after sunrise, at both detectors. Bat activity was generally higher in summer and spring compared to that of autumn and winter. Activity across all seasons showed the same trend of activity over time. All activity peaked within 2 hours after sunset, whereby it then declined. A secondary, marginally lower peak then occurred approximately 6-8 hours after sunset, after which it then declined once again to very low levels after the 12^{th} hour (Graph 3). A possible explanation for these activity fluctuations could likely be due to bats immediately leaving their roosts at sunset (at which the initial peak of activity would be observed), for foraging purposes, and then returning back to their roosts again before sunrise – whereby a second peak of activity would be noticeable. Such activity data is useful in determining when the risk periods are over time, throughout each night.



Graph 3: Mean number of bat passes per hour after sunset (sunset = 0)

5.2 Active Transect Monitoring

Transect monitoring was conducted across the site over a period of four seasons (winter, spring, summer and autumn) and included a vehicle-based driven transect, with ten monitoring points, consisting of 3-minute recording stops, each. Transects were conducted to assess any relevant patterns in spatial usage of the area by bats, general species composition and to compliment static monitoring data by assessing levels of general seasonal activity of bat species/groups across the site. Across the four seasons monitored, bats appeared to be mostly active during the summer season, where approximately 56% of all activity took place. The activity measured during the winter, spring and autumn seasons were relatively similar to each other, but with winter having marginally higher levels of bat passes (16%) than in spring (13%) and autumn (14%). A likely explanation for the lower levels in spring could however be due to a rain storm that was present in the broader area throughout the course of the sampling period.

Within the winter period, the VES50/NLB group appeared to be the most dominant group of bats that were recorded across the site, with the MOL1 and MOL2 groups being almost equally as prevalent. Only two bat passes were recorded from the VES30 group (Figure 2). Within the spring period, the MOL2 group seemed to have been the most widespread across the site, making up 88% of all calls for that season. The remainder of calls came from VES30 group, where only 2 bat passes were recorded (Figure 3). The summer season showed remarkably higher bat activity and species composition than that found during winter and spring, being consistent with that observed in the static monitoring results. Approximately 66% of all bat calls in summer were attributed to the VES50/NLB group, while 26% of calls were identified from the MOL2 group. Thereafter, lower levels of calls were recorded from the VES30 (5%), VES40 (1%) and BB/LLB (1%) groups (Figure 4). Sampling within the Autumn season revealed that the MOL2 group was the most dominant for that season, making up approximately 74% of the recorded bat calls, followed by the MOL1 (16%) and MOL2 (10%) groups (Figure 5).

In terms of spatial usage, bats seem to be relatively evenly distributed across the site with no significant pattern or spatial preference. This may largely be due to the existing undisturbed landscape with a magnitude of available resources for foraging purposes. The existence of several drainage lines with associated thicket vegetation, as well as rural human dwellings, would provide a degree of preference for area usage over time, as bats are known to use such areas more often for foraging and/or roosting purposes.

5.3 Roost Monitoring

The site was inspected for potential roosting locations, inclusive of local rural dwellings/buildings, cattle kraals and trees. No positive identification of roosts were noted throughout the monitoring campaign, with most inspected structures holding relatively low potential for bats. Nonetheless, bats are cryptic animals and are able to roost in small spaces/crevices, making it difficult to locate their presence. As such, it is still possible for these structures to still hold relevance for bats, although from the site observations made, it is unlikely. Despite roosting potential, these structures could also be relevant for foraging purposes, as human settlements and subsequent agricultural activities can provide the necessary resources to attract bats during their foraging activities.

Of significant relevance is the presence of a large roost within the town of Namaacha, located approximately 10.2 km south of the site. This roost is an old abandoned hotel and is comprised of two main wings – a northern and southern wing. Inspections of this building showed that the northern wing accommodates between 30-50 *Epomophorus wahlbergi / crypturus* fruit bats, while the southern wing has a confirmed presence of several thousand insectivorous bats, with previous estimates ranging between 14,000 and 16,000 bats (MF&A 2021). Recent site visits in winter, spring, summer and autumn showed similar results, with Autumn yielding marginally fewer individuals. Fruit bats, such as *E. wahlbergi*, may travel over 13 km each night between roosting sites and feeding sites. As such, it is possible for fruit bat individuals from this roost to use the site (Monadjem et al. 2010) – particularly due to the presence of fruit trees on and near the site. Nonetheless, during all inspections to date, no fruit bats were observed foraging or roosting on/near the site. Regarding the southern wing of the roost, of particular relevance is the presence of bats from the VES50/NLB group, which has shown to make up approximately 82% of all bat calls recorded from within the roost over all four seasons, collectively. From the data analysed, evidence suggests that most of the species associated with this roost would be that of the Natal long-fingered bat (*Miniopterus natalensis*). This species is a relatively common and widespread species, with its core distribution located within the savannahs and grasslands of southern Africa. Females are known to migrate seasonally between winter hibernation sites and summer maternity roosts. These seasonal migration events may be separated by up to 260 km, making informed wind farm planning essential (MacEwan et al. 2016). This migratory behaviour and roost usage also raises an essential consideration for this roost in terms of it having the potential for it to be classified as a "Critical Habitat", as such habitats are defined as areas with high biodiversity value, including that of habitat supporting globally significant concentrations of migratory species and/or congregatory species. This has been further assessed in section 8.3, below. In addition to these high numbers of *M. natalensis*, lower numbers of species from groups MOL2 (13%), VES30 (4%) and VES40 (1%) were also detected.

6 IDENTIFICATION OF LIKELY IMPACTS

Wind Farms have the potential to impact bats directly through collisions (with spinning turbine blades) and barotrauma resulting in mortality (Horn et al. 2008; Rollins et al. 2012), and indirectly through the modification of habitats (Kunz et al. 2007b; Millon et al. 2018). Similarly, associated infrastructure such as grid connections are also able to impact bats directly through collisions (with transmission lines, in the case of larger frugivorous bats), and indirectly through habitat modification. Modification of habitat includes roost destruction, roost disturbance, and potential displacement from foraging areas and/or commuting routes. Direct impacts pose the greatest risk to bats and, in the context of the project, habitat modification impacts should be present, although is not anticipated to pose a significant risk because the project footprint is considered to be small with an abundant availability of suitable/undisturbed natural habitat within the broader region. No confirmed roosting sites have been located within the project boundaries, besides a large roost located approximately 10.2 km south of the site. Monitoring data obtained to date suggests that the same species occupying this roost (*Miniopterus natalensis*) does not appear to significantly use the study area, as data across the 12 months of monitoring yielded a total of 1,004 bat passes – making up only 1.6% of all bat calls recorded on site. Of these passes, 990 of them were recorded at ground height, while only 14 were recorded within the rotor swept zone. Although no evidence of frugivorous bats was observed on site, it is predicted that four such species would occur in the area and use the site. Therefore, impacts associated with wind turbine and grid connection collisions are possible to occur.

Direct impacts to bats posed by the turbines at the proposed Wind Farm will be limited to species that make use of the airspace in the rotor-swept zone of the wind turbines. Up to 23 of the bat species that were recorded on site exhibit behaviour that would have a higher probability of bringing them into contact with wind turbine blades, based on their foraging behaviours and ecology. They are thus at risk of negative impacts if not properly mitigated. This includes 13 high risk species and 10 medium-high risk species (Table 1). An additional four species of fruit bat also exhibit potential to be negatively affected by the development, although these were not observed on site. Direct impacts of the grid connection transmission lines would primarily be limited to such fruit bats. A further detailed description of the main impacts expected to occur on site are presented below:

6.1 Roost Disturbance

Wind Farms have the potential to impact bats directly through the disturbance of roosts during construction and operation. Relevant activities include the construction of roads, Operation and Maintenance (O&M) buildings, sub-station(s), internal transmission lines and installation of wind turbines. Excessive noise and dust during the construction phase could result in bats abandoning their roosts, depending on the proximity of construction activities to roosts. This impact will vary depending on the species involved; species that roost in trees are likely to be impacted more (e.g. Cape serotine and Egyptian free-tailed bats; Monadjem et al. 2010), as tree roosts are less buffered against noise and dust compared to roosts in buildings and rocky crevices. Roosts are limiting factors in the distribution of bats and their availability is a major determinant in whether bats would be present in a particular location. Reducing roosting opportunities for bats is likely to have negative impacts. If all buffers of the sensitivity map are adhered to, then the significance of this impact is not expected to be high.

6.2 Roost Destruction

Wind Farms have the potential to impact bats directly through the physical destruction of roosts during construction. Relevant activities include the construction of roads, O&M buildings, sub-station(s), grid connection transmission lines and installation of wind turbines. Roosting structures that are likely to be impacted by construction activities include trees, crevices in rocky outcrops and buildings. Roost destruction can impact bats either by removing suitable potential roosting spaces which reduces available roosting sites or, if a roost is destroyed while bats are occupying the roost, this is likely to result in bat mortality. Reducing suitable roosting opportunities for bats or killing bats during the process of destroying roosts will have severe negative impacts on local populations. If all buffers of the sensitivity map are adhered to, then the significance of this impact is not expected to be high.

6.3 Habitat modification

Bats can be impacted indirectly through the modification or removal of habitats (Kunz et al. 2007) and can also be displaced from foraging habitat by the construction of wind turbines (Millon et al. 2018). The removal of vegetation during the construction phase can impact bats by removing vegetation cover and linear features that some bats use for foraging and commuting (Verboom and Huitema 1997). The modification of habitat could create linear edges which some bats commute or forage along. This modification could subsequently also create favourable conditions for insects upon which bats feed which would in turn attract bats to the proposed wind farm area. Habitat modification should be avoided in all high sensitive areas and reduced as far as possible across the project site.

6.4 Bat Mortality during Commuting, Foraging and/or Migration

The major potential impact of wind turbines on bats is direct mortality resulting from collisions with turbine blades and/or barotrauma (Grodsky et al. 2011; Horn et al. 2008; Rollins et al. 2012). These impacts will be limited to species that make use of the airspace within in the rotor swept zone of the wind turbines, during foraging, commuting and/or migration activities. Up to 23 bat species that were recorded on site exhibit behavior that would bring them into contact with wind turbine blades, putting them at risk of severe negative impacts of mortality. An additional four species of fruit bat also exhibit potential to be negatively affected by the development, although these were not observed on site. All restrictions around turbine high sensitivity areas should be strictly adhered to for the development of the project. Direct fatality impacts as a result of foraging activities would also be further exacerbated with potential light pollution that would be present during both construction and operational activities. Currently the local region experiences very little light pollution from anthropogenic sources and the construction of a Wind Farm will marginally increase light pollution. This excludes turbine aviation lights which do not appear to impact bats (Baerwald and Barclay 2011; Horn et al. 2008; Jain et al. 2011; Johnson et al. 2003). Certain bat species actively forage around artificial lights due to the higher numbers of insects which are attracted to these lights (Blake et al. 1994; Rydell 1992; Stone 2012). This would bring these species into the vicinity of the operating turbines and increase the risk of collision/barotrauma for these species. This impact is likely to be low to moderate with mitigation, but must be carefully considered because the consequence could be severe without mitigation. Lighting at the project should be kept to a minimum during all project phases, and appropriate types of lighting should be explored and used to avoid attracting insects, and hence, bats (for example downward facing lighting). No turbines should be placed within pre-identified high sensitivity areas, as far as possible. Should placement of turbines in these areas be unavoidable, then appropriate minimisation techniques (including curtailment and/or acoustic deterrents) must be implemented according to the parameters defined in Table 4.

6.5 Residual Impacts

Residual impacts during the operational phase are likely for most wind farm projects and will warrant additional mitigation measures, with curtailment and deterrents the main options once turbines are operational. Curtailment techniques that can be considered for

Namaacha Wind Farm are blade-feathering, raising the cut-in speed and if needed, shutting down turbines. The exact choice will depend on the scale of the impact, which should be evaluated against threshold levels (MacEwan et al*.* 2018). Deterrence mechanisms are also a form of mitigation for further consideration, to reduce residual impacts. Further information on residual impacts and potential minimisation is presented in Section 7, below.

6.6 Cumulative Impacts

Cumulative impacts to bats, such as those relating to changes to physical environment (e.g. roost and habitat destruction) and direct mortality are likely to be low across the cumulative impact region, given that there are no other known operational wind energy facilities within Mozambique. No operational facilities are known to occur within 50 km of the project boundaries, and the nearest known WEF, in accordance with the South African Renewable Energy EIA Application Database (REEA_OR_2022_Q1), is located approximately 187 KM south-west of the project, within the Republic of South Africa. This facility is for the proposed establishment of a wind energy facility outside of Carolina, Mpumalanga, and is not presently operational. As such, cumulative impacts are not expected to be significant, although should be considered nonetheless. This is especially relevant for migratory species (e.g. the Natal long-fingered bat) which travels long distances between roosting sites. Impact ratings are not expected to be severe with appropriate turbine siting and operational mitigation (where relevant). However, these ratings would be dependent on all other surrounding wind energy facilities also adopting similar mitigation strategies to reduce impacts to bats.

6.7 Decommissioning Phase

The impacts to bats during this phase are likely to be restricted to disturbance. Provided decommissioning activities are restricted to daylight hours, the impact to bats should be low.

7 MITIGATION

7.1 Recommendations

While the overall bat activity was generally low/moderate for the respective ecoregion, it was at its highest during the spring and summer seasons, with numerous high activity spikes being recorded – demonstrating the potential for high-risk impact events during these periods. As such, certain measures to avoid risks to bats will be needed. Mitigation options that must be incorporated into the project to minimise the higher risk periods during spring and summer can be categorised into avoidance and minimisation techniques. Avoidance includes buffering key habitats and considering turbine design so that potential interactions between bats and wind turbines are spatially limited as much as possible. Minimisation relates to mitigating residual impacts to bats primarily through various forms of curtailment[8] or by using ultrasonic deterrents.

In accordance with IFC Performance Standard 1, the mitigation hierarchy to address the identified risks and impacts will favour the avoidance of impacts over minimisation, and, where residual impacts remain, compensation/offset, wherever technically and financially feasible (IFC 2012a). As the potential impacts / risks to bats have been defined in this report, the first and most important form of such impact mitigation is therefore avoidance.

Avoidance mitigation techniques have been incorporated by buffering key habitat features for bats. These include potential roosts and foraging areas, including buildings/dwellings and riverine features such as rivers, drainage lines and associated riparian vegetation. The sensitivity of each buffer was determined relative to the different infrastructure elements

[8] Curtailment – the act restricting normal operation of a wind turbine by slowing or stopping blade rotation for a period of time.

incorporated into the project and the relevance of such assessed features to the infrastructure. Due to the abundant presence of suitable natural vegetation and habitat complexity, the site is considered to have an overall medium sensitivity rating, with certain features that are considered as being highly sensitive. Rivers have been buffered by 500m, while buildings/dwellings and drainage lines have all been buffered by 200m (Figure 6). Such buffers have been defined according to South African and international best practice, whereby MacEwan et al. (2020) recommends, at an absolute minimum, for all potentially bat important features to be buffered by at least 200m, while Rodrigues et al. (2014)[9] states that buffer zones of 200m should apply to habitats which are specifically important for bats, such as tree lines, hedge-row networks, wetlands, waterbodies and watercourses, as well as to any areas where high bat activity has been determined by impact assessment. All buffers aside from buildings/dwellings have a high sensitivity rating and should be avoided (inclusive of the full length of the blade length). Where not possible to avoid, suitable minimisation techniques (such as curtailment and/or ultrasonic deterrents) are to be implemented from the start of operation (in accordance with the parameters defined in Table 4) – keeping in mind that ultrasonic deterrents are only effective against microbats (bats which predominantly use echolocation for foraging and navigation – particularly insectivorous bats). Turbine curtailment is recommended in order to mitigate impacts on megabats (bats which predominantly use sight and smell to forage and navigate, and lack the ability to echolocate – particularly frugivorous bats), although other forms of mitigation may be considered in the event that new systems are introduced that are scientifically proven to effectively work against megabats. No megabats were however observed on site during the 12-month monitoring campaign, and although possible, the anticipated risk of significant impacts occurring is considered to be low. The 200m buffers around the local buildings/dwellings has been reduced in their sensitivity rating, based on their observed low potential for accommodating bats for roosting purposes. Most of these buildings are noted to be occupied by the local community and are very light inside with the absence of a ceiling, while some are relatively derelict or exposed to the elements. Some of the other more rural dwellings are very small and are occupied by local villagers. Such dwellings also possess no ceilings and are mostly made of natural resource materials. No signs of occupation or guano were noted upon inspection at any of these features, and interviews conducted with the local community yielded the same result, in which no bat roosting activity has ever been observed at these structures. From indications provided at the time of this reporting, some of these structures may be considered for removal during the projects' development phase, following a potential resettlement process. Presently, it does however remain unconfirmed to what extent this may occur. Given the absence of physical observations of bats (including guano, scratch marks or smudges) made during the relevant site inspections, such features are not deemed to be significantly important for the proposed facility or local bat community on site. Turbines are therefore allowed to be placed within such buffers, if avoidance is not possible. Given the observations made, it would be beneficial if such features were removed, as far as possible, in order to avoid potential use of these structures by bats in future. If such features are not removed and found to be used by bats during the construction and/or operational phase of the project, then the appointed bat specialist must advise on appropriate management/mitigation actions for further implementation.

An additional mitigation that could be used to avoid impacts to bats is the choice of wind turbine technology. Evidence of a relationship between turbine size and bat fatality is equivocal. Some evidence suggests that larger turbines kill more bats (Baerwald and Barclay 2009) or that as the distance between the blade tips and the ground increases, bat fatality decreases (Georgiakakis et al. 2012). However, other studies have found no

[9] As stated in the World Bank Group EHS Guidelines (2015), the guidelines developed by Rodrigues et al. (2014), among others, are a set of guidelines that can be used for ecological studies and impact assessments in the absence of in-country guidelines (in this case, for Mozambique).

evidence that turbine height or the number of turbines influences bat mortality (Berthinussen et al. 2014; Thompson et al. 2017). Some species in South Africa that are not adapted for flight at height have suffered mortality from wind turbines (e.g. the Cape serotine) suggesting that some bats are killed in the lower edge of the rotor swept zone. The data presented in this report shows that median bat activity was 0.14 passes/hour at ground level, versus 1.79 passes/hour at rotor height. These results indicate that activity was actually marginally higher at rotor height, than that observed at ground level. This corresponds to the median activity levels, as presented in the best practice guidelines, for the Maputoland Coastal Forest Mosaic ecoregion – which also shows higher median bat passes per hour at rotor height, than at ground level. As such, it can be assumed that increasing the distance between the turbine blades and the ground, as well as decreasing the overall height of the turbine towers could help to mitigate some impacts.

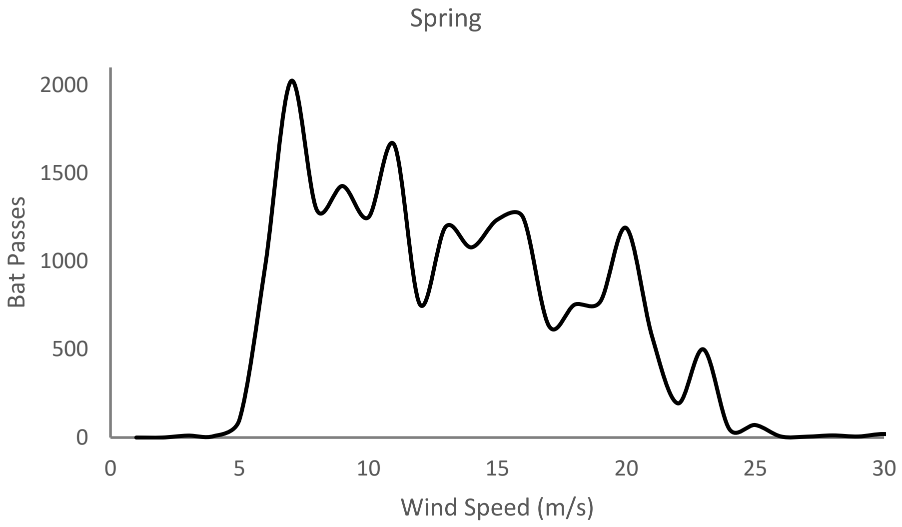
Lighting at the project should be kept to a minimum during all project phases, and appropriate types of lighting should be explored and used to avoid attracting insects, and hence, bats (for example downward facing lighting).

Based on the monitoring results assessed thus far, the potential for residual impacts is highly likely. The residual impacts will warrant additional mitigation measures, with curtailment and deterrents the main options once turbines are operational. Both of these mitigation measures are known to reduce bat fatality (Arnett and May 2016). The World Bank Group EHS guidelines (2015) support the use of curtailment and deterrents for residual impacts. These guidelines state that careful site selection and layout should reduce adverse impacts on biodiversity, while any significant residual adverse impacts will need appropriate mitigation, including (but not limited to) active turbine management such as curtailment, adjustments of cut-in speed, eliminating free-wheeling and assessing current state of the art bat deterrence technology (WBG 2015). Curtailment techniques that can be considered for Namaacha Wind Farm are blade-feathering, raising the cut-in speed and if needed, shutting down turbines. The exact choice will depend on the scale of the impact, which should be evaluated against threshold levels (MacEwan et al*.* 2018). Deterrence mechanisms are also a form of mitigation for further consideration, to reduce residual impacts, but are only effective against mitigating impacts to microbats (bats which predominantly use echolocation for foraging and navigation – particularly insectivorous bats) – making turbine curtailment the preferred option (alone or together with deterrence mechanisms).

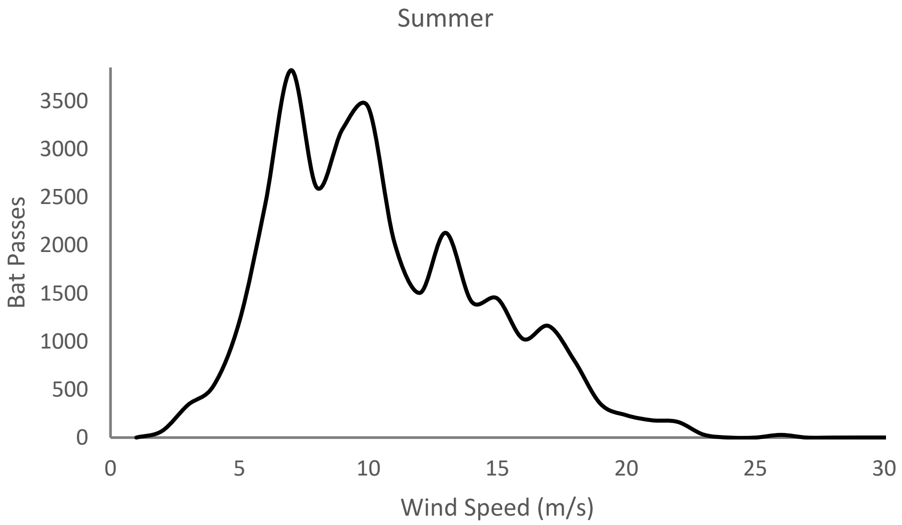
As the designation of the site has been classified as natural habitat, mitigation measures are to be designed to achieve no net loss of biodiversity, where feasible. As such, in order to achieve this, fatality thresholds are prescribed to further inform future management of residual impacts. Such thresholds are usually influenced by the natural mortality of bat species, density dependent factors, activity levels per ecoregion, percent loss to natural declines and size of the site. Research suggests that if 2% of additional losses to bat populations from anthropogenic pressures in a particular ecoregion occurs, then bat populations will start to decline. These losses can be calculated according to The South African Bat Assessment Association fatality threshold guidelines (MacEwan et al*.* 2018). As per these guidelines, bat occupancy per 10 ha within the Maputaland Coastal Forest Mosaic ecoregion is 133.27 bats. Two percent of bats for this size area equates to an annual threshold limit of 2.67 'least concern' insectivorous bats per 10 ha. Additionally, if one fatality of any conservation important or frugivorous bat species occurs during a 12-month period, then these mitigation measures would also need to be applied, as per the respective guidelines (refer to MacEwan et al. 2020 for species list). Estimated thresholds for Namaacha Wind Farm is expected to be 228.81 Least Concern insectivorous bats per annum. Any fatalities occurring at or beyond the estimated fatality threshold level would constitute a net loss for the species/taxa under consideration, and would not be compliant with IFC Performance Standard 6. As such, appropriate mitigation beyond these threshold levels would be required. A suitable bat specialist appointed at the start of the projects' operational phase must inform the required mitigation measures to be implemented, according to latest available guidelines and technologies. Monitoring of fatalities is to occur from the outset, as soon as the first wind turbine is erected and starts spinning.

As approximately 25% of bat activity at Namaacha Wind Farm has been noted to occur within wind speeds of up to 3.5 m/s (for the higher activity periods in spring and summer), the initial recommended approach for reducing impacts at the facility would be to apply blade feathering below the manufacturers cut-in speed to prevent free-wheeling during these periods, for all wind turbines, from the date of turbine installation. An adaptive management approach is then recommended for the duration of the facilities' operational lifespan, in order to mitigate potential residual impacts. This is aligned with the requirements set out in the IFC Performance Standard 6, whereby it states that the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle (IFC 2012a). Such an approach would include monitoring fatalities and continuously assessing threshold values, in accordance with the recommendations made in the relevant bat monitoring and threshold guidelines (MacEwan et al. 2018 & 2020). Overall, a minimum of two years of operational monitoring is required (acoustic monitoring, carcasses searches and fatality estimations) in accordance with best practice guidelines. Thereafter, monitoring must be repeated again in year five, and every five years thereafter. Should any such threshold values be exceeded, then further curtailment or deterrents are recommended to be applied. Monitoring of fatalities is to occur from the outset, as soon as the first wind turbine is erected and starts spinning.

During spring, bat activity accumulated relatively quickly in temperatures ranging between approximately 15°C and 20°C, while 16% of activity occurred below a wind speed of 3.5m/s. In spring, up to 90% (approx.) of bat activity was recorded at wind speeds of up to 10 m/s (Graph 4). During summer bat activity accumulated between temperatures of approximately 19°C and 22°C, while approximately 28% of activity occurred below a wind speed of 3.5m/s. In summer, up to 90% (approx.) of bat activity was recorded at wind speeds of up to 8 m/s (Graph 5). During winter, results have shown that bat activity remained at relatively low levels across the site, considering all time and weather parameters, while Autumn showed similar results, although marginally higher. Approximately 33% of all activity in spring took place between 18h00 and 22h00, while a secondary peak of activity (54%) took place between 23h00 and 03h00. In summer, approximately 95% of all activity was recorded between 19h00 and 04h00.



Graph 4: Number of bat passes versus wind speed in Spring



Graph 5: Number of bat passes versus wind speed in Summer

Independent of a standard recommended blade feathering (up to 3.5 m/s) during spring and summer from the date that turbines become operational; should curtailment or deterrents be required (based on threshold values being exceeded or high sensitivity areas not being able to be avoided), their use would be confined to specific periods of the year and under specific combinations of meteorological conditions, as described above. A summary of such parameters during these periods is described in Table 4 below, as a preliminary measure of minimisation. Such a schedule must however be updated over time, when further information becomes available during the projects' operational phase.

Table 4: Minimisation Parameters if fatality thresholds are exceeded or if turbines are sited in high sensitivity areas

	1 September – 30 November (Spring)	1 December – 29 February (Summer)
Time Period	18h00 – 22h00 ; 23h00 – 03h00	19h00 – 04h00
Temperature	Between 15°C and 20°C	Between 19 °C and 22°C
Wind Speed	Up to 10 m/s	Up to 8 m/s

Further to the above, and in the event that wind turbines are unable to avoid high sensitive areas, the above parameters would be applicable as well – with wind turbines in such areas being subjected to minimisation techniques (turbine curtailment and/or deterrence mechanisms) as soon as turbines become operational, independent of whether or not fatality thresholds are reached.

7.2 Summary

As per the recommendations listed above, mitigation for Namaacha Wind Farm can be summarised as follows:

- All wind turbines are to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of project inception. This should be implemented throughout the lifespan of the project, with specific parameters (seasonality and wind speed) being updated throughout the course of an operational bat monitoring campaign, as more fatality and acoustic data becomes available.
- A minimum of two years of operational monitoring is required (acoustic monitoring, carcasses searches and fatality estimations) in accordance with the methodologies, as laid out in the South African best practice guidelines for monitoring bats at operational wind energy facilities. Thereafter, monitoring must be repeated again in year five, and every five years thereafter.
- All turbines (including the full blade length) are to avoid high sensitive areas as a primary measure of mitigation (i.e. avoidance), in accordance with the mitigation hierarchy as defined by IFC (2012a).
    - In the event that high sensitivity areas are unable to be avoided, then minimisation must be applied at those turbines encroaching into such areas from the start of project inception. Such minimisation includes either turbine curtailment or deterrence mechanisms. Turbine curtailment is however preferred, as ultrasonic deterrence mechanisms are not effective against mitigating impacts on megabats (bats which predominantly use sight and smell to forage and navigate, and lack the ability to echolocate – particularly frugivorous bats). No megabats were however visually observed using the site during the 12-month monitoring campaign, and although possible, the anticipated risk of significant impacts occurring is considered to be low. Minimisation must be undertaken in accordance with the parameters defined in Table 4. This should be implemented throughout the lifespan of the project, with specific minimisation parameters being updated throughout the course of an operational bat monitoring campaign, as more fatality and acoustic monitoring data becomes available.
- All turbines (including the full blade length) are to avoid medium sensitive areas (associated with buildings/dwellings), as far as possible. However, given the absence of physical observations of bats (including guano, scratch marks or smudges) made during the relevant inspections, such features are not deemed to be significantly important for the proposed facility or local bat community on site. Turbines are therefore allowed to be placed within such buffers, if avoidance is not possible. Given the observations made, it would be beneficial if such features (associated with medium sensitivity buffers) were removed, as far as possible, in order to avoid potential use of these structures by bats in future. If such features are not removed and found to be

used by bats during the construction and/or operational phase of the project, then the appointed bat specialist must advise on appropriate management/mitigation actions for further implementation.

- For all wind turbines, if the fatality thresholds are reached at any point during the projects' lifespan, then appropriate mitigation in the form of either turbine curtailment and/or acoustic deterrence mechanisms is to be applied to reduce residual impacts, in accordance with the minimisation parameters as defined in Table 4. Threshold limits are defined as 228.81 Least Concern insectivorous bats per annum, or 1 conservation important or frugivorous bat per annum, in accordance with best practice threshold guidelines (MacEwan et al*.* 2018).

All above recommendations relating to mitigation and minimisation techniques, with associated parameters, must form part of an adaptive management process, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impact is realised. All recommendations are therefore to be updated on an on-going basis, as soon as additional information becomes available.

8 CRITICAL HABITAT ANALYSIS

The critical habitat assessment in this section is a high-level general assessment and has been conducted to provide guidance within this final monitoring report.

The performance standards of the IFC, as published in 2012 (IFC 2012a) and supplemented with the Guidance Notes (IFC 2012b) aim to fully identify the risk of any project to biodiversity. PS6 specifically addresses the objective to avoid or minimise loss of biodiversity, ensure benefits from ecosystem services are maintained, and overall promote sustainable development by appropriate management of and conservation of living natural resources.

The IFC PS6 requires identified habitats to be classified as either modified, natural or critical. Critical habitats, as discussed further below, are a subset of modified or natural habitats. A summary of these habitat classifications are presented in Table 5, below. The definition and key implications as set out by the IFC are as follows:

Modified Habitat

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands. This performance standard applies to those areas of modified habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in PS1 (IFC 2012a).

Natural Habitat

Natural habitats are areas composed of viable assemblages of plant and/or animal species largely of native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. Additionally, the client must not significantly convert or degrade natural habitats. In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity, where feasible (IFC 2012a).

Critical Habitat

In accordance with IFC (2012a), critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated: (a) No other viable alternatives within the region exist for development of the project on modified or natural habitats, (b) the project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat as designated, (c) the project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time, and (d) a robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program. In such cases where a client is able to meet the requirements, the project's mitigation strategy will be described in a Biodiversity Action Plan ('BAP') and will be designed to achieve net gains of those biodiversity values for which the critical habitat was designated (IFC 2012a).

Table 5: Summary of Habitat Classifications

<table>
<tr><th colspan="2" rowspan="2">Habitat Classes as per PS6</th><th colspan="2">Habitat Ecological Condition</th></tr>
<tr><th>Natural</th><th>Modified</th></tr>
<tr><td rowspan="2">Significant types or quantities of biodiversity (Critical Habitat triggering features as per PS6 Criteria)</td><td>Present</td><td>Critical Habitat</td><td>Critical Habitat</td></tr>
<tr><td>Absent</td><td>Natural Habitat</td><td>Modified Habitat</td></tr>
</table>

Based on the above, it was determined that the project site for the proposed Namaacha Wind Farm is mainly comprised of natural habitats and ecosystems, particularly due to the absence of significant human activity which has not substantially modified the overall landscape of the area, and subsequently not expected to have modified its primary ecological functions and species composition – particularly in relation to that of the local bat community expected to occur on site. Nonetheless, further investigation of specific species, habitats and ecosystems is required in order to determine whether the various deciding criteria would meet the thresholds for critical habitat or not. All such parameters, in accordance with IFC (2012b), have been assessed and further detailed information on Criterion 1-5 is presented below:

8.1 Criterion 1: Critically Endangered or Endangered species

Criterion 1, as presented in IFC GN6 (IFC 2012b), states that (1) species threatened with global extinction and listed as CR and EN on the IUCN Red List of Threatened Species shall be considered as part of Criterion 1, and (2) species listed as nationally or regionally CR or EN in countries that adhere to IUCN guidance shall also be considered as part of Criterion 1. The three thresholds for Criterion 1 are: (a) Areas that support globally important concentrations of an IUCN Red-listed EN or CR species (≥ 0.5% of the global population and ≥ 5 reproductive units of a CR or EN species). (b) Areas that support globally important concentrations of an IUCN Red-listed VU species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72a. (c) As appropriate, areas containing important concentrations of a nationally or regionally listed EN or CR species.

Of these three thresholds, the third one has been deemed potentially applicable for the proposed Namaacha Wind Farm, as the general distribution of a single regionally Vulnerable species has been predicted to occur on site. The relevance of this species would subsequently need to be determined, together with assessing if this species occurs in 'important concentrations' on site. According to Balona et al. (2016), *Cloeotis percivali* (Short-eared Trident Bat) is known from only nine subpopulations in South Africa, with the five surveyed estimated to have fewer than 100 mature individuals. The overall population for the region is suspected to be less than 2,000 mature individuals. This species is largely confined to southern Africa, with records from South Africa, Swaziland, south-east Botswana, southern Zambia and Zimbabwe, while records also exist from southern Democratic Republic of Congo, Malawi, north-western Mozambique, and coastal Kenya. After twelve months of continuous acoustic monitoring at the proposed Namaacha Wind Farm, the subsequent results thereof indicated that no bat passes of this species were obtained. Limitations are however likely to occur, as this species is known to call with a high peak frequency of 207.8±3 kHz – a frequency in which bat monitoring detectors, set up to record up to 192 kHz, would not be able to detect. However, it is also noted that besides the second harmonic, the fundamental harmonic is often present on the spectrogram at around 104 kHz (Monadjem et al., 2010). Subsequent analysis of possible calls within that frequency range yielded no confirmed presence of the species. *C. percivali* is known as a clutter forager, which also makes them less susceptible to encountering spinning turbine blades, as they tend to prey exclusively on Lepidoptera around clutter. They are also known to roost in caves, mine tunnels and crevices (Balona et al. 2016 ; Monadjem et al., 2010). Although difficult to locate, no such features were positively identified within the proposed site boundaries during the four seasons of on-site monitoring.

Based on the above acoustic monitoring data results, lack of observed suitable roosting habitat, and that only a few records have been found in north-western Mozambique (Balona et al. 2016), it is not currently perceived for the area to support important concentrations of the species, and as such, Criterion 1 was not determined to satisfy the requirements for the designation of critical habitat.

8.2 Criterion 2: Endemic and Restricted-range species

IFC GN6 (IFC 2012b) states that the term endemic is defined as restricted-range. Restricted range refers to a limited extent of occurrence (EOO). For the context of the proposed development and region involved, the restricted-range of species (under the terrestrial vertebrates and plants criteria) are defined as those species that have an EOO less than 50,000 km^2. The subsequent threshold for Criterion 2 has been defined as areas that regularly hold ≥ 10% of the global population size and ≥ 10 reproductive units of a species.

An assessment of the potential species likely to occur on site yielded that four species are likely to be considered as restricted-range species. These include:

- Cohen’s Horseshoe Bat (*Rhinolophus cohenae*). A range-restricted species with an estimated extent of occurrence of only 15,640 km^2.
- Lander’s Horseshoe Bat (*Rhinolophus landeri*). A range-restricted species with an estimated extent of occurrence of 2,570 km^2.
- Ruppell’s Horseshoe Bat (*Rhinolophus fumigatus*). A range-restricted species with an estimated extent of occurrence of 19,150 km^2.
- Light-winged Lesser House Bat (*Scotoecus albofuscus*). A range-restricted species with an estimated extent of occurrence of 1,795 km^2.

Of the species listed above, only *S. albofuscus* could have been detected on site throughout the 12-month monitoring campaign, as it falls within the VES30 group, which is noted to be the group with the second highest number of bat recordings obtained over the 12-month monitoring period. It must be noted, however, that even though *S. albofuscus* falls within the VES30 group, it is not necessarily the case that this species was detected on site. The VES30 group is comprised of several species, including *Eptesicus hottentotus*, *Scotophilus dinganii*, *Myotis welwitschii* and *Scotoecus albofuscus*. It is subsequently possible for many of the recordings obtained to rather be from that of more common / widespread species, such as *Eptesicus hottentotus*, for example. Nonetheless, further investigations of the global distribution range of this species yielded that it has been sparsely recorded from across South Africa, Mozambique, Zambia and southern Malawi, and also from scattered localities in Benin, Sierra Leone, Gambia, Senegal, northern Uganda, southern Kenya, Tanzania, south-eastern Democratic Republic of Congo and Nigeria (Richards et al. 2016). Occurrence records, as presented in Richards et al. (2016) from within South Africa do not show any occurrences within close proximity of the proposed project site. As such, it is not anticipated for the project area to regularly hold ≥ 10% of the global population of this species.

It must also be noted that the EOO under consideration for all of the listed species is applicable for the assessment region only (assessed for South Africa and presented in Child et al. 2016). These species, apart from *R. cohenae*, have a wide distribution range and occur throughout central and west Africa. It is subsequently not expected for ≥ 10% of the global populations to occur within the proposed project boundaries. *R. cohenae* is a recently described species and has been noted to only occur within an isolated region of South Africa, from the two northernmost provinces of the country. It is known from the Mpumalanga escarpment to Machadodorp (Cohen et al. 2016). No records of this species have been made within the region of the proposed project site to date.

As no activity of *R. cohenae*, *R. landeri*, and *R. fumigatus* was detected at either ground or rotor height throughout the entire monitoring campaign, it is not expected for these species to occur in sufficient numbers on site to meet the threshold for critical habitat. Additionally, as no occurrences of *S. albofuscus* are noted to occur within close proximity to the proposed project site (Cohen et al. 2016), and as this species is generally considered to be sparsely recorded throughout a few smaller portions of east and west Africa, it is unlikely that this species will also occur in sufficient numbers on site to meet the threshold for critical habitat.

Based on the above, Criterion 2 was not determined to satisfy the requirements for the designation of critical habitat.

8.3 Criterion 3: Migratory and Congregatory species

In accordance with IFC GN6 (IFC 2012b), Criterion 3 addresses the potential presence and assessment of migratory and congregatory species. Migratory species are defined as any species of which a significant proportion of its members cyclically and predictably move from one geographical area to another. Congregatory species are defined as species whose individuals gather in large groups on a cyclical or otherwise regular and/or predicable bases. The thresholds for Criterion 3 are (a) areas known to sustain, on a cyclical or otherwise regular basis, ≥ 1 percent of the global population of a migratory or congregatory species at any point of the species' lifecycle, and (b) areas that predictably support ≥ 10 percent of the global population of a species during periods of environmental stress.

As per the taxa under assessment in this report, it can be noted that bats are largely considered to be congregatory species with potential for some to undergo cyclical migrations. Some bats are able to form large colonies, while others are known to roost singly or in pairs (Monadjem et al. 2010). Of the species identified as relevant for this study (Table 1), it is assumed that all species would likely serve as potential congregatory species. However, it is not currently expected for the small extent of the proposed project area to support ≥ 1 percent of the global population of any of these known congregatory species, or more than 10 percent of the global population of these species during periods of environmental stress – particularly due to the abundance of similar available habitat in the broader region, as well as the lack of confirmed roosting locations on site.

Species identified in this study (Table 1) with known migratory behaviours, in accordance with Child et al. (2016), include:

- African Straw-coloured Fruit bat (*Eidolon helvum*). A migratory species in parts of its range, including Southern Africa.

- Bushveld Horseshoe Bat (*Rhinolophus simulator*). In spring, females have been observed migrating to maternity roosts to give birth, before returning to the colony with their young.
- Egyptian Fruit Bat (*Rousettus aegyptiacus*). A migratory species known to migrate over hundreds of kilometres.
- Large-eared Giant Mastiff Bat (*Otomops martienssenі*). For African populations, this species is listed as Appendix II (2006) under the Convention of the Conservation of Migratory Species of Wild Animals (CMS), and although there is no direct evidence of migration, in East Africa, seasonal absence of the sister species (*Otomops harrisoni*) at important colony sites indicate that migration may occur.
- Lesser Long-fingered Bat (*Miniopterus fraterculus*). A widespread species with no major identified threats. However, disruption to migration routes for this species need to be further investigated – particularly with the ongoing emergence of wind farm projects within Southern Africa.
- Natal Long-fingered Bat (*Miniopterus natalensis*). A migratory species where females are known to typically migrate seasonally between winter hibernation roosts and summer maternity roosts, which have been reported to be separated by up to 260 KM.
- Temmick's Hairy Bat (*Myotis tricolor*). This species exhibits migratory behaviour and is known to migrate hundreds of kilometres between warmer summer maternity caves and colder winter hibernation caves.

Of these species, two of them are known migratory fruit bats and have been predicted to occur in the area. Although the site is located within the distribution ranges of *Eidolon helvum* and *Rousettus aegyptiacus*, visual observations were not made during regular day or night site assessments, particularly when inspecting available fruit trees found on site. *E. helvum* is a common species across much of its range, forming large colonies of thousands to even millions of individuals (Sorensen & Halberg 2001), while *R. aegyptiacus* is also widely distributed and abundant, and occurs in multiple protected areas and modified habitats. In accordance with Child et al. (2016), there are no major identified threats that could cause a significant population decline and thus the species is listed as Least Concern.

With reference to the five remaining insectivorous species, it is noted that all five species are likely to have been detected during the 12-month acoustic monitoring campaign.

Rhinolophus simulator was only detected 6 times during 12 months of monitoring and is subsequently not expected to occur in large abundances on site. This species is listed as Least Concern in view of its wide distribution, it's presumed large population, ability to utilise modified habitats for roosting, and although declining in some parts of its range, the overall population within the assessment region is not suspected to be declining fast enough to qualify for listing in a threatened category (Child et al. 2016).

Otomops martiensseni forms part of the MOL1 group (Table 1), which accounted for relatively low activity levels (approximately 2.1 % of all bat calls) over a 12-month period. This species has a patchy distribution across Africa occurring from Ghana and Cote d'Ivore in the West, extending eastward through to Central African Republic, Rwanda, Uganda, Tanzania, and southwards towards Angola, Zambia, Zimbabwe, north-western Mozambique and South Africa. Nonetheless, the species continues to be rare throughout most of its range (Child et al. 2016). Although the distribution of the species may include small portions of western Mozambique (particularly within the north-western regions), there are currently no occurrence records noted within the assessment region (Child et al. 2016), adjacent to the proposed project site. It is currently not expected for this species to be abundant within the proposed project area.

Myotis tricolor forms part of the VES50/NLB group (Table 1), which accounted for low activity levels (approximately 1.6 % of all bat calls) over a 12-month period, and is subsequently not expected to occur in large abundances on site. This species has been listed as Least Concern in view of its wide distribution, its occurrence in multiple protected areas across its range, its known large population and because there are no major identified threats that could be causing widespread population decline (Child et al. 2016).

Miniopterus fraterculus forms part of the BB/LLB group (Table 1), which accounted for very low activity levels (approximately 0.1 % of all bat calls) over the 12-month monitoring period, and is subsequently not expected to occur in large abundances on site. This species is widespread in the assessment region and despite experiencing some localised declines, it continues to remain sufficiently widespread to not qualify for a threatened category (Child et al. 2016).

Miniopterus natalensis forms part of the VES50/NLB group (Table 1), which accounted for low activity levels (approximately 1.6 % of all bat calls) over a 12-month period, and is subsequently not expected to occur in large abundances on site. This species is listed as Least Concern in view of its wide distribution and large population. Although this species has been reported to experience localised declines due to disturbance of roosting sites, loss of foraging habitat and collisions with wind turbines, it remains sufficiently widespread to not qualify under a category of threat. However, wind farms are permanent structures and there is an overlap between the species' known and modelled distribution and that of existing and planned wind farms, which ultimately disrupts migration routes and thus poses a major threat (Child et al. 2016). Of more specific concern is the presence of a large known roost, approximately 10.2 km south of the proposed Namaacha Wind Farm. This roost is an old abandoned hotel that has a confirmed presence of several thousand *M. natalensis* individuals, with previous estimates ranging between 14,000 and 16,000 bats (MF&A 2021). Recent site visits in winter, spring, summer and autumn showed similar results, with Autumn yielding marginally fewer individuals. In terms of defining critical habitat, one can view the presence of this roost in two ways: (1) The roost location itself being classified as critical habitat, and (2) whether or not the proposed site itself will be classified as critical habitat or influence the known roost. In order to determine whether or not this roost itself can be classified as critical habitat, an estimated or known population size of *M. natalensis* would need to be determined. Unfortunately, according to MacEwan et al. (2016) and IUCN (2022), the overall population size of *M. natalensis* is unknown. Records do however exist which show that colonies may exceed 200,000 individuals in certain seasons, such as De Hoop Guano Cave in the Western Cape (Monadjem et al. 2010). In the Highveld caves, its numbers vary from a few individuals up to an estimated 4,000 individuals (van der Merwe 1973). As such, due to the species being widespread and occurring in several large colonies, it is currently not perceived for this roost to accommodate ≥ 1% of the global population of *M. natalensis* to subsequently trigger critical habitat status. Nonetheless, due to the lack of sufficient data on known population sizes, the exact status of this roost remains unknown. Considering the precautionary principle and assuming this roost would be classified as critical habitat, it would then be necessary to determine whether the proposed Namaacha Wind Farm would significantly impact this roost or not, and whether the site itself could trigger critical habitat status. As the proposed wind farm is located approximately 10.2 km north of the known roost, it is not currently perceived for any major construction or operational activities to significantly influence the roost negatively. All such activities would likely be restricted to the immediate WEF area itself, where disturbance of the roost would be unlikely. Data from 12 months of acoustic monitoring on site also showed that the VES50/NLB group (in which *M. natalensis* is grouped under) only accounted for approximately 1.6 % of all bat activity recorded during the monitoring campaign. Of this activity, only 1.4 % of recordings were noted to occur within the rotor swept zone (approximately 14 bat passes). It is currently also unclear, without the use of tracking data, as to whether the activity from the VES50/NLB group belongs to that of the individuals utilising the known roost to the south, or whether it belongs to that of more localised individuals from a different colony. Regardless, with such low activity levels, particularly at rotor height, it is not currently perceived for the presence of this species or roost to classify the proposed project site as having critical habitat status.

Due to the known and expected abundances of all of the above species, as well as the small extent of the project area, Criterion 3 was not determined to satisfy the requirements for the designation of critical habitat.

8.4 Criterion 4: Highly Threatened or Unique Ecosystems

IFC (2012b) states that, for Criterion 4, the client should use the Red List of Ecosystems where formal IUCN assessments have been performed. Where not performed, the use of assessments using systematic methods at the national/regional level can be used. A subsequent review of the IUCN Red List of Ecosystem assessments revealed that terrestrial systematic assessments for Mozambique are currently in progress. However, systematic assessments for all ecosystems were conducted in South Africa (IUCN 2020). Due to the project’s close proximity to South Africa (within 3 km), it is expected that the ecosystem assessments made for South Africa would be applicable to the project site itself. As such, this information was considered as a baseline for this part of the assessment. The considerations for Criterion 4 are explicit in stating that (1) areas representing ≥ 5% of the global extent of an ecosystem type, meeting the criteria for IUCN status of Critically Endangered or Endangered, would constitute the area being defined as critical habitat. Or, (2) in the absence of assessed areas, if areas are determined to be of high priority for conservation by regional or national systematic conservation planning (carried out by governmental bodies and/or other qualified organisations), then the area would also be defined as critical habitat. In terms of consideration 1, a desktop review of the Red List ecosystem’s database did not reveal any Critically Endangered or Endangered ecosystems (within the borders of South Africa) adjacent to the project site. Nonetheless, data deficiencies are possible, and as such, the second consideration for thresholds were also considered. Desktop available information obtained from the National Administration of Conservation Areas (‘ANAC’), a body supervised by the Ministry of Land, Environment and Rural Development (‘MITADER’), revealed that several conservation-important areas have been delineated within the borders of Mozambique (ANAC 2017). A spatial review of these conservation areas (consisting of national parks, national reserves and special reserves) showed that the project site is not located within or adjacent to any of these conservation areas. Furthermore, an assessment of the predicted dominant vegetation type (Lebombo Bushveld) and its associated Bioregion (Lowveld) for the area, revealed that the Lowveld Bioregion has a Vulnerable conservation status, as opposed to Critically Endangered or Endangered (Mucina & Rutherford 2006).

Based on the above, it is not currently anticipated for the project site to exhibit Critically Endangered or Endangered habitat that would include ≥ 5% of the global extent of its particular ecosystem type – particularly due to the small extent of the project area. Additionally, no areas have been identified as high priority for conservation, particularly in relation to the predicted bioregion conservation status and when assessed against existing delineated conservation areas within the borders of Mozambique. For such reasons, Criterion 4 was not determined to satisfy the requirements for the designation of critical habitat.

8.5 Criterion 5: Key Evolutionary Processes

Criterion 5, as presented in IFC GN6 (IFC 2012b), states that the structural attributes of a region, such as topography, geology, soil, temperature, vegetation, and combinations of these variables can influence the evolutionary processes that give rise to regional configurations of species and ecological properties. This Criterion emphasises that maintaining these key evolutionary processes inherent in a landscape as well as the resulting species (or subpopulations of species) is considered important for the conservation of biodiversity and genetic diversity. Such examples of spatial features include:

- Landscapes with high spatial heterogeneity;
- Environmental gradients, also known as ecotones;
- Edaphic interfaces that have led to the formation of unique plant communities characterised by both rarity and endemism;
- Connectivity between habitats; and
- Sites of demonstrated importance to climate change adaptation.

The significance of structural attributes in a landscape is determined on a case-by-case basis, and determination of critical habitat will be heavily reliant on scientific knowledge. In the majority of cases, criterion will apply in areas that have been previously investigated and that are already known or suspected to be associated with unique evolutionary processes.

In terms of the proposed Namaacha Wind Farm, the area is estimated to have high habitat heterogeneity with various plant, grass and tree species, which would provide several niche habitats with associated high species diversity. Certain bats are adapted to foraging and moving within open spaces, while some are adapted to more cluttered environments. As such, habitat complexity is considered important for bats as it offers a variety of clutter conditions and would be more likely to support a greater diversity of bat species. Regardless, the high habitat heterogeneity is not considered unique to the proposed site only, as the broader region is largely undisturbed and presents the same or similar landscape as that found on site. As such, the species diversity occurring on site is not likely to be genetically unique for that area, as a result of habitat heterogeneity. Of the bat species with potential to occur on site (Table 1), no locally isolated species are known to occur that could genetically develop into new varieties. Although this habitat is important, it is distributed well beyond that of the project area, and therefore would likely not meet Criterion 5. No further features that meet the criteria for key evolutionary processes have been identified. With the information known to date, Criterion 5 was not determined to satisfy the requirements for the designation of critical habitat.

Critical Habitat Assessment Conclusion

Based on the above assessments of the five Criterion, all parameters that could designate the site as having a critical habitat status (as presented above) yielded that, although important, the habitat associated directly with the project site does not appear to meet the thresholds to trigger critical habitat status. The habitat is thus classified as natural habitat and the relevant considerations and mitigation measures (in accordance with IFC 2012b), as presented below, would apply:

The client will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified habitat;
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and
- Any conversion or degradation is mitigated according to the mitigation hierarchy.

In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity, where feasible. Appropriate actions include:

- Avoiding impacts on biodiversity through the identification and protection of set-asides;
- Implementing measures to minimise habitat fragmentation, such as biological corridors;
- Restoring habitats during operations and/or after operations; and

- Implementing biodiversity offsets.

9 DISCUSSION

The overall findings to date from four seasons of sampling at Namaacha Wind Farm showed that bat activity peaked during the spring and summer seasons, with lower activity in autumn and winter. While the overall bat activity for the particular associated ecoregion (Maputaland Coastal Forest Mosaic) showed that median bat passes per hour at height was low, it was noted to be moderate near the ground. Despite activity near ground level being moderate during months of spring and summer, 31 nights of substantial high activity spikes were recorded during this same period. These nights are considered as high-risk events and are indicating an importance for bat activity during the overall spring and summer periods.

Seventeen high risk species have a likely potential to occur on site, while up to 13 of these have been detected through acoustic monitoring. Bat species from the MOL2 group accounted for approximately 71% of the total bat activity during the sample period. Such species are classified as high risk to wind energy developments due to their foraging ecology, which allows for increased activity in open areas, high above the ground where they may encounter wind turbine blades. The VES30 group accounts for the second highest activity levels on site, making up a total of 22.5% of all bat calls. These species largely have a medium-high risk of suffering impacts, as they are classified as clutter-edge foragers and may encounter wind turbine blades when the lower rotor swept area overlaps with their foraging airspaces.

Of particular importance for the site is the potential presence of a regionally Endangered species (*Cloeotis percivali*), and the presence of a major roost, 10.2 km south of the proposed facility – which accommodates few fruit bats (*Epomophorus wahlbergi / crypturus*) and substantial numbers of *Miniopterus natalensis*. In terms of the presence of *C. percivali*, a relevant Critical Habitat Analysis was conducted (Section 8.1) which determined that, based on the acoustic monitoring data results, lack of observed suitable roosting habitat and that only a few records have been found in north-western Mozambique (Balona et al. 2016), it is not currently perceived for the project site to support important concentrations of the species, and as such, Criterion 1 was not determined to satisfy the requirements for the designation of critical habitat. With regards to the known *M. natalensis* roost; importance of this roost was placed on the probability for those individuals to use the site. In accordance with the most recent version of the bat monitoring guidelines for wind farms in South Africa (MacEwan et al. 2020), a bat roost with >= 2000 bats is classified as an extra-large roost, and should be assigned with a 20 km buffer, in which the placement of wind turbines is to be avoided. By applying this buffer, it is observed that the site completely falls within this buffer (Figure 1). This is a distinctive consideration, and therefore 12 months of monitoring data was gathered and assessed to validate to what degree these bats use the area in which the facility is being proposed. Of additional importance is that this population could fall under the protection of the Bonn Convention, to which Mozambique is a signatory, and "*habitat supporting globally significant concentrations of migratory species and/or congregatory species*" is regarded as Critical Habitat under IFC PS6 (IFC 2012a) (WSP 2020). Despite this, results over four seasons of monitoring to date revealed that only 1.6% of all bats recorded on site belong to the VES50/NLB group. Such activity levels are considered relatively low in comparison to all other bat species recorded. Additionally, a total of 990 passes from this group were recorded at ground level across all four seasons, while only 14 were recorded within the rotor swept area. This indicates that the location of the proposed facility does not serve as a major flyway or foraging area for the *M. natalensis* individuals that roost in the identified abandoned hotel. As such, this roost is not considered a limiting factor for the facility. A relevant Critical Habitat High Level Assessment has been developed in this regard, and is presented in Section 8.3. The results thereof demonstrated that Criterion 3 was not determined to satisfy the requirements for the designation of critical habitat.

The data suggests that the overall risk to bats posed by the wind energy development at the site is predominantly low-moderate for the particular ecoregion and time period being reported on, with several high-risk events being recorded during spring and summer, as well as the potential existence of an endangered species on site and major bat roost 10.2 km south of the site. Results from the associated Critical Habitat Assessment yielded that, although important, the habitat associated directly with the project site does not meet the thresholds to trigger critical habitat status. The habitat is thus classified as natural habitat and the relevant considerations and mitigation measures (in accordance with IFC 2012b) would apply. With the results and information obtained to date, no further critical habitat assessments are deemed necessary to be undertaken for this project, with respect to bats.

An initial mitigation measure to avoid impacts is for all wind turbines (irrespective of sensitive area overlap) to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of project inception, to prevent fatalities – particularly during turbine free-wheeling. This should be implemented throughout the lifespan of the project, with specific parameters (seasonality and wind speed) being updated throughout the course of an operational bat monitoring campaign (as more fatality and acoustic data becomes available). A minimum of two years of operational monitoring is required (acoustic monitoring, carcass searches and fatality estimations) in accordance with the methodologies, as laid out in the South African best practice guidelines for monitoring bats at operational wind energy facilities. Thereafter, monitoring must be repeated again in year five, and every five years thereafter. Monitoring of fatalities is to occur from the outset, as soon as the first wind turbine is erected and starts spinning. Furthermore, the correct placement of wind turbines is considered crucial. All turbines (inclusive of the full blade length) are to avoid high sensitive areas as a primary measure of mitigation (i.e. avoidance), in accordance with the mitigation hierarchy (as defined in IFC Performance Standard 1). In the event that high sensitivity areas are unable to be avoided, then minimisation must be applied at those turbines encroaching into such areas from the start of project inception. Such minimisation includes either turbine curtailment and/or deterrence mechanisms. Turbine curtailment is however preferred, as ultrasonic deterrence mechanisms are not effective against mitigation impacts on megabats (bats which predominantly use sight and smell to forage and navigate, and lack the ability to echolocate – particularly frugivorous bats). No megabats were visually observed using the site during the 12-month monitoring campaign, and although possible, the anticipated risk of significant impacts occurring is considered to be low. Minimisation must be undertaken in accordance with the parameters defined in Table 4. This should be implemented throughout the lifespan of the project at the relevant turbines, with specific minimisation parameters being updated throughout the course of an operational bat monitoring campaign, as more fatality and acoustic monitoring data becomes available. For medium sensitive areas, all turbines (including the full blade length) are to avoid such areas (associated with buildings/dwellings), as far as possible. However, given the absence of physical observations of bats (including guano, scratch marks or smudges) made during the relevant site inspections, such features are not deemed to be significantly important for the proposed facility or local bat community on site. Turbines are therefore allowed to be placed within such buffers, if avoidance is not possible. Given the observations made, it would be beneficial if such features (associated with medium sensitivity buffers) were removed, as far as possible, in order to avoid potential use of these structures by bats in future. If such features are not removed and found to be used by bats during the construction and/or operational phase of the project, then the appointed bat specialist must advise on appropriate management/mitigation actions for further implementation. For all wind turbines, if the fatality thresholds are reached at any point during the projects' lifespan, then appropriate mitigation in the form of either turbine curtailment and/or acoustic deterrence mechanisms is to be applied to reduce residual impacts, in accordance with the minimisation parameters as defined in Table 4. Threshold limits are defined as 228.81 Least Concern insectivorous bats per annum, or 1 conservation important or frugivorous bat per annum, in accordance with best practice threshold guidelines (MacEwan et al. 2018).

All above recommendations relating to mitigation and minimisation techniques, with associated parameters, must form part of an adaptive management process, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impact is realised. All recommendations are therefore to be updated on an on-going basis, as soon as additional information becomes available.

Provided that the specialist recommendations in this report are adhered to, as well as those defined by IFC (2012b) in terms of the considerations and mitigation measures defined for natural habitats (as summarised in section 8), the development of the Namaacha Wind Farm may be considered for implementation.

10 REFERENCES

ACR, 2020. African Chiroptera Report 2020. AfricanBats NPC, Pretoria. i-xvi + 1-8028 pp.

Adams, A. M., M. K. Jantzen, R. M. Hamilton, and M. B. Fenton. 2012. Do you hear what I hear? Implications of detector selection for acoustic monitoring of bats. Methods in Ecology and Evolution 3:992-998.

ANAC 2017. Administracao Nacional das Areas de Conservacao – Conservation Areas. https://www.anac.gov.mz/en/conservation-areas/. Accessed: 2022/08/19

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

Balona, J., Cohen, L., White, W., Jacobs, D., MacEwan, K., Monadjem, A., Richards, L.R., Schoeman, C., Sethusa, T., Taylor, P. 2016. A conservation assessment of *Cloeotis percivali*. In Child M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., Davies-Mostert, H.T. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

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

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

Cooper-Bohannon, R., Rebelo, H., Jones, G., Cotterill, F., Monadjem, A., Schoeman, M.C., Taylor, P., Park, K., 2016. Predicting bat distributions and diversity hotspots in southern Africa. Hystrix 27, 47-57.

Cohen, L., Taylor, P.J., Jacobs, D., Kearney, T., MacEwan, K., Monadjem, A., Richards. L.R., Schoeman, C., Sethusa, T. 2016. A conservation assessment of *Rhinolophus cohenae*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies Mostert Ht, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa

Child, M.F., Roxburgh, L., Do Linh San, E., Raimondo, D., Davies-Mostert, H.T. The 2016 Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

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

Greif, S., Siemers, B.M., 2010. Innate recognition of water bodies in echolocating bats. Nature Communications 1, 107.

Hayes, J.P., 1997. Temporal Variation in Activity of Bats and the Design of Echolocation-Monitoring Studies. Journal of Mammalogy 78, 514-524.

IFC, 2012a. International Finance Corporation: Performance Standards on Environmental and Social Sustainability.

IFC, 2012b. International Finance Corporation's Guidance Notes: Performance Standards on Environmental and Social Sustainability.

IUCN 2020. IUCN Red List of Ecosystems. https://assessments.iucnrle.org/. Accessed: 2022/08/19.

IUCN 2022. IUCN Red List of Threatened Species. https://www.iucnredlist.org/species/44862/22073129. Accessed: 2022/08/20.

Kunz, T.H., Lumsden, L.F., 2003. Ecology of Cavity and Foliage Roosting Bats In Bat Ecology. eds T.H. Kunz, M.B. Fenton, pp. 3-89. The Univ. Chicago Press, Chicago.

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

MacEwan, K., Richards. L.R., Cohen, L., Jacobs, D., Monadjem, A., Schoeman, C., Sethusa, T., Taylor, P.J., 2016. A conservation assessment of *Miniopterus natalensis*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies Mostert Ht, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

MacEwan, K., Aronson, J., Richardson, E., Taylor, P., Coverdale, B., Jacobs, D., Leeuwner, L., Marais, W., Richards, L. 2018. South African Bat Fatality Threshold Guidelines – ed 2. South African Bat Assessment Association.

MacEwan, K., Sowler, S., Aronson, J. and Lötter, C., 2020. South African best practice guidelines for pre-construction monitoring of bats at wind energy facilities.

MF&A MoÇambique, 2021. Bat Monitoring Report. Namaacha Wind Farm. Final Report. Central Electrica da Namaacha.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D., Schoeman, M.C., 2010. Bats of Southern and Central Africa: A Biogeographic and Taxonomic Synthesis. Wits University Press, Johannesburg.

Mucina & Rutherford. 2006. The Vegetation of South Africa, Lesotho and Swaziland.

Noer, C.L., Dabelsteen, T., Bohmann, K., Monadjem, A., 2012. Molossid bats in an African agro-ecosystem select sugarcane fields as foraging habitat. African Zoology 47, 1-11.

Richards. L.R., White, W., Cohen, L., Jacobs, D., MacEwan, K., Monadjem, A., Schoeman, C., Taylor, P.J., 2016. A conservation assessment of *Scotoecus albofuscus*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies Mostert Ht, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa

Rodrigues, L., Bach, L., Dubourg-Savage, M.J., Karapandza, B., Kovac, D., Kervyn, T., Dekker, J., Kepel, A., Bach, P., Collins, J., Harbusch, C., Park, K., Micevski, B., Minderman J., 2014. Eurobats: Guidelines for consideration of bats in wind farm projects. Revision 2014. Publication Series No. 6.

Schnitzler, H.-U., Kalko, E.K.V., 2001. Echolocation by insect-eating bats. BioScience 51, 557-568.

Schnitzler, H.U. and Kalko, E.K., 2001. Echolocation by insect-eating bats: we define four distinct functional groups of bats and find differences in signal structure that correlate with the typical echolocation tasks faced by each group. Bioscience, 51(7), pp.557-569.

Sirami, C.l., Jacobs, D.S., Cumming, G.S., 2013. Artificial wetlands and surrounding habitats provide important foraging habitat for bats in agricultural landscapes in the Western Cape, South Africa. Biological Conservation 164, 30-38.

Sorensen, U.G., Halberg, K. 2001. Mammoth roost of nonbreeding straw-coloured fruit bat *Eidolon helvum* (Kerr, 1792) in Zambia. African Journal of Ecology 39: 213-215.

Taylor, P., Mkhari, D., Mukwevho, T., Monadjem, A., Schoeman, M., Schoeman, C., Steyn, J., 2011. Bats as potential biocontrol agents in an agricultural landscape, Levubu Valley: Diet, activity and species composition of bats in macadamia orchards and neighbouring natural habitats. South African Avocado Growers Association Yearbook 34.

Thomas, D.W., 1988. The distribution of bats in different ages of Douglas-Fir forests. The Journal of Wildlife Management 52, 619-626.

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

Toffoli, R., 2016. The importance of linear landscape elements for bats in a farmland area: The influence of height of activity. Journal of Landscape Ecology (2016) Vol: 9 No: 1.

Van der Merwe, M. 1973. Aspects of hibernation and winter activity of the Natal clinging bat, *Miniopterus schreibersii natalensis* (A. Smith 1834), on the Transvaal Highveld. South African Journal of Science 69: 116-118.

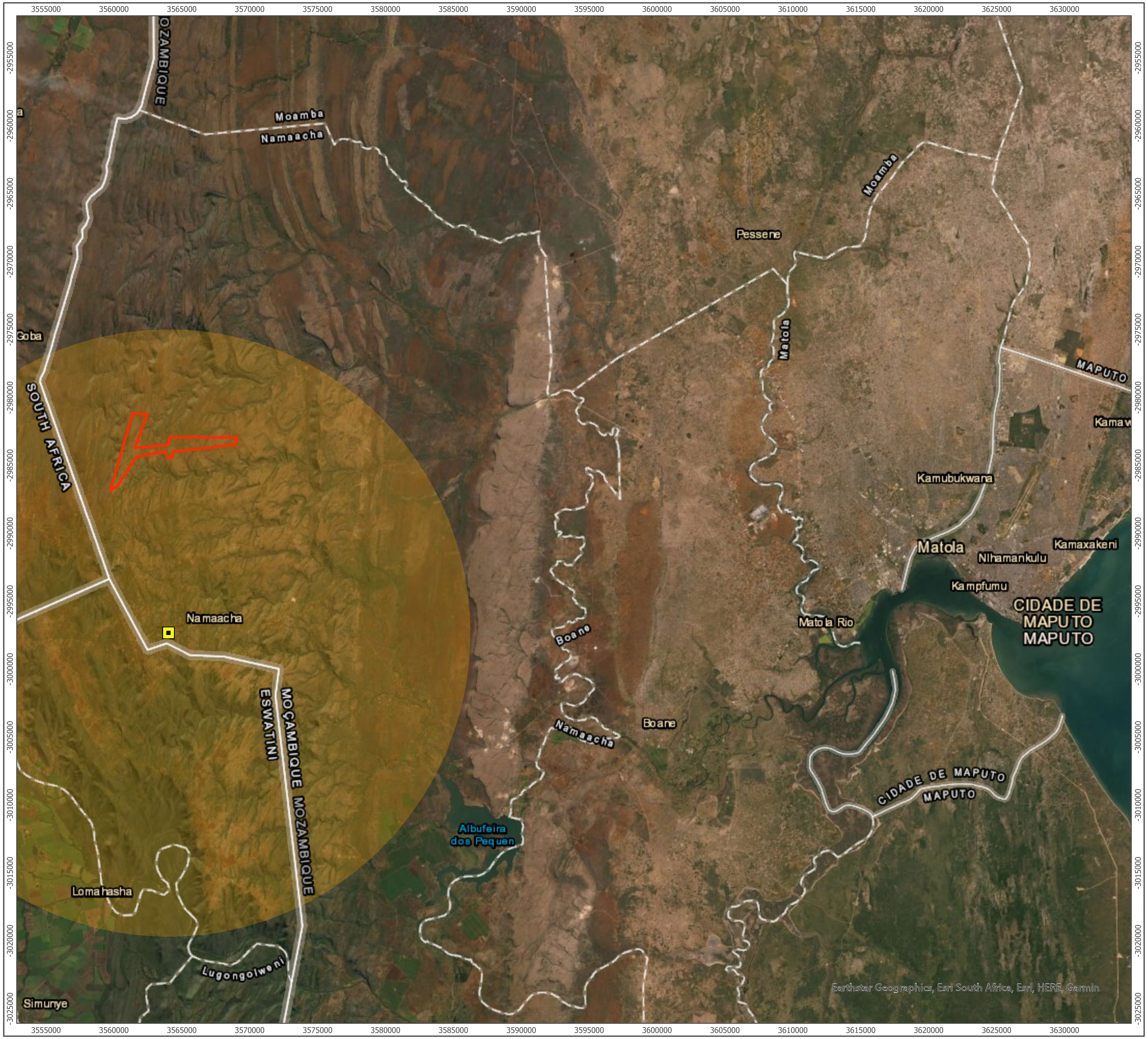
Verboom, B., Huitema, H., 1997. The importance of linear landscape elements for the pipistrelle *Pipistrellus pipistrellus* and the serotine bat *Eptesicus serotinus*. Landscape Ecology 12, 117-125.

Verboom, B., 1998. The use of edge habitats by commuting and foraging bats. IBN-DLO, Wageningen.

WBG, 2015. World Bank Group: Environmental, Health, and Safety Guidelines: Wind Energy.

WSP Environmental, 2020. Proposed 63 MW Namaacha Wind Farm Project in Namaacha, Mozambique: ESIA and RAP Gap Analysis.

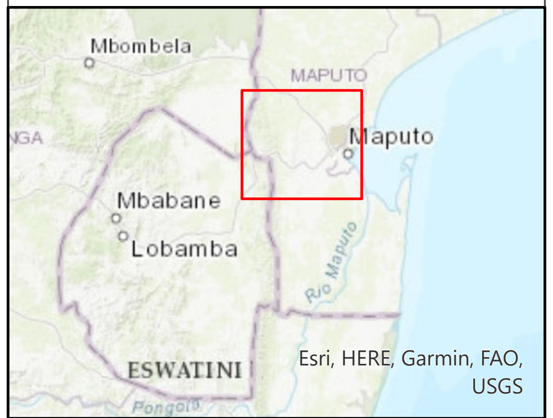
11 FIGURES



Namaacha WEF AOI

Namaacha Bat Roost

20 KM Roost Buffer



1:270,000 Scale @ A3

0 5 10 km

NORTH

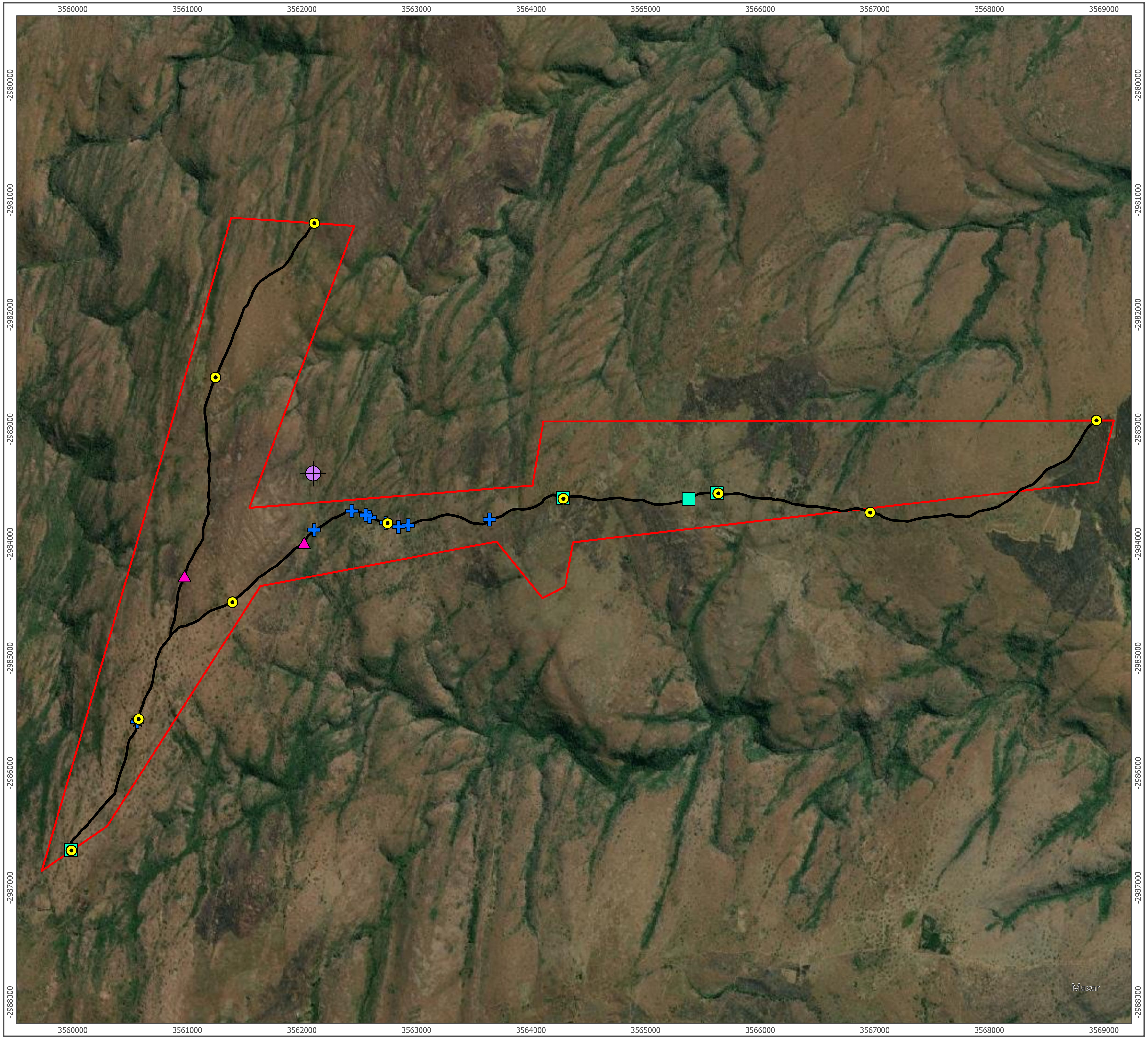
Produced By: CC	Ref: 4417-GIS-001
Checked By: MB	Date: 8/18/2022

Locality Map

Figure 1

Namaacha Wind Farm Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-001 Fig 1 Site Locality Map



Namaacha WEF AOI
Met Mast
Transect Route
Monitoring Point Locations
Bat Species Groups (Winter Transect)
MOL1
MOL2
VES30
VES50/NLB

1:32,000 Scale @ A3

0 0.6 1.2 km

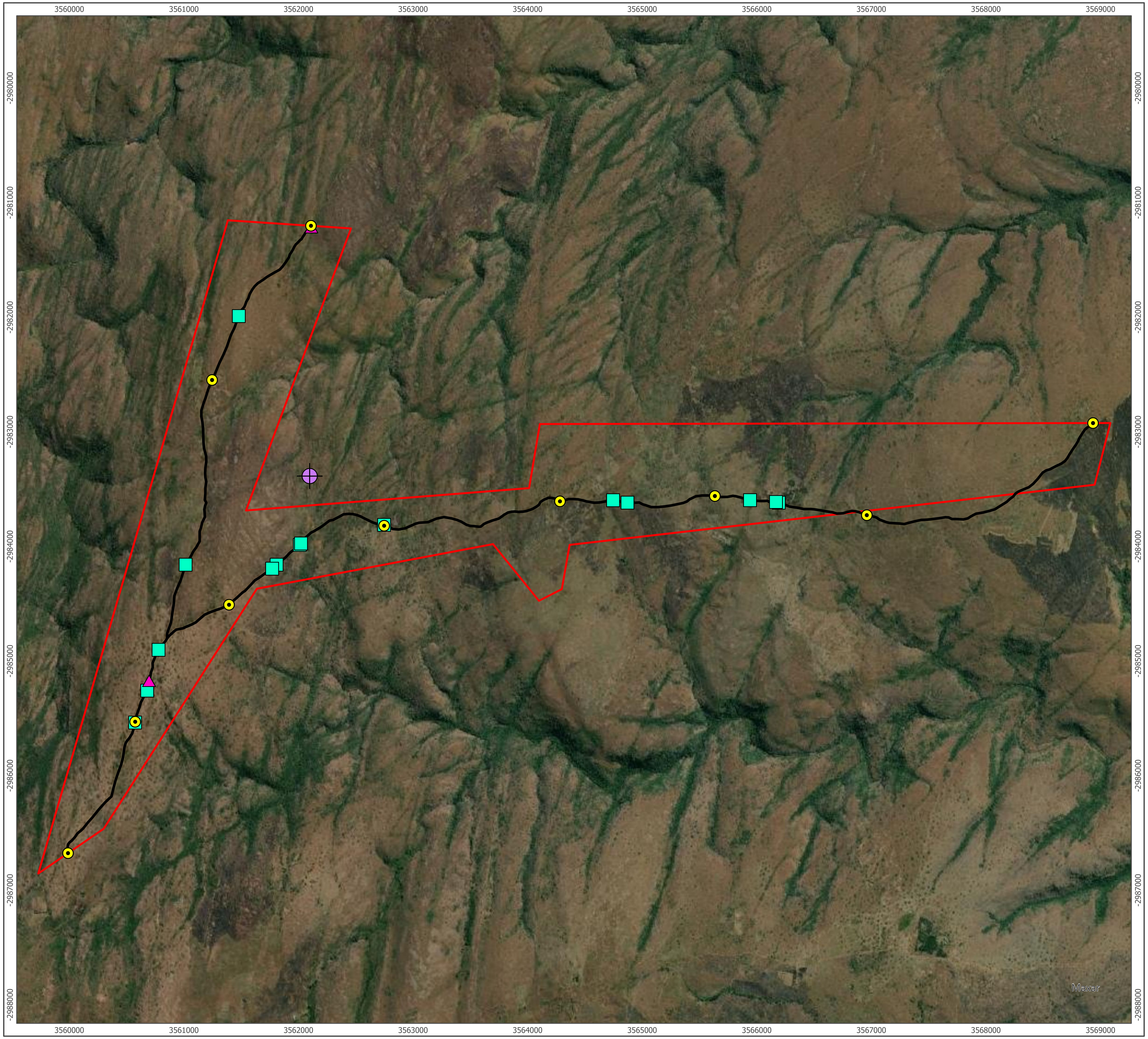
NORTH

Produced By: CC	Ref: 4417-GIS-002
Checked By: MB	Date: 8/18/2022

Winter Transect
Figure 2

Namaacha Wind Farm
Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-002 Fig 2 Bat Transect Winter Map



ARCUS

Namaacha WEF AOI

Met Mast

Transect Route

Monitoring Point Locations

Bat Species Groups (Spring Transect)

MOL2

VES30

1:32,000 Scale @ A3

0 0.6 1.2 km

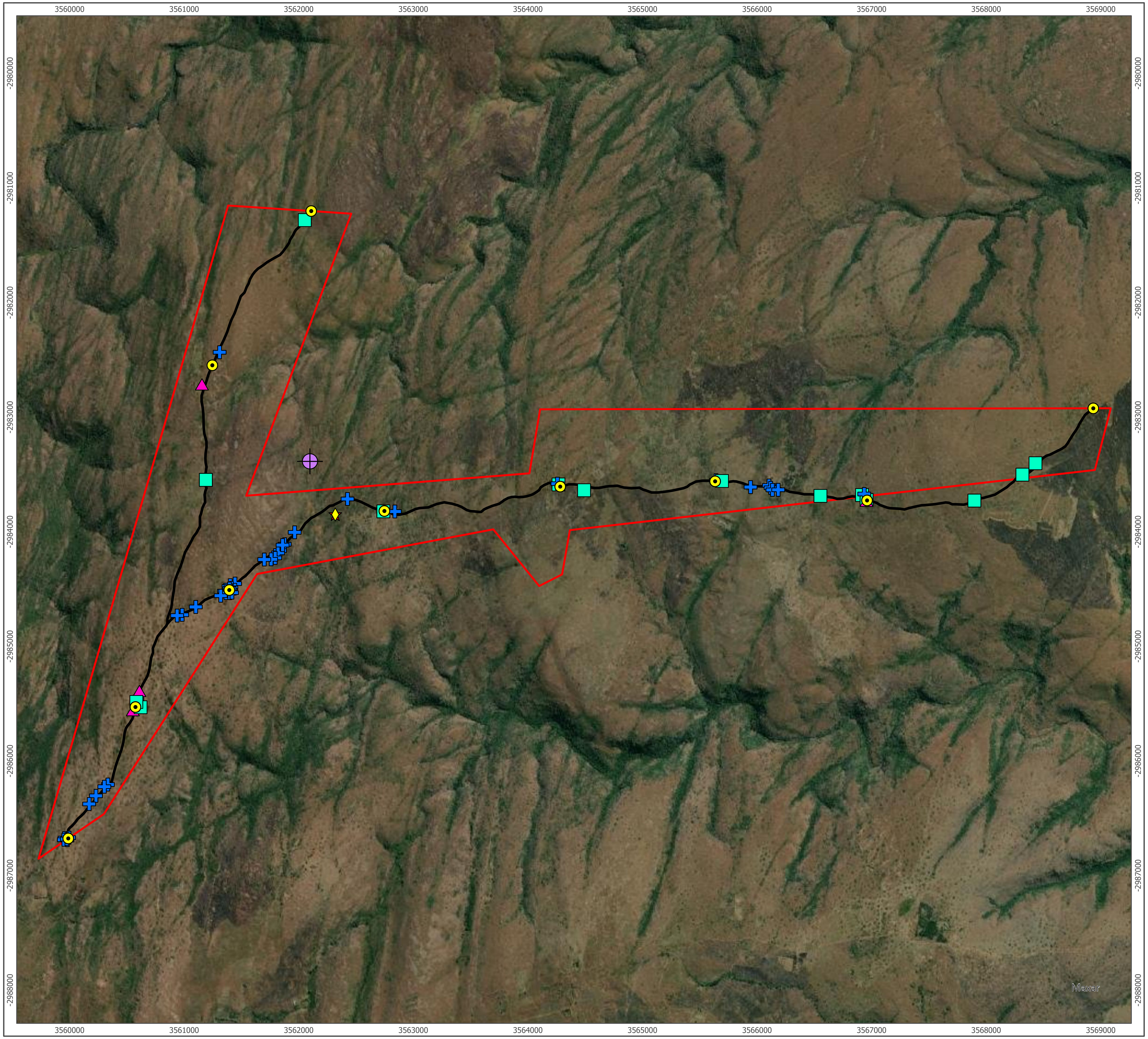
NORTH

Produced By: CC	Ref: 4417-GIS-003
Checked By: MB	Date: 8/18/2022

Spring Transect
Figure 3

Namaacha Wind Farm
Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-003 Fig 3 Bat Transect Spring Map



Namaacha WEF AOI

Met Mast

Transect Route

Monitoring Point Locations

Bat Species Groups (Summer Transect)

- BB/LLB
- MOL2
- VES30
- VES40
- VES50/NLB

1:32,000 Scale @ A3

0 0.6 1.2 km

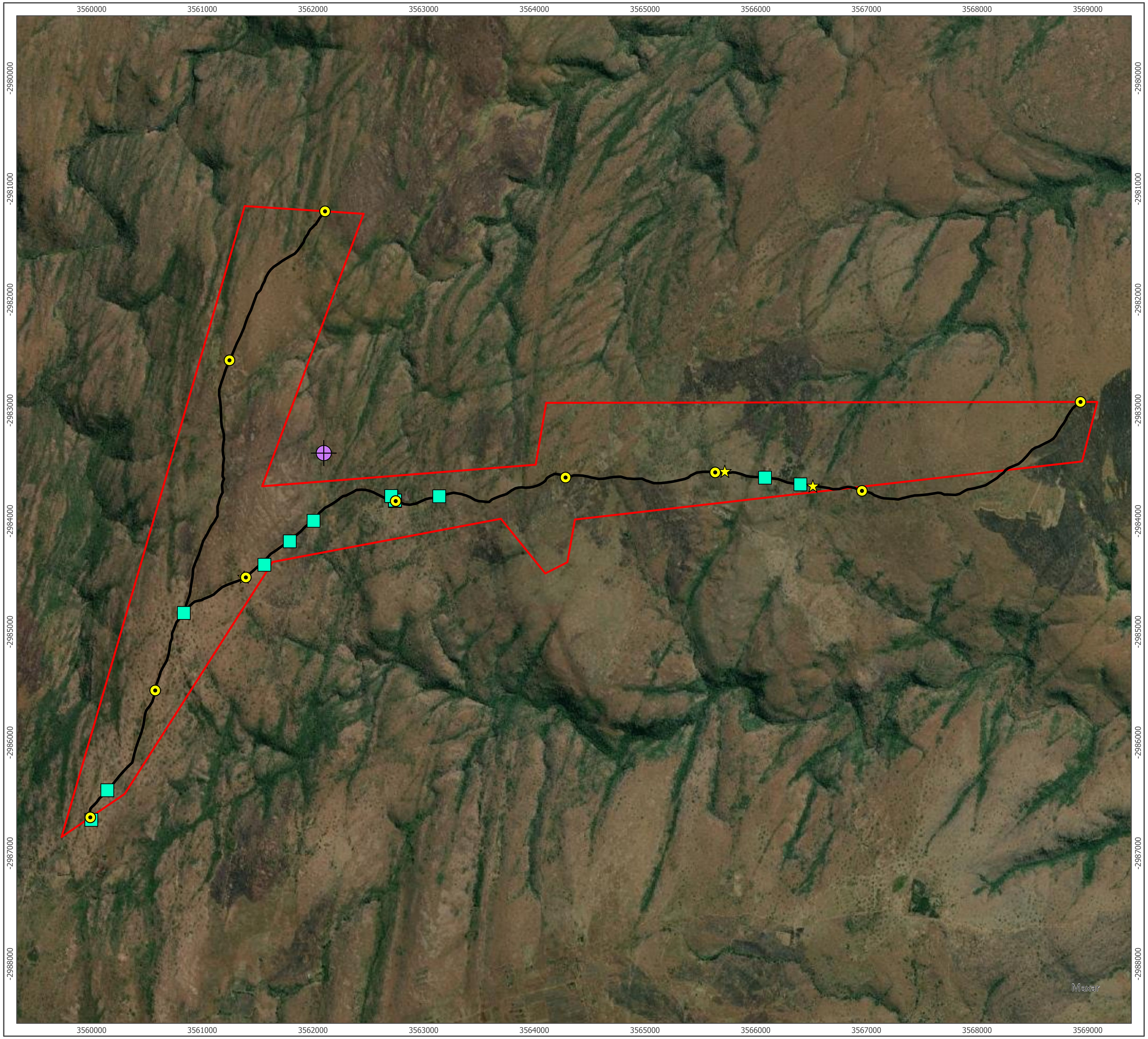
NORTH

Produced By: CC	Ref: 4417-GIS-004
Checked By: MB	Date: 8/18/2022

Summer Transect
Figure 4

Namaacha Wind Farm
Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-004 Fig 4 Bat Transect Summer Map



ARCUS

Namaacha WEF AOI

Met Mast

Transect Route

Monitoring Point Locations

Bat Species Groups (Autumn Transect)

MOL1

MOL2

VES50/NLB

1:33,125 Scale @ A3

0 0.65 1.3 km

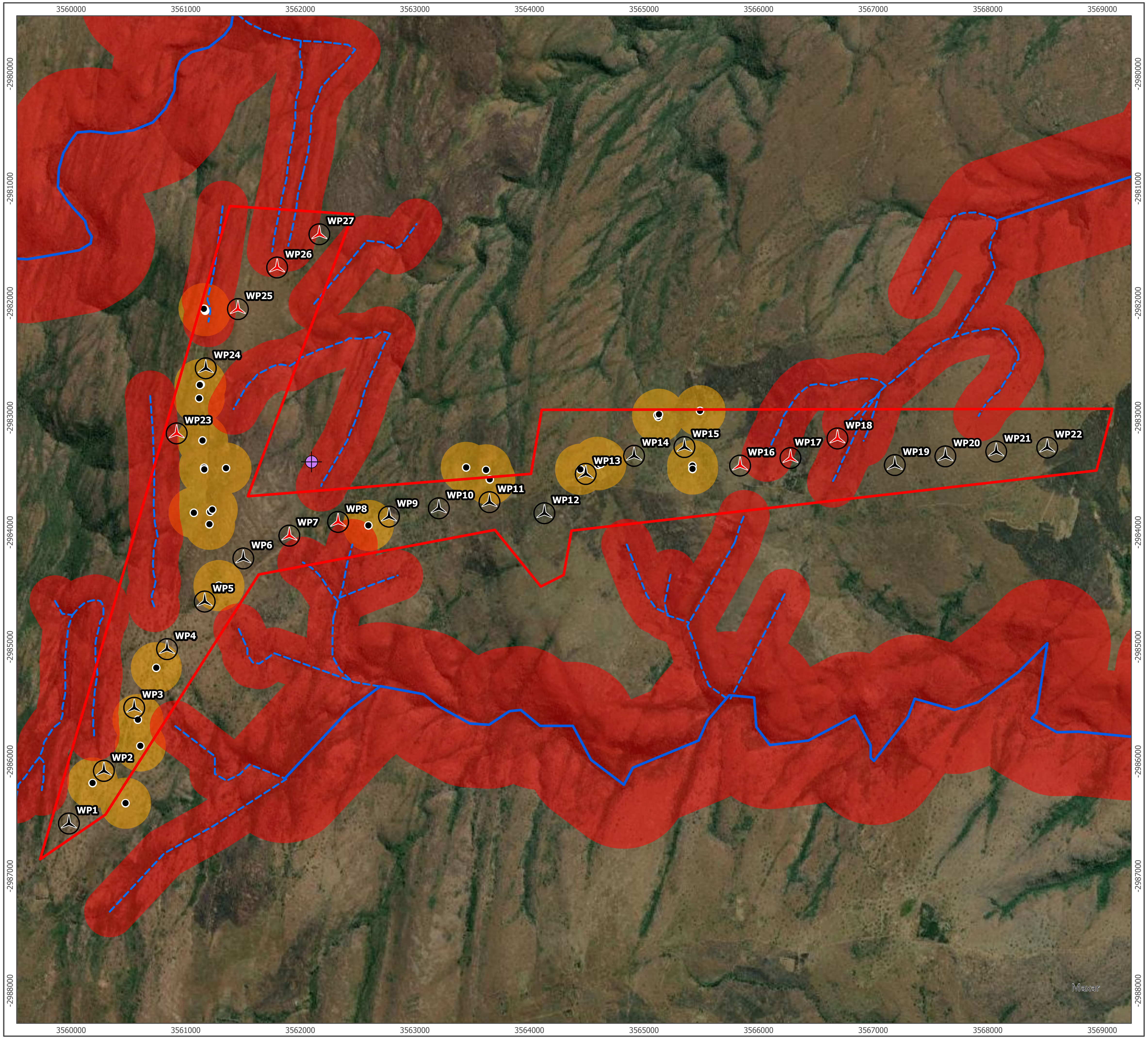
NORTH

Produced By: CC	Ref: 4417-GIS-005
Checked By: MB	Date: 8/18/2022

Autumn Transect
Figure 5

Namaacha Wind Farm
Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-005 Fig 5 Bat Transect Autumn Map



ARCUS

- Namaacha AOI
- Meteorological Mast
- Buildings or Dwellings
- Rivers
- Drainage Lines
- High Sensitivity
- Medium Sensitivity
- Turbines within High Sensitivity Areas
- Turbines outside High Sensitivity Areas
- Turbine Blade Length (81.5m)

1:32,000 Scale @ A3

0 0.6 1.2 km

NORTH

Produced By: CC	Ref: 4417-GIS-007
Checked By: AB	Date: 12/1/2022

Sensitivity Map
Figure 6

Namaacha Wind Farm
Final Monitoring Report

G:\Projects\4417 Namaacha\4417 Namaacha.aprx\4417-GIS-007 Fig 6 Site Sensitivity Map

Namaacha Wind Farm

Bat Impact Assessment Report

PREPARED FOR

Globeleq Africa Limited

DATE
22 November 2023

REFERENCE
0669516

CONTENTS

LIST OF TABLES

1. IDENTIFICATION AND EVALUATION OF ENVIRONMENTAL IMPACTS

1.1 METHODOLOGY AND CRITERIA FOR ANALYSIS

1.1.1 INTRODUCTION

Globeleq Africa Limited (Globeleq) is proposing to develop a wind farm approximately 12 km north of Namaacha, in the Maputo Province of Mozambique (hereafter known as "the Project" or "the Namaacha Wind Farm"). It is proposed that the Project will have a generating capacity of up to 120 MW. Arcus (now Environmental Resources Management Southern Africa Pty Ltd, "ERM") was formerly appointed to conduct the pre-construction bat monitoring campaign for the Project, to comply with International Finance Corporation (IFC) and World Bank Standards for these development types. The monitoring was based on a study area / area of interest of approximately 857 ha.

Wind Farms have the potential to impact bats directly and indirectly. Direct impacts identified for the Namaacha Wind Farm would be bat mortality through turbine collisions and barotrauma (Horn et al. 2008; Rollins et al. 2012). Indirect impacts include the modification / destruction of habitats (Kunz et al. 2007b; Millon et al. 2018), as well as disturbance / displacement effects. These indirect impacts may lead to roost destruction, roost disturbance, and potential displacement from foraging areas and/or commuting routes.

Within the context of the Project, direct impacts pose the greatest risk to bats. Although indirect impacts are likely to occur, their significance is considered lower, relative to that of direct impacts. This is largely due to the small Project footprint, as well as the availability of suitable/undisturbed natural habitat within the broader region. No confirmed roosting sites have been located within the Project boundaries, besides a large roost located approximately 10.2 km south of the site. This roost and its relevance to the proposed development area has been further assessed within the final bat monitoring report (Arcus, 2023).

Direct impacts to bats posed by the turbines at the Project will be limited to species that make use of the airspace in the rotor-swept zone of the wind turbines. Up to 23 of the bat species that were recorded on site exhibit behaviour that would have a higher probability of bringing them into contact with wind turbine blades (Arcus, 2023), based on their foraging behaviours and ecology. They are thus at risk of negative impacts if not properly mitigated. An additional four species of fruit bat also exhibit potential to be negatively affected by the development, although these were not observed on site during the respective bat monitoring campaign.

This impact assessment was compiled with reference to the baseline environment, summarised in Section 4 of the final bat monitoring report (Arcus, 2023).

1.1.2 METHODOLOGY

The assessment of impacts consider those expected to occur during the construction, operational and decommissioning phases of the Project. Cumulative impacts are also assessed further. The key definitions used in the assessment methodology are provided below in Table 1, Table 2, Table 3 and Table 4. This impact assessment has followed the same assessment methodology that was used in the approved national EIA (MFA, 2022) as well as the revised specialist assessments carried out by WSP for the ESIA addendum.

Table 1: Description of impact

Descriptor	Scale	Explanation
Nature of Impact	Positive	Impact that represents an improvement of the baseline situation or introduces a positive change.
	Negative	Impact that represents an adverse change from the baseline situation or introduces an undesirable factor.
	Direct	Impact arising directly from activities that are an integral part of the project (e.g., new infrastructure).
	Indirect	Impact that arises indirectly from activities that are not an integral part of the project (e.g., noise due to the movement of vehicles and machinery).
	Secondary	Secondary or change-induced impact due to the Project (e.g. employment opportunities due to material and labour requirements).
Scope	Site	The impact will be limited to the Project site.
	Local	The impact will be limited to the local area.
	Regional	The impact will be limited to the region.
	National	The impact will be national.
	International	The impact will be international.
Duration	Temporary	The impact is expected to be very short-lived (days) and/or intermittent/occasional.
	Medium-term	The impact is expected to be short term (0-5 years).
	Long-term	The impact will prevail over the life of the project. It will disappear when the project ends operations, i.e., deactivated (normally >15 years)
	Permanent	Impact that causes a permanent and irreversible change in the affected recipient or resource.
Probability	Unlikely impact	Not likely to happen.
	Likely	There is a possibility that the impact will occur.
	Very likely	It is very possible that the impact will happen.
	Certain	The impact will occur regardless of any preventative measures.
Reversibility	Immediate	The impact is immediately reversible.
	Reversible	The impact is reversible within 2 years after the cause of the impact is removed.
	Irreversible	The activity will lead to an impact that in all practical terms will be permanent.

Table 2: Magnitude of impact and vulnerability of the receiving environment

Descriptor	Definition	Scale	Explanation
Impact Magnitude	Describes the expected intensity of change to the resource/receiver as a result of the impact	Negligible impact	Impact is minimal and will have no effect on the receiving environment.
		Reduced	The impact is reduced and will result in the processes continuing in an altered form. Reduced environmental changes. No involuntary resettlement. Good information and high awareness of potential environmental factors influencing impact. High degree of confidence.
		Moderate	The impact is moderate, and processes will be significantly changed and may be temporarily halted. Moderate environmental changes. Involuntary resettlement and limited economic displacement. Reasonable amount of information and relatively good perception of potential environmental factors influencing impact. Reasonable degree of confidence.
		High	The impact is high and results in the complete destruction of patterns and permanent interruption of processes. Destruction of rare or endangered species. Devaluation of the character or quality of important historical, archaeological, architectural or aesthetic resources or the character of a community. Negative effects on vulnerable or disadvantaged communities. Involuntary resettlement and substantial economic displacement. Limited information and limited insight into potential environmental factors influencing impact. Low degree of confidence.
Sensitivity	The importance of the environmental attribute in question, the distribution of change in time and space. The	Low	Disturbance of degraded areas, with little conservation value or unimportant as a resource for humans. Affected species are not listed or protected. The importance of an environmental

Descriptor	Definition	Scale	Explanation
	magnitude of the change and the feasibility in which that change was predicted or measured		resource or attribute is based on knowledge, technical or scientific or appreciation of the characteristics of critical resources.
		Medium / Average	Disturbance of areas with conservation value at the local or regional level or with potential use for humans. Audience segments recognize the importance of an environmental feature or attribute. Public recognition can take the form of support, conflict or opposition. Public action can be expressed formally or informally. The environment is susceptible to change.
		High	Disturbance of areas with regional or national conservation value and important human resource. The importance of an environmental feature or attribute is recognized by law, plans or policy statements from government agencies or private groups. The environmental resource affected is significant. The environment is sensitive to change.

Table 3: Impact significance matrix

Significance		Sensitivity		
Magnitude		**Low**	**Medium**	**High**
	Insignificant	Insignificant	Negligible	Negligible
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High
	Positive impacts			
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High

Table 4: Description of the degrees of significance of impacts

Impact Rating	Description
Negative impacts	
Insignificant	The receiving environment will not be affected by the activity. Impacts do not require further assessment.
Negligible	The effect of an activity on the receptive environment is not significant enough to be observed. Impacts do not need to be minimized and are not a concern in decision-making processes.
Reduced	Detectable changes in the baseline situation are expected, in addition to natural variations, but difficulties, degradation or damage to the function and value of the resource/receptor are not expected. The significance of impacts is within the applicable parameters.
Moderate	Moderate significance indicates that an impact may reach the threshold of legal limits. Substantial impacts that could result in lasting changes to the baseline are anticipated. These impacts are a priority in minimizing, in order to prevent or reduce the significance of the impact.
High	A high degree of significance means that legal limits or standards have been exceeded or impacts of high magnitude have occurred in highly sensitive environments or affected people. Residual impacts with high significance can be considered a fatal project failure. High residual impacts must be further avoided or minimized, in order to avoid severe impacts on the receiving environment.
Positive impacts	
Reduced	Impacts of reduced significance are noticeable, but do not permanently and radically improve the receiving environment, or benefit those affected. There is compliance with all standards and legislation.

Moderate	Positive impacts are felt and results in measurable improvements relative to baseline. There is compliance with all standards and legislation.
High	Impacts of high significance that provide substantial benefits where large improvements are felt over an extended period of time. There is compliance with all standards and legislation.

1.2 EVALUATION OF IMPACTS

1.2.1 DESIGN PHASE

Although potential bat mortality impacts (as a result of collisions and/or barotrauma) will be realised during the operational phase of the Project (and have been assessed during the operational phase, accordingly (refer to Table 8)), turbine placement must be considered during the Project design phase. All turbines (including the full blade length) are to avoid highly sensitive areas as a primary measure of mitigation (i.e., avoidance) in accordance with the mitigation hierarchy as defined by IFC (2012a). In the event that high sensitivity areas are unable to be avoided, then minimisation must be applied at those turbines encroaching into such areas from the start of Project inception. Such minimisation includes either turbine curtailment and/or deterrence mechanisms.

All turbines (including the full blade length) are to avoid medium sensitive areas linked to buildings and/or dwellings, as far as possible. However, the absence of bat indicators (guano, scratch marks or smudges) during the relevant site inspections (site visits were conducted by the specialist from August 2021 to May 2022) suggests these features are not considered significantly important for the Project or local bat community on site. Turbines may be sited within such buffers, only if avoidance is not possible. Given the observations made, it is recommended that features associated with medium sensitivity buffers be removed, as far as possible, to avoid potential use by bats in future. If such features are not removed and found to be used by bats during the construction and/or operational phase of the Project, then an appointed bat specialist must advise on appropriate management/mitigation actions for further implementation.

1.2.2 CONSTRUCTION PHASE

Impacts anticipated during the construction phase of the project include habitat modification/destruction and disturbance/displacement effects.

1.2.2.1 HABITAT MODIFICATION/DESTRUCTION

In terms of habitat modification/destruction, bats can be impacted through the removal and/or alteration of habitats (particularly vegetation, other natural resources and suitable roosting habitat), potentially affecting linear features, which bats rely on for navigational cues during foraging, commuting and migration activities, as well as roosting habitat which bats rely on for shelter, protection and reproductive success. This modification could also create favourable conditions for insects, upon which bats feed, which would in turn attract bats to the proposed development area. Habitat modification should be avoided in all highly sensitive areas and reduced as far as possible across the Project site.

Table 5: Habitat modification/destruction during the construction phase.

Ecology - Bats	
Impact	Habitat modification/destruction as a result of the removal of natural vegetation and/or suitable roosting habitat when constructing the Project infrastructure.

Project Phase	Construction		
Nature of Impact	Indirect; Negative		
Duration	Medium-term		
Reversibility	Immediate		
Impact Assessment	**Impact before mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Moderate	1. The removal of natural vegetation and man-made buildings, for the purpose of constructing project infrastructure, should be avoided in all high sensitive areas, as far as possible, and reduced across the Project site in all other areas. 2. Avoid land clearance activities within 500 m of rivers and 200 m of drainage lines. 3. Avoid creation of new linear edges of forested areas from site clearance activities that could create a new pathway for bat foraging.	Reduced
Scope	Local		Site
Probability	Very Likely		Likely
Sensitivity	Average		Average
Classification of Significance	Moderate		Reduced

1.2.2.2 DISTURBANCE /DISPLACEMENT EFFECTS

For disturbance/displacement effects, wind farms have the potential to impact bats indirectly when conducting construction activities (for wind turbines and associated infrastructures) during hours of important bat foraging activities. Additionally, excessive noise and dust could disturb bats during roosting periods, which could result in bats abandoning their roosts, depending on the proximity of construction activities to their roosts. This impact will vary depending on the species involved. Species that roost in trees are likely to be impacted more (e.g., Cape serotine and Egyptian free-tailed bats; Monadjem et al. 2010), as tree roosts are less buffered against noise and dust compared to roosts in buildings and rocky crevices. Roosts are limiting factors in the distribution of bats and their availability is a major determinant in whether bats would be present in a particular location. Reducing roosting opportunities for bats is likely to have negative impacts. If all buffers of the sensitivity map (Appendix A) are adhered to, then the significance of this impact is not expected to be high. No roosts were found on the proposed development site, yielding medium sensitivity buffers, rather. Due to the absence of confirmed roosting features, the impact is not currently expected to be high.

Table 6: Disturbance/ displacement of bat species during the construction phase.

Ecology - Bats			
Impact	Disturbance/displacement effects as a result of construction activities (noise, dust, movement, etc.)		
Project Phase	Construction		
Nature of Impact	Indirect; Negative		
Duration	Medium-term		
Reversibility	Immediate		
Impact Assessment	**Impact before mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Moderate	1. Limit construction activities to daylight hours. 2. Limit construction activities in areas that are listed as High sensitivity. 3. Lighting at the Project site should be kept to a minimum during all phases, and appropriate types of lighting are to be used to avoid attracting insects, and hence, bats. This includes downward facing low-pressure sodium and warm white LED lights. 4. If using explosives, pre-cutting techniques and the use of micro-retarders should be used, thus attenuating the intensity of the vibrations produced. 5. Prior to construction, a suitably qualified bat specialist should revisit the site to identify any potential new roosts, so these can be documented and monitored during the construction and operational phases of the Project - with appropriate management/mitigation measures implemented, where required.	Reduced
Scope	Local		Local
Probability	Very Likely		Likely
Sensitivity	Average		Average
Classification of Significance	Moderate		Reduced

1.2.3 OPERATIONAL PHASE

The major potential impact of wind turbines on bats is direct mortality as a result of collisions with wind turbine blades and/or barotrauma (Grodsky et al. 2011; Horn et al. 2008; Rollins et al. 2012).

1.2.3.1 BAT MORTALITY (WIND TURBINE COLLISIONS AND/OR BAROTRAUMA)

Direct impacts will be limited to species that make use of the airspace within the rotor swept zone of the wind turbines, during foraging, commuting and/or migration activities. Up to 23 bat species that were recorded on site exhibit behavior that would bring them into contact with wind turbine blades, putting them at risk of severe negative impacts of mortality. All restrictions around turbine high sensitivity areas should be strictly adhered to for the development of the Project. The specialist identified both medium-sensitivity and high-sensitivity areas within the Project's area of influence (AOI). The medium sensitivity areas that were flagged within the Project's AOI were due to the presence of structures resembling local homes and/ or farms that could provide potential roosting areas for bats (although none were observed to currently be serving this purpose). As all identified structures will be removed due to the physical resettlement required for the area, these sensitivities will not exist during the operational phase of the Project.

Highly sensitive areas flagged by the specialist include drainage lines with a 200 m buffer and rivers with a 500 m buffer, although no rivers were located on site (See Appendix A). No turbines should be placed within pre-defined high sensitivity areas, as far as possible. It is noted that the Project has implemented avoidance mitigation techniques by carefully micro-siting the turbines to avoid highly sensitive areas, as far as possible. Should placement of turbines in these areas be unavoidable, appropriate minimisation techniques (including curtailment and/or acoustic deterrents) must be implemented as soon as the first wind turbine has been erected, in accordance with the parameters defined in Table 7 below.

Table 7: Minimisation parameters if fatality thresholds are exceeded or if wind turbine blades overlap with high sensitivity areas

	1 September – 30 November (Spring)	1 December – 29 February (Summer)
Time Period	18h00 – 22h00; 23h00 – 03h00	19h00 – 04h00
Temperature	Between 15°C and 20°C	Between 19 °C and 22°C
Wind Speed	Up to 10 m/s	Up to 8 m/s

Direct fatality impacts as a result of foraging activities would also be further exacerbated with potential light pollution that would be present during both construction and operational phases. Currently the local region experiences very little light pollution from anthropogenic sources and operation of the Project will marginally increase light pollution. This excludes turbine aviation lights, which do not appear to impact bats (Baerwald and Barclay 2011; Horn et al. 2008; Jain et al. 2011; Johnson et al. 2003). Certain bat species actively forage around artificial lights due to the higher numbers of insects attracted to these lights (Blake et al. 1994; Rydell 1992; Stone 2012). This would attract bats to the vicinity of the operating wind turbines and increase the risk of collision and/or barotrauma for these species. This impact is likely to be moderate to low with mitigation but must be carefully considered because the consequence could be severe without mitigation. Lighting at the Project should be kept to a minimum during all phases and appropriate types of lighting should be used to avoid attracting insects, and hence, bats (for example downward facing low-pressure sodium and warm white LED lights). The impact is further addressed in Table 8.

1.2.3.2 MITIGATION MEASURES AND MONITORING FOR BAT MORTALITY (AS A RESULT OF WIND TURBINE COLLISIONS AND/OR BAROTRAUMA)

1. Although the impact of mortality is realised during the operational phase, the mitigation measure for avoidance must be implemented from the outset of the Project design phase already. All turbines (inclusive of the full blade length) are to avoid highly sensitive areas as a primary measure of mitigation (i.e. avoidance), in accordance with the mitigation hierarchy (as defined in IFC Performance Standard 1). Where avoidance is not possible, all wind turbines (inclusive of the full blade length) overlapping with high sensitivity buffers (currently identified as WP7, WP8, WP16, WP17, WP18, WP23, WP25, WP26 and WP27 – Appendix A) should be subjected to suitable minimisation techniques (i.e. curtailment or ultrasonic deterrents) as soon as the first wind turbine has been erected, in accordance with the parameters defined in Table 7.
2. A minimum of two years of operational monitoring is required (acoustic monitoring, carcasses searches and fatality estimations) in accordance with the methodologies, as laid out in the South African best practice guidelines for monitoring bats at operational wind energy facilities. Due to the geographical relevance, South African best practice guidelines are recommended to be followed. Thereafter, monitoring must be repeated again in year five, and every five years thereafter, unless otherwise recommended by the appointed bat specialist.
3. All wind turbines (irrespective of sensitive area overlap) are to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of Project inception. This should be implemented throughout the lifespan of the Project, with specific parameters (seasonality and wind speed) being updated throughout the course of the operational bat monitoring campaign, as more fatality and acoustic data becomes available.
4. Minimise artificial light sources as far as possible. White, steady lights in particular attract prey (e.g., insects), which in turn attract bats. If lights are used, red or white blinking or pulsing lights are best. Steady or slow blinking lights are to be avoided. Timers, motion sensors, or downward-hooded lights help to reduce light pollution.
5. Appropriate types of lighting are to be used to avoid attracting insects, and hence, bats. This includes downward facing low-pressure sodium and warm white LED lights.
6. Fatality thresholds for all identified bat species should be closely monitored following international best practice (e.g., The South African Bat Assessment Association fatality threshold guidelines, MacEwan et al. 2018), with suitable mitigation measures implemented

(in accordance with table 7) if such thresholds are exceeded. For all wind turbines, if the fatality thresholds are reached at any point during the Projects' lifespan, then appropriate mitigation in the form of either turbine curtailment and/or acoustic deterrence mechanisms is to be applied to reduce residual impacts. Threshold limits are defined as 228.81 Least Concern insectivorous bats per annum, or 1 conservation important or frugivorous bat per annum, in accordance with best practice threshold guidelines.

7. If unacceptable impacts to megabats are identified through ongoing monitoring, then wind turbine curtailment (following the parameters detailed in Table 7) should be implemented.
8. All recommendations relating to mitigation and minimisation techniques, with associated parameters, must form part of an adaptive management process, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impact is realised. All recommendations are therefore to be updated on an on-going basis, as soon as additional information becomes available.

Table 8: Bat Mortality as a result of collisions with turbine blades and/or barotrauma during the operational phase.

Ecology: Bats			
Impact	Bat mortality as a result of collisions with wind turbine blades and/or barotrauma during commuting, foraging and/or migration activities.		
Project Phase	Operational Phase		
Nature of Impact	Direct; Negative		
Duration	Long-term		
Reversibility	Irreversible		
Impact Assessment	**Impact prior to mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	High	1. All wind turbines are to avoid high sensitivity areas, as far as possible. Where unavoidable, any turbines overlapping with such buffers should be subjected to suitable minimisation techniques (i.e. curtailment or ultrasonic deterrents). 2. All wind turbines are to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of Project inception. 3. Minimise artificial light sources as far as possible.	Moderate
Scope	Site		Site
Probability	Very Likely		Very Likely
Sensitivity	Average		Average
Classification of Significance	High		Moderate

		4. Appropriate types of lighting are to be used to avoid attracting insects. 5. Fatality thresholds for all identified bat species should be closely monitored following international best practice, with additional mitigation measures implemented if such thresholds are exceeded. 6. An adaptive management process should be used, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impact is realised. All recommendations are therefore to be updated on an on-going basis as soon as additional information becomes available.	

1.2.4 DECOMMISSIONING PHASE

The impacts to bats during this phase are likely to be restricted to disturbance/displacement effects as a result of decommissioning activities. The impacts to bats should be low, provided decommissioning activities are restricted to daylight hours and that activities are carefully monitored and managed (with inputs provided by an appropriate bat specialist) around any confirmed roosts that may be identified during the relevant project phases (if relevant). The impact is further addressed in table 9 below:

Table 9: Disturbance/ displacement effects during the decommissioning phase.

Ecology - Bats			
Impact	Disturbance/displacement effects as a result of decommissioning activities (noise, dust, movement, etc.)		
Project Phase	Decommissioning Phase		
Nature of Impact	Indirect; Negative		
Duration	Medium-term		
Reversibility	Immediate		
Impact Assessment	**Impact before mitigation**	**Mitigation measures**	**Residual impact**

Magnitude	Moderate	1. Limit decommissioning activities to daylight hours. 2. Avoid all decommissioning activities within potential roosting habitats, if identified during the Projects' operational phase bat monitoring campaign, when decommissioning wind turbines and associated infrastructures. 3. Consult with an appointed bat specialist on further management measures, particularly if any confirmed roosts are identified on site, during the lifespan of the Project.	Reduced
Scope	Local		Local
Probability	Very Likely		Likely
Sensitivity	Average		Average
Classification of Significance	Moderate		Reduced

1.2.5 CUMULATIVE IMPACTS

Cumulative impacts to bats, such as those relating to changes to physical environment (e.g., roost and habitat destruction) and direct mortality are likely to be low across the cumulative impact region, given that there are no other known operational wind energy facilities within Mozambique. No operational facilities are known to occur within 50 km of the Project boundaries, and the nearest known wind energy facility, in accordance with the South African Renewable Energy EIA Application Database (REEA_OR_2023_Q2), is located approximately 187 KM west of the Project, within the Republic of South Africa. This facility is for the proposed establishment of a wind energy facility outside of Carolina, Mpumalanga, and is not presently operational. As such, cumulative impacts are not expected to be significant.

2. CONCLUSION

An initial mitigation measure to avoid impacts is for all wind turbines (irrespective of sensitive area overlap) to be subjected to standard blade feathering (up to 3.5 m/s) during spring and summer from the date of Project inception, to prevent fatalities during wind turbine free-wheeling. This should be implemented throughout the lifespan of the Project, with specific parameters (seasonality and wind speed) being updated throughout the course of an operational bat monitoring campaign (as more fatality and acoustic data becomes available).

A minimum of two years of operational monitoring is required (acoustic monitoring, carcass searches and fatality estimations) in accordance with the methodologies, as laid out in the South African best practice guidelines for monitoring bats at operational wind energy facilities. Thereafter, monitoring must be repeated again in year five, and every five years thereafter. Monitoring of fatalities is to occur from the outset, as soon as the first wind turbine is erected and starts spinning.

Furthermore, the correct placement of wind turbines is considered crucial. All turbines (inclusive of the full blade length) are to avoid highly sensitive areas as a primary measure of mitigation (i.e. avoidance), in accordance with the mitigation hierarchy (as defined in IFC Performance Standard 1). If high sensitivity areas are unable to be avoided, then minimisation must be applied at those turbines encroaching into such areas from the start of Project inception in accordance with the parameters listed in Table 7. Turbine curtailment is preferred, particularly for megabats, as ultrasonic deterrence mechanisms are not effective against mitigation impacts on megabats (which do not use echolocation for navigation). No megabats were visually observed using the site during the 12-month monitoring campaign, and although possible, the anticipated risk of significant impacts occurring is not considered to be high. Their presence should however be carefully monitored during the lifespan of the Project, with appropriate mitigation measures recommended (by the appointed bat specialist) and implemented, wherever considered necessary. Minimisation must be undertaken in accordance with the parameters defined in Table 7. This should be implemented throughout the lifespan of the Project at the relevant turbines, with specific minimisation parameters being updated throughout the course of an operational bat monitoring campaign, as more fatality and acoustic monitoring data becomes available.

Turbines may be placed within medium-sensitive buffers, if avoidance is not possible, given the absence of physical bat indicators in dwellings and structures associated with these buffers. However, it is beneficial if such features (associated with medium sensitivity buffers) are removed, as far as possible, in order to avoid potential use of these structures by bats in future. Because all identified structures will be removed as part of the physical resettlement required for the area, these sensitivities will not exist during the operational phase of the Project.

For all wind turbines, if the fatality thresholds are reached at any point during the projects' lifespan, then appropriate mitigation in the form of either turbine curtailment and/or acoustic deterrence mechanisms is to be applied to reduce residual impacts, in accordance with the minimisation parameters as defined in Table 7. Threshold limits are defined as 228.81 Least Concern insectivorous bats per annum, or 1 conservation important or frugivorous bat per annum, in accordance with best practice threshold guidelines (MacEwan et al. 2018).

All above recommendations relating to mitigation and minimisation techniques, with associated parameters, must form part of an adaptive management process, whereby any residual impacts are mitigated according to the best available data obtained at the time that the impact is realised. All recommendations are therefore to be updated on an on-going basis as soon as additional information becomes available.

Provided that the specialist recommendations in this report are adhered to, as well as those defined by IFC (2012b) in terms of the considerations and mitigation measures defined for natural habitats, as summarised in section 8 of the final bat monitoring report (Arcus, 2023), the development of the Namaacha Wind Farm may be considered for implementation.

3. REFERENCES

Arcus, 2023. Bat Pre-Construction Monitoring. Namaacha Wind Farm. Mozambique. Final Report.

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

IFC, 2012a. International Finance Corporation: Performance Standards on Environmental and Social Sustainability.

IFC, 2012b. International Finance Corporation's Guidance Notes: Performance Standards on Environmental and Social Sustainability.

IUCN 2020. IUCN Red List of Ecosystems. https://assessments.iucnrle.org/. Accessed: 2022/08/19.

IUCN 2022. IUCN Red List of Threatened Species. https://www.iucnredlist.org/species/44862/22073129. Accessed: 2022/08/20.

Kunz, T.H., Lumsden, L.F., 2003. Ecology of Cavity and Foliage Roosting Bats In Bat Ecology. eds T.H. Kunz, M.B. Fenton, pp. 3-89. The Univ. Chicago Press, Chicago.

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

MacEwan, K., Richards. L.R., Cohen, L., Jacobs, D., Monadjem, A., Schoeman, C., Sethusa, T., Taylor, P.J., 2016. A conservation assessment of *Miniopterus natalensis*. In Child MF, Roxburgh L, Do Linh San E, Raimondo D, Davies Mostert Ht, editors. The Red List of Mammals of South Africa, Swaziland and Lesotho. South African National Biodiversity Institute and Endangered Wildlife Trust, South Africa.

MacEwan, K., Aronson, J., Richardson, E., Taylor, P., Coverdale, B., Jacobs, D., Leeuwner, L., Marais, W., Richards, L. 2018. South African Bat Fatality Threshold Guidelines – ed 2. South African Bat Assessment Association.

MacEwan, K., Sowler, S., Aronson, J. and Lötter, C., 2020. South African best practice guidelines for pre-construction monitoring of bats at wind energy facilities.

MF&A MoÇambique, 2021. Bat Monitoring Report. Namaacha Wind Farm. Final Report. Central Electrica da Namaacha.

Monadjem, A., Taylor, P.J., Cotterill, F.P.D., Schoeman, M.C., 2010. Bats of Southern and Central Africa: A Biogeographic and Taxonomic Synthesis. Wits University Press, Johannesburg.

Mucina & Rutherford. 2006. The Vegetation of South Africa, Lesotho and Swaziland.

Taylor, P., Mkhari, D., Mukwevho, T., Monadjem, A., Schoeman, M., Schoeman, C., Steyn, J., 2011. Bats as potential biocontrol agents in an agricultural landscape, Levubu Valley: Diet, activity and species composition of bats in macadamia orchards and neighbouring natural habitats. South African Avocado Growers Association Yearbook 34.

WBG, 2015. World Bank Group: Environmental, Health, and Safety Guidelines: Wind Energy.

WSP Environmental, 2020. Proposed 63 MW Namaacha Wind Farm Project in Namaacha, Mozambique: ESIA and RAP Gap Analysis.

ERM

APPENDIX A FIGURE OF NAMAACHA SITE SENSITIVITY TO BATS (ARCUS, 2023)

ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Ghana
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique
The Netherlands
New Zealand
Peru
Poland
Portugal
Puerto Rico
Romania
Senegal
Singapore
South Africa
South Korea
Spain
Switzerland
Taiwan
Tanzania
Thailand
UAE
UK
US
Vietnam

ERM's Cape Town Office
240 Main Road
1st Floor Great Westerford
Rondebosch
7700

T: +27 21 681 5400
F: +27 21 686 0736

www.erm.com

NAMAACHA WIND ENERGY FACILITY

BIRD MONITORING REPORT

JULY 2023

AfriAvian Environmental
Formerly Afrimage Photography t/a Chris van Rooyen Consulting and Albert Froneman Consulting
VAT#: 4580238113
email: albert.froneman@gmail.com
Tel: +27 (0)82 901 4016

Contents

List of Figures

List of Tables

1. Objectives

The objective of the year of pre-construction monitoring at the proposed Namaacha Wind Energy Facility (WEF) is to gather pre-construction baseline data according to internationally accepted standards e.g., the World Bank Environmental, Health, and Safety Guidelines for Wind Energy (EHS Guidelines)(IFC 2015) and the IFC Performance Standards (IFC 2012) on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the proposed WEF, and a suitable control site to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the WEF to assess the potential collision risk with the turbines.

2. Guidance

The methods followed for the pre-construction monitoring are in accordance with the standards set by the World Bank Group and the IFC. These are set out below:

2.1 International Finance Corporation (IFC) (Word Bank Group) Standards

2.1.1 Pre-construction assessments

The Environmental, Health, and Safety Guidelines for Wind Energy (EHS Guidelines) were published by the World Bank Group, (ifc.org 2015) of which the IFC is a member. The EHS Guidelines contain the performance levels and measures that are normally acceptable to the World Bank Group, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. The World Bank Group requires borrowers/clients to apply the relevant levels or measures of the EHS Guidelines. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent.

The EHS Guidelines for Wind Energy Facilities provides the following guidance related to pre-construction assessments of birds for onshore wind farms.

- *Surveys should consider the following:*
    - ***Site-specific issues****: consideration of habitats, geographical location, topography, and vicinity of the wind energy facility to sites of high biodiversity value.*
    - ***Species-specific issues:*** *surveys should be targeted to species of flora and fauna of high biodiversity value, those with a special international or national conservation status, endemic species, and species that are at elevated risk of impact from wind energy facilities. For example, species with a relatively high collision risk include certain soaring, aerial-displaying, and/or migratory birds and flocking birds, as well as birds of prey. Species with a relatively high risk of visual disturbance include open-country species that instinctively avoid tall structures. Some species may be attracted to wind energy facilities as perches or feeding areas, which could further increase potential for collision. Species at risk of collision with associated transmission lines include relatively heavy-bodied birds with limited manoeuverability (e.g., vultures, bustards, waterfowl, cranes, storks, pelicans, herons, flamingos), as well as flocking bird species. Species at risk of electrocution from associated transmission lines include various raptors, vultures, owls, and certain storks and other birds with large wingspans, and with behavioural tendencies to perch frequently on power lines and associated structures.*

These impacts and potential mitigation options should be assessed on a species-by-species basis.

- ***Season-specific issues:** surveys should take into consideration certain periods during the year when the project site may have a greater or different ecological function or value (e.g., migration, breeding season, or winter seasons). Surveys should usually be conducted for at least one year when at-risk wildlife is identified. Longer surveys may sometimes be necessary in areas with exceptional aggregations of at-risk migratory birds and where existing biodiversity data are limited. This would be determined on a project-by-project basis.*

- *Surveys should be designed and implemented to adequately guide the micro-siting of turbines (and turbine selection) to minimize collision risks to birds and bats. This is normally expected to entail gathering relatively precise information on the spatial patterns of site utilization by at-risk wildlife species, as well as consideration of the locations of certain topographic, ecological, or other landscape features that may attract or otherwise concentrate the activity of flying wildlife within the project area and its surrounding landscape. Specific data-gathering methods and study designs should be selected based on site- and species-specific considerations, guided by technical experts, and may include vantage point surveys point count surveys, ultrasound acoustic methods, remote-sensing data-gathering techniques, and/or other techniques to understand movement patterns, as appropriate. The extent of data collection should be commensurate with the biodiversity risk at the wind energy facility.*

- *Depending on the location of the wind energy facility and on species-specific considerations, Collision Risk Modelling (CRM) may be also appropriate, especially when wind energy facilities are located close to areas of high biodiversity value. The utility of CRM is to be evaluated on a project-by-project basis with qualified experts.*

2.1.2 Mitigation measures (Onshore)

Avoidance of impacts through site selection is considered as the preferred mitigation measure; however, the EHS Guidelines for Wind Energy Facilities also provides the following guidance related to potential mitigation for impacts to birds from onshore wind farms:

- *Modify the number and size of turbines and their layout in accordance with site-, species-, and season-specific risks and impacts. Fewer taller towers may reduce the collision risk for most birds and reduce vegetation clearing for construction. The location of associated infrastructure—such as transmission lines, substations, and access roads—should also be accordingly informed by biodiversity risk and impact assessments.*
- *If the wind energy facility is located close to areas of high biodiversity value, active turbine management such as curtailment and shut-down on-demand procedures should be considered as part of the mitigation strategy and factored into financial modelling and sensitivities at an early stage. This method of mitigation should be adaptive and guided by a well-developed post-construction monitoring program. Curtailment and shut-down on-demand measures should be first conducted as an experiment, with control turbines that are not curtailed and with both sets carefully monitored, to determine whether or not the curtailment is producing the desired fatality reduction. Technology-led turbine shut-down should be considered in certain cases, although any such system should be subject to a period of observer-led ground truthing and evaluation through a process of adaptive management.*
- *Avoid artificially creating features in the environment that could attract birds to the wind energy facility, such as water bodies, perching or nesting areas, novel feeding areas, and staging or roosting habitats.*
- *Avoid attracting birds to predictable food sources, such as on-site or off-site waste disposal areas, or landfills; this is especially relevant when vultures or other carrion-eating birds are*

present. These types of mitigation measures may also need to be carried out in the surroundings of the wind energy facility in order to be effective.

- *Eliminate "free-wheeling" (free spinning of rotors under low wind conditions when turbines are not generating power).*
- *Avoid artificial light sources where possible. In particular, white, steady lights attract prey (e.g., insects), which in turn attracts predators. If lights are used, red or white blinking or pulsing lights are best.*
- *Assess the current state of the art of bird and bat deterrence technology and consider implementing any proven effective technologies where appropriate.*

2.2 International Finance Corporation (IFC) Performance Standards

IFC Performance Standard 6 (PS6) recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as *"the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems."*

PS6 identifies three types of habitat which are subject to specific requirements under the Performance Standards. These are: modified habitat, natural habitat and critical habitat. The definitions and requirements for these types of habitat are described below.

Modified Habitat

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Modified habitats may include areas managed for agriculture, forest plantations, reclaimed coastal zones, and reclaimed wetlands.

[PS6] applies to those areas of modified habitat that include significant biodiversity value, as determined by the risks and impacts identification process required in Performance Standard 1. The [project] should minimize impacts on such biodiversity and implement mitigation measures as appropriate.

Natural Habitat

Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.

The [project] will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- *No other viable alternatives within the region exist for development of the project on modified habitat;*
- *Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and*
- *Any conversion or degradation is mitigated according to the mitigation hierarchy.*

In areas of natural habitat, mitigation measures will be designed to achieve no net loss9 of biodiversity where feasible. Appropriate actions include:

- *Avoiding impacts on biodiversity through the identification and protection of set-asides;*
- *Implementing measures to minimize habitat fragmentation, such as biological corridors;*
- *Restoring habitats during operations and/or after operations; and*
- *Implementing biodiversity offsets.*

Critical Habitat

Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

In areas of critical habitat, the client will not implement any project activities unless all of the following are demonstrated:

- *No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;*
- *The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;*
- *The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and*
- *A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.*

In such cases where a client is able to meet the requirements defined [above], the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.

For an evaluation of the potential of the Source Area to contain critical habitat see the Critical Habitat Screening prepared by WSP.

2.3 Other Best Practice Guidelines

Additional guidance used to inform the monitoring includes:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.* Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Henceforth this will be referred to as the SA Wind Guidelines.

The SA Wind Guidelines were used as Mozambique does not have its own guidelines for assessing the impacts of wind energy facilities on avifauna. As these guidelines are not a national requirement, they have been used to supplement the IFC/World Bank Guidance as optional additional guidance. The SA Wind Guidelines conform to the requirements of the World Bank Group: Environmental, Health and Safety Guidelines for Wind Energy (August 2015). Note that the SA Wind Guidelines require a minimum of four site visits a year, so this is the basis that has been taken in designing the surveys.

Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms. The BLSA list of priority species consider the following factors:

- Family groups of bird that were killed or otherwise affected by wind farms in the rest of the world. Other families of birds that do not occur in the rest of the world and that might be affected by wind farms (for example all larger birds) were also added to the list.
- Conservation status (regional and global)
- Endemic status (southern Africa)
- Range size
- Morphology
- Behaviour

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species (2022 - 2) was consulted to determine the conservation status of the priority species that were recorded. Established in 1964, the International Union for Conservation of Nature's Red List of Threatened Species has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.

3. Fieldwork Methodology

3.1 General

The objective of the monitoring is to gather baseline data on the use of the Project Area by birds to measure potential displacement by the wind farm activities. The fieldwork consisted of four seasonal surveys conducted over a period of 8 months.

Table 1: Surveys conducted at Namaacha Wind Farm

Survey	Date	Season
1	9 – 17 November 2022	Spring
2	28 February to 6 March 2023	Summer
3	25 March to 2 April 2023	Autumn
4	30 May to 05 June 2023	Winter

The first survey was conducted in spring when many migrant raptor species are already present e.g. Common Buzzard and Wahlberg's Eagle. The second survey was conducted during late summer (end February – early March) when migratory species were still present. The autumn survey took place at the end of March early April while the dry season (winter) survey took place at the end of May – early June within the peak breeding season of most resident raptors. Weather conditions during surveys ranged from cloudy, partly cloudy to sunny but visibility was generally always good. Surveys were conducted during three time envelopes to cover all the daylight hours: morning, mid-afternoon and late afternoon. Nocturnal species were recorded on site before dawn and after dusk while travelling to / from vantage points.

The field team consist of two experienced observers using the following equipment:

- Binoculars
- Two-way radios
- Nikon D810 DSLR with a 600mm lens
- 4 x 4 vehicle

3.2 Survey Area

The surveys evaluated both the Source Area, (Project Area), and a Control Site. The Control Site is located between 6.4 and 10km to the north-east of the centre of the Source Area (see Figure 1). The Control Site was selected on the basis of (i) similar habitat (ii) ease of access to reduce travelling time (iii) security – largely uninhabited and (iv) low likelihood that land use will change in the medium term.

A Control Site is an area that is similar to the development site (i.e. the Source Area), but far enough away not to be affected by activities on the site – a key part of any Before (pre-construction) – After (post-construction) – Control – Impact (development) (BACI) study.

The data collected at the control site will be used to conduct a BACI (Before-After × Control-Impact) analysis once the site is operational to assess the effect of the facility on avifauna.

Figure 1 (below) indicates the Source Area and Control Site where monitoring is taking place.

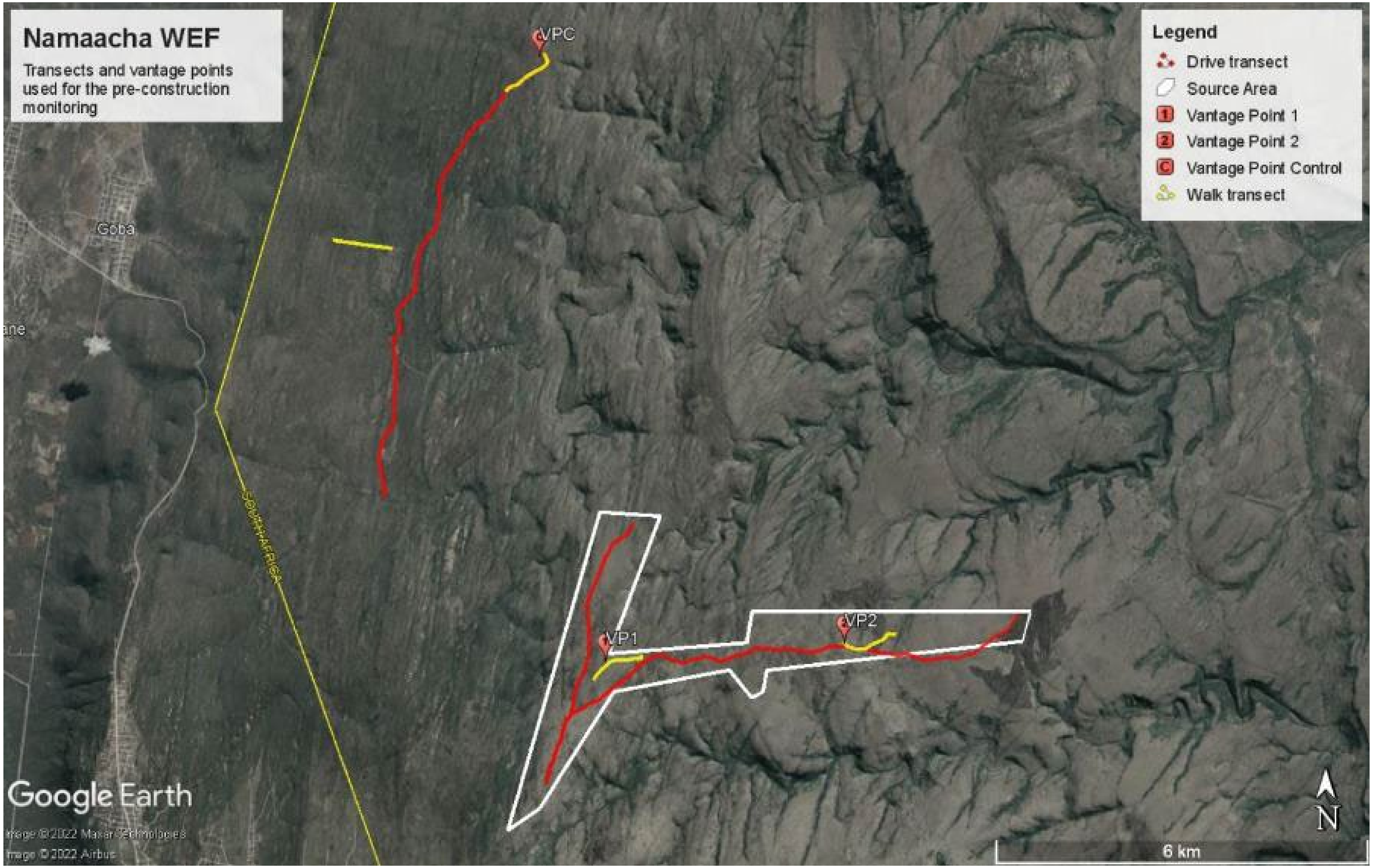


Figure 1: Area where monitoring is taking place, with position of VPs, drive transects, walk transects and development site. The area to the north-west of the Project Site is the Control Site.

3.3 Transects

Both driven and walked transects were conducted to identify avifauna sensitivities. The aim of drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are primarily aimed at recording small passerines. All efforts were made to avoid errors such as double counting and surveys were not performed when visibility was poor. The primary objective of the transect monitoring is to gather baseline data on the use of the site by birds to measure potential displacement by the wind farm activities.

Drive Transects

- Drives were performed in one direction only.
- One 14km drive transect survey was carried out within the Source Area. This route was selected because it covered the entire Source Area and represented all habitat types.
- One 8.35km drive transect survey was carried out in the Control Site. This route was selected because it represented similar habitat types as what was covered in the Source Area.
- The two surveyors drove the route slowly (± 10km/h) in a vehicle recording all birds on both sides of the transect.
- The surveyors stopped at regular intervals (i.e. every 500m) to scan the environment with binoculars. Drive transects are counted three times per sampling session, four times per year.

Walk Transects

- Two 1km walk transects were identified in the Source Area. These routes were selected because they represented all habitat types.
- Two 1km walk transects were identified in the Control Site. These routes were selected because they represented similar habitat types what was covered in the Source Area.
- All observed birds are recorded during walk transects.
- The transects are counted four times per each sampling survey, four times per year.

The following variables were recorded for all transects:

- Date
- Start time and end time
- Estimated distance from transect
- Wind direction
- Wind strength (estimated Beaufort scale)
- Weather (sunny; cloudy; partly cloudy; rain; mist)
- Temperature (cold; mild; warm; hot)
- Species
- Number of birds
- Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
- Co-ordinates (priority species only)

Table 2: Time slots when surveys were conducted (rounded off)

	Date	Start time	End time
Survey 1			
Control Site drive transect	2022/11/15 2022/11/16 2022/11/17	10:16 11:53 08:49	11:59 13:43 11:01

Control Site walk transect 1	2022/11/14 2022/11/15 2022/11/16 2022/11/17	17:32 07:42 14:52 11:57	18:05 08:20 15:31 12:36
Control Site walk transect 2	2022/11/15 2022/11/16 2022/11/16	14:59 07:06 10:10	15:34 07:43 10:45
Source Area drive transect	2022/11/10 2022/11/12 2022/11/13	08:45 15:07 11:32	11:01 17:04 13:58
Source Area walk transect 1	2022/11/09 2022/11/11 2022/11/12 2022/11/12	11:57 16:54 07:32 11:46	12:32 17:30 08:21 12:28
Source Area walk transect 2	2022/11/10 2022/11/11 2022/11/11 2022/11/12	17:25 05:11 10:12 14:07	17:58 05:53 10:59 14:42

Survey 2			
Control Site drive transect	2023/03/04 2023/03/05 2023/03/06	08:00 13:01 10:00	09:37 14:42 11:52
Control Site walk transect 1	2023/03/04 2023/03/05 2023/03/05 2023/03/06	10:54 15:20 17:16 07:05	11:27 15:57 17:55 07:48
Control Site walk transect 2	2023/03/04 2023/03/04 2023/03/05 2023/03/05	14:36 17:38 06:35 10:38	15:14 18:11 07:20 11:13
Source Area drive transect	2023/02/28 2023/03/01 2023/03/03	17:27 14:49 07:44	18:52 16:54 09:47
Source Area walk transect 1	2023/03/02 2023/03/03 2023/03/03 2023/03/03	07:02 10:58 15:05 17:09	07:44 11:36 15:47 17:47
Source Area walk transect 2	2023/03/01 2023/03/01 2023/03/02 2023/03/02	06:48 12:42 15:10 17:12	07:34 13:21 15:44 17:53

Survey 3			
Control Site drive transect	2023/03/28 2023/03/29 2023/03/30	07:31 12:55 09:36	09:10 14:20 11:43
Control Site walk transect 1	2023/03/28 2023/03/29	10:08 15:07	10:43 15:38

	2023/03/29 2023/03/30	16:39 06:28	17:24 07:20
Control Site walk transect 2	2023/03/28 2023/03/28 2023/03/29	14:25 17:16 07:10	15:04 17:51 07:48
Source Area drive transect	2023/03/25 2023/03/25 2023/03/26	10:39 12:44 15:46	11:21 14:51 17:44
Source Area walk transect 1	2023/03/25 2023/03/26 2023/03/26 2023/03/27	16:57 07:37 10:25 08:36	17:35 08:21 11:06 10:45
Source Area walk transect 2	2023/03/24 2023/03/25 2023/03/25 2023/03/26 2023/03/27	17:02 06:49 10:56 14:15 14:19	17:48 07:31 11:36 14:56 14:59

Survey 4			
Control Site drive transect	2023/06/03 2023/06/04 2023/06/05	07:46 11:40 13:57	10:24 13:30 15:42
Control Site walk transect 1	2023/06/05 2023/06/05 2023/06/05 2023/06/05	07:34 10:42 12:49 16:35	08:21 11:10 13:29 16:55
Control Site walk transect 2	2023/06/03 2023/06/03 2023/06/04	14:12 16:40 07:04	14:43 17:19 07:48
Source Area drive transect	2023/06/04 2023/05/31 2023/06/01	10:18 12:46 07:24	10:55 14:33 09:14
Source Area walk transect 1	2023/06/01 2023/05/31 2023/06/01 2023/06/01	15:33 16:12 10:40 14:07	17:17 16:55 11:21 14:44
Source Area walk transect 2	2023/06/02 2023/05/30 2023/05/31 2023/05/31 2023/06/02	07:47 16:10 08:06 11:34 14:39	08:44 16:52 08:52 12:11 15:38

3.4 Vantage Points

The objective of vantage point counts is to assess the potential collision risk with the turbines. Two vantage points (VP1 and VP2) were identified from which the best view of the WEF site can be obtained, to record the flight altitudes and patterns of priority species. One vantage point (VPC) was also identified on the Control Site. The VP at the Control Site is located approximately 10km away from the centre of the site. VP watches are conducted for 12 hours per vantage point, four times per year.

The following variables are recorded for each flight:

- Date
- Start time and end time
- Wind direction
- Wind strength (estimated Beaufort scale 1-7)
- Weather (sunny; cloudy; partly cloudy; rain; mist)
- Temperature (cold; mild; warm; hot)
- Species
- Number of birds
- Flight altitude (high i.e.>300m; medium i.e. 30 – 300m; low i.e. <30m)
- Flight mode (soar; flap; glide; kite; hover) and
- Flight time (in 15 second intervals).

Table 3: Time slots when vantage point watches were conducted (rounded off)

Survey 1			
Vantage point	Date	Start time	End time
VP 1.1	11/11/2022	12:08	18:18
VP 1.2	12/11/2022	06:55	12:45
VP 2.1	09/11/2022	16:06	18:29
VP 2.2	10/11/2022	11:27	16:04
VP 2.3	11/11/2022	04:54	09:54
Control VP 1	15/11/2022	12:16	18:20
Control VP 2	16/11/2022	05:00	10:56
Survey 2			
VP 1.1	02/03/2023	05:52	12:21
VP 1.2	03/03/2023	13:07	18:38
VP 2.1	01/03/2023	05:43	12:14
VP 2.2	02/03/2023	13:10	18:39
Control VP 1	04/03/2023	12:35	18:35
Control VP 2	05/03/2023	05:45	12:27
Survey 3			
VP 1.1	25/03/2023	15:22	18:13
VP 1.2	26/03/2023	06:35	11:50
VP 1.3	27/03/2023	11:29	15:23
VP 2.1	24/03/2023	15:15	18:15
VP 2.2	25/03/2023	05:49	12:20
VP 2.3	26/03/2023	12:41	15:10
Control VP 1	28/03/2023	11:45	18:12
Control VP 2	29/03/2023	05:53	11:26
Survey 4			
VP 1.1	31/05/2023	15:04	17:21
VP 1.2	01/06/2023	09:44	14:48
VP 1.3	02/06/2023	06:17	10:56
VP 2.1	30/05/2023	15:08	17:32
VP 2.2	31/05/2023	06:12	12:12
VP 2.3	02/06/2023	13:20	16:56
Control VP 1	03/06/2023	10:22	17:26
Control VP 2	04/06/2023	06:17	11:13

3.5 Focal Points

No potential focal points (FPs) of bird activity have been identified within the Source Area to date.

4 Receiving Environment

The Source Area is located in the Savanna Biome on an elevated plateau surrounded by deep, thickly wooded valleys. The vegetation is dominated by *Vachellia* and *Combretum* species and supports *Vachellia* woodlands, *Combretum* woodlands, mixed woodlands, *Vachellia* degraded woodland, small forest patches, small streams, grassland patches, a few subsistence agricultural areas and a few small dwellings.

In the Namaacha region, the forest extends over the Lebombo mountain range, especially in deeper valleys and along south-eastern slopes. The canopy varies in height between 10 m and 35 m. Although the composition of the tree species varies, it is dominated by *Chrysophyllum viridifolium*, *Homalium dentatum*, *Combretum kraussii* and several species of *Ficus* spp, *Celtis* spp and *Strychnos* spp. The tall open canopy bushes include *Buxus natalensis*, *Englerophytum natal* and *Rothmannia globose.*

Namaacha has a sub-tropical climate. The district's yearly average temperature is 26°C, with an average daily summer temperature of around 32°C, and average winter daily temperatures of around 23°C. Namaacha typically receives about 837 millimetres of annual precipitation and has 120.04 rainy days (32.89%) annually (https://tcktcktck.org/mozambique/maputo/namaacha). The primary land-use in the area is live-stock grazing.

According to International Finance Corporation (IFC) Performance Standard 6 (PS6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources) (IFC, 2012) habitats can be classified as described below:

- **Natural Habitats** are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition.
- **Modified Habitats** are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition.
- **Critical Habitat** Critical habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes.

The main human activities in the area that cause the modification of habitats are human settlements in the form of isolated houses built predominantly using local materials (poles, rocks/stones and thatching grass), cultivated areas for subsistence farming covering areas <0,5 hectares and livestock grazing.

CEAGRE (2015) produced a habitat classification for Mozambique that defines a Mixed Habitat category, which lies between Natural and Modified habitats:

- **Mixed Habitat** consists of a mosaic composed of natural areas, small, cultivated areas and isolated villages / houses.

In general, Modified Habitats are considered to be less sensitive to additional disturbance, since these habitats have already lost their natural structure and integrity, thus containing a lower biodiversity value and a lower conservation value. Natural Habitats are considered to be highly sensitive to habitat loss and degradation, because they retain their natural structure and their biodiversity is still largely intact in terms of the representation of natural species (albeit with a reduction in the abundance of large mammals), thus these areas are vulnerable to the increase of human disturbance.

The CEAGRE (2015) habitat classification of the Source Area is illustrated in **Figure 2**. The Source Area falls within natural habitat (as classified by CEAGRE, 2015).

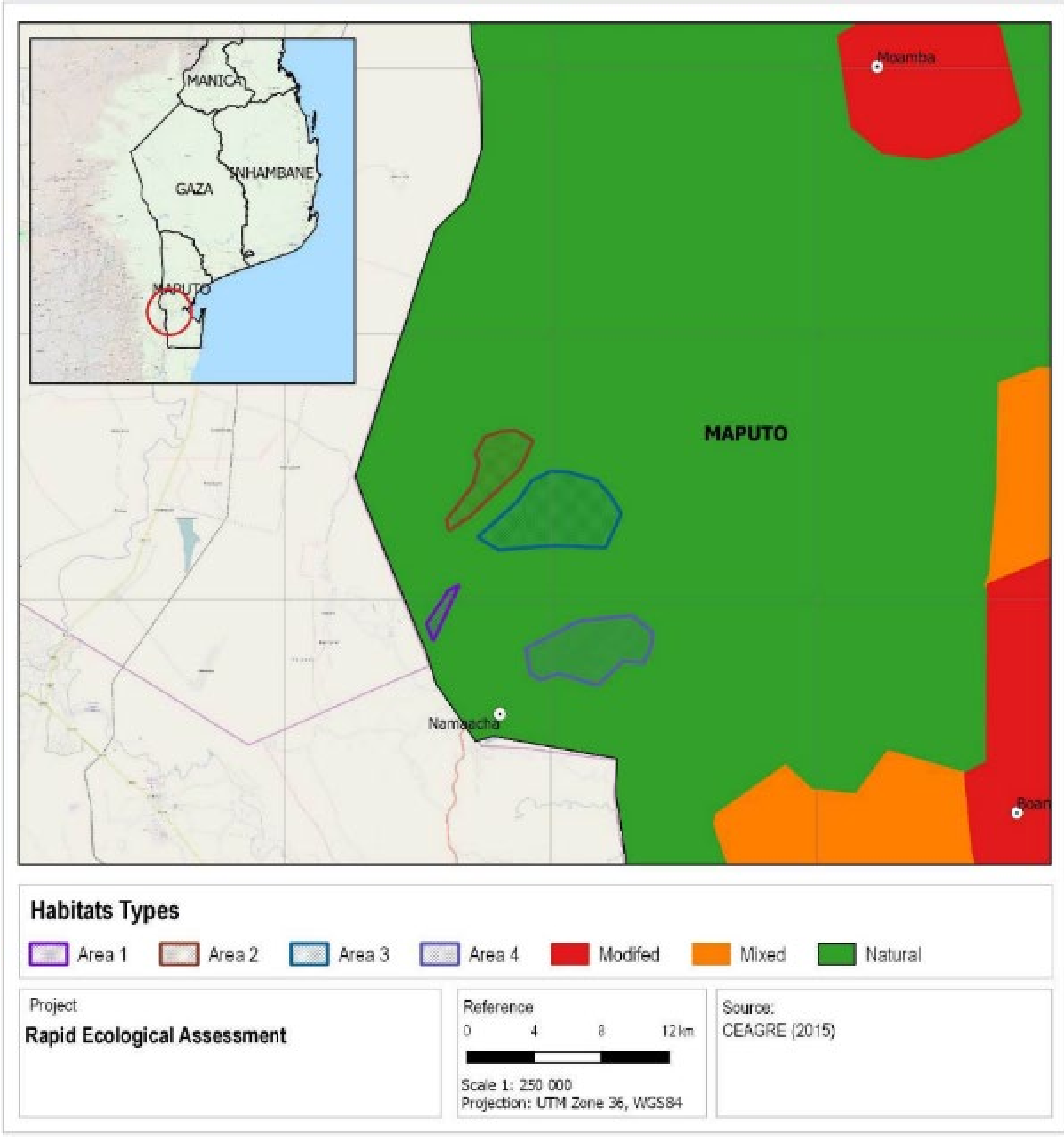


Figure 2: Habitat categories in the Namaacha Source Area. Information sourced from the June 2017 Rapid Ecological Assessment Report.

5 Priority Species

Priority species are defined as threatened or rare birds (in particular those unique to the region and especially those which are considered to be more susceptible to wind-energy impacts), which occur in the given development area at relatively high densities or have high levels of activity in the area. These species should be the primary (but not the sole) focus of all subsequent monitoring and assessment.

Priority species for wind developments were also identified from the most recent (November 2014) list of priority species for wind farms compiled for the Avian Wind Farm Sensitivity Map (Retief et al. 2012) in neighbouring South Africa. The global threatened status of all priority species was determined by consulting the latest IUCN Red List of Threatened Species (2022.2) (http://www.iucnredlist.org/). The list of Priority species identified for this Project and confirmed on site during preconstruction monitoring surveys is provided in **Table 4**. Note that species that are Endangered, Critically Endangered or that are range restricted can also trigger critical habitat classification as defined under PIFC's Performance Standard 6.

Table 4: Priority species recorded during preconstruction monitoring surveys.

Common Name	**Scientific Name**	**IUCN Classification**
White-backed Vulture	Gyps africanus	**CR**
Bateleur	*Terathopius ecaudatus*	**EN**
Martial Eagle	*Polemaetus bellicosus*	**EN**
African Harrier-Hawk	*Polyboroides typus*	LC
African Hawk-Eagle	*Aquila spilogaster*	LC
Black Stork	*Ciconia nigra*	LC
Black-bellied Bustard (Korhaan)	*Lissotis melanogaster*	LC
Black-chested Snake Eagle	*Circaetus pectoralis*	LC
Black-winged Kite	*Elanus caeruleus*	LC
Brown Snake Eagle	*Circaetus cinereus*	LC
Common Buzzard	*Buteo buteo*	LC
Jackal Buzzard*	*Buteo rufofuscus*	LC
Lanner Falcon	*Falco biarmicus*	LC
Peregrine Falcon	*Falco peregrinus*	LC
Shelley's Francolin	*Scleroptila shelleyi*	LC
Short-tailed Pipit	*Anthus brachyurus*	LC
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC
Crowned Eagle	*Stephanoaetus coronatus*	NT

* Endemic species to Southern Africa

5.1 Habitat Preferences of Red List Species

The habitat preferences of the Red List species that have been recorded during the study are discussed below.

- **Bateleur**

Bateleur eagles prefer open woodland and tree savanna, extending into bush savanna but less into scrubby steppe and grassland. They are occasionally recorded over forest and wetlands, but only while travelling between suitable areas of habitat (Hockey et al. 2005). They are found from sea-level to 4500 m, but mainly below 3000 m (Ferguson-Lees & Christie 2001).

- **Martial Eagle**

Martial Eagles prefer sparse woodlands and woodland edges and other open habitats such as deserts, steppes, savannas, grasslands and shrublands (Hockey et al. 2005). They generally avoid settled areas. They occur mostly below 1500 m elevation, occasionally up to 3000 m (Ferguson-Lees & Christie 2001).

- **Black Stork**

Generally, Black Storks prefer undisturbed open woodland, foraging in streams, pools, marshes, riverbanks, occasionally grasslands, normally avoiding large bodies of water and closed forest (Hancock et al. 2010). Black Storks usually avoid humans when nesting. In sub-Saharan Africa they are associated with rocky habitats and watercourses that traverse these areas. Black Storks are not usually found in extensive open areas, especially when nesting. However, flocks of migrating birds may be encountered in open marshland (Hancock et al. 2010).

- **Crowned Eagle**

Crowned Eagles prefer forest and dense woodland, from extensive lowland rainforest to small patches of montane and riverine forest, and even stands of mature exotic plantations, e.g. eucalypts in South Africa (Ferguson-Lees & Christie 2001). In north-eastern South Africa there is a preference for nesting in the Northern Mistbelt Forest vegetation type and a study found 82% of nests (n = 28) located in indigenous trees (Swatridge et al. 2014). There is also a record from Zimbabwe of pair nesting in a large gum tree in a garden of a homestead for 10+ years (O'Donoghue 2002). When foraging, Crowned Eagles move into surrounding secondary forest or dry savanna where necessary. They have been recorded from sea-level to at least 3300 m asl (Ash & Atkins 2009).

- **White-backed Vulture**

In southern Africa, White-backed Vultures are locally common across the northern half of the region, extending into the savanna and grassland of South Africa. They generally prefer arid savanna with scattered trees, such as Mopane *Colosphermum mopane*, avoiding dense forests, deserts, treeless grassland and shrubland (Hockey et al. 2005).

6 Results

The aggregated results of the surveys are presented in Tables 4 to 5 and Figures 3 to 4. Figures 3 to 4 present the transect count data of priority species for the Source Area and the Control Site, presented as an Index of Kilometric Abundance (IKA = number of bird observations/km).

6.1 Transects

Table 5: The results of the transect counts.

Source Area					
Species composition	**Survey 1**	**Survey 2**	**Survey 3**	**Survey 4**	**Grand Total**
Priority Species	10	10	6	9	17
Non-Priority Species	90	73	85	80	140
Total	**100**	**83**	**91**	**89**	**157**
Individual records					**Grand Total**
Drive transect sightings	1017	560	517	490	2584
Walk transect sightings	802	594	667	569	2632
Total	**1819**	**1154**	**1184**	**1059**	**5216**
Control Site					

Species composition	Survey 1	Survey 2	Survey 3	Survey 4	Grand Total
Priority Species	7	5	6	4	12
Non-Priority Species	104	98	105	85	151
Total	**111**	**103**	**111**	**89**	**163**
Individual records					**Grand Total**
Drive transects	872	654	649	439	2614
Walk transects	745	789	791	535	2860
Total	**1617**	**1443**	**1440**	**974**	**5474**

Table 6: Priority species abundance recorded within the Source Area - Transects

Common Name	Scientific Name	IUCN Classification	Survey 1	Survey 2	Survey 3	Survey 4	Grand Total
African Harrier-Hawk	*Polyboroides typus*	LC	-	2	-	-	2
African Hawk-Eagle	*Aquila spilogaster*	LC	-	4	-	2	6
Bateleur	*Terathopius ecaudatus*	**EN**	-	-	1	1	2
Black Stork	*Ciconia nigra*	LC	-	-	-	5	5
Black-bellied Bustard (Korhaan)	*Lissotis melanogaster*	LC	4	2	-	1	7
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	2	2	2	-	6
Black-winged Kite	*Elanus caeruleus*	LC	-	-	-	3	3
Brown Snake Eagle	*Circaetus cinereus*	LC	2	4	6	3	15
Common Buzzard	*Buteo buteo*	LC	12	1	-	-	13
Crowned Eagle	*Stephanoaetus coronatus*	NT	3	-	-	-	3
Jackal Buzzard	*Buteo rufofuscus*	LC	2	3	-	2	7
Lanner Falcon	*Falco biarmicus*	LC	-	2	-	-	2
Martial Eagle	*Polemaetus bellicosus*	**EN**	1	-	2	2	5
Peregrine Falcon	*Falco peregrinus*	LC	-	-	1	-	1
Shelley's Francolin	*Scleroptila shelleyi*	LC	3	2	5	9	19
Short-tailed Pipit	*Anthus brachyurus*	LC	1	-	-	-	1
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	9	2	-	-	11

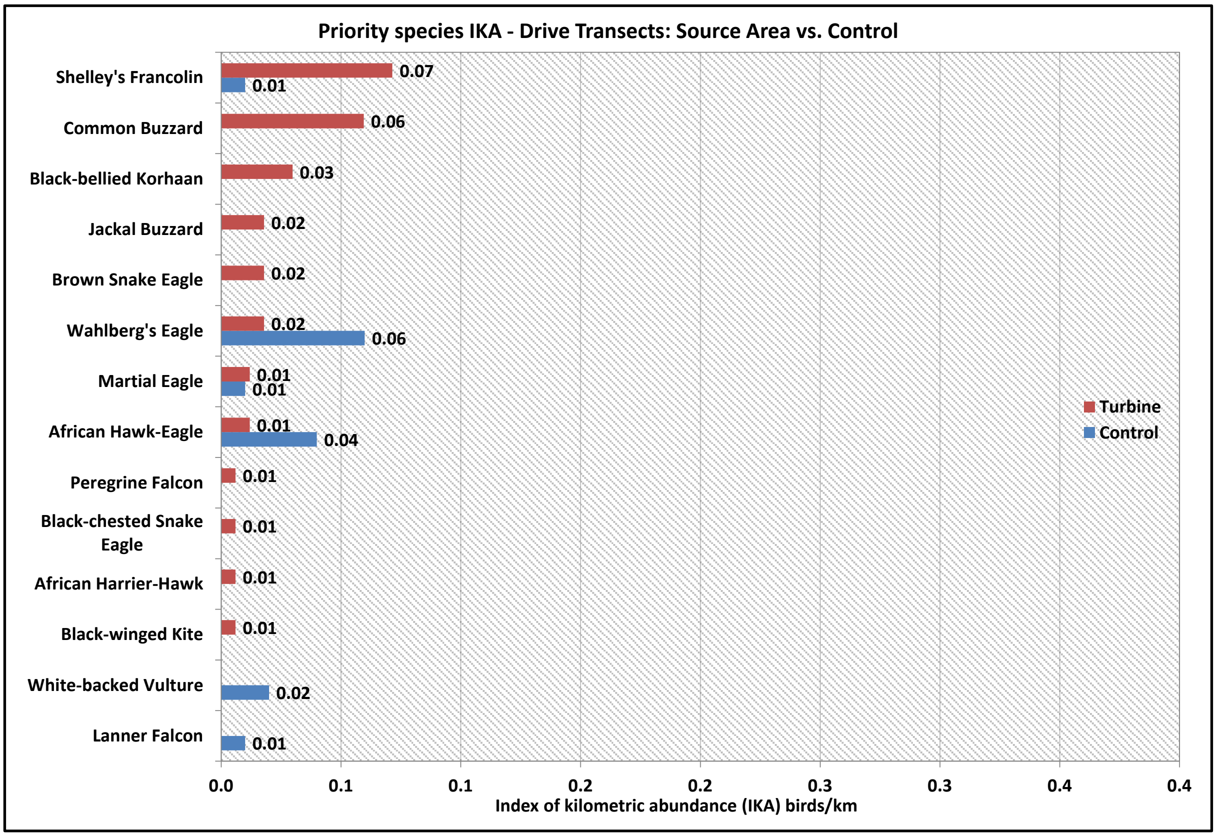


Figure 3: IKA for drive transect wind priority species at the Source Area vs. Control Site after four surveys.

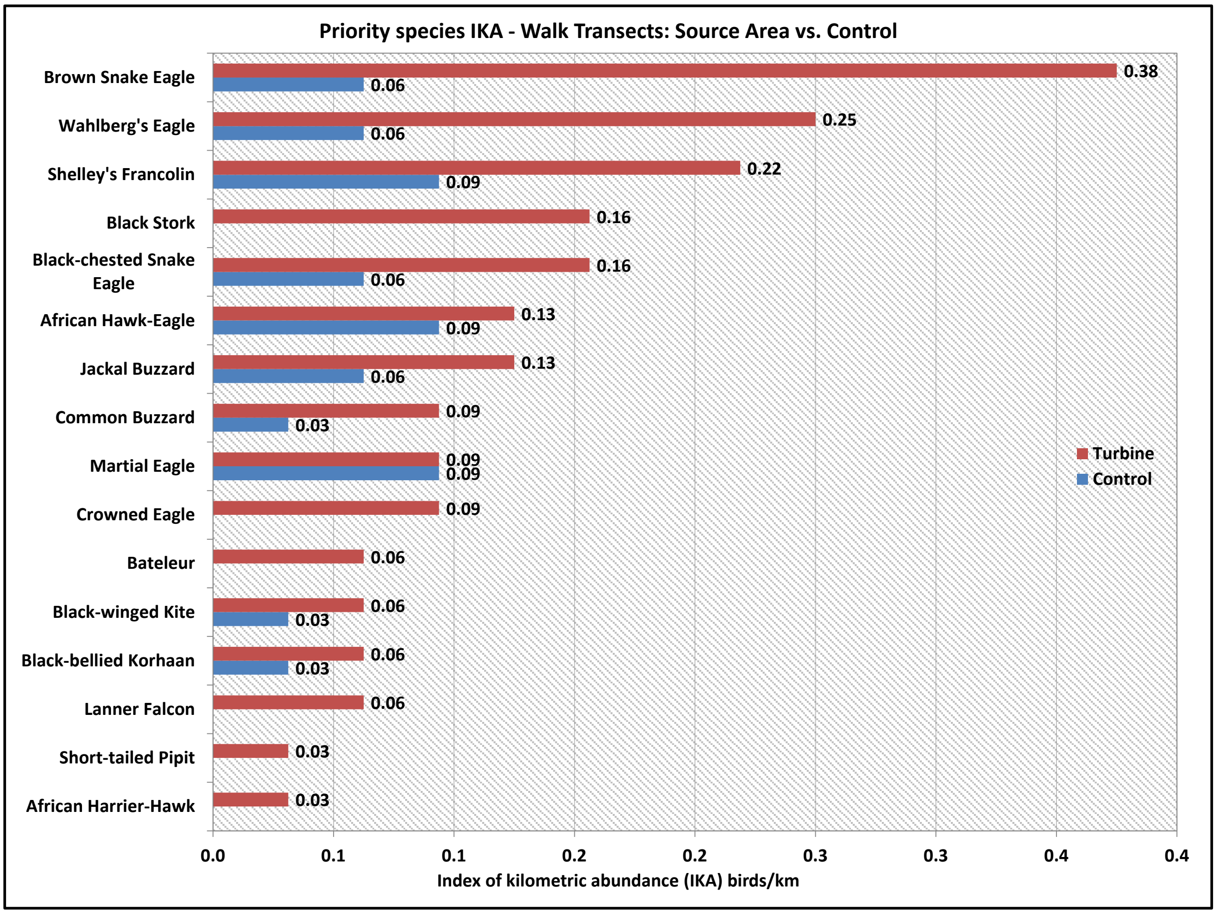


Figure 4: IKA for walk transects wind priority species at the Source Area vs. Control Site after four surveys.

6.2 Incidental Counts

The following priority species were recorded as incidental records (between formal surveys) while travelling on and in the immediate vicinity of the Source Area and Control Site. Incidental records provide additional information on the species present in the area.

Table 7: Priority species recorded as incidental records on or near the Source Area and Control Site

Priority Species (Incidentals)		IUCN Status	S1	S2	S3	S4	Grand Total
Control Site							
African Harrier-Hawk	*Polyboroides typus*	LC	1	0	2	0	**3**
Black-bellied Korhaan	*Lissotis melanogaster*	LC	1	1	0	0	**2**
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	1	0	0	0	**1**
Black-winged Kite	*Elanus caeruleus*	LC	1	0	0	0	**1**
Jackal Buzzard	*Buteo rufofuscus*	LC	2	0	0	0	**2**
Spotted Eagle-Owl	*Bubo africanus*	LC	0	2	0	0	**2**
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	5	0	0	0	**5**
Source Area							
African Fish Eagle	*Haliaeetus vocifer*	LC	0	0	0	1	**1**
African Harrier-Hawk	*Polyboroides typus*	LC	2	0	0	0	**2**
Black-bellied Korhaan	*Lissotis melanogaster*	LC	3	0	0	0	**3**
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	2	1	0	0	**3**
Brown Snake Eagle	*Circaetus cinereus*	LC	3	0	1	1	**5**
Common Buzzard	*Buteo buteo*	LC	12	0	0	0	**12**
Crowned Eagle	*Stephanoaetus coronatus*	NT	0	0	0	1	**1**
Jackal Buzzard	*Buteo rufofuscus*	LC	0	1	0	0	**1**
Lanner Falcon	*Falco biarmicus*	LC	2	0	0	0	**2**
Spotted Eagle-Owl	*Bubo africanus*	LC	0	2	2	1	**5**
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	4	0	0	0	**4**
White-backed Vulture	*Gyps africanus*	**CR**	2	0	0	0	**2**
Woolly-necked Stork	*Ciconia episcopus*	LC	1	0	0	0	**1**

6.3 Vantage Points

Please see summary of flight data obtained after four surveys at the Source Area and Control Site below and in Figures 4 and 5.

Table 8: Summary of flight data i.e., time spent by priority species at each altitude band during the four surveys at the Source Area – 96 hours of observation. Time is indicated in hours (HH) minutes (MM) and seconds (SS).

Priority Species	Low altitude (<30m)	Medium altitude (30m – 300m)	High altitude (>300m)	Total
Survey 1 - Spring				
African Harrier-Hawk		0:26:20		0:26:20
Black Stork		0:39:07		0:39:07
Black-Bellied Bustard	0:00:24			0:00:24
Black-Chested Snake Eagle	0:00:09	7:57:03		7:57:12
Brown Snake Eagle	0:00:09	0:00:08		0:00:17
Common Buzzard	0:00:05	5:06:21		5:06:26
Crowned Eagle		1:36:46		1:36:46
Jackal Buzzard		1:00:14		1:00:14
Lanner Falcon		0:11:09		0:11:09
Wahlberg's Eagle	0:01:39	7:26:59	0:09:46	7:38:24
Survey 2 - Summer				
African Harrier-Hawk	0:01:03	0:00:15		0:01:18
African Hawk-Eagle	0:38:20	1:30:32		2:08:52
Bateleur (EN)		0:43:42		0:43:42
Black-Chested Snake Eagle		11:57:58		11:57:58
Brown Snake Eagle		3:10:36		3:10:36
Common Buzzard		0:16:32		0:16:32
Jackal Buzzard		2:50:44		2:50:44
Lanner Falcon		0:04:30		0:04:30
Wahlberg's Eagle		3:40:52		3:40:52
Woolly-necked Stork		0:06:55	0:03:17	0:10:12
Survey 3 - Autumn				
African Harrier-Hawk	0:00:06			0:00:06
Bateleur (EN)		0:06:08		0:06:08
Black-Chested Snake Eagle		3:56:12		3:56:12
Brown Snake Eagle		13:30:54		13:30:54
Crowned Eagle		0:11:38		0:11:38
Jackal Buzzard		0:06:46		0:06:46
Martial Eagle (EN)		2:29:20	0:08:08	2:37:28
Wahlberg's Eagle		0:09:29		0:09:29
Survey 4 - Winter				
African Harrier-Hawk	0:01:08	0:07:26		0:08:34
African Hawk-Eagle		0:52:40		0:52:40
Bateleur (EN)		0:20:27		0:20:27
Black Stork		2:00:12		2:00:12

Black-Chested Snake Eagle		0:19:58		0:19:58
Black-winged Kite	0:04:04	0:19:26		0:23:30
Brown Snake Eagle		3:50:33		3:50:33
Jackal Buzzard		0:20:08		0:20:08
Lanner Falcon		0:03:11		0:03:11
Martial Eagle (EN)		1:32:13		1:32:13
Total	**0:47:07**	**79:03:24**	**0:21:11**	**80:11:42**

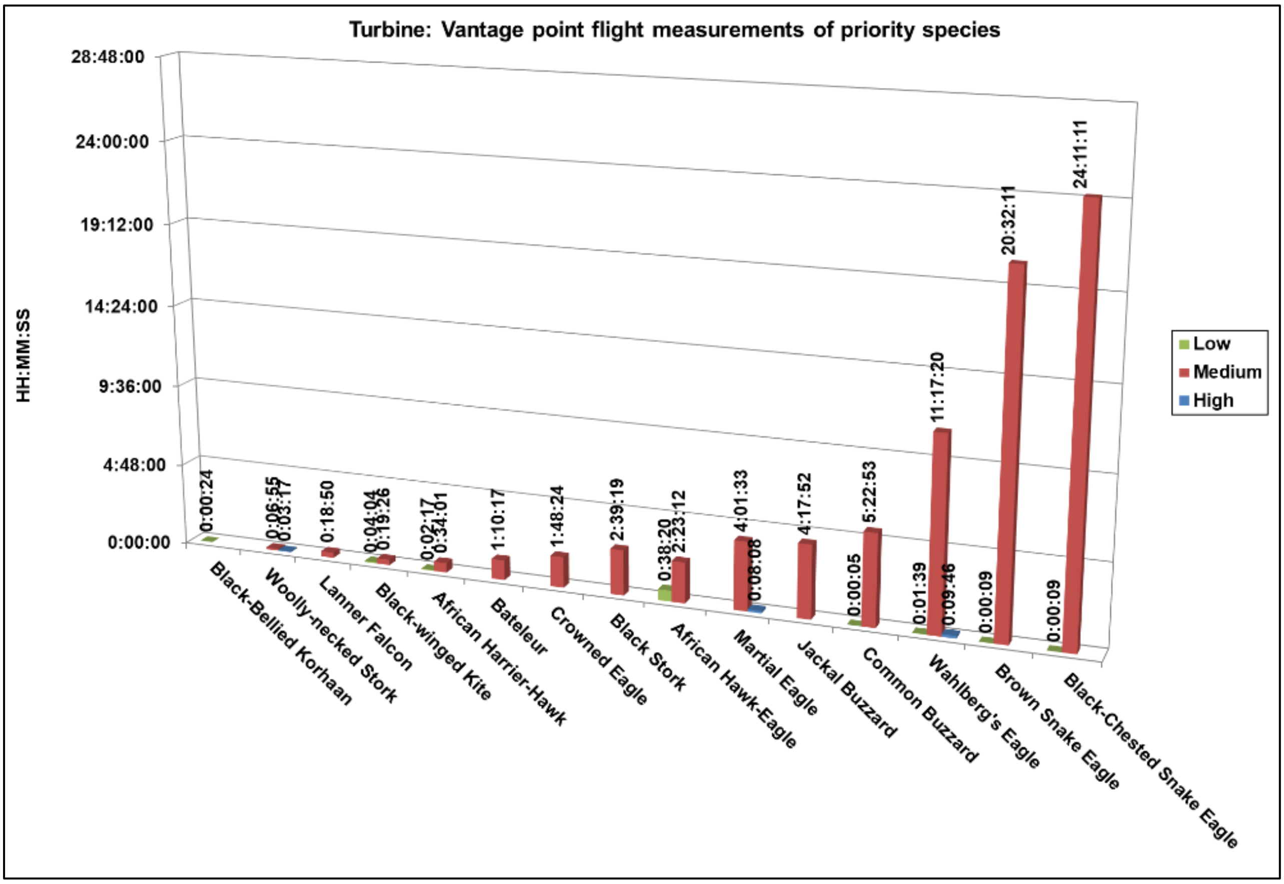


Figure 5: Flight time and altitude recorded for all individuals of priority species after four surveys at the Source Area (96 hours of observation). Time is indicated in hours: minutes: seconds. Flight altitude is indicated as low (green/<30m), red/medium/30 – 300m, blue/high/>300m).

Table 9: Summary of flight data i.e. time spent by priority species at each altitude band during four surveys at the Control Site – 48 hours of observation. Time is indicated in hours (HH) minutes (MM) and seconds (SS).

Priority species	Low altitude (<30m) HH:MM:SS	Medium altitude (30m – 300m) HH:MM:SS	High altitude (>300m) HH:MM:SS	Total HH:MM:SS
Survey 1 - Spring				
African Harrier-Hawk	0:00:05	0:06:48		0:06:53
Black-Chested Snake Eagle		0:35:00		0:35:00
Brown Snake Eagle	0:00:31	0:16:03		0:16:34
Common Buzzard	0:00:43	0:06:35		0:07:18
Jackal Buzzard		0:08:41		0:08:41

Martial Eagle (EN)		0:00:30		0:00:30
Wahlberg's Eagle		1:34:47	0:04:06	1:38:53
Survey 2 - Summer				
African Harrier-Hawk	0:03:12	0:17:47	-	0:20:59
African Hawk-Eagle	-	0:01:48	-	0:01:48
Black Stork	-	0:13:40	0:23:04	0:36:44
Black-Chested Snake Eagle	-	0:41:46	-	0:41:46
Black-winged Kite	-	0:10:23	-	0:10:23
Brown Snake Eagle	0:00:31	0:29:28	-	0:29:59
Common Buzzard	0:00:43	0:06:35		0:07:18
Jackal Buzzard	-	0:19:06	-	0:19:06
Martial Eagle (EN)	-	2:41:04	0:12:14	2:53:18
Wahlberg's Eagle	0:00:27	2:38:21	0:04:06	2:42:54
Survey 3 - Autumn				
African Harrier-Hawk		0:02:52		0:02:52
Bateleur (EN)		0:29:00		0:29:00
Black Stork		0:05:42		0:05:42
Black-Chested Snake Eagle		0:16:44		0:16:44
Black-winged Kite		0:04:43		0:04:43
Brown Snake Eagle		0:18:02		0:18:02
Common Buzzard		0:02:59		0:02:59
Jackal Buzzard		0:53:51		0:53:51
White-backed Vulture (CR)		0:29:32	0:04:14	0:33:46
Survey 4 - Winter				
African Fish Eagle		0:13:10		0:13:10
African Hawk-Eagle		0:34:32		0:34:32
Bateleur (EN)		1:19:35		1:19:35
Black Stork		0:01:48		0:01:48
Black-Chested Snake Eagle		0:54:16		0:54:16
Brown Snake Eagle		3:29:46		3:29:46
Lanner Falcon		0:16:30		0:16:30
Martial Eagle (EN)		1:07:58		1:07:58
White-backed Vulture (CR)		0:41:48		0:41:48
Total	**0:04:53**	**19:02:46**	**0:43:38**	**19:51:17**

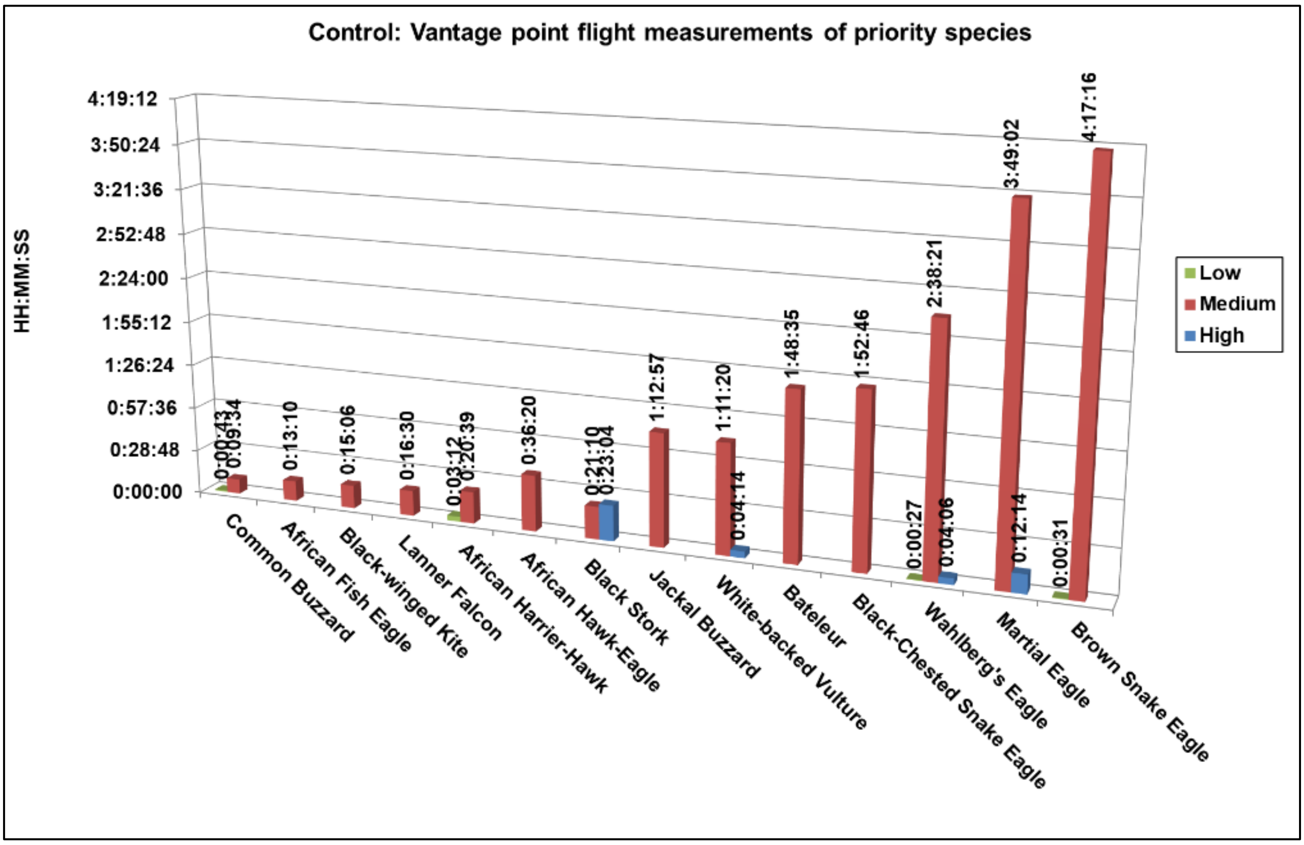


Figure 6: Flight time and altitude recorded for all individuals of priority species after four surveys at the Control Area (48 hours of observation). Time is indicated in hours: minutes: seconds. Flight altitude is indicated as low (green/<30m), red/medium/30 – 300m, blue/high/>300m).

Figure 7 displays the flight lines of Red Listed priority species recorded from the Source Area vantage points. The flight lines of all the priority species at the Source Area and Control Site are displayed in **Appendix B** and **Appendix C**.

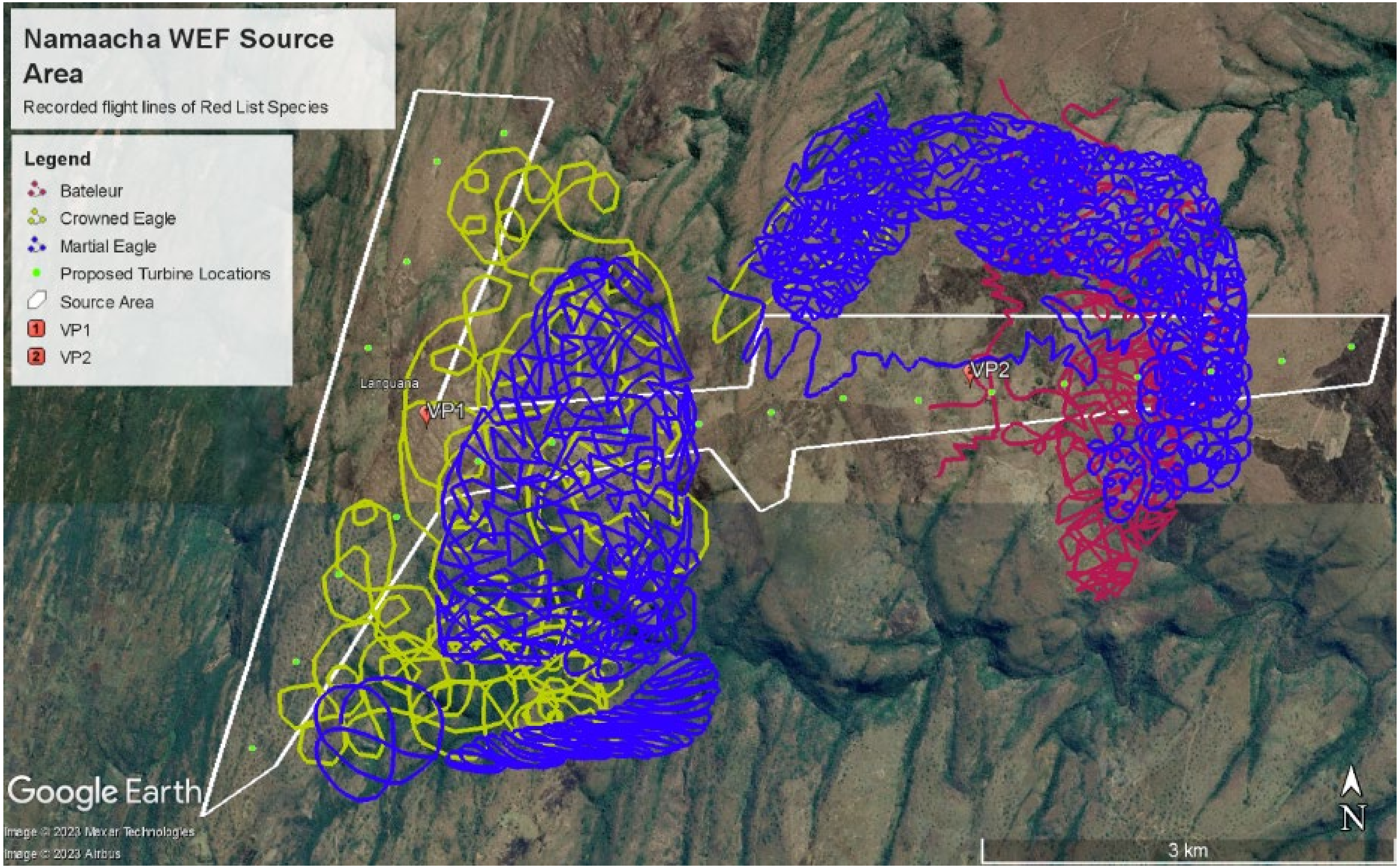


Figure 7: The flight lines of Red List species recorded after four surveys at the Source Area.

7 Discussion of Results

7.1 Overview

The Source Area is evidently good habitat for raptors in particular, with 16 species recorded during the surveys. The variety is significant for such a small site, with three Red List species recorded at the Source Area itself, i.e. Crowned Eagle (NT) Martial Eagle (EN), and Bateleur (EN). Based on the flight data recorded during the surveys, all the Red List raptor species are at risk of collisions with wind turbines. Crowned Eagle and Martial Eagle presumably breed close to the Source Area as is evident from territorial display flights.

The Source Area experienced high flight activity of priority species, particularly raptors, over the survey periods. Based on observed trends in extensive pre-construction bird monitoring data gathered for numerous WEF IA in southern Africa we would suggest the following classification for passage rates at the Source Area as a whole within a southern African context: 1 < bird/hour = low, 1 – 2 birds per hour = moderate, 2 > birds/hour = high. Based on this classification, the passage rate for priority species would fall within the **high** category.

The passage rate for priority species at the Source Area after four surveys is high at 2.26 birds per hour or approximately 29 birds per day[1]. The passage rate for Red List species at the Source Area after four surveys was 0.23 birds per hour, or approximately three birds per day, which is low, but does point to a constant presence.

Most of the recorded flights were at medium altitude (i.e., within the rotor swept area of wind turbines).

Table 9 lists the Red List species that have been recorded to date. A consolidated list of all recorded species is attached as **Appendix A.**

[1] Assuming 13 hours of daylight averaged over all four seasons.

Table 10: Sightings of priority species recorded

Common Name	Scientific Name	IUCN Classification	Source Area												Control Area											
			Transect				Vantage Point				Incidental				Transect				Vantage Point				Incidental			
			Survey 1	Survey 2	Survey 3	Survey 4	Survey 1	Survey 2	Survey 3	Survey 4	Survey 1	Survey 2	Survey 3	Survey 4	Survey 1	Survey 2	Survey 3	Survey 4	Survey 1	Survey 2	Survey 3	Survey 4	Survey 1	Survey 2	Survey 3	Survey 4
African Fish Eagle	*Haliaeetus vocifer*	LC	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
African Harrier-Hawk	*Polyboroides typus*	LC	0	2	0	0	6	4	1	4	2	0	0	0	0	0	0	0	6	3	1	0	1	0	2	0
African Hawk-Eagle	*Aquila spilogaster*	LC	0	4	0	2	0	16	0	4	0	0	0	0	2	0	2	3	0	1	0	6	0	0	0	0
Bateleur	*Terathopius ecaudatus*	**EN**	0	0	1	1	0	3	1	2	0	0	0	0	0	0	0	0	0	0	5	8	0	0	0	0
Black Stork*	*Ciconia nigra*	LC	0	0	0	5	6	0	0	13	0	0	0	0	2	0	0	0	0	6	3	1	0	0	0	0
Black-bellied Korhaan	*Lissotis melanogaster*	LC	4	2	0	1	2	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	2	2	2	0	22	10	6	3	2	1	0	0	0	1	1	0	3	1	3	4	1	0	0	0
Black-winged Kite	*Elanus caeruleus*	LC	0	0	0	3	0	0	0	7	0	0	0	0	0	0	1	0	0	2	1	0	1	0	0	0
Brown Snake Eagle	*Circaetus cinereus*	LC	2	4	6	3	2	10	10	18	3	0	1	1	0	0	1	1	6	1	3	12	0	0	0	0
Common Buzzard	*Buteo buteo*	LC	12	1	0	0	24	3	0	0	12	0	0	0	1	0	0	0	4	0	1	0	0	0	0	0
Crowned Eagle	*Stephanoaetus coronatus*	NT	3	0	0	0	4	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Jackal Buzzard	*Buteo rufofuscus*	LC	2	3	0	2	5	14	2	5	0	1	0	0	1	0	1	0	4	4	5	0	2	0	0	0
Lanner Falcon	*Falco biarmicus*	LC	0	2	0	0	3	1	0	1	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Martial Eagle	*Polemaetus bellicosus*	**EN**	1	0	2	2	0	0	5	10	0	0	0	0	1	2	0	1	1	12	0	5	0	0	0	0
Peregrine Falcon	*Falco peregrinus*	LC	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shelley's Francolin	*Scleroptila shelleyi*	LC	3	2	5	9	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0
Short-tailed Pipit	*Anthus brachyurus*	LC	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spotted Eagle-Owl	*Bubo africanus*	LC	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0	2	0	0
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	9	2	0	0	50	16	2	0	4	0	0	0	6	2	0	0	13	6	0	0	5	0	0	0
White-Backed Vulture	*Gyps africanus*	**CR**	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0
Woolly-Necked Stork	*Ciconia episcopus*	LC	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*See Section 7.6

7.2 Crowned Eagle (Global Status: Near Threatened)

- Crowned Eagles were recorded during transect counts and vantage point watches during Survey 1, indicating a regular presence at the Source Area.
- Crowned Eagles were also recorded on four occasions flying over the Source Area during Survey 1. They are most likely the same pair of birds breeding in one of the deep wooded valleys below the plateau (refer to **Figure 8**).
- Crowned Eagles were not observed over the Source Area during Survey 2.
- The passage rate for Crowned Eagle at the Source Area after four surveys was 0.05 birds/hour or approximately one bird every 1,5 days. All recorded flights at the Source Area were at medium altitude (within the rotor swept area).
- The passage rate alludes to the regular presence of this species in and near the Source Area.

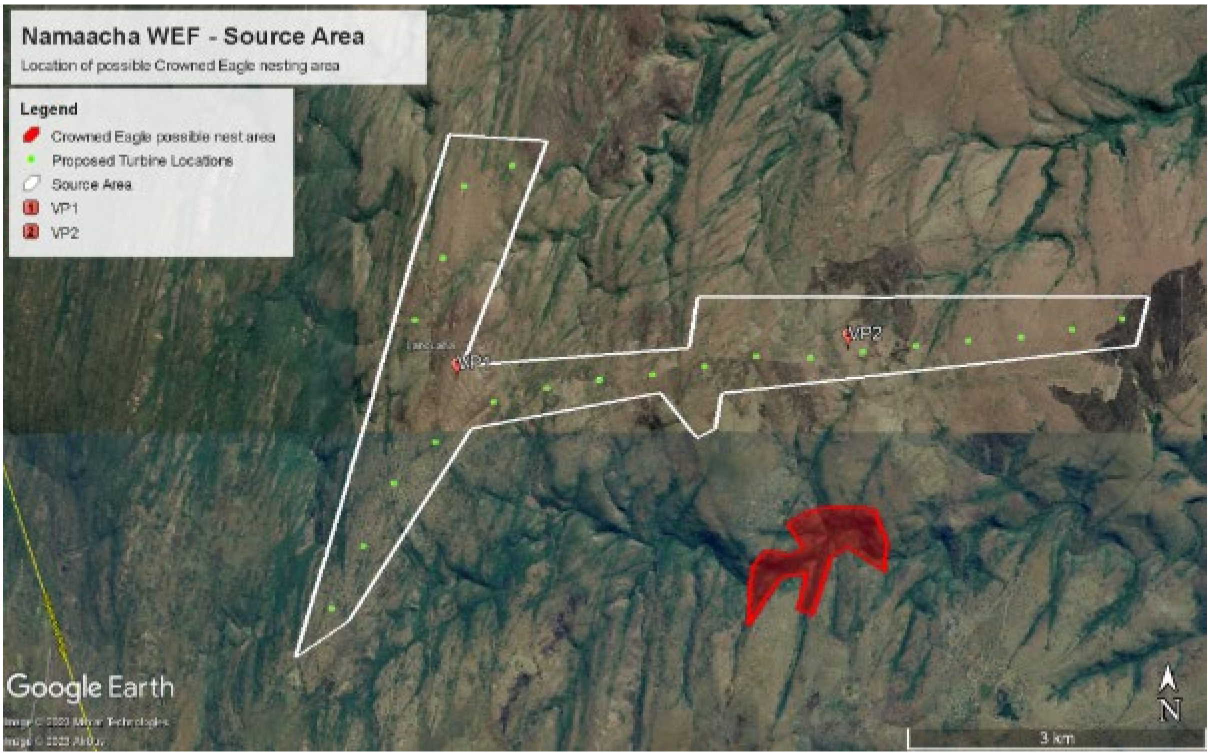


Figure 8: Possible nesting area of Crowned Eagle (red polygon).

7.3 Martial Eagle (Global Status: Endangered)

- One Martial Eagle was recorded during drive transects at the Source Area during Survey 1.
- Several flights were recorded at the Control Site vantage point and one adult bird was recorded during the Control Site transect during each of the surveys.
- During Survey 2, a single adult bird was observed soaring above the Control Site for a total of 22 minutes, and then started a long purposeful glide east towards a rugged area with several deep ravines and large trees approximately 5km north of the Source Area. During Survey 3, two adult birds and a juvenile were observed flying over the Source Area for 2 hours and 30 min. Further display flight behaviour was observed over and just north of the source area during Survey 4 for 1 hour and 32 min. This behaviour and observations indicate a high probability of a nest somewhere in densely wooded valleys just north of the Source area (see **Figure 9** for more detail).

- After four surveys, the passage rate for Martial Eagle at the Source Area was 0.10 birds/hour or at least one bird per day. The passage rate at the Control Site after four surveys was 0.13 birds/hour or at least one bird per day.
- Most recorded flights at the Source Area were at medium altitude (within the rotor swept area), but there was also one limited recorded flight at high altitude.

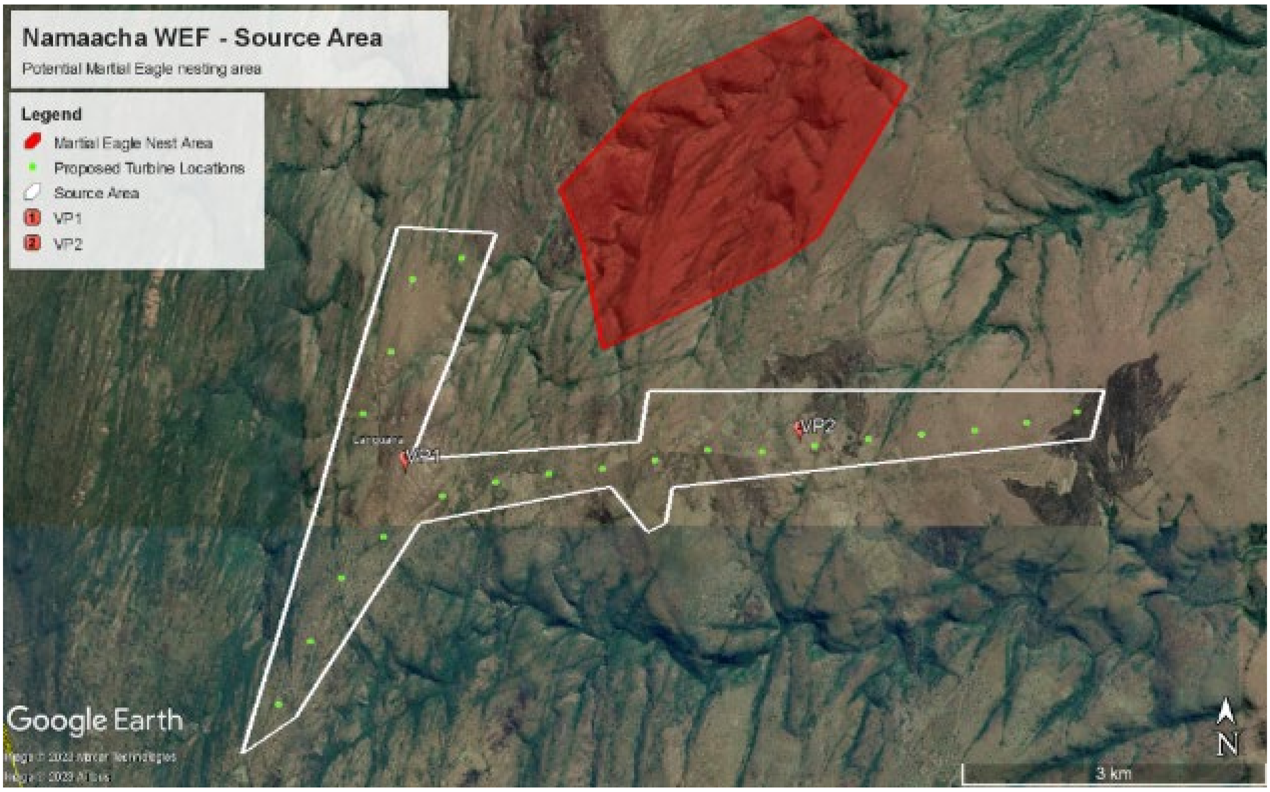


Figure 9: Potential Martial Eagle nesting area (red polygon).

7.4 White-backed Vulture (Global status: Critically Endangered)

- Two individuals were incidentally recorded flying over the Source Area to the west of Vantage Point 1 during Survey 1. The closest White-backed Vulture colonies are located in eSwatini approximately 30 – 35km away.
- The passage rate for White-backed Vulture at the Control Site after four surveys was 0.17 birds/hour or approximately two birds per day.
- The lack of vulture records at the Source Area may be due to a lack of foraging opportunities. Existing data indicates that the eSwatini birds forage almost exclusively to the north in the Kruger National Park and to the south in northern KwaZulu-Natal flying parallel to the Lebombo Mountains in a north-south/south-north flyway, which does not route them over the Source Area.
- Several herds of cattle were regularly observed at and near to the Source Area. On average herds contained about 20 animals. In the event of livestock mortalities (if carcasses are not removed immediately by the herdsman) vultures may be attracted to the Source Area to feed.

7.5 Bateleur (Global status: Endangered)

- Three Bateleur sightings were recorded from vantage points over the Source Area during Survey 2. The total flight time for Bateleur was just over 43 minutes. No Bateleurs were observed over the Source Area or the Control Site during Survey 1. A single individual was observed over the Source Area for 6 min during Survey 3. Twenty minutes of flight activity were recorded during Survey 4.

- The passage rate for this species at the Source Area after four surveys was 0.06 birds/hour or approximately one bird every 1,2 days.
- All recorded flights at the Source Area were at medium altitude (within the rotor swept area).
- Two Bateleurs were recorded during the transect counts after four surveys at the Source Area.

7.6 Black Stork (Global status: Least Concern)

- Although Black Storks are currently listed as Least Concern globally by the IUCN red list, populations in the southern African region shows a concerning decline (Lee et al. 2023) and its status could be revised in the near future.
- Black Storks were recorded over the Source Area during Survey 1 for 39 min and for 2 hours during Survey 4.
- The passage rate for Black Stork at the Source Area after four surveys was 0.14 birds/hour or almost two birds per day (1.82 birds per day).
- All recorded flights at the Source Area were at medium altitude (within the rotor swept area).
- The passage rate for Black Stork at the Control Site after four surveys was 0.13 birds/hour or almost two birds per day (1.69 birds per day).
- Five Black Storks were recorded during the transect counts at the Source Area during Survey 4.

8 Recommendations

During the monitoring at the Source Area, an exceptional abundance of priority species flights was recorded, which indicates a high likelihood of turbine collisions. The presence of Red Listed raptors, namely Martial Eagle and Crowned Eagle and the suspected breeding of both species in close proximity to the Source Area, are of particular concern. Numerous other priority species, especially raptors, were also recorded flying for extensive periods over the Source area within the rotor swept zone. This indicates that the proposed facility is likely to have a high negative impact on priority avifauna in the area as a result of potential turbine collision mortalities, unless stringent mitigation measures are implemented for the operational lifespan of the facility.

The following additional analysis and associated mitigation measures are required to reduce the negative effects of the facility:

1. Given the high intensity of flight activity at the Source Area, it is recommended that the aggregate flight activity of all the Red List raptors and the Black Stork at the Source Area is modelled to create a spatially explicit risk profile for the Source Area. The aim of the avian risk modelling will be to assess if any associations exist between observed high risk flight behaviour (i.e. flights within rotor sweep height) and underlying environmental and habitat conditions. A range of variables will be generated to characterise the environment within the Source Area. Subsequently, predictor variables will be generated related to various aspects of the topography, hydrology/drainage, vegetation (type and state). The processes to be used to characterise the underlying environment relates to topography, vegetation and hydrology and will follow the approaches used successfully in assessing habitat associations and suitability in previous avian studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c).

   The modelled output will indicate high usage areas for the Red List raptors and Black Stork that should be used to inform the turbine layout to avoid the areas on the site where the highest turbine collision risk prevails.

   The purpose of this modelling is to evaluate if the turbine layout can be optimised to avoid high risk flight areas and to also help design where curtailment measures may be required, and how often.

2. The flight risk modelling and spatial analysis should also include a Collision Risk Model (CRM). The CRM should be used to calculate fatality estimates for the all the Red List raptors and the Black Stork at the Source Area. Fatality estimates should be calculated for the following scenarios:

    a. Turbine layout without avoidance of high-risk flight areas derived by the modelled output in point 1 above.
    b. Optimised turbine layout avoiding high risk flight areas.
    c. Optimised turbine layout avoiding high risk flight areas plus Shut Down on Demand (SDoD) curtailment measures (note that automated, camera-based SDoD is the Project's current preference).
3. Blade Painting – All wind turbines must have one blade painted according to a local civil aviation authority approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase, but research indicates that it has a very good chance of reducing raptor mortalities, based on research conducted in Norway (see Simmons et al. 2021 (Appendix D) for an explanation of this mitigation method).
4. If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and relevant local conservation agencies, additional measures will have to be implemented.
5. Livestock carcass and prey-availability management programme:
    a. In the event of livestock deaths on, or in the immediate vicinity of the Source Area a carcass removal programme should be in place to locate and remove carcasses from the site immediately to prevent vultures from coming down to feed. Details of such a programme should be developed as part of the operational avifaunal management plan of the facility.
    b. Rock piles should be eliminated during construction, and infilling to construct roads should be compacted to avoid the creation of crevices and habitat for small mammals such as Rock Hyraxes *Procavia capensis* at the facility, that could potentially serve as a food source for birds of prey.
6. Live-bird monitoring and carcass searches should be implemented in the operational phase, as per international best practise standards at the time, for the lifespan of the facility.
7. An avifaunal specialist should be appointed to advise on the ongoing implementation and adaptive management of the avifaunal component of the operational programme at the facility.

9 References

- Ash, J. S., and J. Atkins (2009). Birds of Ethiopia and Eritrea: An Atlas of Distribution. Christopher Helm, London, UK.
- CEAGRN (2015). Mapeamento de Habitats de Moçambique. Centro de Estudos de Agricultura e Recursos Naturais. Maputo, Moçambique.
- Colyn R.B., Henderson, CL., Altwegg, R., Smit-Robinson, HA. (2020c). Habitat transformation and climate change: Implications for the distribution, population status and colony extinction of Southern Bald Ibis (Geronticus calvus) in southern Africa. *Condor: Ornithological Applications* 122: 1-17.
- Colyn, RB., Ehlers Smith, DA., Ehlers Smith YC., Smit-Robinson, HA., Downs, CT. (2020b). Predicted distributions of avian specialists: A framework for conservation of endangered forests under future climates. *Diversity and Distributions*, 1: 1-16.
- Colyn, RB., Whitecross, MA., Howes, CA., Smit-Robinson, HA. (2020a). Restricted breeding habitat of the Critically Endangered White winged Flufftail in Ethiopia and its conservation implications. *Ostrich* 91: 204-213.
- Ferguson-Lees, J., and D. A. Christie (2001). Raptors of the World. Christopher Helm, London, UK.
- Hancock, James; Kushlan, James A.; Kahl, M. Philip (2010). Storks, Ibises and Spoonbills of the World. London: Bloomsbury Publishing. pp. 70–74.

- Hockey PAR, Dean WRJ and Ryan PG (2005). Roberts - Birds of southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town
- Lee ATK, Whitecross MA, Smit-Robinson HA, Allan DG, van den Heever L, Jenkins A, Retief EF, Colyn RB, Tarboton W, Chetty K, Brink CW (2023). A review of the conservation status of Black Stork Ciconia nigra in South Africa, Lesotho, and Eswatini. *Bird Conservation International*, 33: e56, 1–15.
- O'Donoghue, F. (2002). Crowned Eagle breeds in garden. Honeyguide. 48(2): 249.
- Swatridge, C.J., Monadjem, A., Steyn, D.J., Batchelor, G.R. and Hardy, I.C.W. (2014). Factors affecting diet, habitat selection and breeding success of the African Crowned Eagle Stephanoaetus coronatus in a fragmented landscape. Ostrich. 85(1): 47–55.

APPENDIX A: Consolidated list of species recorded at the Namaacha WEF Source Area and Control Site after four surveys.

Priority Species	**Scientific Name**	**Transects Source Area**	**Transects Control**	**Vantage Points Source Area**	**Vantage Point Control**	**Incidentals Source Area**	**Incidentals Control**
African Fish Eagle	*Haliaeetus vocifer*				*	*	
African Harrier-Hawk	*Polyboroides typus*	*		*	*	*	*
African Hawk-Eagle	*Aquila spilogaster*	*	*	*	*		
Bateleur (EN)	*Terathopius ecaudatus*	*		*	*		
Black Stork	*Ciconia nigra*	*		*	*		
Black-bellied Korhaan	*Lissotis melanogaster*	*	*	*		*	*
Black-chested Snake Eagle	*Circaetus pectoralis*	*	*	*	*	*	*
Black-winged Kite	*Elanus caeruleus*	*	*	*	*		*
Brown Snake Eagle	*Circaetus cinereus*	*	*	*	*	*	
Common Buzzard	*Buteo buteo*	*	*	*	*	*	
Crowned Eagle (NT)	*Stephanoaetus coronatus*	*		*		*	
Jackal Buzzard	*Buteo rufofuscus*	*	*	*	*	*	*
Lanner Falcon	*Falco biarmicus*	*	*	*	*	*	
Martial Eagle (EN)	*Polemaetus bellicosus*	*	*	*	*		
Peregrine Falcon	*Falco peregrinus*	*					
Shelley's Francolin	*Scleroptila shelleyi*	*	*				
Short-tailed Pipit	*Anthus brachyurus*	*					
Spotted Eagle-Owl	*Bubo africanus*					*	*
Wahlberg's Eagle	*Hieraaetus wahlbergi*	*	*	*	*	*	*
White-backed Vulture (CR)	*Gyps africanus*		*		*	*	
Woolly-necked Stork	*Ciconia episcopus*			*		*	
Number of species: 21		**17**	**12**	**15**	**14**	**13**	**7**

Non-Priority Species	**Scientific Name**	**Transects turbine**	**Transects control**
Acacia Pied Barbet	*Tricholaema leucomelas*	*	*
African Cuckoo	*Cuculus gularis*		*
African Firefinch	*Lagonosticta rubricata*	*	*
African Golden Weaver	*Ploceus xanthops*	*	
African Goshawk	*Accipiter tachiro*		*
African Green Pigeon	*Treron calvus*	*	
African Hoopoe	*Upupa africana*	*	*
African Jacana	*Actophilornis africanus*	*	
African Palm Swift	*Cypsiurus parvus*		*
African Paradise Flycatcher	*Terpsiphone viridis*	*	*
African Pipit	*Anthus cinnamomeus*	*	*
African Stonechat	*Saxicola torquatus*	*	

Amethyst Sunbird	*Chalcomitra amethystina*	*	*
Arrow-marked Babbler	*Turdoides jardineii*	*	*
Ashy Flycatcher	*Muscicapa caerulescens*		*
Barn Swallow	*Hirundo rustica*	*	*
Bearded Scrub Robin	*Cercotrichas quadrivirgata*	*	
Bearded Woodpecker	*Chloropicus namaquus*		*
Black Crake	*Zaporina flavirostra*		*
Black Cuckoo	*Cuculus clamosus*	*	*
Black Cuckooshrike	*Campephaga flava*	*	*
Black Saw-wing	*Psalidoprocne pristoptera*	*	
Black-backed Puffback	*Dryoscopus cubla*	*	*
Black-collared Barbet	*Lybius torquatus*	*	*
Black-crowned Tchagra	*Tchagra senegalus*	*	*
Black-headed Heron	*Ardea melanocephala*	*	
Black-headed Oriole	*Oriolus larvatus*	*	*
Blue Waxbill	*Uraeginthus angolensis*	*	*
Brimstone Canary	*Crithagra sulphurata*	*	*
Bronze Mannikin	*Lonchura cucullata*	*	*
Brown-crowned Tchagra	*Tchagra australis*	*	*
Brown-hooded Kingfisher	*Halcyon albiventris*	*	*
Brubru	*Nilaus afer*	*	*
Buffy Pipit	*Anthus vaalensis*	*	
Burchell's Coucal	*Centropus burchellii*	*	*
Bushveld Pipit	*Anthus caffer*	*	*
Cape Glossy Starling	*Lamprotornis nitens*	*	*
Cape Sparrow	*Passer melanurus*		*
Cape Turtle Dove	*Streptopelia capicola*	*	*
Cape White-eye	*Zosterops virens*	*	*
Cardinal Woodpecker	*Dendropicos fuscescens*	*	*
Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*		*
Chinspot Batis	*Batis molitor*	*	*
Cinnamon-breasted Bunting	*Emberiza tahapisi*	*	*
Collared Sunbird	*Hedydipna collaris*	*	*
Common Buttonquail	*Turnix sylvaticus*	*	*
Common House Martin	*Delichon urbicum*	*	*
Common Scimitarbill	*Rhinopomastus cyanomelas*	*	*
Common Waxbill	*Estrilda astrild*	*	*
Crested Barbet	*Trachyphonus vaillantii*		*
Crested Francolin	*Ortygornis sephaena*	*	*
Croaking Cisticola	*Cisticola natalensis*	*	*
Crowned Hornbill	*Lophoceros alboterminatus*	*	*
Crowned Lapwing	*Vanellus coronatus*	*	
Cuckoo finch	*Anomalospiza imberbis*	*	
Dark Chanting Goshawk	*Melierax metabates*	*	*
Dark-capped Bulbul	*Pycnonotus tricolor*	*	*
Diederik Cuckoo	*Chrysococcyx caprius*	*	*
Dusky Indigobird	*Vidua funerea*		*
Eastern Nicator	*Nicator gularis*	*	

Emerald-spotted Wood Dove	*Turtur chalcospilos*	*	*
European Bee-eater	*Merops apiaster*	*	*
European Honey Buzzard	*Pernis apivorus*	*	
European Nightjar	*Caprimulgus europaeus*	*	
European Roller	*Coracias garrulus*		*
Fiscal Flycatcher	*Melaenornis silens*	*	
Flappet Lark	*Mirafra rufocinnamomea*	*	*
Fork-tailed Drongo	*Dicrurus adsimilis*	*	*
Gabar Goshawk	*Micronisus gabar*		
Garden Warbler	*Sylvia borin*	*	*
Golden-breasted Bunting	*Emberiza flaviventris*	*	*
Golden-tailed Woodpecker	*Campethera abingoni*	*	*
Gorgeous Bushshrike	*Telophorus viridis*	*	*
Greater Honeyguide	*Indicator indicator*	*	*
Green Wood Hoopoe	*Phoeniculus purpureus*		*
Green-backed Camaroptera	*Camaroptera brachyura*	*	*
Green-winged Pytilia	*Pytilia melba*	*	*
Grey Go-away-bird	*Crinifer concolor*		*
Grey Penduline Tit	*Anthoscopus caroli*		*
Grey-backed Camaroptera	*Camaroptera brevicaudata*		*
Grey-headed Bushshrike	*Malaconotus blanchoti*	*	*
Groundscraper Thrush	*Turdus litsitsirupa*	*	*
Hadeda	*Bostrychia hagedash*	*	*
Helmeted Guineafowl	*Numida meleagris*		*
House Sparrow	*Passer domesticus*		*
Jacobin Cuckoo	*Clamator jacobinus*	*	*
Jameson's Firefinch	*Lagonosticta rhodopareia*		*
Klaas's Cuckoo	*Chrysococcyx klaas*	*	*
Kurrichane Thrush	*Turdus libonyana*	*	*
Laughing Dove	*Spilopelia senegalensis*		*
Lazy Cisticola	*Cisticola aberrans*	*	*
Lesser Honeyguide	*Indicator minor*		*
Lesser Masked Weaver	*Ploceus intermedius*	*	*
Lesser Moorhen	*Paragallinula angulata*	*	
Lesser Striped Swallow	*Cecropis abyssinica*	*	*
Levaillant's Cuckoo	*Clamator levaillantii*		*
Lilac-breasted Roller	*Coracias caudatus*		*
Little Bee-eater	*Merops pusillus*	*	*
Little Rush Warbler	*Bradypterus baboecala*		*
Little Sparrowhawk	*Accipiter minullus*	*	*
Little Swift	*Apus affinis*	*	*
Long-billed Crombec	*Sylvietta rufescens*	*	*
Long-tailed Paradise Whydah	*Vidua paradisaea*	*	*
Malachite Kingfisher	*Corythornis cristatus*		*
Marsh Warbler	*Acrocephalus palustris*	*	*
Natal Spurfowl	*Pternistis natalensis*	*	*
Neddicky	*Cisticola fulvicapilla*	*	*
Orange-breasted Bushshrike	*Chlorophoneus sulfureopectus*	*	*

Pale Flycatcher	*Melaenornis pallidus*	*	*
Pied Crow	*Corvus albus*	*	
Pink-throated Twinspot	*Hypargos margaritatus*	*	*
Pin-tailed Whydah	*Vidua macroura*	*	*
Purple Indigobird	*Vidua purpurascens*		*
Purple-banded Sunbird	*Cinnyris bifasciatus*		*
Purple-crested Turaco	*Gallirex porphyreolophus*	*	*
Rattling Cisticola	*Cisticola chiniana*	*	*
Red-backed Shrike	*Lanius collurio*	*	*
Red-billed Firefinch	*Lagonosticta senegala*		*
Red-billed Oxpecker	*Buphagus erythrorynchus*		*
Red-billed Quelea	*Quelea quelea*	*	*
Red-capped Robin-Chat	*Cossypha natalensis*	*	
Red-chested Cuckoo	*Cuculus solitarius*	*	*
Red-collared Widowbird	*Euplectes ardens*	*	*
Red-eyed Dove	*Streptopelia semitorquata*	*	*
Red-faced Cisticola	*Cisticola erythrops*	*	*
Red-faced Mousebird	*Urocolius indicus*	*	*
Red-fronted Tinkerbird	*Pogoniulus pusillus*		*
Red-headed Weaver	*Anaplectes rubriceps*		*
Red-throated Wryneck	*Jynx ruficollis*	*	
Retz's Helmetshrike	*Prionops retzii*		*
Rock Martin	*Ptyonoprogne fuligula*	*	*
Rufous-naped Lark	*Mirafra africana*	*	*
Sabota Lark	*Calendulauda sabota*		*
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	*	*
Sombre Greenbul	*Andropadus importunus*	*	*
Southern Black Flycatcher	*Melaenornis pammelaina*	*	*
Southern Black Tit	*Melaniparus niger*	*	*
Southern Boubou	*Laniarius ferrugineus*	*	*
Southern Fiscal	*Lanius collaris*	*	
Southern Grey-headed Sparrow	*Passer diffusus*	*	*
Southern Masked Weaver	*Ploceus velatus*	*	*
Southern Red Bishop	*Euplectes orix*	*	*
Southern Yellow-billed Hornbill	*Tockus leucomelas*		*
Speckled Mousebird	*Colius striatus*	*	*
Spectacled Weaver	*Ploceus ocularis*	*	*
Spotted Flycatcher	*Muscicapa striata*		*
Spotted Thick-knee	*Burhinus capensis*	*	
Square-tailed Drongo	*Dicrurus ludwigii*	*	
Streaky-headed Seedeater	*Crithagra gularis*	*	*
Striped Kingfisher	*Halcyon chelicuti*		*
Striped Pipit	*Anthus lineiventris*	*	
Tawny-flanked Prinia	*Prinia subflava*	*	*
Terrestrial Brownbul	*Phyllastrephus terrestris*	*	
Thick-billed Weaver	*Amblyospiza albifrons*	*	*
Trumpeter Hornbill	*Bycanistes bucinator*	*	
Village Weaver	*Ploceus cucullatus*		*

Violet-backed Starling	*Cinnyricinclus leucogaster*	*	*
Wailing Cisticola	*Cisticola lais*	*	
Wattled Starling	*Creatophora cinerea*		*
White-backed Duck	*Thalassornis leuconotus*	*	
White-bellied Sunbird	*Cinnyris talatala*	*	*
White-browed Robin-Chat	*Cossypha heuglini*	*	*
White-browed Scrub Robin	*Cercotrichas leucophrys*	*	*
White-crested Helmetshrike	*Prionops plumatus*	*	*
White-faced Whistling Duck	*Dendrocygna viduata*	*	
White-rumped Swift	*Apus caffer*	*	*
White-throated Robin	*Irania gutturalis*		*
White-throated Robin-Chat	*Cossypha humeralis*	*	*
White-winged Widowbird	*Euplectes albonotatus*	*	*
Willow Warbler	*Phylloscopus trochilus*	*	*
Woodland Kingfisher	*Halcyon senegalensis*		*
Yellow Weaver	*Ploceus subaureus*	*	
Yellow-bellied Eremomela	*Eremomela icteropygialis*	*	*
Yellow-bellied Greenbul	*Chlorocichla flaviventris*	*	*
Yellow-billed Kite	*Milvus aegyptius*	*	
Yellow-breasted Apalis	*Apalis flavida*	*	*
Yellow-fronted Canary	*Crithagra mozambica*	*	*
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*		*
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*		*
Yellow-throated Longclaw	*Macronyx croceus*	*	*
Yellow-throated Petronia	*Gymnoris superciliaris*	*	*
Zitting Cisticola	*Cisticola juncidis*	*	
Number of species: 182	**Subtotal**	**140**	**151**
	Grand total	**157**	**163**

APPENDIX B: FLIGHT ACTYIVITY AT THE SOURCE AREA: SURVEYS 1 – 4

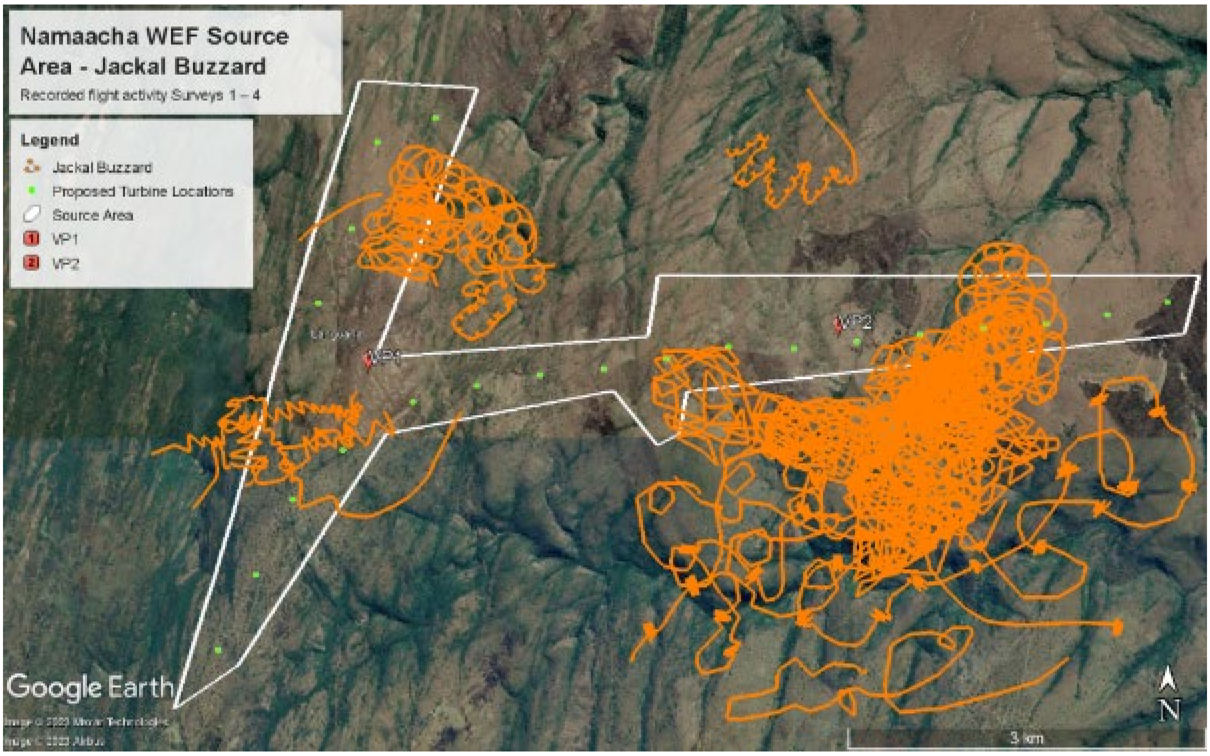


Figure 1: Flight activity of Jackal Buzzard to date (four surveys)

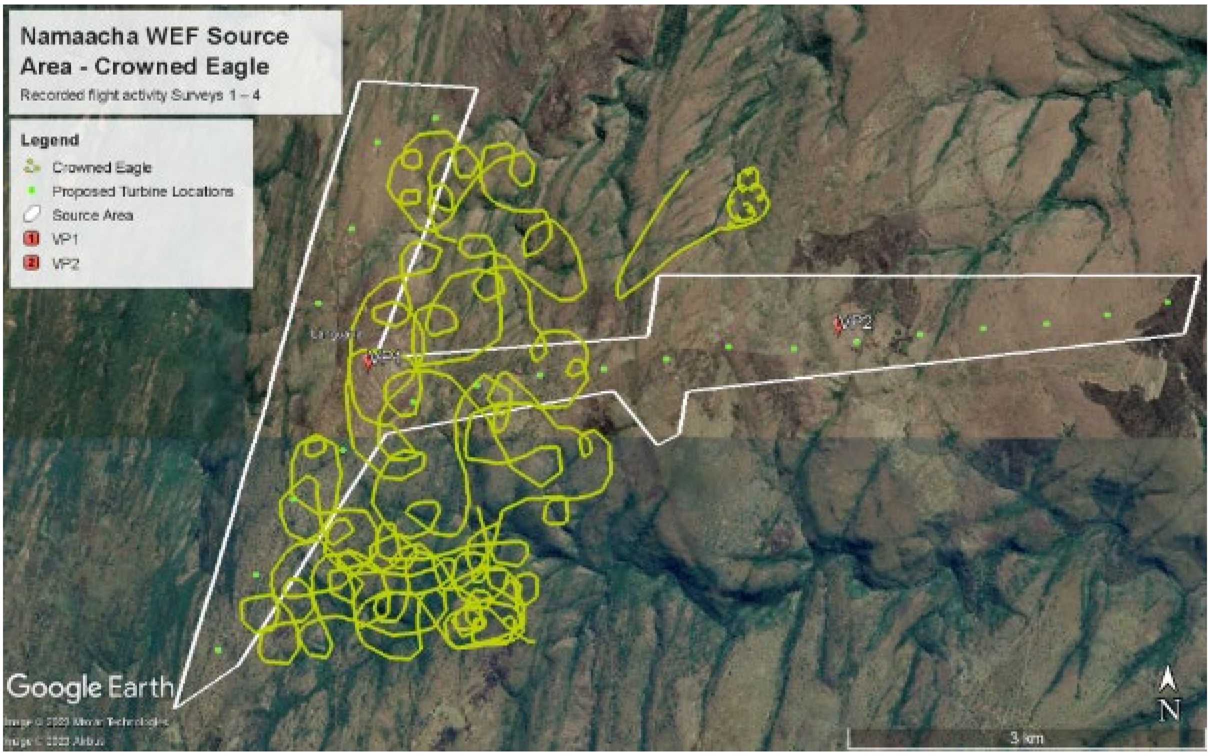


Figure 2: Flight activity of Crowned Eagle to date (four surveys)

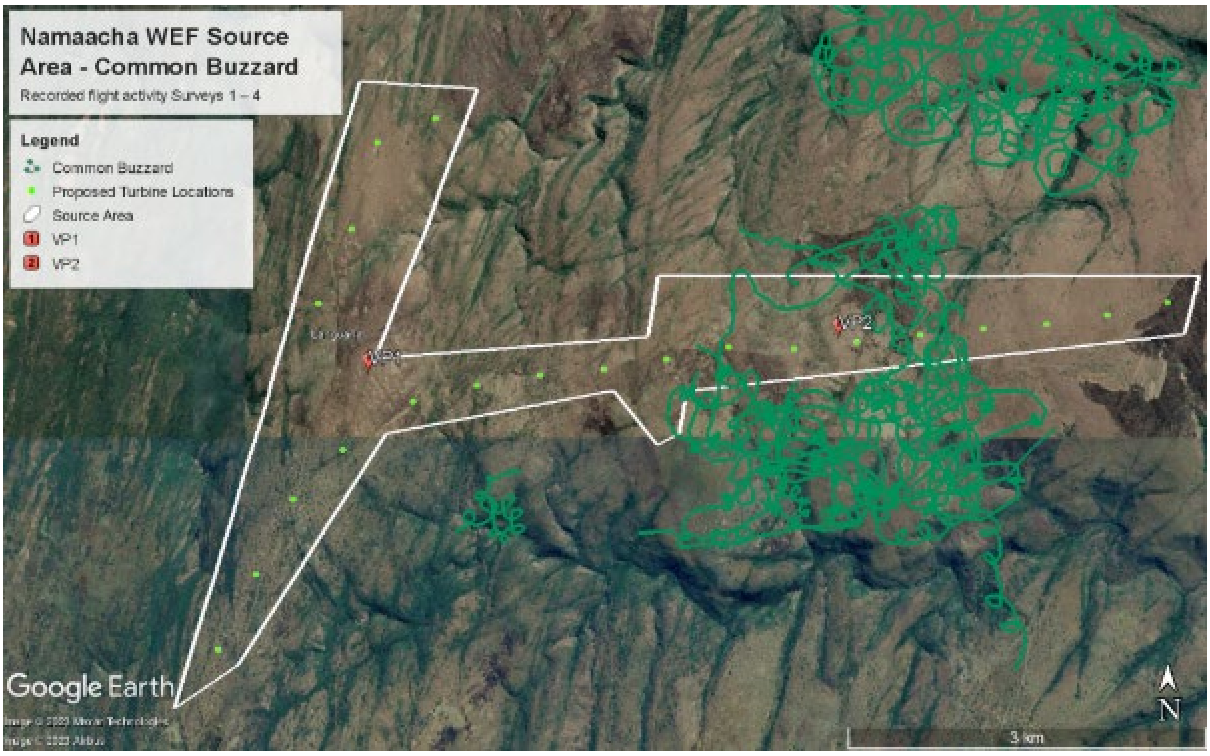


Figure 3: Flight activity of Common Buzzard to date (four surveys)

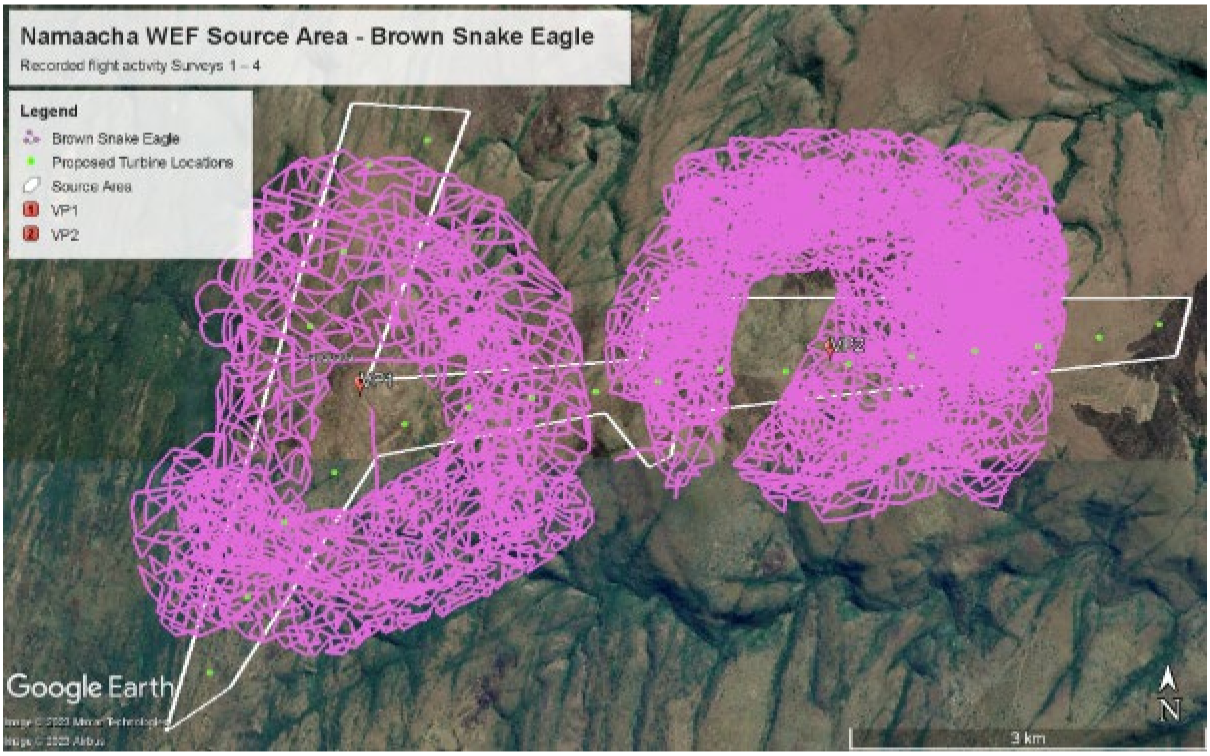


Figure 4: Flight activity of Brown Snake-Eagle to date (four surveys)

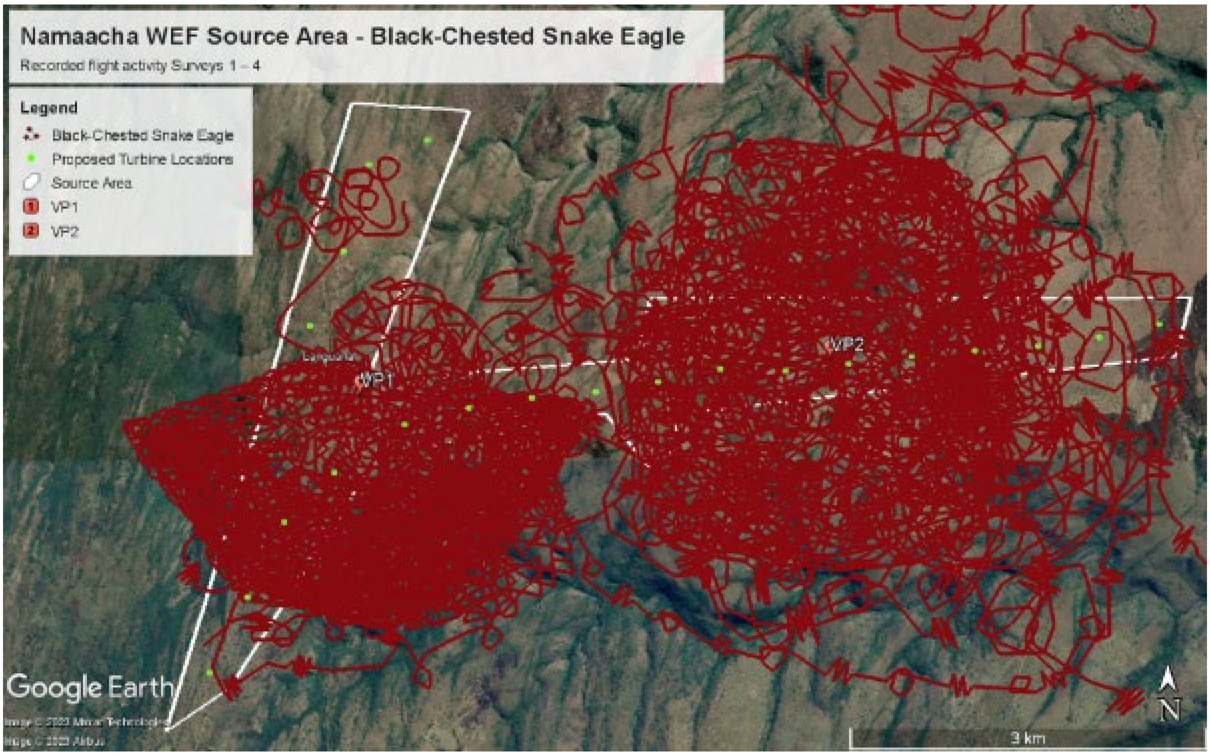


Figure 5: Flight activity of Black-chested Snake-Eagle to date (four surveys)

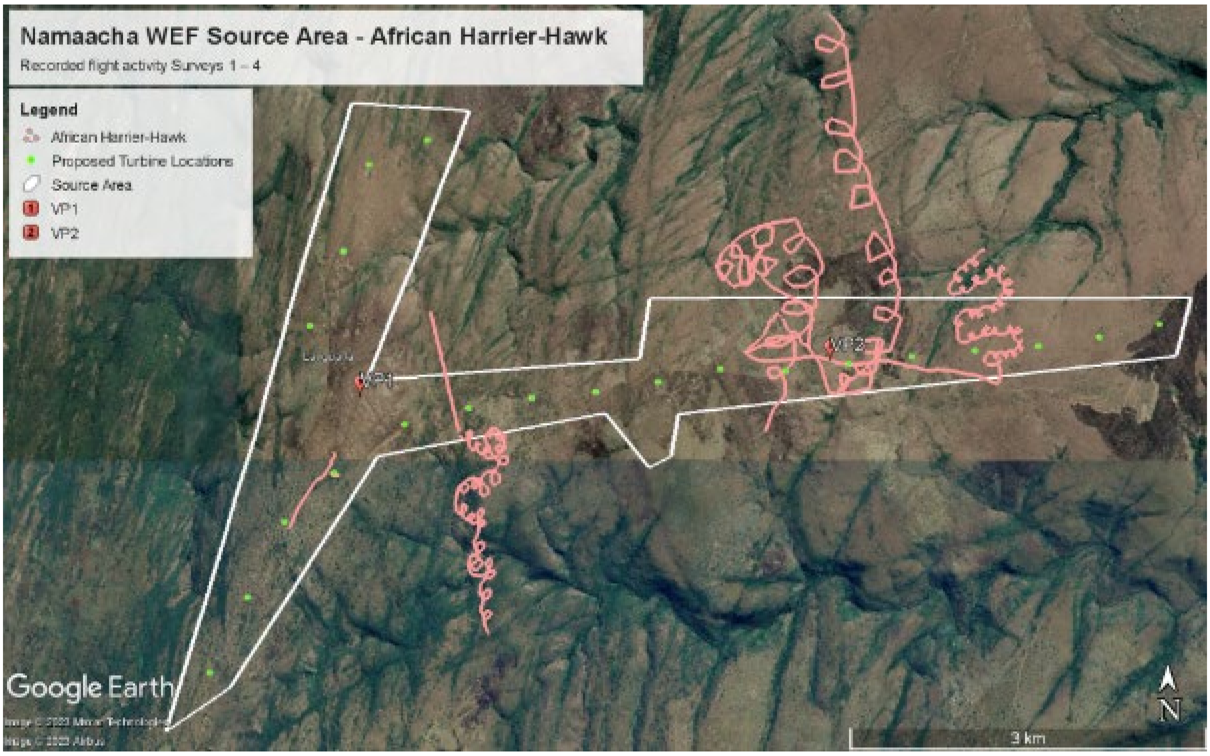


Figure 6: Flight activity of African Harrier-Hawk to date (four surveys)

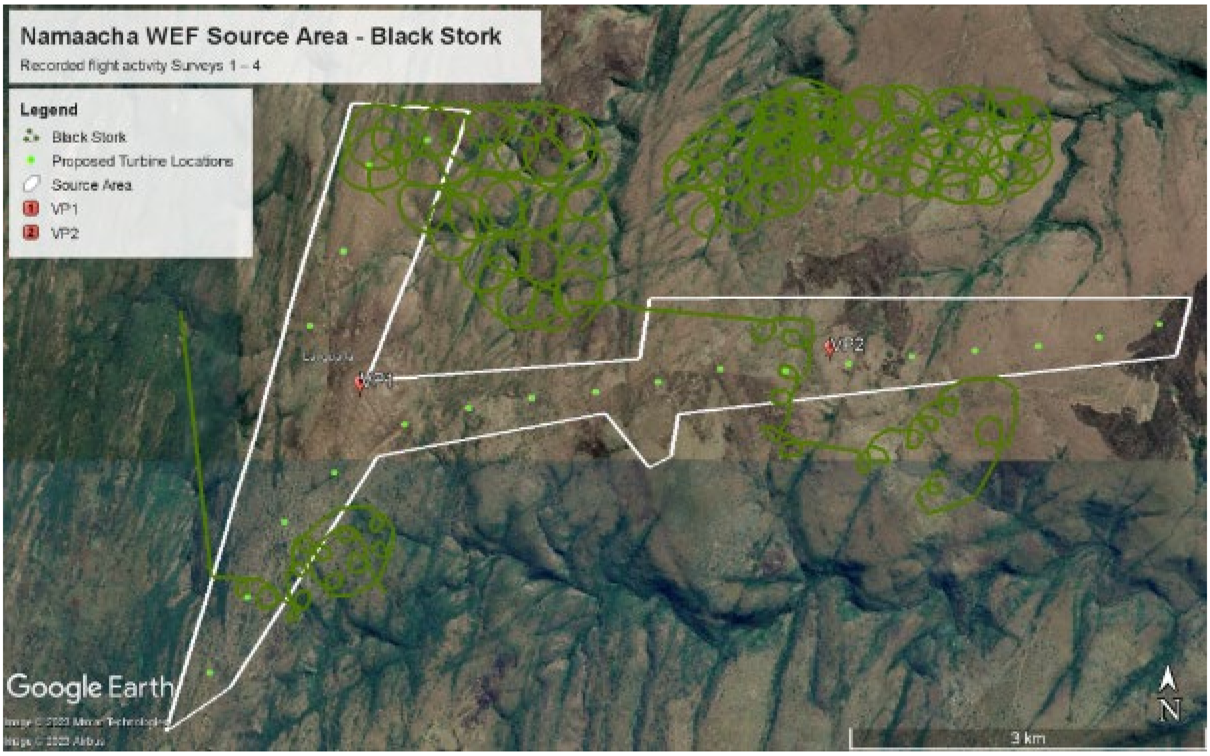


Figure 7: Flight activity of Black Stork to date (four surveys)

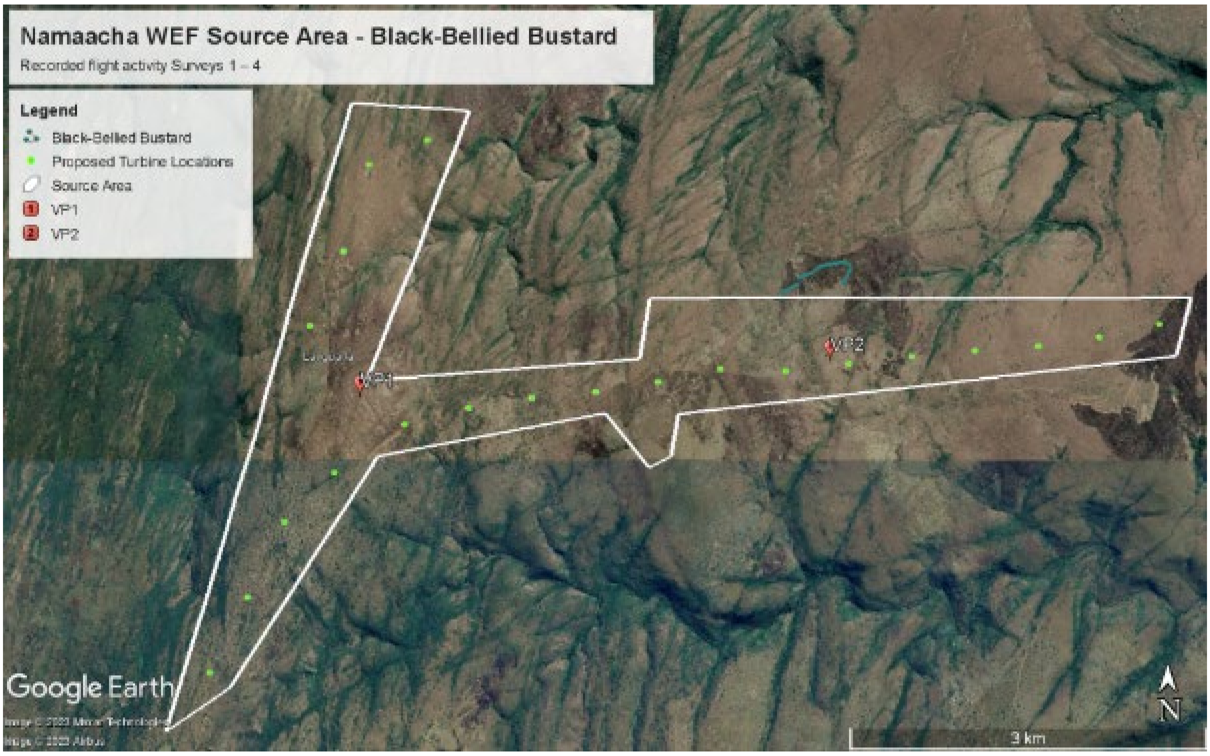


Figure 8: Flight activity of Black-bellied Bustard to date (four surveys)

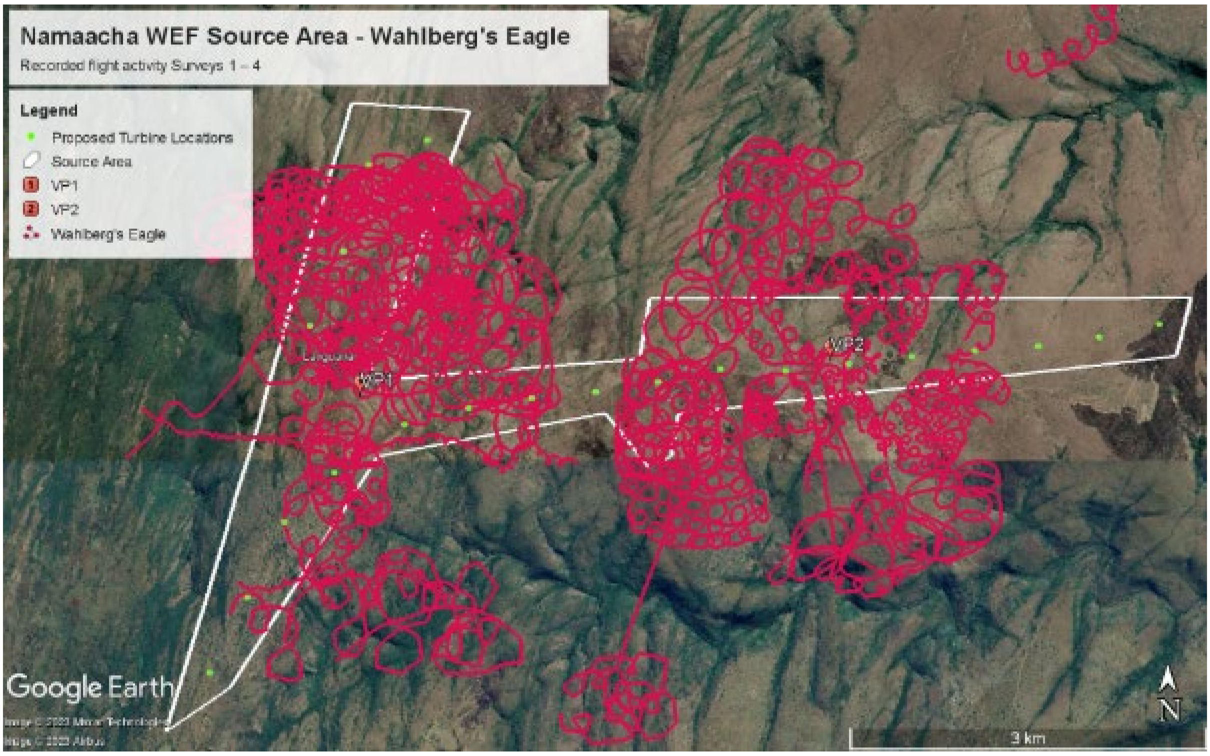


Figure 9: Flight activity of Wahlberg's Eagle to date (four surveys)

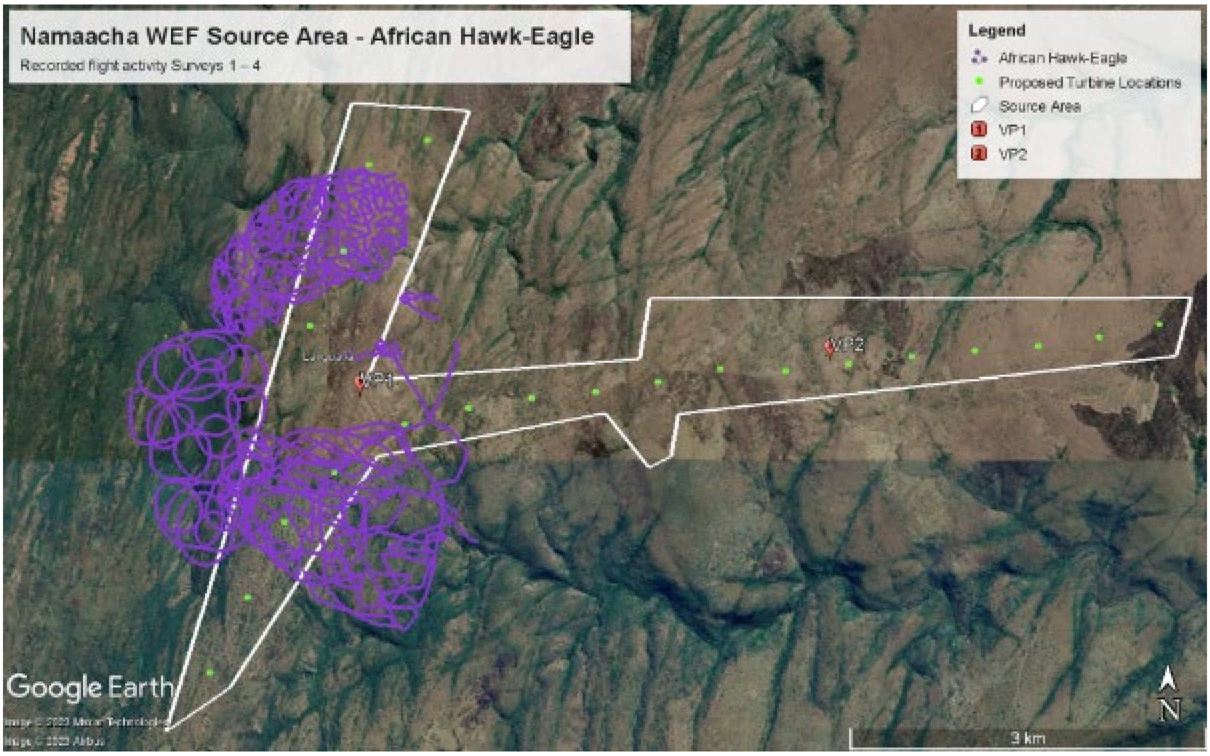


Figure 10: Flight activity of African Hawk-Eagle to date (four surveys)

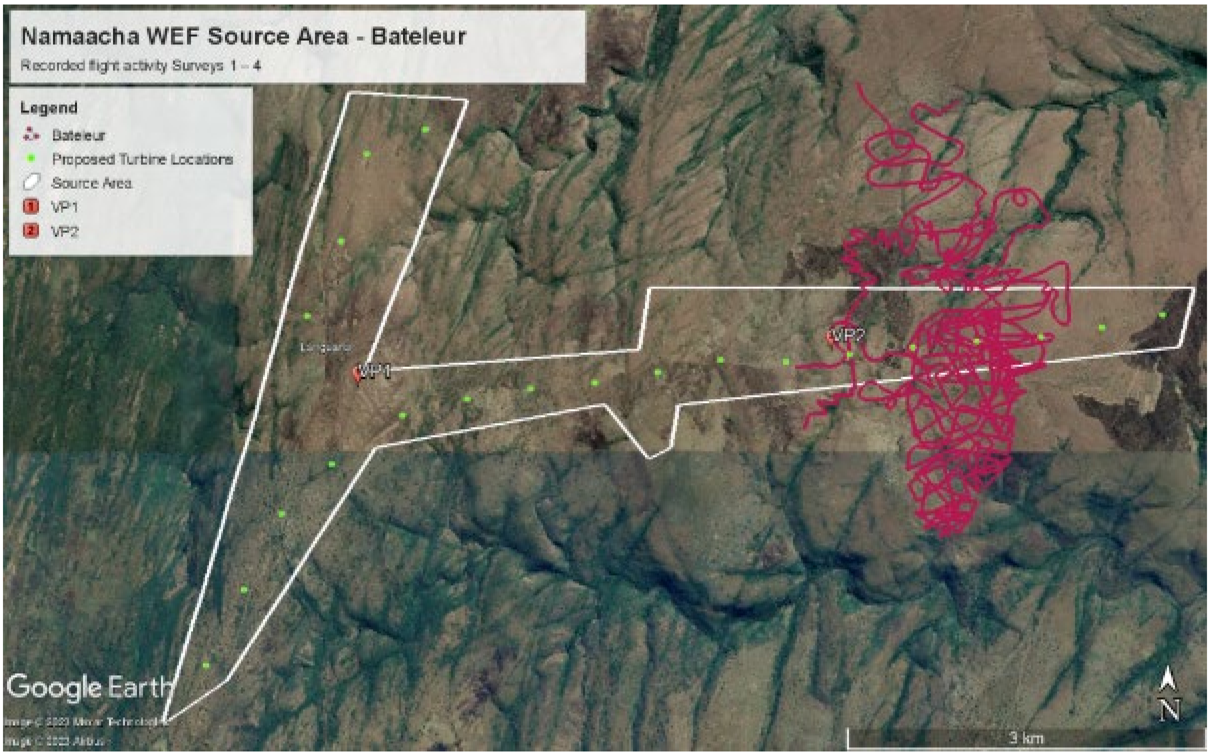


Figure 11: Flight activity of Bateleur to date (four surveys)

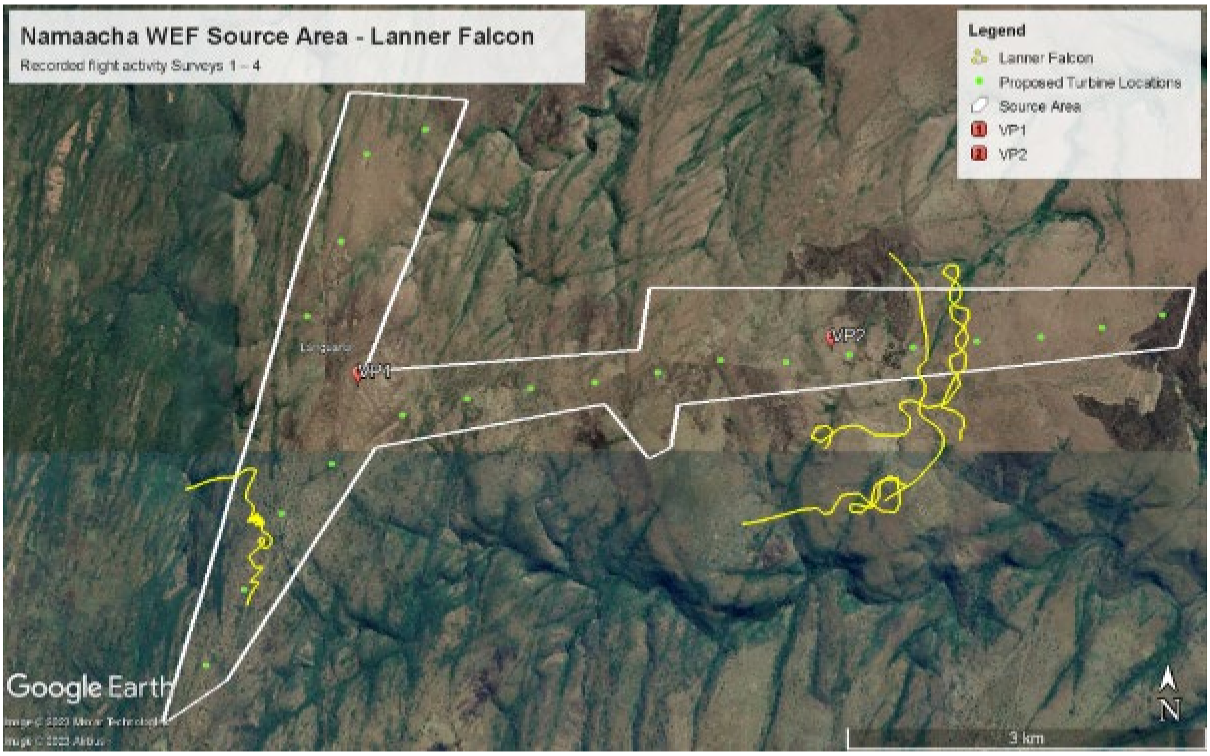


Figure 12: Flight activity of Lanner Falcon to date (four surveys)

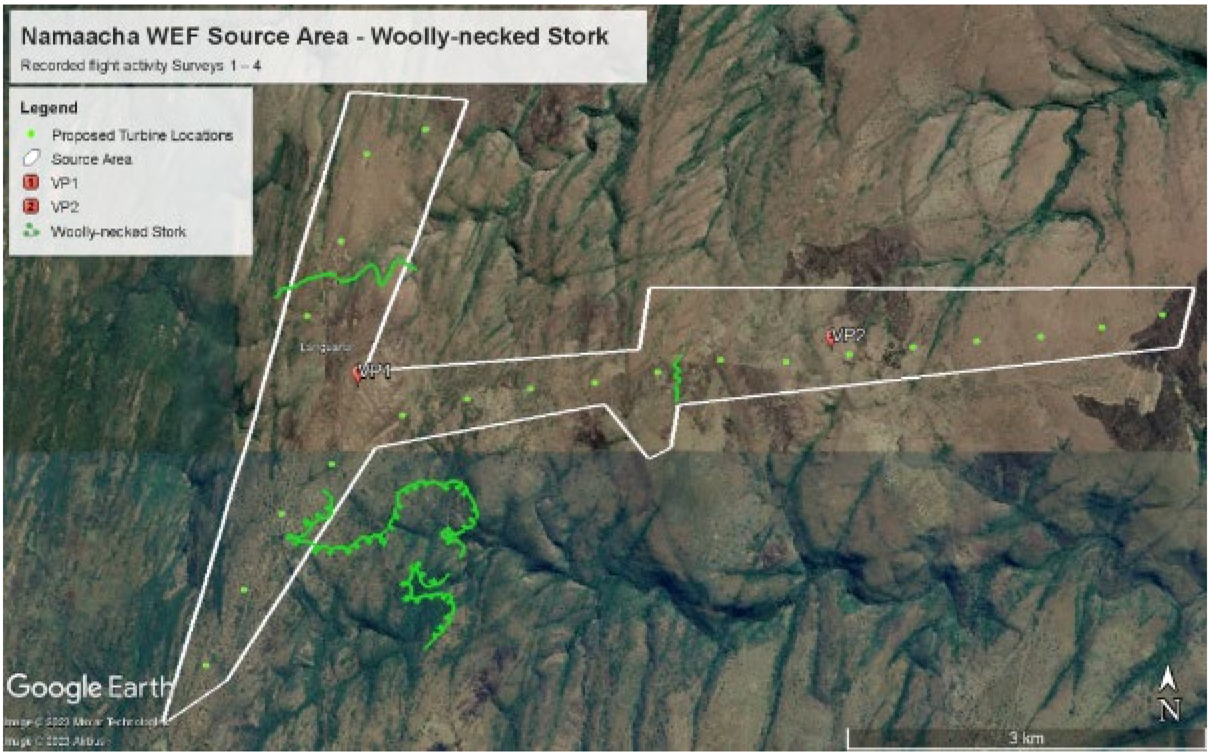


Figure 13: Flight activity of Woolly-necked Stork to date (two surveys)

APPENDIX C: FLIGHT ACTYIVITY AT THE CONTROL AREA: SURVEYS 1 – 4

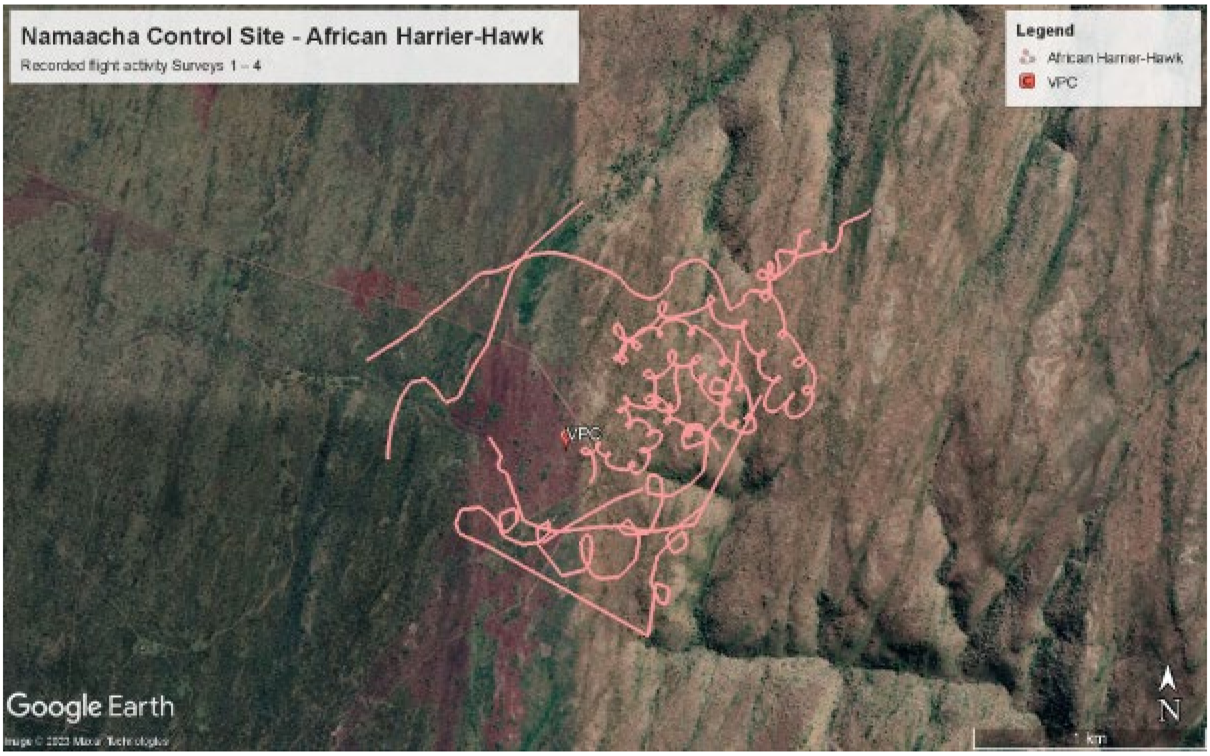


Figure 1: Flight activity of African Harrier-Hawk to date (four surveys)

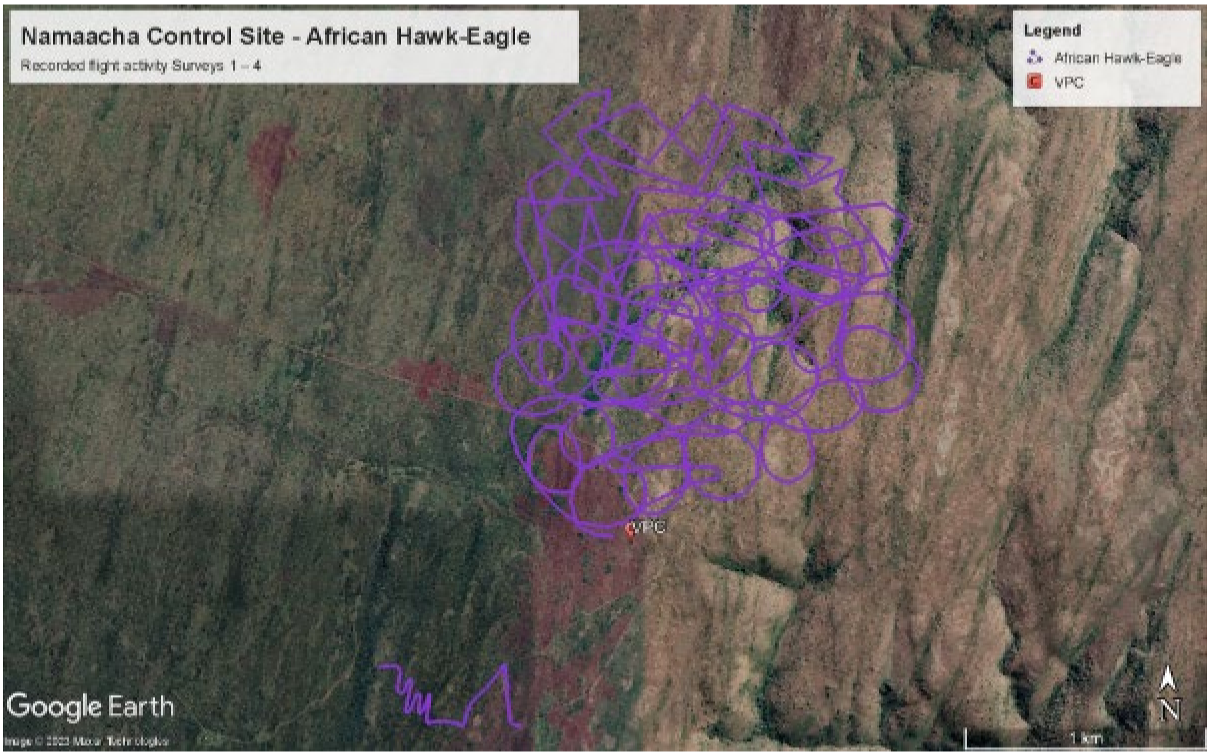


Figure 2: Flight activity of African Hawk-Eagle to date (four surveys)

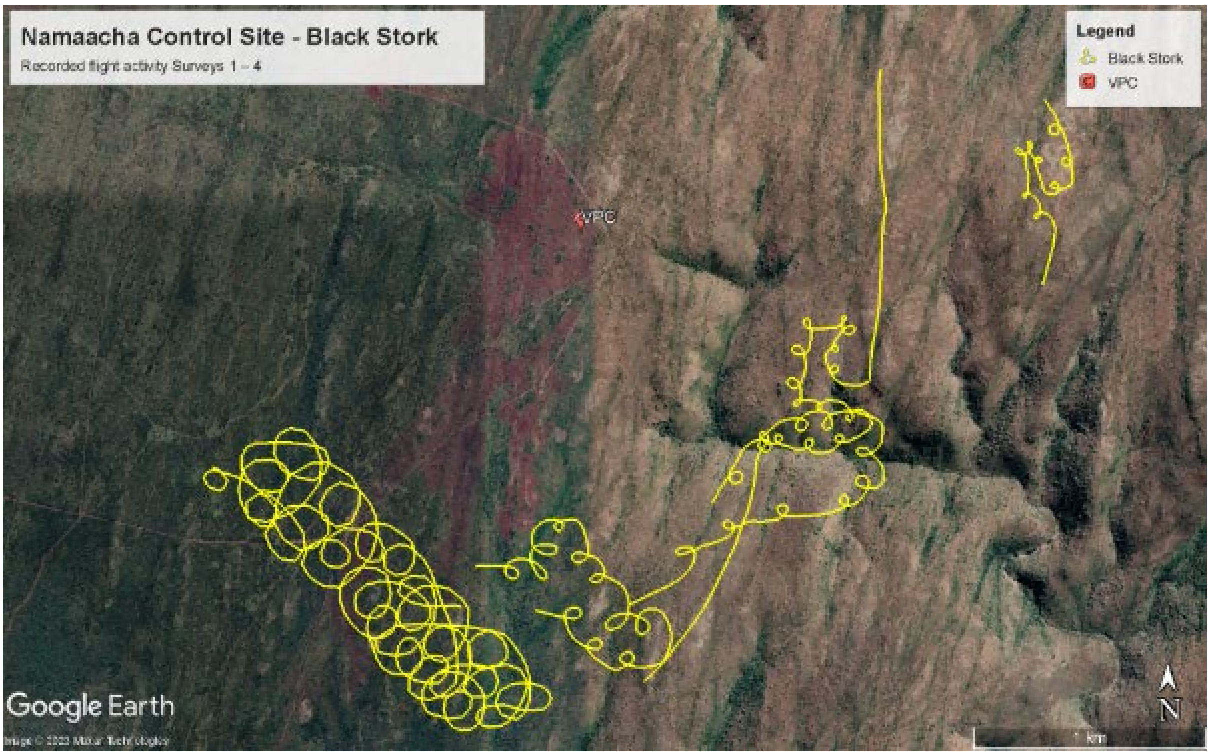


Figure 3: Flight activity of Black Stork to date (four surveys)

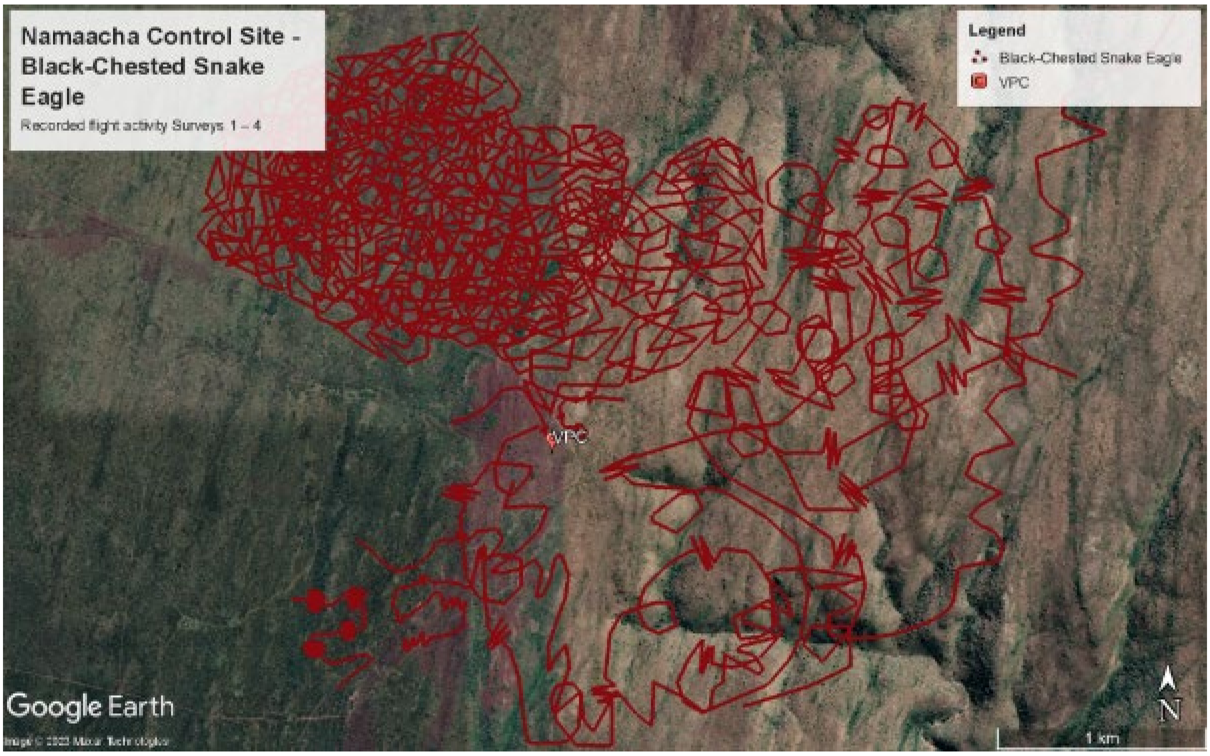


Figure 4: Flight activity of Black-chested Snake Eagle to date (four surveys)

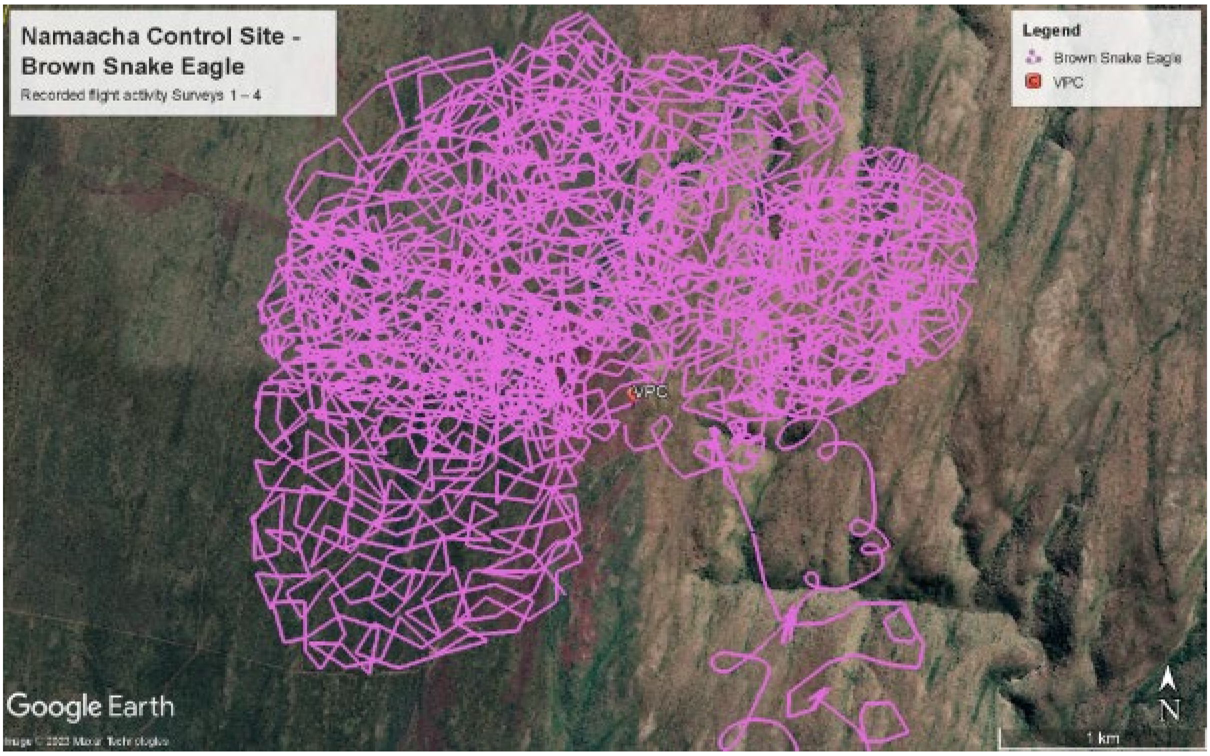


Figure 4: Flight activity of Brown Snake Eagle to date (four surveys)

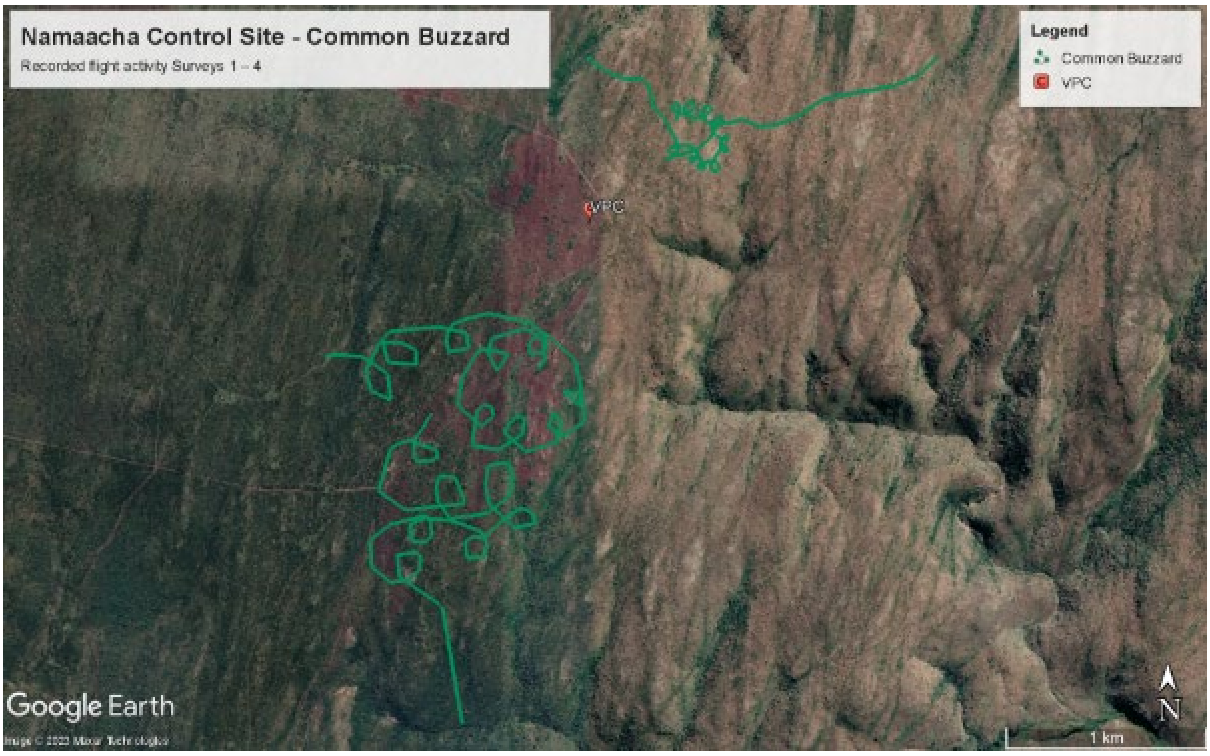


Figure 5: Flight activity of Common Buzzard to date (four surveys)

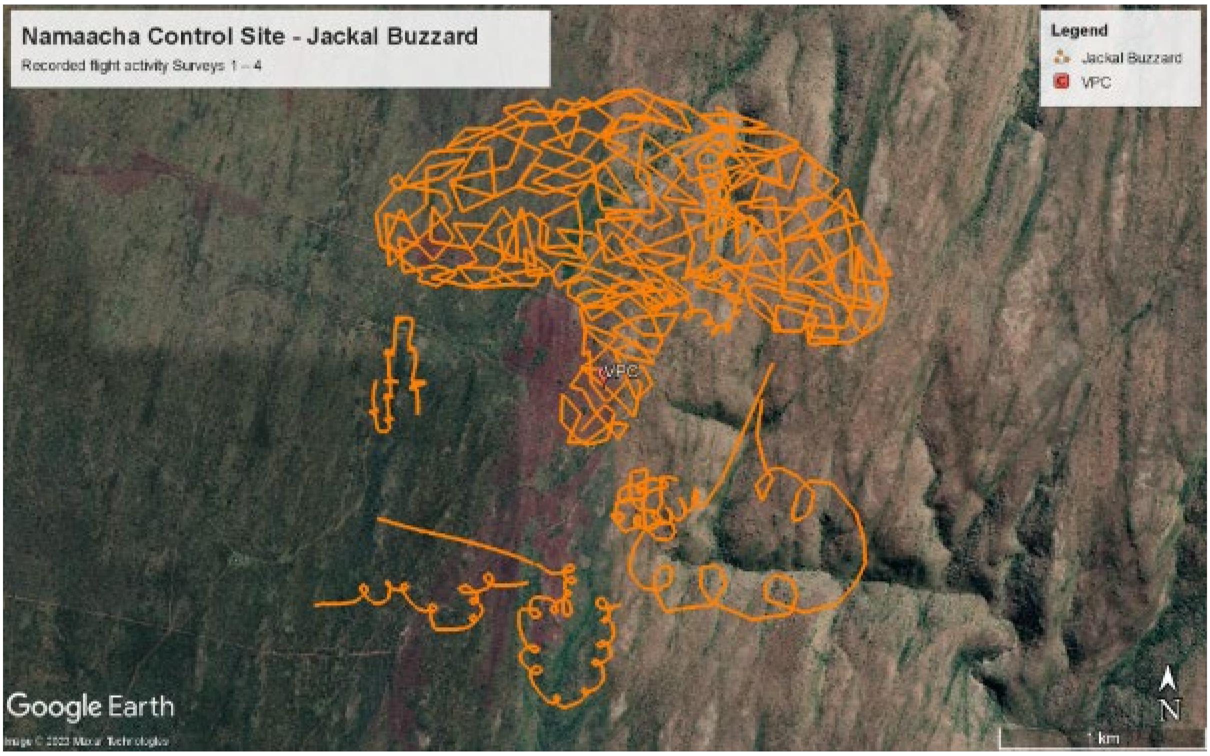


Figure 6: Flight activity of Jackal Buzzard to date (four surveys)

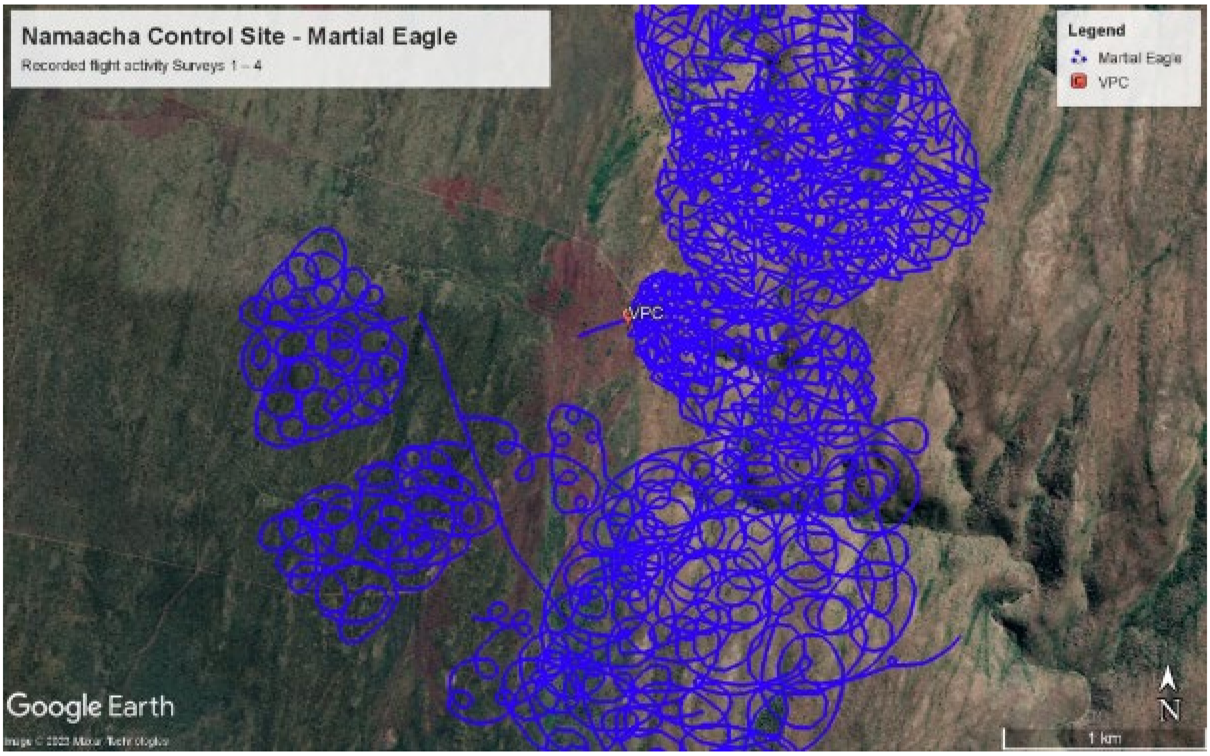


Figure 7: Flight activity of Martial Eagle to date (four surveys)

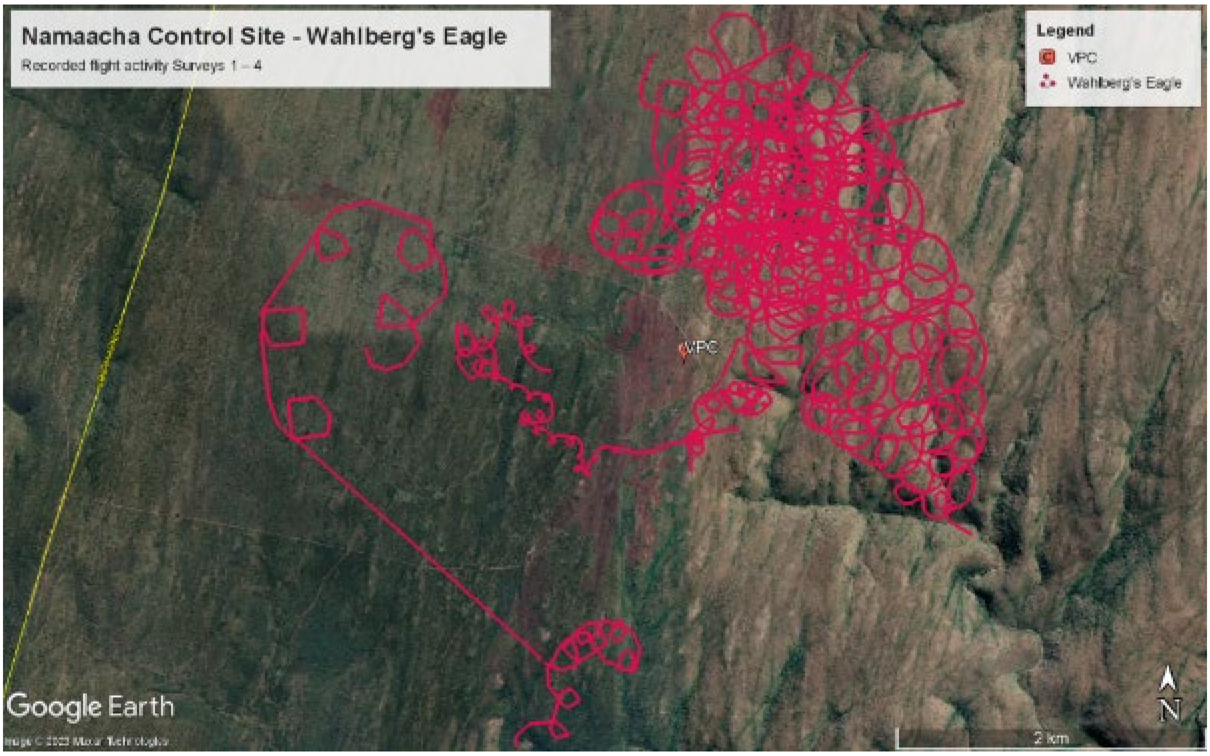


Figure 8: Flight activity of Wahlberg's Eagle to date (four surveys)

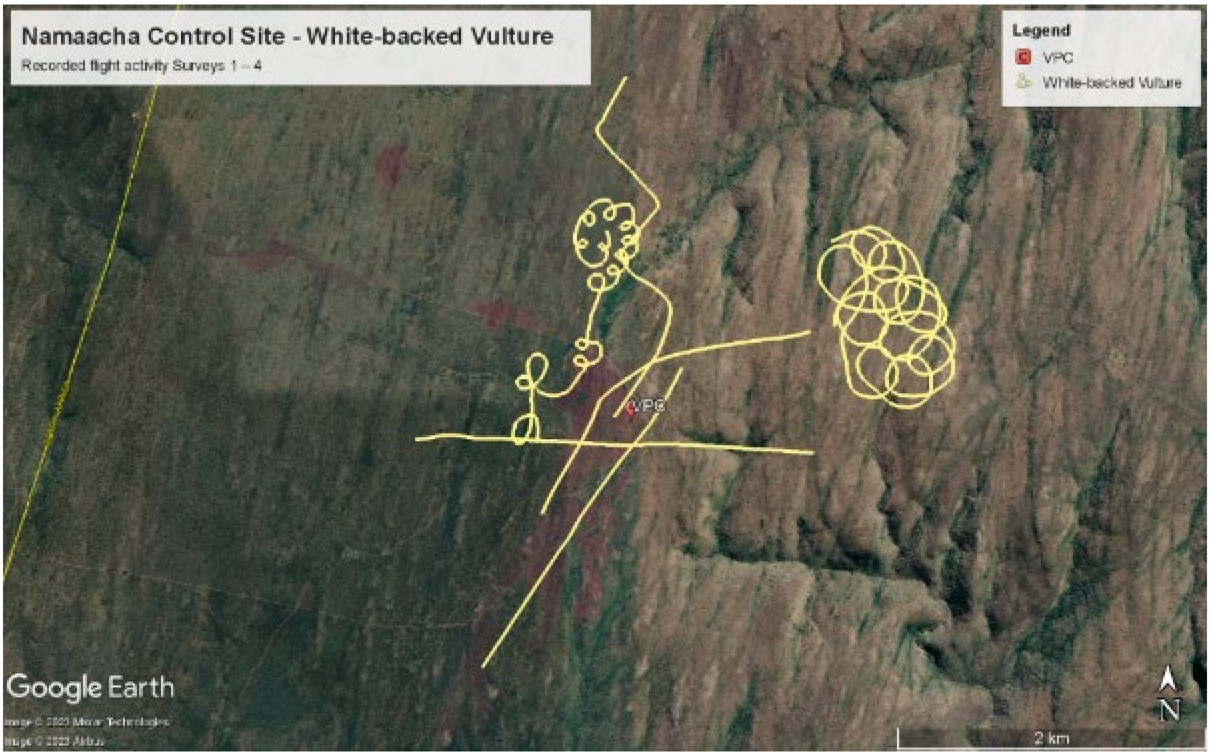


Figure 9: Flight activity of White-backed Vulture to date (four surveys)

APPENDIX D: BLADE PAINTING AS MITIGATION

Coloured-blade mitigation at Africa's wind farms to reduce eagle deaths: implementation, challenges and solutions

Robert E Simmons *FitzPatrick Institute, Department of Biological Sciences, University of Cape Town, Rondebosch 7701, South Africa* Rob.Simmons@uct.ac.za

Marlei Martins *Birds & Bats Unlimited, 8 Sunhill Estate, Capri, 7975, South Africa* Marlei@bushbaby@gmail.com

Roel May *Norwegian Institute for Nature Research, P.O. Box 5685 Torgarden, 7485 Trondheim, Norway* roel.may@nina.no

Introduction

The recent publication of the ground-breaking experimental study of black-blade mitigation at an operational wind farms in Norway (May et al. 2020) has opened up a new and exciting method that could reduce avian fatalities at wind farms in other, more biologically diverse area of the world where renewable energies are being rolled out. This contribution :

- Explains what black/coloured-blade mitigation is
- Outlines the theory behind the black-blade mitigation
- Outlines the field test of the idea
- Summarises the challenges for rolling it out in Africa
- Assesses what it could mean for reducing raptor fatalities in Africa

Figure 1: The single black-blade in the process of being painted in situ, at the Smøla Wind Farm. Painting white blades black after they are erected is more expensive than producing them at source.

Rationale

Research around the world has shown that avian populations are declining due to climate change effects arising from increasing temperature and decreased rainfall in arid areas (www.ipcc.ch/, Thomas et al. 2004, Simmons et al. 2004, Phipps et al. 2017). In the USA, non-renewable fossil fuel energy sources are estimated to kill ~14.5 million birds annually, whereas green wind energy kills about 234 000 birds per year (Sovacool 2013, Loss et al. 2013). That is a 62-fold difference and a powerful environmental argument in support of renewable energy for our future needs. But while wind farms have many positive effects, they also pose some environmental challenges, particularly where wind farms are poorly positioned (on migration corridors for example Smallwood references).

In Africa two data sets on avian fatalities indicate that an average of 2.0 bird (adjusted) fatalities occur per MW per year in South Africa (Perold et al. 2020), and at one farm 1 raptor per month is killed of which 17% are breeding red data raptors (Simmons and Martins 2018). With about 2294 MW already being produced by 27 operational farms here in 2019 (energy.org.za), the cumulative impacts of South African wind farms alone are in excess of 4500 birds annually. If about 36% (>1600 birds per annum) are predicted to be raptors (Ralston-Paton et al. 2017) and about 17% (Simmons and Martins 2018) are known to be red data species, then an estimated 280 red data raptors are likely to be killed per year in South Africa in 2020. Since taller and longer-bladed turbines kill significantly more birds (Loss et al. 2013) and bats (Barclay et al. 2007) then Africa's threatened birds face increasing risks.

The need for urgent mitigations to reduce these costs is at a premium. Enter the coloured-blade mitigation.

What is coloured-blade mitigation?

This is a new mitigation technique in which one of the three white blades on a wind turbine are painted black (figure 1). About two thirds of the blade to the tip is painted this way. This is designed to increase visibility and decrease avian impacts (May et al. 2020). Since Civil Aviation in South Africa does not allow black but does allow "Signal Red" we propose that this is used in experiments here in South Africa. The amount of paint required can also be reduced by using the two-strip patterning shown in the experiments of McIsaac (see below).

Why black-blade mitigation?

Several innovative mitigation measures have recently been proposed for wind farms (flashing UV lights, automated shut-down-on demand, habitat management: May et al. 2017) and in a few cases have reduced collisions. However, developers are reticent to implement these.

The idea for **Black-blade mitigation** arose from work by Hodos (2003) who argued that a bird's retina views moving objects differently at different distances and as the bird gets close to a fast-moving object, the retinal image is moving so fast that the birds' brain can no longer process it. This was dubbed "motion smear" and means that birds approaching a fast-moving object no longer see it, with disastrous consequences. He suggested that a single coloured-blade may break up the motion smear. This is supported by recent work from Sweden (Potier et al. 2018) who show that raptors, despite their very high visual acuity, have very poor contrast abilities (poorer than humans). So, a coloured blade may be even better than a black one. So, a light (white) blade against a bright background is unlikely to be seen. But a black or coloured one is.

What is the evidence that it works?

Black-blade mitigation was field-tested by May et al. (2020) at the Smøla wind farm in 2013 in Norway over 3.5 years. On Smøla, White-tailed Eagles *Haliaeetus albicilla* are being killed at a very high rate by collision with the turbine blades. Four turbines were painted with a single black-painted blade in summer 2013. The black-painted turbines killed (i) 71% fewer total birds and (ii) 100% fewer eagles relative to unpainted blades.

Even more exciting in 2020 still no eagles have been killed at the coloured-blade turbines since 2013. In other words, no more eagles were killed in the 11-year experiment (starting 7.5 years before painting (2006-2013) and in situ 3.5 years after painting (2013-2016) (May et al.

2020). This despite 45-50 territorial pairs present on the island of Smøla (Dahl et al. 2012). The white-bladed turbines, however, are still killing birds at an average of 6 eagles per year (B. Iuell in litt.).

We see little reason why coloured blade – in the form of **Signal-red**, approved by Civil Aviation, would not work as well. This is because raptors see well in the colour spectrum (i.e. with the cones in the retina as opposed to the rods which see in black and white).

What are the visual impacts?

Discussions with wind farm managers in South Africa and Kenya suggest that visual effects are among the possible negative perceptions. We, therefore, requested the Smøla managers to supply us with images and videos of the turning blades to determine the effects.

Figure 1: The black-blade set up on a cloudy day in Norway is shown left. The black-blade (far turbine) is little different to the shadow cast by the all-white blades in the foreground © Bjorn Iuell.

The effect can be seen in the video kindly provided by Arild Soleim at www.birds-and-bats.com/specialist-studies. This shows little to no visual flicker or intrusion on the landscape from a single coloured-blade, and this concern is largely negated for all but the most sensitive human observer. It also has the effect of making the blade appear slower as one follows the black blade itself.

We argue that the benefits (no eagles killed) far outweigh the costs (initial costs to produce the coloured-blades). And once the blades are installed there will be no further costs as there are with competing mitigations (DT bird, or observer-operated shut-downs).

Black blade and Civil Aviation – white blades are not the most conspicuous

South African Civil Aviation state that white is "to provide the maximum daytime conspicuousness" However this statement was tested by McIsaac (2003) and he found that white is NOT the most conspicuous colour for either a moving blade or a stationary one

Embedded in the experiments undertaken by McIsaac's (2003) on kestrels is this very revealing graphic showing how human observers perceive the same patterns (including pure white).

Raptor Acuity and Wind-Turbine Blade Conspicuity

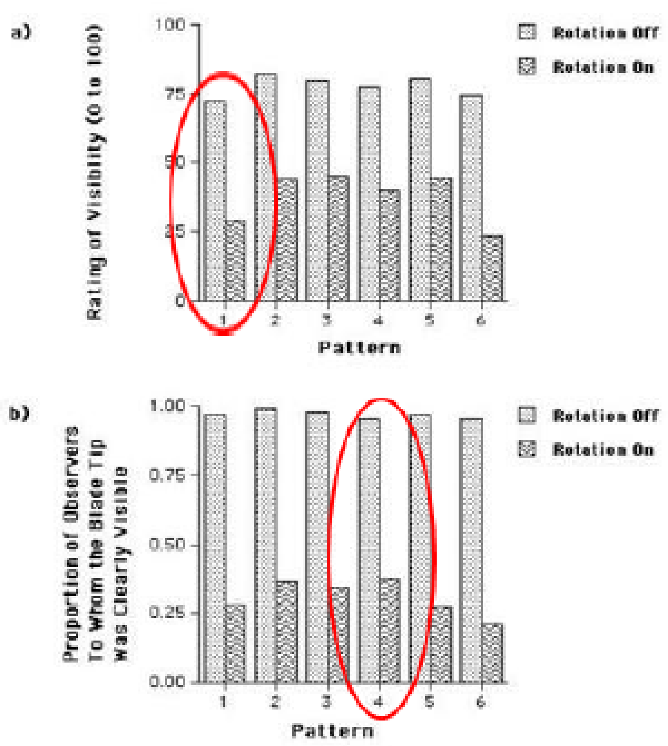


FIGURE 10. Human-perceived blade-pattern conspicuity: two-factor interactions of pattern and rotation. *These diagrams show the relationship between blade-pattern conspicuity and the effects of rotation. Illustrations of the blade patterns are presented in Fig. 9. Both blade pattern and rotation significantly affected conspicuity. Two ratings of pattern conspicuity are presented, a) full-blade visibility ratings, b) blade-tip visibility ratings.*

- **The pure white blade [pattern 1] was perceived as <u>less visible</u> by human observers than 5 of the other 6 patterns used whether the blades were spinning or not (top graph)**
- The <u>tip</u> of the pure white blade [pattern 1] was also perceived as less visible by human observers than 4 of the other 6 patterns used whether the blades were spinning or not (bottom graph)
- Like the Kestrels being tested, human observers saw patterned blades (patterns 2,3,4,5,6) better than pure white [pattern 1].

So, the CAA assumption that white is the most conspicuous colour for humans is not supported by experimentation with either raptorial birds or humans.

Patterned blades are better for both humans and raptors.

It is very important the South African Civil Aviation Authority is aware of these findings. Why? Because their guiding documents on painting of tall structures (**139.01.30 OBSTACLE LIMITATIONS AND MARKINGS OUTSIDE AERODROME OR HELIPORT (effective 1 August 2012)**) makes the following statement under section in **1.14. Wind turbine generators (Windfarms)**

- (4) Windfarm Markings (page 12 of 16)
  Wind turbines shall be painted bright white to provide the maximum daytime conspicuousness. The colours grey, blue and darker shades of white should be avoided altogether. If such colours have been used, the wind turbines shall be supplemented with daytime lighting, as required.

While this assumption that "bright white" would be most obvious to pilots and others, the experiments of McIsaac (2001) indicate that this is a false assumption. The pure white blade performed very poorly in the experiments of McIsaac (2001) and the patterned blade (No. 4 below) performed best of all.

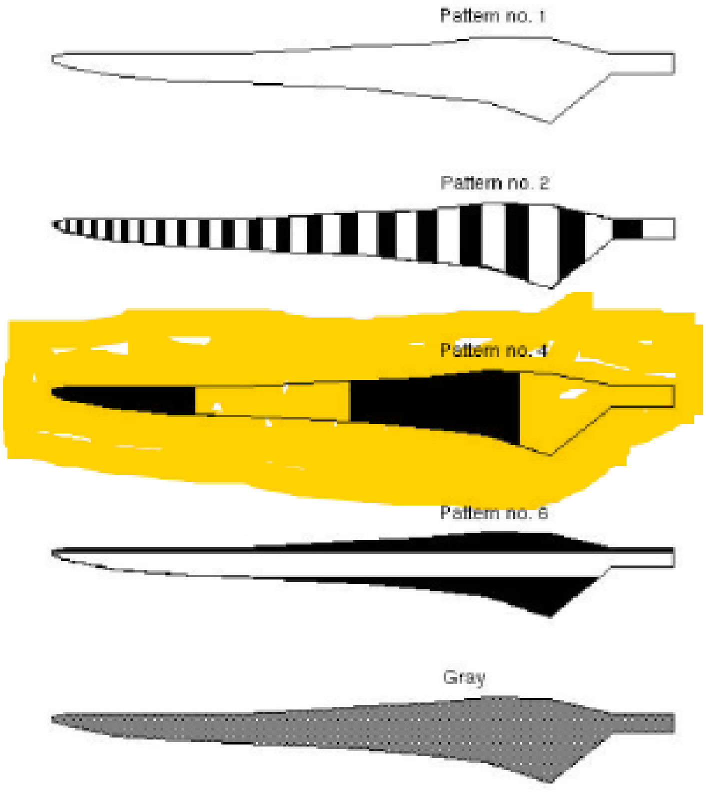


FIGURE 12. Kestrel-perceived blade-pattern conspicuity: stimulus blade patterns. *Depicted are the four black-and-white test patterns and the gray control pattern that were used to determine pattern conspicuity as perceived by a kestrel.*

Can it be applied in an African setting?

Given that eagles and raptors the world over probably see the landscape in similar ways there is a high probability that African eagles will see coloured-blades similarly well. Recent research on other raptors shows that despite their high visual acuity they see contrast more poorly than do humans (Potier, Milbus & Kelber 2019). This nicely explains why raptors take no avoiding action and are struck by white blades in the first place, and second why painting a blade black (increasing the contrast) increases the avoidance of those blades by eagles.

It also breaks up the "motion smear" researched by Hodos (2003) because he predicted a single black or coloured blade would increase the ability of birds to see movement in a set of fast-moving blade (the same effect can be seen by pilots of prop-driven planes, where one blade is painted differently). In an African setting the same can be seen on farmers' metal windmills where a blade is missing or painted on the rapidly spinning blades. Both increase the visual contrast and effect of movement.

The coloured-blade mitigation has yet to be rolled out in Africa – where it is urgently needed, given that we have over 100 species of raptors – more than any other continent (Clark and Davies 2018). Red blade tips have, however, already been used at the Ysterfontein Wind farm in the Western Cape, setting a precedent for their use elsewhere in South Africa.

Figure 2: Red-tipped turbine-blades on turbines at the Ysterfontein wind farm north west of Clanwilliam in the Western Cape (S 32° 9'23.42" E 18°49'7.10"). While these mitigations are not used in the correct single-blade configuration used by the Norwegians, they set a precedent for turbine blades to be red-painted in South Africa © RE Simmons

We have been informed that this mitigation is indeed being rolled out at the Kobe wind farm site in Japan. And there are plans for testing it in the Netherlands (Arjen Schultinga of Innogy, to Iuell Bjorn, Senior Environmental Advisor at Smøla Wind farm.)

This suggests that General Electric Renewables (GE), a manufacture of wind turbine blades, are already in the market for coloured blades. Attempts to engage with GE Renewables through the internet have proven unsuccessful despite contact with officials there.

We as avian specialist recommend the coloured-blade version of the black blade mitigation because (i) it is likely to be seen even more clearly by raptors than black, (ii) South African Civil Aviation (Lizell Stroh) in correspondence with Birdlife SA and Birds & Bats Unlimited have suggested that "signal red" would be preferable to black as it already used for marking structures such as towers, and is approved by them and (iii) the red paint may heat up less than a black blade in an African environment.

Four more aspects to consider from experience at the Smøla wind farm:

(i) It will cost a fraction to paint while the rotor blades are still on the ground instead of installed at the hub. At Smøla the painting was done with the blades up on the tower in situ and proved quite costly. The cost of painting one blade (with the crane lift and specialised personnel) was K55,000 ($5900). For all four blades and all fees and disbursements included over 2 weeks (due mainly to inclement weather) the total cost was c. K750 000 ($79 000). This would have been negligible had the blades been painted on the ground or come pre-painted (B. Iuell pers comm).

(ii) Although not an issue at Smøla, potentially a black blade may increase the blade temperature with potential consequences for blade quality and operation. We noticed that the temperature in the turbine tower at ground level with a painted tower base was high in summer (Stokke et al. 2020); there the surface area is large and more localized, and, of course, is not moving. No such effect was noticed for the black-painted turbine blades and there was no effect of any imbalance of the blades from differential heating of the black blade.

(iii) Smøla wind farm was not allowed to paint turbines which were constructed in the second construction stage due to insurance issues. Thus, guarantees with the blade manufacturers must be secured before the painting takes places – and preferably come pre-manufactured with a blade already painted red or black.

(iv) Each blade weighed 9 tonnes and the blade were painted with Carboline Windmastic TopCoat HSX. Two coats were applied and weighed approximately 60 kg. This is about 0.66% the weight of the blade and no mechanical effects were apparent. On inspection of the paint there was no wear or cracking apparent (B Iuell pers comm).

It is for influential players such as those in the South African Wind Energy Association and other wind farm developers, their governing bodies and avian conservation organisations to lobby the main players such as General Electric and Siemens to roll out this form of mitigation to reduce to a minimum the thousands of raptors deaths likely in future years. Without black or coloured blades on Africa's turbines we will continue to see the high fatality rates already apparent at some wind farms in South Africa (Simmons and Martins 2018, Perold et al. 2020).

With black-blade mitigation now shown to be highly effective in reducing eagle deaths in Norway, there is a great incentive for wind farm developers elsewhere to enact the coloured blade mitigation to reduce raptor deaths, particularly since it has no operational costs once installed.

Acknowledgments

Grateful thanks to Bjorn Iuell (Environmental Advisor to Smøla wind farm) for answering our numerous questions and providing extra information and photographs on Smøla's black blade project. Also to Arild Soleim at Smøla for the video clip of the moving blades, and to Lizell Stroh of SA Civil Aviation for valuable inputs.

Figure 3: A 4-year old Martial Eagle, struck by a white-bladed turbine, plummets to the earth at an Eastern Cape wind farm. Deaths like this could be reduced or avoided with black/coloured blade mitigation . © RE Simmons

References

Barclay RMR, Baerwald EF, Gruver JC. 2007. Variation in bat and bird fatalities at wind energy facilities: assessing the effects of rotor size and tower height. Can. J. Zool. 85: 381–387.

Clark WS, Davies RAG 2018. African Raptors. Helm, London.

Hodos W. 2003. Minimization of Motion Smear: Reducing Avian Collisions with Wind Turbines National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado 80401-3393 www.osti.gov/bridge

Loss SR, Will T, Marra PP. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. Biological Conservation 168: 201–209.

May R, Nygård T, Falkdalen U, Åström J, Hamre Ø, Stokke BG. 2020. May R, Nygård T, Falkdalen U, Åström J, Hamre Ø, Stokke BG. Paint it black: Efficacy of increased wind-turbine rotor blade visibility to reduce avian fatalities. *Ecol Evol*. 2020;00:1–9. https://doi.org/10.1002/ece3.6592

May R. Åström J, Hamre Ø, Dahl EL, 2017. Do birds in flight respond to (ultra)violet lighting? Avian Research 8:33. https://doi.org/10.1186/s40657-017-0092-3

McIsaac HP. 2001 Raptor Acuity and Wind Turbine Blade Conspicuity. Raptor Research Center, Boise State University. Department of Biological Sciences, F.W. Olin Science Hall, University of Denver, 2190 E. Iliff Ave., Denver, CO 80208-2601. Report for National Renewable Energy Laboratory.

Perold V, Ralston-Paton S, Ryan PG. 2020. On a Collision Course? The large diversity of birds killed by wind turbines in South Africa. Ostrich in press.

Phipps WL, Wolter K, Michael MD, MacTavish LM, Yarnell RW. 2017. Due South: A first assessment of the potential impacts of climate change on Cape vulture occurrence. Biological Conservation 210: 16–25.

Potier S, Mitkus M, Kelber A. 2018 High resolution of colour vision, but low contrast sensitivity in a diurnal raptor. Proc. R. Soc. B 285: 20181036. http://dx.doi.org/10.1098/rspb.2018.1036

Ralston Paton, S, Smallie J., Pearson A, Ramalho R. 2017. Wind energy's impacts on birds in South Africa: A preliminary review of the results of operational monitoring at the first wind farms of the Renewable Energy Independent Power Producer Procurement Programme in South Africa. *BirdLife South Africa Occasional Report Series No. 2.* BirdLife South Africa, Johannesburg, South Africa

Simmons RE, Barnard P, Dean WRJ, Midgley GF, Thuiller W, Hughes G. 2004. Climate change and birds: perspectives and prospects from southern Africa. Ostrich 75: 295–308.

Simmons RE, Martin M. 2019. Raptors and wind farms: fatalities, behaviour and mitigations for the Jeffreys bay wind farm. Unpubl report to Globeleq South Africa by Birds and Bats Unlimited, Cape Town.

Sovacool B. 2013 Contextualizing avian mortality: A preliminary appraisal of bird and bat fatalities from wind, fossil-fuel, and nuclear electricity. Energy Policy 37: 2241–2248

Stokke, BG, Nygård, T, Falkdalen, U, Pedersen, HC & May, R. 2020. Effect of tower base painting on willow ptarmigan collision rates with wind turbines. Ecology & Evolution ece3.6307.

Thomas CD. Cameron A, Green RE, Bakkenes M Beaumont LJ, Collingham YC, Erasmus BFN et al. 2004. Extinction risk from climate change. Nature 427: 145-148. www.nature.com/nature

CENTRAL ELECTRICA DA NAMAACHA SA

REVISED AVIFAUNAL IMPACT ASSESSMENT

Namaacha Windfarm Project

AfriAvian Environmental
Formerly Afrimage Photography t/a Chris van Rooyen Consulting and Albert Froneman Consulting

PUBLIC

PROJECT NO. 41104276

DATE: SEPTEMBER 2023

CONTENTS

TABLES

FIGURES

APPENDICES

DECLARATION OF INDEPENDENCE

I, Albert Froneman (SACNASP Zoological Science Registration number 400177/09) as duly authorised representative of AfriAvian Environmental, hereby confirm my independence (as well as that of AfriAvian Environmental) as a specialist and declare that neither I nor AfriAvian Environmental have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which we were appointed as specialist consultants, other than fair remuneration for work performed, specifically in connection with the Environmental Impact Assessment for the Namaacha Wind Energy Project.

Full Name: Albert Froneman

Title / Position: Director

1. INTRODUCTION

This report details the findings of the revised Avifaunal Impact Assessment for the proposed Namaacha Wind Energy Project, a proposed wind farm with up to 21 turbines and an approximate capacity of 120 MW (the “Project”) located near the town of Namaacha, 50 km West of Maputo, Mozambique, and in close proximity to the border with South Africa and Eswatini (Swaziland) (**Figure 1-1**). The site covers an area of approximately 855 ha. Maputo province is the most southern of Mozambique’s provinces. It is bordered to the North by the Gaza province, the Indian Ocean and the city of Maputo to the East, the South African province of KwaZulu-Natal to the South, and Swaziland and Mpumalanga province of South Africa to the West.

An initial avifaunal baseline description and impact assessment was provided in the existing Environmental Impact Assessment (EIA) (Matos, Fonseca & Associados, 2022). However, since the Corrective Action Plan (CAP) was developed, the findings of the gap analysis indicated that the methods used to gather baseline data for avifauna populations for the original assessment were not aligned with standard guidance for pre-construction avifauna monitoring schemes to inform WEF impact assessments. WSP were appointed by Central Electrica da Namaacha SA to conduct avifaunal monitoring to the required standard over a 12-month period and to revise the existing avifaunal impact assessment and mitigation measures based on the findings, in line with best practise guidelines.

This report builds on the previous avifaunal impact assessment, using the updated baseline avifauna dataset to identify sensitive receptors and assess potential WEF impacts on them accordingly. In addition, the existing proposed mitigation measures are reviewed and enhanced in an effort to avoid and minimise impacts on birds – and on priority avifauna species in particular.

1.1. PROJECT DESCRIPTION

The Namaacha WEF will consist of the installation of wind turbines, which will be distributed over an area of approximately 855 ha. with a total power generation capacity of 120 MW. The facility is expected to produce approximately 340 GWh per year.

The proposed Namaacha WEF has two possible operational designs, with two different turbine layouts, which include:

- A WEF comprising of up to 21 Nordex N163 5.9 MW wind turbines with a 118 m hub height, or
- A WEF comprising of up 20 Goldwind 165 6.0 MW wind turbines with a hub height of 120 m.

The proposed project components include the following:

- Wind turbines (height of approximately 120m from the base to the hub, with a rotor diameter of approximately 150 m) and concrete foundations;
- Substation (consisting of a panel with 275 kV equipment and a transformer within a fenced-off area);
- Internal power cable network (underground 30 kV cables connecting each wind turbine to the substation);
- Control building (with office, warehouse, and ablutions);
- Access roads; and
- Associated infrastructure (including overhead transmission line connecting the facility to the national grid).

1.2. TERMS OF REFERENCE

In line with the developed Corrective Action Plan (CAP) and based on the findings of the gap analysis, 12 months of pre-construction avifaunal monitoring surveys, and a revised avifaunal impact assessment and accompanying mitigation measures were required to be undertaken.

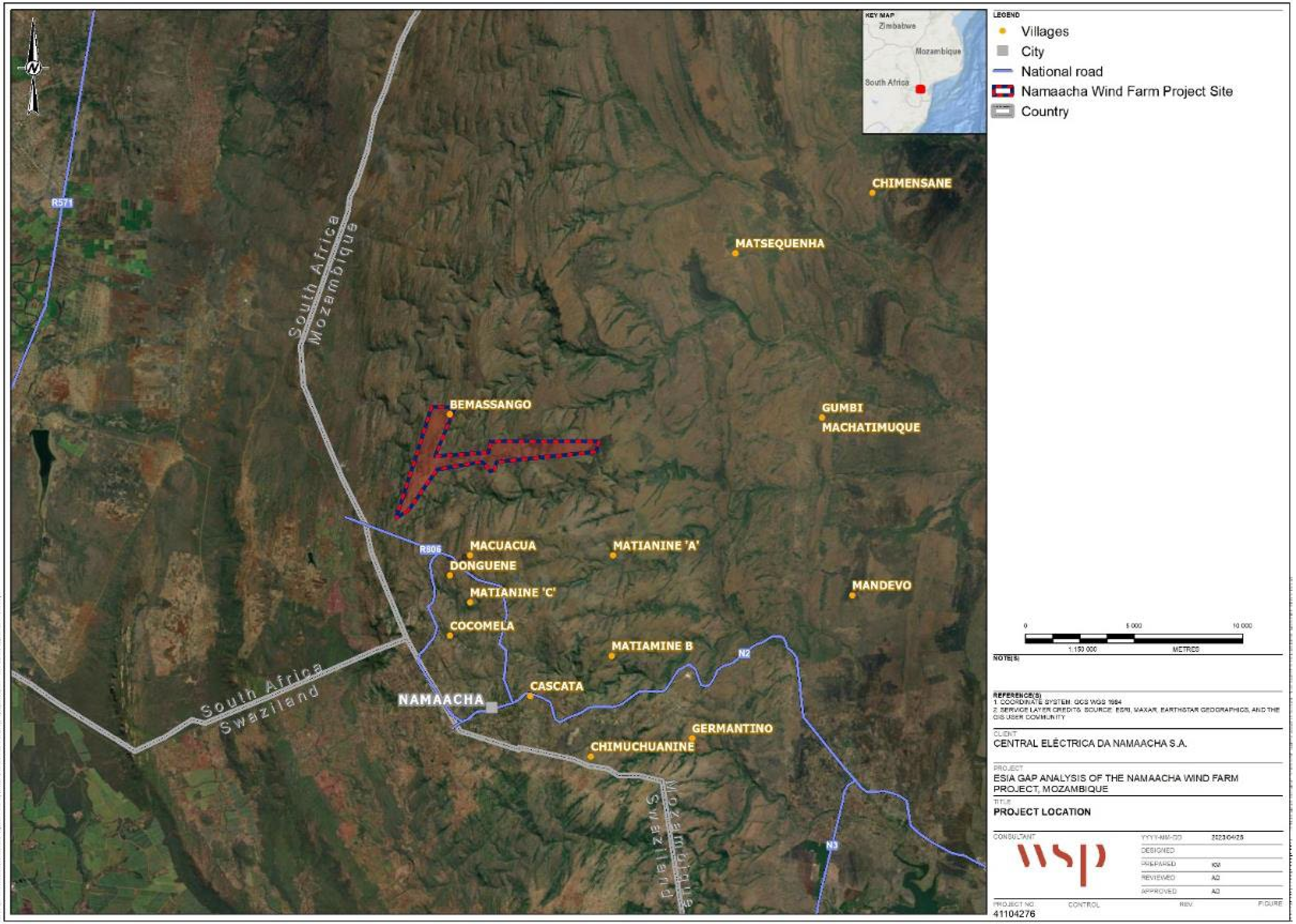


Figure 1-1 - Project Location (Source Area).

2. LEGISLATION AND POLICY CONTEXT

This section describes the requirements of the IFC Performance Standard 6 on biodiversity conservation and sustainable management of living natural resources (IFC, 2012). An overview of pertinent Mozambican policy and international agreements on biodiversity conservation is also provided.

2.1. NATIONAL STRATEGY AND ACTION PLAN OF BIOLOGICAL DIVERSITY OF MOZAMBIQUE (2015-2035)

One of the four strategic objectives of the National Strategy and Action Plan of Biological Diversity of Mozambique (NSAPBDM) 2015-2035 is to improve the benefits sharing from biodiversity and ecosystem services for all sectors of Mozambican society, Actions that have been identified towards achieving this objective include the development of tools to value ecosystem services, and defining sustainable levels of extraction for the main ecosystem services which are listed as firewood, charcoal, honey, wood, building materials, hunting and agriculture.

To the extent possible, the mitigation measures devised as part of the ecosystem services impact assessment process presented in this report aim to align with the NSAPBDM such that sustainable use of ecosystem services by local beneficiaries can continue throughout the construction and operation phases of the Project.

2.2. NATIONAL LEGISLATION

Key pieces of national legislation relevant to biodiversity in Mozambique are summarised in Table 2-1.

Table 2-1: Relevant national legislation pertaining to biodiversity

Legislation	Relevance
Environmental Law (Law 20/1997)	The Environment Law is the main instrument for all environmental activities in Mozambique. Of particular relevance to biodiversity are numbers 1 and 2 of Article 12 on Biodiversity Protection, which can be summarised as follows: all activities against the conservation, reproduction, quality and quantity of biological resources, especially those threatened with extinction, are prohibited the Government shall ensure that (a) appropriate maintenance and regeneration of species action is taken; (b) rehabilitation of degraded habitats and creation of new habitats, mainly by controlling the activity or use of substances that may harm the wildlife species and their habitats is undertaken; and (c) plant species threatened with extinction or of botanical specimen that require special protection due to their genetic potential, size, age, rarity, scientific and cultural value are specially protected.
Land Law (Law 19/97)	Sets out Total Protection and Partial Protection Areas, i.e. Protected Areas.
Law of Forestry and Wildlife (Law 10/99)	Promotes the sustainable use and protection initiatives, conservation of forest and wildlife resources

Legislation	Relevance
Conservation Areas Law (Law 16/2014)	This law represents the first legal tool in Mozambique that refers to "no net loss of biodiversity" to indicate that public and private entities engaged in natural resources in conservation areas, or their buffer zones should compensate for the negative impacts (MITADER, 2015). It assigns 10 categories of conservation areas, three of which are ‘protected area’ and seven of which are ‘sustainable use’ areas.
Decree nº 25/2008, of 1 of July Regulation for Invasive Alien Species	Decree nº 25/2008, of 1 of July Regulation for Invasive Alien Species
Decree nº 16/2013, of 26 of April	Regulation on International Trade of Endangered Species of Fauna and Flora

2.3. IFC PERFORMANCE STANDARD 6

At the project financing level, the management of biodiversity is addressed by IFC Performance Standard 6 (PS6) (IFC, 2012), and the supplementary Guidance Notice 6 (GN6) (IFC, 2019).

The requirements set out in PS6 have been guided by the Convention on Biological Diversity. PS6’s main priority is that proposed project infrastructure and activities should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimise impacts and restore biodiversity and ecosystem services should be implemented.

However, when a project occurs in critical habitat supporting exceptional biodiversity value, a net gain in biodiversity value is required.

PS6 sets specific biodiversity protection and conservation standards relating to potential project impact. The specific requirements are separated according to the following categories:

- **Modified Habitat**: Areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area’s primary ecological functions and species composition. PS6 relates to areas of modified habitat that have significant biodiversity value, and requires that impacts on such biodiversity must be minimised, and mitigation measures implemented as appropriate;
- **Natural Habitat**: Viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area’s primary ecological functions and species composition. In such areas, the conservation outcome required by PS6 is no-net-loss of biodiversity value achieved using the “like-for-like” or better principle of biodiversity offsets, where feasible;
- **Critical Habitat**: Areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary processes. When a project occurs in critical habitat supporting exceptional biodiversity value, a net gain in biodiversity value is required by PS6. This is achievable through appropriate biodiversity offsets;

- **Legally Protected and Internationally Recognised Areas**: Such areas often have high biodiversity value; when this is the case these areas are likely to qualify as critical habitat and, as such, the conservation outcome required by PS6 is also a net gain in biodiversity value, as well as obtaining the relevant legal permits, following standard governmental regulatory procedures, and engagement of affected communities and other stakeholders;
- **Invasive Alien Species**: The development project should not intentionally introduce any new alien species (unless carried out within the appropriate regulatory permits) and should not deliberate any alien species with a high risk of invasive behaviour under any circumstance. PS6 requires that any introduction of alien species be the subject of a risk assessment for potential invasive behaviour, and that the project should implement measures to avoid the potential for accidental or unintended introductions; and
- **Management of Ecosystem Services**: Where a project is likely to adversely impact ecosystem services, an ecosystem service review to identify priority ecosystem services is required. Priority ecosystem services are (i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to Affected Communities; and/or (ii) those services on which the project is directly dependent for its operations (for example, water). If adverse impacts on Priority ecosystem services are unavoidable, these must be minimised and mitigation measures that aim to maintain the value and functionality of priority services implemented. With respect to impacts on priority ecosystem services on which the project depends, impacts on ecosystem services should be minimised and measures that increase resource efficiency of their operations implemented.

2.4. INTERNATIONAL CONVENTIONS AND AGREEMENTS

Mozambique is a signatory to the following applicable international conventions and agreements relating to biodiversity:

- Convention on Biological Diversity (CBD) (Signed 1992): Under the convention, each contracting party is expected to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity;
- Convention on International Trade in Endangered Species (CITES) (Signed 1976);
- Convention on the Conservation of Migratory Species of Wild Animals (CMS), (also referred to as the Bonn Convention) (Signed 1990);
- United Nations Convention to Combat Desertification (26 December 1996);
- Convention on Wetlands of International Importance (the Ramsar Convention); and
- UNESCO World Heritage Commission.

3. METHODOLOGY

This section presents the approach used to develop the consolidated baseline description of avifauna in the Project study area, incorporating both the previous bird survey findings (Matos et al., 2022) and the results of the recently completed preconstruction monitoring surveys (Chris van Rooyen Consulting, 2023).

The method used to identify and assess the potential direct and indirect impacts of the construction and operational phases of the WEF on avifauna receptors is described.

3.1. BASELINE DATA GATHERING

3.1.1. LITERATURE REVIEW AND GAP ANALYSIS

A gap analysis of the previous EIA for the project in the context of the IFC PS6 requirements, subsequent to which a Corrective Action Plan was developed which detailed the supplementary environmental and social studies necessary to prepare the ESIA to meet lender's standards, was conducted by WSP in 2022. While bird surveys had been done in support of the original ESIA, the methods used were not aligned with those considered as international best practise (e.g. ifc.org 2015; Jenkins et al., 2015). The baseline bird data provided in the original ESIA was reviewed and utilised as scoping input for the design of the preconstruction monitoring surveys that were subsequently conducted by Chris van Rooyen Consulting in support of this revised impact assessment.

3.1.2. PRE-CONSTRUCTION MONITORING SURVEYS

The Environmental, Health, and Safety Guidelines for Wind Energy (EHS Guidelines) were published by the World Bank Group, (ifc.org 2015) of which the IFC is a member. The EHS Guidelines contain the performance levels and measures that are normally acceptable to the World Bank Group, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology. The World Bank Group requires borrowers/clients to apply the relevant levels or measures of the EHS Guidelines. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will be required to achieve whichever is more stringent.

The objective of the 12 months of pre-construction monitoring at the proposed Namaacha Wind Energy Facility (WEF) was to gather pre-construction baseline data according to internationally accepted standards e.g., the World Bank Environmental, Health, and Safety Guidelines for Wind Energy (EHS Guidelines) (IFC 2015) and the IFC Performance Standards (IFC 2012) on the following aspects pertaining to avifauna:

- The abundance and diversity of birds at the proposed WEF, and a suitable control site to measure the potential displacement effect of the wind farm.
- Flight patterns of priority species at the WEF to assess the potential collision risk with the turbines.

Table 3-1 - Surveys conducted at the proposed Namaacha Wind Farm

Survey	Date	Season
1	9 – 17 November 2022	Spring
2	28 February to 6 March 2023	Summer
3	25 March to 2 April 2023	Autumn

4	30 May to 05 June 2023	Winter

Monitoring was conducted with reference to the specific guidance related to pre-construction assessments of birds for onshore wind farms set out in the Environmental, Health, and Safety Guidelines for Wind Energy (EHS Guidelines) (ifc.org 2015), and in document '*Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa'* which was produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa (Jenkins et al., 2015). The South African guidelines were followed since Mozambique does not have its own guidelines for assessing the impacts of wind energy facilities on avifauna, and since the South African guidance is considered best practise and conforms to the requirements of the World Bank Group: Environmental, Health and Safety Guidelines for Wind Energy (August 2015).

Additional guidance used to inform the monitoring included:

- Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & Smit. A.H. 2015. *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa.* Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa. Henceforth this will be referred to as the SA Wind Guidelines.

Wind priority species were identified using the latest (November 2014) BirdLife SA (BLSA) list of priority species for wind farms. The BLSA list of priority species consider the following factors:

- Family groups of bird that were killed or otherwise affected by wind farms in the rest of the world. Other families of birds that do not occur in the rest of the world and that might be affected by wind farms (for example all larger birds) were also added to the list.
- Conservation status (regional and global)
- Endemic status (southern Africa)
- Range size
- Morphology
- Behaviour

The International Union for Conservation of Nature (IUCN) Red List of Threatened Species was consulted to determine the conservation status of the priority species that were recorded. Established in 1964, the International Union for Conservation of Nature's Red List of Threatened Species has evolved to become the world's most comprehensive information source on the global extinction risk status of animal, fungus and plant species.

Full details on the methods used for bird surveys conducted during preconstruction monitoring are provided in Appendix A (Chris van Rooyen Consulting, 2023).

3.2. IMPACT ASSESSMENT

The revised impact assessment was conducted for the construction and operation phases of the Project, using the same impact assessment method that was utilised in the original ESIA (Matos et al., 2022). The method involves four essential aspects:

- **Description of The Impact**: All identified impacts were described based on the current state of the environment (Table 3-2). Once the technical description of each impact was completed, it was analytically characterized by applying the descriptors presented in Table 3-3. For every impact, a scale was assigned for each of the descriptors, i.e., for each impact, the type of impact was defined (positive/negative; direct/indirect/secondary). The extent, duration, reversibility and probability of each impact was also defined;

- **Impact Assessment**: For each identified impact, a significance level was assigned according to the criteria described in Table 3-4. The degree of significance of each impact was assigned by evaluating and defining two essential aspects: The magnitude of the impact, and the sensitivity of the resource or receiver that is impacted. After characterizing the magnitude impact and sensitivity of the receiving medium, the respective degree of significance was assigned, according to Table 3-5;
- **Mitigation Measures:** In order to comply with IFC requirements, minimization measures must be implemented whenever possible. According to the mitigation hierarchy, the focus is to avoid impacts, but when it is not possible, the impacts must be minimized, and the remaining residual impacts compensated;
- **Residual Impact Assessment**: After all acceptable minimization measures and technically feasible to be identified, a degree of significance was assigned to the residual impact. The significance level assignment process is the same as described above in the impact assessment stage, taking into account the reduction of the impact (or increase if it is positive) after the implementation of recommended mitigation measures.

Table 3-2 - Description of Impact

Descriptor	Scale	Explanation
Nature of impact	Positive	Impact that represents an improvement of the baseline situation or introduces a positive change.
	Negative	Impact that represents an adverse change from the baseline situation or introduces an undesirable factor.
	Direct	Impact arising directly from activities that are an integral part of the project (e.g., new infrastructure).
	Indirect	Impact that arises indirectly from activities that are not an integral part of the project (e.g., noise due to the movement of vehicles and machinery).
	Secondary	Secondary or change-induced impact due to the Project (e.g., employment opportunities due to material and labour requirements).
Scope	Site	The impact will be limited to the work site.
	Local	The impact will be limited to the local area.
	Regional	The impact will be limited to the region.
	National	The impact will be national.
	International	The impact will be international.
Duration	Temporary	The impact is expected to be very short-lived (days) and/or intermittent/occasional.

Descriptor	Scale	Explanation
	Short-term	The impact is expected to be short term (0 to 5 years).
	Medium-term	The impact is expected to last 5 to 15 years.
	Long term	The impact will prevail over the life of the project. It will disappear when the project ends operations, i.e. deactivated (normally >15 years).
	Permanent	Impact that causes a permanent and irreversible change in the affected recipient or resource.
Probability	Unlikely	Impact not likely to happen.
	Likely	There is a possibility that the impact will occur.
	Very likely	It is very possible that the impact will happen.
	Right	The impact will occur regardless of any preventive measures.
Reversibility	Immediate	The impact is immediately reversible.
	Reversible	The impact is reversible within 2 years after the cause of the impact is removed.
	Irreversible	The activity will lead to an impact that in all practical terms will be permanent.

Table 3-3 - Magnitude of impact and vulnerability of the receiving environment/receptor

Descriptor	Definition	Scale	Explanation
Impact magnitude	Describes the expected intensity of change to the resource/receiver as a result of the impact	Negligible	Impact is minimal and will have no effect on the environment.
		Reduced	The impact is reduced and will result in the processes continuing in an altered form. Reduced environmental changes. No involuntary resettlement. Good information and high awareness of potential environmental factors influencing impact. High degree of confidence.
		Moderate	The impact is moderate, and processes will be significantly changed and may be temporarily halted. Moderate environmental changes. Involuntary resettlement and limited economic displacement. Reasonable amount of information and relatively good perception of potential environmental factors influencing impact. Reasonable degree of confidence.
		High	The impact is high and results in the complete destruction of patterns and

Descriptor	Definition	Scale	Explanation
			permanent interruption of processes. Destruction of rare or endangered species. Depreciation of the character or quality of important historical, archaeological, architectural or aesthetic resources or the character of a community/ neighbourhood. Negative effects on vulnerable or disadvantaged communities. Involuntary resettlement and substantial economic displacement. Limited information and limited insight into potential environmental factors influencing impact. Low degree of confidence.
Sensitivity	The importance of the environmental attribute in question, the distribution of change in time and space.	Low	Degraded areas, with little conservation value or unimportant as a resource for humans. Affected species are not listed or protected. The importance of an environmental resource or attribute is based on knowledge, technical, or scientific or appreciation of the characteristics of critical resources.
		Average	Areas with conservation value at the local or regional level, or with potential use for humans. Affected species may be regionally red listed or protected. Audience segments recognize the importance of an environmental feature or attribute. Public recognition can take the form of support, conflict or opposition. Public action can be expressed formally or informally. The environment is susceptible to change
		High	Areas with regional or national conservation value and important human resource. Affected species may be globally red listed, or protected at a national level. The importance of an environmental feature or attribute is recognized by law, plans or policy statements from government agencies or private groups. The environmental resource affected is significant. The environment is sensitive to change.

Table 3-4 - Impact Significance Matrix

Significance		**Sensitivity**		
		Low	**Average**	**High**
Magnitude	**Insignificant**	Insignificant	Negligible	Negligible
	Reduced	Negligible	Reduced	Moderate

Significance		Sensitivity		
		Low	Average	High
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High
	Positive impacts			
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High

Table 3-5 - Description of The Degrees of Significance Of Impacts

Impact rating	Description
Negative impacts	
Insignificant	The receiving environment will not be affected by the activity. Impacts do not require further assessment.
Negligible	The effect of an activity on the receptive environment is not significant enough to be observed. Impacts do not need to be minimized and are not a concern in decision-making processes.
Reduced	Detectable changes in the baseline situation are expected, in addition to natural variations, but difficulties, degradation or damage to the function and value of the resource/receptor are not expected. The significance of impacts is within the applicable parameters.
Moderate	Moderate significance indicates that an impact may reach the threshold of legal limits. Substantial impacts that could result in lasting changes to the baseline are anticipated. These impacts are a priority in minimizing, in order to prevent or reduce the significance of the impact.
High	A high degree of significance means that legal limits or standards have been exceeded or impacts of high magnitude have occurred in highly sensitive environments or affected people. Residual impacts with high significance can be considered a fatal project failure. High residual impacts must be further avoided or minimized, in order to avoid severe impacts on the receiving environment.
Positive impacts	
Reduced	Impacts of reduced significance are noticeable, but do not permanently and radically improve the receiving environment, or benefit those affected. There is compliance with all standards and legislation.
Moderate	Positive impacts are felt and results in measurable improvements relative to baseline. There is compliance with all standards and legislation.
High	Impacts of high significance that provide substantial benefits where large improvements are felt over an extended period of time. There is compliance with all standards and legislation.

4. UPDATED BASELINE DESCRIPTION OF AVIFAUNA

The baseline description is based on the findings of the pre-construction monitoring surveys conducted by Chris van Rooyen Consulting from November 2022 to June 2023 (Appendix A). It summarises the findings of those surveys and includes the identification of specific avifauna species receptors/receptor groups, for which impacts were assessed in detail.

4.1. RECEIVING ENVIRONMENT

The Source Area (Project Site) is located in the Savanna Biome on an elevated plateau surrounded by deep, thickly wooded valleys. The vegetation is dominated by *Vachellia* and *Combretum* species and supports *Vachellia* woodlands, *Combretum* woodlands, mixed woodlands, *Vachellia* degraded woodland, small forest patches, small streams, grassland patches, a few subsistence agricultural areas and a few small dwellings.

In the Namaacha region, the forest extends over the Lebombo mountain range, especially in deeper valleys and along south-eastern slopes. The canopy varies in height between 10 m and 35 m. Although the composition of the tree species varies, it is dominated by *Chrysophyllum viridifolium*, *Homalium dentatum*, *Combretum kraussii* and several species of *Ficus* spp, *Celtis* spp and *Strychnos* spp. The tall open canopy bushes include *Buxus natalensis*, *Englerophytum natal* and *Rothmannia globose*.

Namaacha has a sub-tropical climate. The district's yearly average temperature is 26°C, with an average daily summer temperature of around 32°C, and average winter daily temperatures of around 23°C. Namaacha typically receives about 837 millimetres of annual precipitation and has 120.04 rainy days (32.89%) annually (https://tcktcktck.org/mozambique/maputo/namaacha). The primary land-use in the area is live-stock grazing.

Refer to **Appendix C** for examples of the bird habitat at and near the Source Area (i.e., the Project Site).

4.2. AVIFAUNA AT THE SOURCE AREA

A total of 203 bird species were recorded within the Project area during the 2022 and 2023 surveys; of which, 21 species are considered bird species of concern and/or priority species for wind energy developments. Refer to Appendix B for the full list of recorded species.

4.3. PRIORITY SPECIES AND RED LIST SPECIES

Priority species that are typically impacted by wind developments have been identified by using a sensitivity rating based on several features of birds in neighbouring South Africa (Retief et al. 2012). The criteria for the sensitivity rating include the morphological features and behaviour of birds, their conservation status, and their range. While the range information is not directly applicable to the Mozambiquan context, the conservation status and the features of the bird species themselves are relevant and were therefore deemed appropriate to use as a proxy.

The latest IUCN Red List of Threatened Species (2022.2) (http://www.iucnredlist.org/) was used to determine the conservation status of all priority species. Any species with a global threatened status of Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and Near Threatened (NT) were identified and are hereafter defined as **red list species**.

The list of Priority species (and their Red List status) identified for this Project and confirmed on site during preconstruction monitoring surveys is provided in Table 4-1. Note that species that are Endangered, Critically Endangered or that are range restricted can also trigger critical habitat classification as defined under IFC's Performance Standard 6.

Table 4-1: Priority species recorded during pre-construction monitoring surveys (2022–2023).

Common Name	Scientific Name	IUCN Classification
White-backed Vulture	Gyps africanus	**CR**
Bateleur	*Terathopius ecaudatus*	**EN**
Martial Eagle	*Polemaetus bellicosus*	**EN**
Crowned Eagle	*Stephanoaetus coronatus*	**NT**
African Harrier-Hawk	*Polyboroides typus*	LC
African Hawk-Eagle	*Aquila spilogaster*	LC
Black Stork	*Ciconia nigra*	LC
Black-bellied Bustard (Korhaan)	*Lissotis melanogaster*	LC
Black-chested Snake Eagle	*Circaetus pectoralis*	LC
Black-winged Kite	*Elanus caeruleus*	LC
Brown Snake Eagle	*Circaetus cinereus*	LC
Common Buzzard	*Buteo buteo*	LC
Jackal Buzzard	*Buteo rufofuscus*	LC
Lanner Falcon	*Falco biarmicus*	LC
Peregrine Falcon	*Falco peregrinus*	LC
Shelley's Francolin	*Scleroptila shelleyi*	LC
Short-tailed Pipit	*Anthus brachyurus*	LC
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC

* Endemic species to Southern Africa (Southern African countries include Botswana, Eswatini, Lesotho, Mozambique, Namibia, South Africa and Zimbabwe).

The habitat preferences of the Red List species that were recorded during the study are discussed below:

Bateleur

Bateleur eagles prefer open woodland and tree savanna, extending into bush savanna but less into scrubby steppe and grassland. They are occasionally recorded over forest and wetlands, but only while travelling between suitable areas of habitat (Hockey et al. 2005). They are found from sea-level to 4500 m, but mainly below 3000 m (Ferguson-Lees & Christie 2001).

Crowned Eagle

Crowned Eagles prefer forest and dense woodland, from extensive lowland rainforest to small patches of montane and riverine forest, and even stands of mature exotic plantations, e.g. eucalypts in South Africa (Ferguson-Lees & Christie 2001). In north-eastern South Africa there is a preference for nesting in the Northern Mistbelt Forest vegetation type and a study found 82% of nests (n = 28) located in indigenous trees (Swatridge et al. 2014). There is also a record from Zimbabwe of pair nesting in a large gum tree in a garden of a homestead for 10+ years (O'Donoghue 2002). When foraging, Crowned Eagles move into surrounding secondary forest or dry savanna where necessary. They have been recorded from sea-level to at least 3300 m asl (Ash & Atkins 2009).

Martial Eagle

Martial Eagles prefer sparse woodlands and woodland edges and other open habitats such as deserts, steppes, savannas, grasslands and shrublands (Hockey et al. 2005). They generally avoid settled areas. They occur mostly below 1500 m elevation, occasionally up to 3000 m (Ferguson-Lees & Christie 2001).

White-backed Vulture

In southern Africa, White-backed Vultures are locally common across the northern half of the region, extending into the savanna and grassland of South Africa. They generally prefer arid savanna with scattered trees, such as Mopane *Colosphermum mopane*, avoiding dense forests, deserts, treeless grassland and shrubland (Hockey et al. 2005).

4.4. RESULTS OF PRE-CONSTRUCTION MONITORING

4.4.1. TRANSECTS

The aggregated results of the pre-construction monitoring surveys are presented in Tables 4-2 and 4-3 and Figures 4-1 to 4-2. Figures 4-1 and 4-2 present the transect count data of priority species for the Source Area and the Control Site, presented as an Index of Kilometric Abundance (IKA = number of bird observations/km).

Table 4-2: The results of the transect counts.

Source Area					
Species Composition	**Survey 1**	**Survey 2**	**Survey 3**	**Survey 4**	**Grand Total**
Priority Species	10	10	6	9	17
Non-Priority Species	90	73	85	80	140
Total	**100**	**83**	**91**	**89**	**157**
Individual Records					**Grand Total**
Drive Transect Sightings	1017	560	517	490	2584
Walk Transect Sightings	802	594	667	569	2632
Total	**1819**	**1154**	**1184**	**1059**	**5216**
Control Site					
Species Composition	**Survey 1**	**Survey 2**	**Survey 3**	**Survey 4**	**Grand Total**
Priority Species	7	5	6	4	12
Non-Priority Species	104	98	105	85	151
Total	**111**	**103**	**111**	**89**	**163**

Individual Records					Grand Total
Drive Transects	872	654	649	439	2614
Walk Transects	745	789	791	535	2860
Total	**1617**	**1443**	**1440**	**974**	**5474**

Table 4-3: Priority species abundance recorded within the Source Area - Transects

Common Name	Scientific Name	IUCN Classification	Survey 1	Survey 2	Survey 3	Survey 4	Grand Total
African Harrier-Hawk	*Polyboroides typus*	LC	-	2	-	-	2
African Hawk-Eagle	*Aquila spilogaster*	LC	-	4	-	2	6
Bateleur	***Terathopius ecaudatus***	**EN**	-	-	1	1	2
Black Stork	*Ciconia nigra*	LC	-	-	-	5	5
Black-bellied Bustard (Korhaan)	*Lissotis melanogaster*	LC	4	2	-	1	7
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	2	2	2	-	6
Black-winged Kite	*Elanus caeruleus*	LC	-	-	-	3	3
Brown Snake Eagle	*Circaetus cinereus*	LC	2	4	6	3	15
Common Buzzard	*Buteo buteo*	LC	12	1	-	-	13
Crowned Eagle	***Stephanoaetus coronatus***	**NT**	3	-	-	-	3
Jackal Buzzard	*Buteo rufofuscus*	LC	2	3	-	2	7
Lanner Falcon	*Falco biarmicus*	LC	-	2	-	-	2
Martial Eagle	***Polemaetus bellicosus***	**EN**	1	-	2	2	5
Peregrine Falcon	*Falco peregrinus*	LC	-	-	1	-	1
Shelley's Francolin	*Scleroptila shelleyi*	LC	3	2	5	9	19
Short-tailed Pipit	*Anthus brachyurus*	LC	1	-	-	-	1
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	9	2	-	-	11

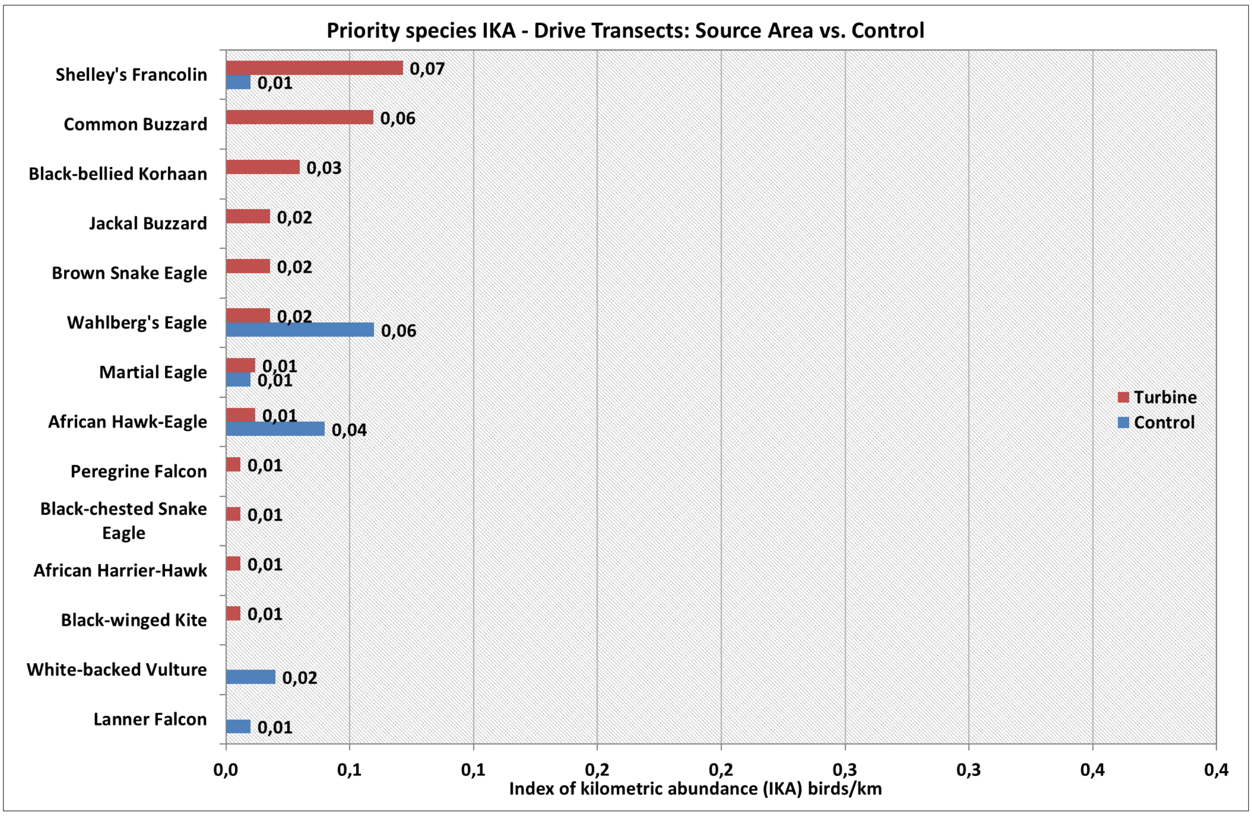


Figure 4-1: IKA of priority species recorded during drive transect at the Source Area (red) vs. Control Site (blue) after four surveys.

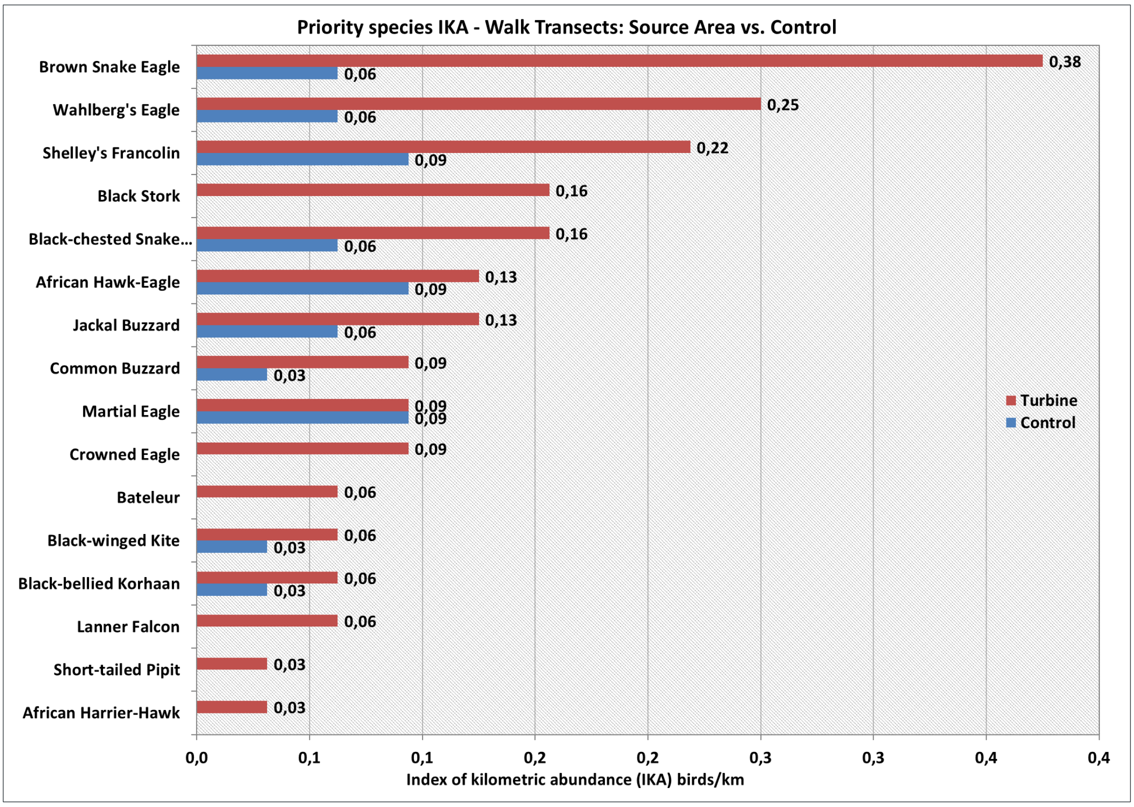


Figure 4-2: IKA of priority species recorded during walk transects at the Source Area (red) vs. Control Site (blue) after four surveys.

4.4.2. INCIDENTAL COUNTS

The following priority species were recorded as incidental records (between formal surveys) while travelling on and in the immediate vicinity of the Source Area. Incidental records provide valuable additional information on the species present in the area.

Table 4-4: Priority species recorded as incidental records on or near the Source Area

Priority Species		IUCN Status	V1	V2	V3	V4	Grand Total
African Fish Eagle	*Haliaeetus vocifer*	LC	0	0	0	1	**1**
African Harrier-Hawk	*Polyboroides typus*	LC	2	0	0	0	**2**
Black-bellied Korhaan	*Lissotis melanogaster*	LC	3	0	0	0	**3**
Black-chested Snake Eagle	*Circaetus pectoralis*	LC	2	1	0	0	**3**
Brown Snake Eagle	*Circaetus cinereus*	LC	3	0	1	1	**5**
Common Buzzard	*Buteo buteo*	LC	12	0	0	0	**12**
Crowned Eagle	***Stephanoaetus coronatus***	**NT**	0	0	0	1	**1**
Jackal Buzzard	*Buteo rufofuscus*	LC	0	1	0	0	**1**
Lanner Falcon	*Falco biarmicus*	LC	2	0	0	0	**2**
Spotted Eagle-Owl	*Bubo africanus*	LC	0	2	2	1	**5**
Wahlberg's Eagle	*Hieraaetus wahlbergi*	LC	4	0	0	0	**4**
White-backed Vulture	***Gyps africanus***	**CR**	2	0	0	0	**2**
Woolly-necked Stork	*Ciconia episcopus*	LC	1	0	0	0	**1**

4.4.3. VANTAGE POINTS

Please see the summary of flight data obtained from Vantage Point watches after four surveys at the Source Area below and in Figures 4-3.

Table 4-5: Summary of flight data i.e., time spent by priority species at each altitude band during the four surveys at the Source Area – 96 hours of observation. Time is indicated in hours (HH) minutes (MM) and seconds (SS).

Priority Species	Low altitude (<30m)	Medium altitude (30m – 300m)	High altitude (>300m)	Total
Survey 1 - Spring				
African Harrier-Hawk		0:26:20		0:26:20
Black Stork		0:39:07		0:39:07
Black-Bellied Bustard	0:00:24			0:00:24
Black-Chested Snake Eagle	0:00:09	7:57:03		7:57:12
Brown Snake Eagle	0:00:09	0:00:08		0:00:17
Common Buzzard	0:00:05	5:06:21		5:06:26
Crowned Eagle		1:36:46		1:36:46
Jackal Buzzard		1:00:14		1:00:14
Lanner Falcon		0:11:09		0:11:09
Wahlberg's Eagle	0:01:39	7:26:59	0:09:46	7:38:24
Survey 2 - Summer				
African Harrier-Hawk	0:01:03	0:00:15		0:01:18

Priority Species	Low altitude (<30m)	Medium altitude (30m – 300m)	High altitude (>300m)	Total
African Hawk-Eagle	0:38:20	1:30:32		2:08:52
Bateleur (EN)		0:43:42		0:43:42
Black-Chested Snake Eagle		11:57:58		11:57:58
Brown Snake Eagle		3:10:36		3:10:36
Common Buzzard		0:16:32		0:16:32
Jackal Buzzard		2:50:44		2:50:44
Lanner Falcon		0:04:30		0:04:30
Wahlberg's Eagle		3:40:52		3:40:52
Woolly-necked Stork		0:06:55	0:03:17	0:10:12
Survey 3 - Autumn				
African Harrier-Hawk	0:00:06			0:00:06
Bateleur (EN)		0:06:08		0:06:08
Black-Chested Snake Eagle		3:56:12		3:56:12
Brown Snake Eagle		13:30:54		13:30:54
Crowned Eagle		0:11:38		0:11:38
Jackal Buzzard		0:06:46		0:06:46
Martial Eagle (EN)		2:29:20	0:08:08	2:37:28
Wahlberg's Eagle		0:09:29		0:09:29
Survey 4 - Winter				
African Harrier-Hawk	0:01:08	0:07:26		0:08:34
African Hawk-Eagle		0:52:40		0:52:40
Bateleur (EN)		0:20:27		0:20:27
Black Stork		2:00:12		2:00:12
Black-Chested Snake Eagle		0:19:58		0:19:58
Black-winged Kite	0:04:04	0:19:26		0:23:30
Brown Snake Eagle		3:50:33		3:50:33
Jackal Buzzard		0:20:08		0:20:08
Lanner Falcon		0:03:11		0:03:11
Martial Eagle (EN)		1:32:13		1:32:13
Total	**0:47:07**	**79:03:24**	**0:21:11**	**80:11:42**

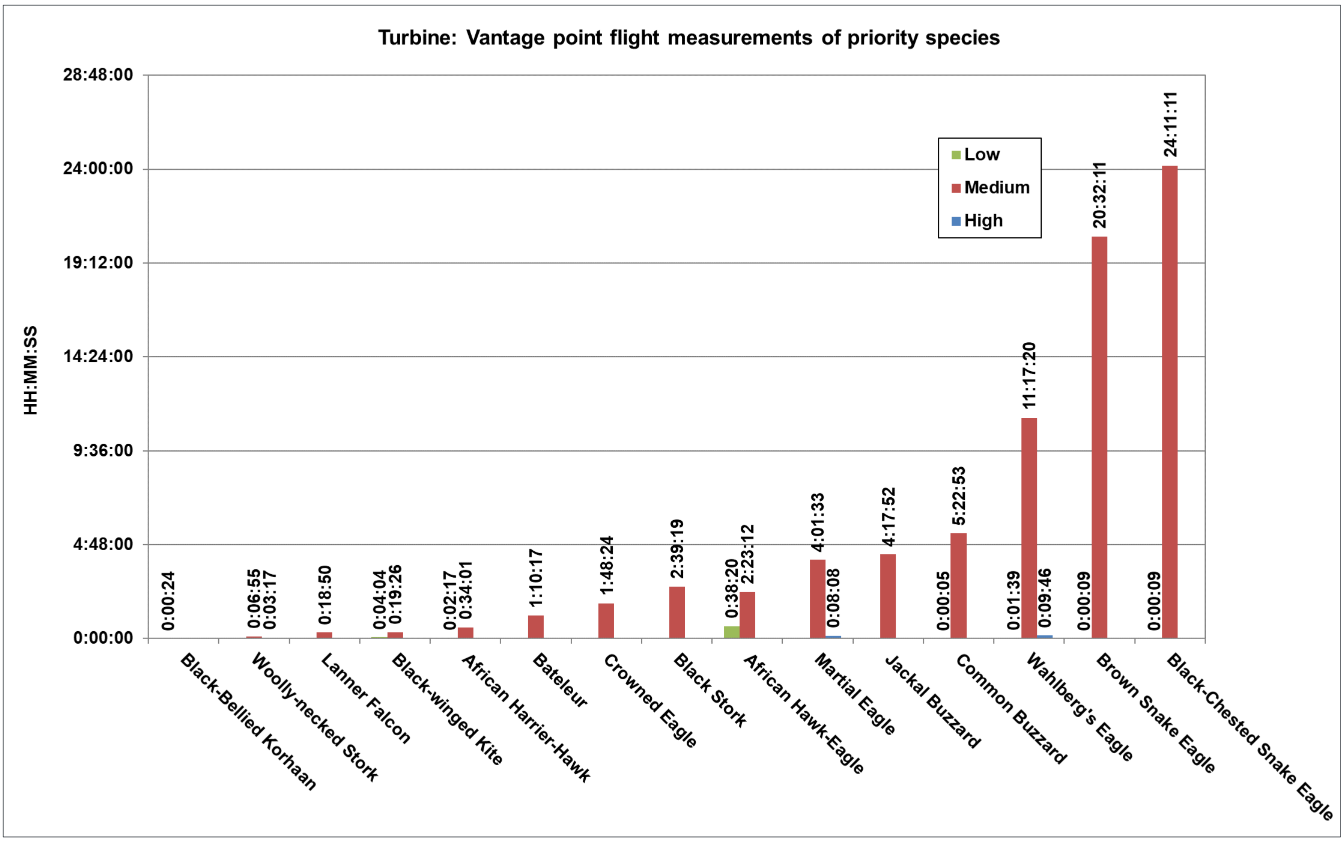


Figure 4-3: Flight time and altitude recorded for all individuals of priority species after four surveys at the Source Area (96 hours of observation). Time is indicated in hours: minutes: seconds. Flight altitude is indicated as low (green/<30m), red/medium/30 – 300m, blue/high/>300m).

Figure 4-4 displays the flight lines of Red Listed priority species recorded from the Source Area vantage points. The Source Area contained high flight activity of Red Listed priority species.

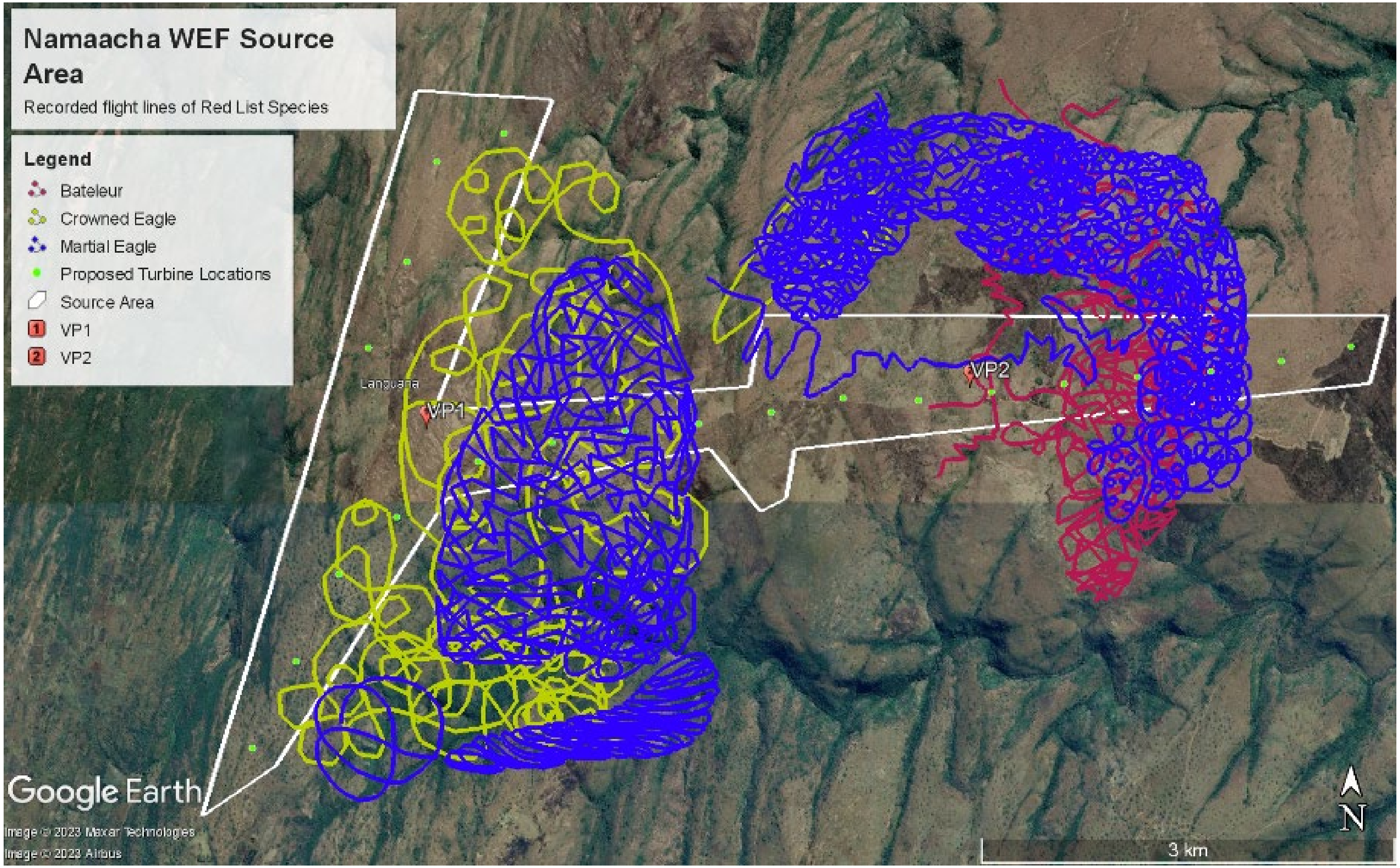


Figure 4-4: The flight lines of Red List species recorded after four surveys at the Source Area.

4.4.4. FLIGHT ACTIVITY

Flight lines of priority species were recorded at the WEF Site during Vantage Point watches during each of the four surveys. The recorded flight lines for priority species after four surveys is shown in **Appendix D.**

4.4.5. COLLISIONS RISK RATINGS

To determine which priority species are most at risk of turbine collisions, a site-specific rating was calculated. Values for each priority species was calculated considering the following factors:

- The duration of rotor altitude flights (medium height flights);
- The susceptibility to collisions, based on morphology (size) and behaviour (soaring, predatory, ranging behaviour, flocking behaviour, night flying, aerial display and habitat preference) using the ratings for priority species in the Avian Wind Farm Sensitivity Map of South Africa (Retief et al., 2012); and
- The number of turbines.

The collision risk ratings provide an estimate of which of the species that were recorded on the proposed development site are most at risk of collisions with the turbines as a result of their size, behaviour and flight times recorded in the rotor blade zone. The formula used is as follows[1]:

Duration of rotor altitude flights (as a fraction of 24 hours) x collision ratings in the Avian Wind Farm Sensitivity Map x number of turbines ÷100.

The results are presented in Table 4-6 below. These risk values are site specific and do not represent a percentage of risk per species. It represents the collision risk of a certain species in relation to other species that occur at the same site.

Table 4-6: Site Specific Collision Risk Rating

Species	Duration of medium height flights	Collision Rating	# turbines	Risk value
Woolly-necked Stork	0,005	85	21	0,09
Lanner Falcon	0,013	85	21	0,23
Black-winged Kite	0,013	57	21	0,16
African Harrier-Hawk	0,024	65	21	0,32
Bateleur	0,049	95	21	0,97
Crowned Eagle	0,075	80	21	1,26
African Hawk-Eagle	0,099	80	21	1,67
Black Stork	0,111	100	21	2,32
Martial Eagle	0,168	100	21	3,52
Jackal Buzzard	0,179	95	21	3,57

[1] It is important to note that the formula does not incorporate avoidance behaviour. This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of bird flights will successfully avoid the turbines (SNH, 2010).

Species	Duration of medium height flights	Collision Rating	# turbines	Risk value
Common Buzzard	0,224	75	21	3,53
Wahlberg's Eagle	0,470	85	21	8,40
Brown Snake Eagle	0,856	80	21	14,38
Black-Chested Snake Eagle	1,008	85	21	17,99

The potential WEF impacts pertaining to avifauna which were originally identified in the existing ESIA (Matos et al., 2022) are summarised in Table 4-7.

Table 4-7: Summarised potential adverse impacts on fauna receptors, including avifauna (Matos et al., 2022)

	Pre-mitigation impact			Residual impact		
Impact	**Magnitude**	**Sensitivity**	**Significance**	**Magnitude**	**Sensitivity**	**Significance**
Construction Phase						
Temporary destruction of wildlife habitat	Reduced	Average	Reduced	Insignificant	Average	Negligible
Removal of vegetation cover	Reduced	Average	Reduced	Insignificant	Average	Negligible
Decreased faunal activity	Reduced	Average	Reduced	Insignificant	Average	Negligible
Degradation of nearby habitats	Reduced	Average	Reduced	Insignificant	Average	Negligible
Operation phase						
Mortality of bird species with unfavourable conservation status due to collision with wind turbines	Reduced	Average	Reduced	Insignificant	Average	Negligible
Mortality of common bird species with favourable conservation status due to collision with wind turbines	Insignificant	Average	Negligible	Insignificant	Average	Negligible
Disturbance of bird species with unfavourable conservation status in the project area	Reduced	High	Moderate	Insignificant	High	Negligible
Disturbance of common bird species in the project area	Insignificant	Average	Negligible	Insignificant	Average	Negligible

The originally assessed impacts have been completely revised in this report to account for changes in the predicted impact magnitude, extent, duration etc. due to the presence of priority species which have been overlooked initially. In addition, species receptors/receptor groups are specifically addressed, rather than grouped simply into two categories (favourable or unfavourable conservation status). The updated and revised avifauna impact assessment for the construction and operation phases of the Project is presented in the sections that follow.

5. REVISED IMPACT ASSESSMENT

5.1. DISCUSSION OF PRECONSTRUCTION RESULTS

5.1.1. OVERVIEW

The Source Area (i.e., the Project Site) is unmistakably good habitat for raptors in particular, with 16 species recorded during the surveys (this constitutes 22% (16/71) of the raptor species known to occur in southern Africa and 25% (16/63) of the raptor species known to occur in Mozambique (south of the Zambezi River). The variety of species is significant for such a small site, with four Red List species recorded at the Source Area itself, i.e. Crowned Eagle (NT) Martial Eagle (EN), Bateleur (EN) and White-backed Vulture (CR). Based on the flight data recorded during the surveys, all the Red List raptor species are at risk of collisions with wind turbines. During the pre-construction monitoring, territorial display flights were observed for both Crowned Eagle and Martial Eagle, indicating that these species breed close to the Source Area.

The Source Area experienced high flight activity of priority species, particularly raptors, during the survey periods. Based on observed trends in extensive pre-construction bird monitoring data gathered for numerous WEF IA in southern Africa we suggest the following classification for passage rates at the Source Area as a whole within a southern African context: 1 < bird/hour = low, 1 – 2 birds per hour = moderate, 2 > birds/hour = high. Based on this classification, the passage rate for priority species would fall within the **high** category.

The passage rate for priority species at the Source Area after four surveys is high at 2.27 birds per hour, or approximately 29 birds per day[2]. The passage rate for Red List species at the Source Area after four surveys was 0.23 birds per hour, or approximately three (3) birds per day, which is low, but does point to a regular presence. It is important to note that despite the perceived low passage rate, the long duration that the individuals spent over the source area would increase their exposure to collision risk. It is important to note that the passage rate is calculated as the number of individuals counted per number of observation hours, and does not take into account the amount of time that the birds spend flying in the high risk zones. Thus, although the passage rate was calculated as low in the present study, the birds spend a considerable time flying over the source area within the rotor swept range, which escalates the risk of collision significantly.

Most of the recorded flights were at medium altitude (i.e., within the rotor swept area of wind turbines).

A consolidated list of all recorded species is attached as **Appendix B.**

5.1.2. CROWNED EAGLE (GLOBAL STATUS: NEAR THREATENED)

- Crowned Eagles were recorded during transect counts and vantage point watches during Survey 1 and 3, indicating a regular presence at the Source Area.

[2] Assuming 13 hours of daylight averaged over all four seasons.

- Crowned Eagles were also recorded on four occasions flying over the Source Area during Survey 1. They are most likely the same pair of birds breeding in one of the deep wooded valleys below the plateau (refer to Figure 5-1).
- Crowned Eagles were not observed over the Source Area during Survey 2.
- The passage rate for Crowned Eagle at the Source Area after four surveys was 0.05 birds/hour or approximately one bird every 1,5 days. All recorded flights at the Source Area were at medium altitude (within the turbine rotor swept area).
- The passage rate alludes to the regular presence of this species in and near the Source Area.

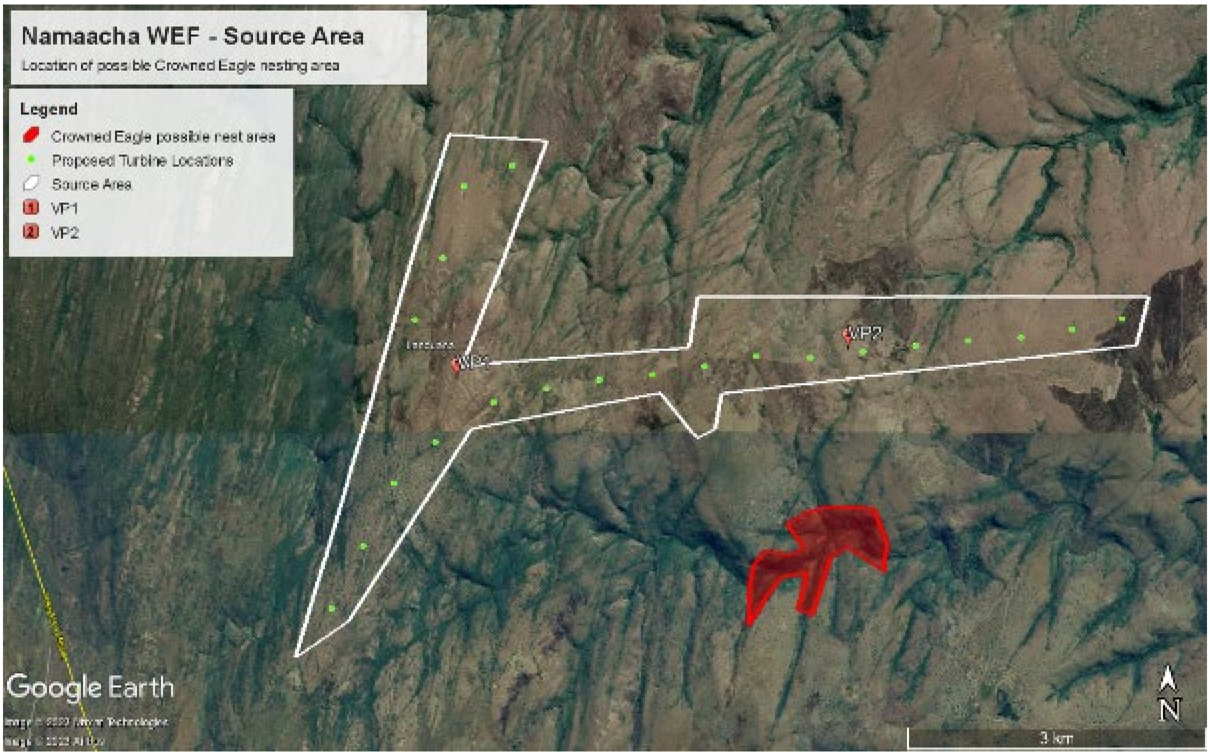


Figure 5-1: Possible nesting area of Crowned Eagle (red polygon).

5.1.3. MARTIAL EAGLE (GLOBAL STATUS: ENDANGERED)

- Martial Eagles were recorded during drive transects at the Source Area during Survey 1, 3 and 4.
- Several flights were recorded at the Control Site vantage point (approximately 7km north-west of the source area) and adult birds were recorded during the Control Site transects during surveys 1,2 and 4.
- During Survey 2, a single adult bird was observed soaring above the Control Site for a total of 22 minutes, and then started a long purposeful glide east towards a rugged area with several deep ravines and large trees approximately 5km north of the Source Area. During Survey 3, two adult birds and a juvenile were observed flying over the Source Area for 2 hours and 30 min. Further display flight behaviour was observed over and just north of the source area during Survey 4 for 1 hour and 32 min. This behaviour and observations indicate a high probability of a nest somewhere in densely wooded valleys just north of the Source area (see Figure 5-2 for more detail).
- After four surveys, the passage rate for Martial Eagle at the Source Area was 0.10 birds/hour or at least one bird per day. The passage rate at the Control Site after four surveys was 0.13 birds/hour or at least one bird per day.

- Most recorded flights at the Source Area were at medium altitude (within the rotor swept area), but there was also one recorded flight at high altitude.

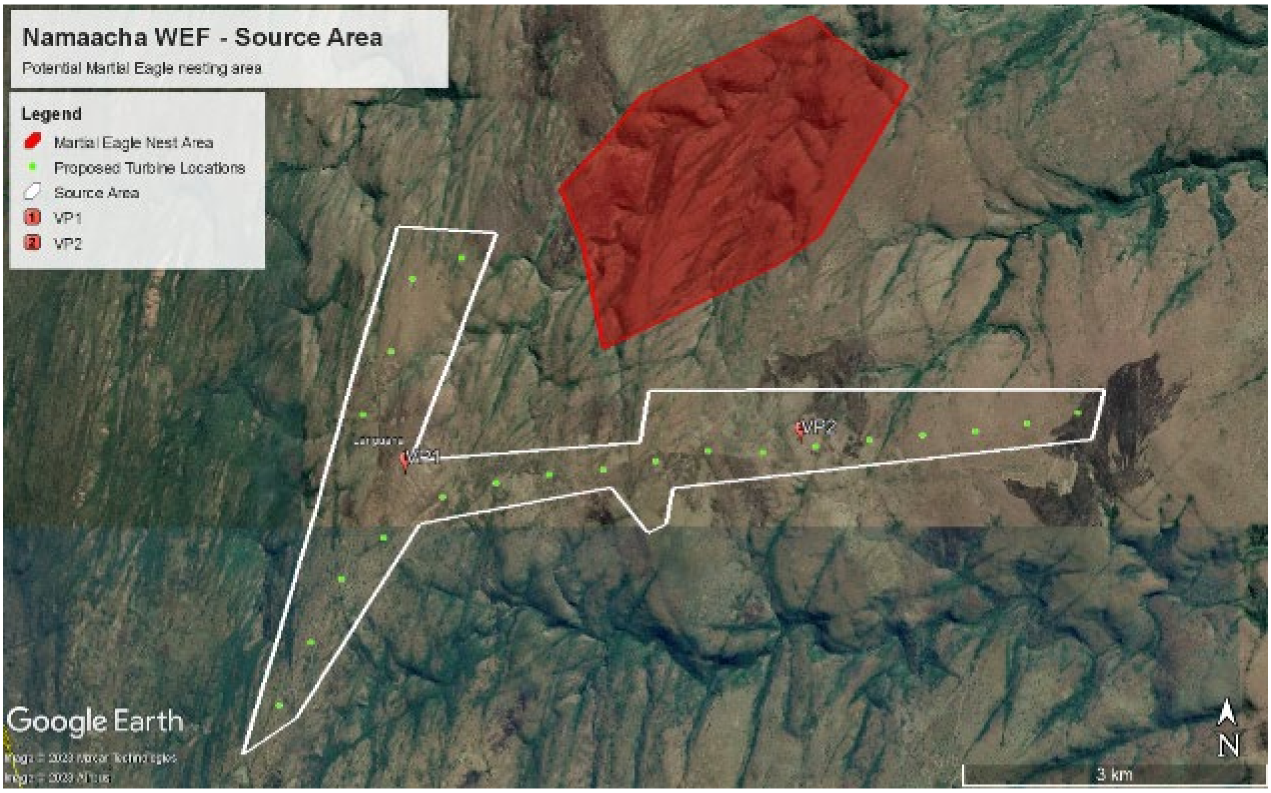


Figure 5-2: Potential Martial Eagle nesting area (red polygon).

5.1.4. WHITE-BACKED VULTURE (GLOBAL STATUS: CRITICALLY ENDANGERED)

- Two individuals were incidentally recorded flying over the Source Area during Survey 1 to the west of VP 1. The closest White-backed Vulture colonies are located in eSwatini approximately 30 – 35km away.
- Six individuals were recorded at the Control Site vantage point during survey 3 and 4.
- The passage rate for White-backed Vulture at the Control Site after four surveys was 0.17 birds/hour or approximately two birds per day.
- The absence of vulture records at the Source Area (during the formal surveys) may be due to a lack of scavenging opportunities as no carcasses were present. Existing data indicates that the eSwatini birds forage almost exclusively to the north in the Kruger National Park and to the south in northern KwaZulu-Natal flying parallel to the Lebombo Mountains in a north-south/south-north flyway, which does not route them over the Source Area.
- Several herds of cattle were regularly observed at and near to the Source Area. On average herds contained about 20 animals. In the event of livestock mortalities (if carcasses are not removed immediately by the herdsman) vultures may be attracted to the Source Area to feed.

5.1.5. BATELEUR (GLOBAL STATUS: ENDANGERED)

- Three Bateleur sightings were recorded from vantage points over the Source Area during Survey 2. The total flight time for Bateleur was just over 43 minutes. No Bateleurs were observed over the

Source Area or the Control Site during Survey 1. A single individual was observed over the Source Area for 6 min during Survey 3. Twenty minutes of flight activity were recorded during Survey 4.

- The passage rate for this species at the Source Area after four surveys was 0.06 birds/hour or approximately one bird every 1,2 days.
- All recorded flights at the Source Area were at medium altitude (within the rotor swept area).
- Two Bateleurs were recorded during the transect counts after four surveys at the Source Area.

5.1.6. BLACK STORK (GLOBAL STATUS: LEAST CONCERN)

- Although Black Storks are currently listed as Least Concern globally by the IUCN red list, populations in the southern African region shows a concerning decline (Lee et al. 2023) and its status could be revised in the near future.
- Black Storks were recorded over the Source Area during Survey 1 for 39 min and for 2 hours during Survey 4.
- The passage rate for Black Stork at the Source Area after four surveys was 0.14 birds/hour or almost two birds per day (1.82 birds per day).
- All recorded flights at the Source Area were at medium altitude (within the rotor swept area).
- Black storks were recorded at the Control Site during surveys 2,3 and 4.
- The passage rate for Black Stork at the Control Site after four surveys was 0.13 birds/hour or almost two birds per day (1.69 birds per day).
- Five Black Storks were recorded during the transect counts at the Source Area during Survey 4.

5.2. GENERAL WIND ENERGY FACILITY IMPACTS ON BIRDS

The impacts of wind farms on bird populations are dependent upon range of factors, including the specification of the development, the local/regional topography, the habitats affected, the abundance, species diversity, and characteristics of birds present. Potential impacts can be:

- discrete – acting in isolation of other impacts (i.e., priority species response to wind farms are idiosyncratic).
- cumulative – exacerbating other the severity of other impacts (i.e., wind turbines and overhead powerlines may pose similar collision risks to a given bird population).
- counter-active – reducing the severity of other impacts (i.e., bird population reduction through habitat loss lowers collision mortality rates)

The multi-faceted impacts that wind farms have on bird populations necessitates that new developments should be assessed on a case-by-case basis. The major concerns surrounding the impacts of wind farms on birds are detailed below:

- Mortality due to collisions with the wind turbines.
- Displacement due to disturbance during construction and operation of the wind farm.
- Displacement due to habitat change and loss at the wind farm.
- Mortality due to collision and/or electrocution on the medium voltage overhead lines.
- Mortality due to collisions with the medium voltage overhead lines.

It should be noted that environmental impact assessments are localised to the contemporary pre-construction conditions of a given development site. Impacts to the regional landscape are not considered as the extent and nature of future developments (not only wind energy development) are unknown at this stage. It is, however, highly unlikely that the land use will change in the foreseeable future due to climatic limitations.

5.2.1. COLLISION MORTALITY ON WIND TURBINES3

Wind energy generation has experienced rapid worldwide development over recent decades as its environmental impacts are considered to be relatively lower than those caused by traditional energy sources, with reduced environmental pollution and water consumption (Saidur et al., 2011). However, bird fatalities due to collisions with wind turbines have been consistently identified as a major ecological drawback to wind energy (Drewitt & Langston, 2006).

Collisions with wind turbines kill fewer birds than collisions with other man-made infrastructure, such as power lines, buildings or even traffic (Erickson et al., 2005). Nevertheless, estimates of bird deaths from collisions with wind turbines worldwide range from 0-40 deaths per turbine per year (Sovacool, 2013). Bird mortality rates vary across sites, as do the number of sensitive bird species impacted (Hull et al., 2013; May, 2015). Estimated mortalities are likely lower than true number of bird deaths from wind farm infrastructure, given that studies may fail to account for detection biases caused by scavenging, searching efficiency and search radius (Bernardino et al., 2013; Erickson et al., 2005; Huso et al., 2015, 2021). Additionally, even for low mortality rates, collisions with wind turbines may disproportionately affect certain species. For long-lived species with low reproductivity and slow maturation rates (e.g. raptors), even low mortality rates can have a significant impact at the population level (Carrete et al., 2009; De Lucas et al., 2008; Drewitt & Langston, 2006). The situation is even more critical for species of conservation concern and those with restricted distributions, which sometimes are most at risk (Osborn et al., 1998).

High bird mortality rates at several wind farms have raised concerns among the industry and scientific community. High profile examples include the Altamont Pass Wind Resource Area (APWRA) in California because of high fatality of Golden eagles (*Aquila chrysaetos*), Tarifa in Southern Spain for Griffon vultures (*Gyps fulvus*), Smøla in Norway for White-tailed eagles (*Haliaatus albicilla*), and the port of Zeebrugge in Belgium for gulls (*Larus* spp.) and terns (*Sterna* spp.) (Barrios & Rodríguez, 2004; Drewitt & Langston, 2006; Huso et al., 2015; Stienen et al., 2008; Thelander et al., 2003). Due to their specific features and location, and characteristics of their bird communities, these wind farms have been responsible for many fatalities that culminated in the deployment of additional measures to minimize or compensate for bird collisions. However, currently, no simple formula can be applied to all sites; in fact, mitigation measures must inevitably be defined according to the characteristics of each wind farm and the diversity of species occurring there (Hull et al., 2013; Marques et al., 2014) An understanding of the factors that explain bird collision risk and how they interact with one another is therefore crucial to proposing and implementing valid mitigation measures. In southern Africa, vultures – followed by larger eagle species – are highlighted as being especially susceptible to collisions with wind turbines (McClure et al., 2021).

The following sections details avifaunal and environmental and characteristics which contribute towards turbine collision mortalities in birds.

5.2.1.1. SPECIES-SPECIFIC FACTORS

5.2.1.2. Morphological Features

Certain morphological traits of birds, especially those related to size, are known to influence collision risk with structures such as power lines and wind turbines. Janss (2000) identified weight, wing length, tail length and total bird length as being collision risk determinant. Wing loading (ratio of body weight to wing area) and aspect ratio (ratio of wing span squared to wing area) are particularly relevant, as they influence flight type and thus collision risk (Bevanger, 1994; De Lucas et al., 2008; Herrera-Alsina et al., 2013; Janss, 2000). Birds with high wing loading, such as the Griffon Vulture (*Gyps fulvus*), seem to collide more frequently with wind turbines at the same sites than birds with lower wing loadings, such as Common Buzzards (*Buteo buteo*) and Short-toed Eagles (*Circaetus gallicus*), and this pattern is not related with their local abundance (Barrios & Rodríguez, 2004; De Lucas et al., 2008). High wing-loading is associated with low flight manoeuvrability (De Lucas et al., 2008), which determines whether a bird can escape an encountered object fast enough to avoid collision.

Information on the wing loading of the priority species potentially occurring regularly at the Source Area was not available at the time of writing. However, based on general observations, and research on related species, it can be confidently assumed that regularly occurring priority species that could potentially be vulnerable to wind turbine collisions due to morphological features (high wing loading) are Black-bellied Bustards, Woolly-necked Storks and Shelley's Francolin, because they are less manoeuvrable in flight (Keskin et al., 2019).

5.2.1.3. Visual Perception

Birds are widely assumed to have excellent visual acuity, slightly superior to that of other vertebrates (Martin et al., 2010; McIsaac, 2001; Mitkus et al., 2018). Despite this, birds incur high collision-related mortalities from conspicuous man-made structures (Drewitt & Langston, 2006; Erickson et al., 2005).

Low visibility weather obscuring these structures was previously believed to increase avian collision risks; however, recent studies suggest this may not always the case (Guichard, 2017; Krijgsveld et al., 2009; May et al., 2015; Mitkus et al., 2018).

Unlike humans, who have a broad horizontal binocular field of 120°, some birds have two high acuity areas that overlap in a very narrow horizontal binocular field (Martin et al., 2010, 2012; Mitkus et al., 2018). Relatively small frontal binocular fields have been described for several species that are particularly vulnerable to power line collisions, such as vultures (*Gyps* spp.) cranes and bustards (Martin, 2011; Martin et al., 2010, 2012; Martin & Katzir, 1999). Relatedly, many bird species may have high resolution vision areas are often found in the lateral, rather than frontal, fields of view (Martin, 2011; Martin et al., 2010, 2012; O'Rourke et al., 2010; Päckert et al., 2012). Finally, some birds tend to look downwards when in flight, searching for conspecifics or food, which puts the direction of flight completely inside the blind zone of some species (Martin et al., 2010).

Some of the regularly occurring priority species at the Source Area have high resolution vision areas found in the lateral fields of view, rather than frontally, e.g., bustards and cranes. The exceptions to this are the priority raptors which all have wider binocular fields, although as pointed out by (Martin et al., 2010), this does not necessarily result in these species being able to avoid obstacles better.

5.2.1.4. Phenology

Turbine collision mortalities within raptors may be higher for resident than for migratory birds of the same species/taxon group. This disparity is possible due to resident birds frequenting areas occupied by wind farms more readily that migratory birds, which typically cross these wind farms *en route* to destinations further afield (Krijgsveld et al., 2009). However, factors like bird behaviour remain relevant. Katzner et al. (2012) showed that Golden Eagles performing local movements fly at lower altitudes, putting them at a greater risk of collision than migratory eagles. Resident eagles flew more frequently over cliffs and steep slopes, using low altitude slope updrafts, while migratory eagles flew more frequently over flat areas and gentle slopes where thermals are generated, enabling the birds to use them to gain lift and fly at higher altitudes.

Southern Mozambique is at the end of the migration path for summer migrants; therefore, the phenomenon of migratory flyways where birds are concentrated in large numbers for a limited period of time (Martín et al., 2018), such as the African Rift Valley or Mediterranean Red Sea flyways, is not a feature of the landscape. The only palearctic migratory priority species observed within the broader area, is Common Buzzard, which is expected to behave much the same as the resident birds once they arrive in the area. The same is valid for intra-african migrants such as the Wahlberg's Eagle. It is expected that, for the period when they are present, these species will be exposed to the same risks as resident species.

5.2.1.5. Bird Behaviour

Flight type seems to play an important role in collision risk, especially when associated with hunting and foraging strategies. Kiting flight (hanging in the wind with almost motionless wings), which is used in strong winds and occurs in rotor swept zones, has been highlighted as a factor explaining the high collision rate of Red-tailed Hawks *Buteo jamaicensis* at APWRA, California (Hoover & Morrison, 2005), and could also be a factor in contributing to the high collision rate for Jackal Buzzards in South Africa (Ralston-Patton & Camagu, 2019). The hovering behaviour exhibited by Common Kestrels *Falco tinnunculus* when hunting may also explain the fatality levels of this species at wind farms in the Strait of Gibraltar (Barrios & Rodríguez, 2004). This may also explain the high mortality rate of Rock Kestrels *Falco rupicolus* at wind farms in South Africa (Ralston-Patton & Camagu, 2019). Kiting and hovering are associated with strong winds, which often produce unpredictable gusts that may suddenly change a bird's position (Hoover & Morrison, 2005). Additionally, while birds are hunting and focused on prey, they might lose track of wind turbine positions (Krijgsveld et al., 2009; Smallwood et al., 2009). In the case of raptors, aggressive interactions may play an important role in turbine fatalities, in that birds involved in these interactions are momentarily distracted, putting them at risk. At least one eye-witness account of a Martial Eagle getting killed by a turbine in South Africa in this fashion is on record (Simmons & Martins, 2016).

Social behaviour may also result in a greater collision risk with wind turbines due to a decreased awareness of the surroundings. Several authors have reported that flocking behaviour increases collision risk with power lines as opposed to solitary flights (Carrete et al., 2012; Janss, 2000), and territoriality and courtship displays may override aversion to wind turbines (Walker et al., 2005). However, caution must be exercised when comparing the particularities of wind farms with power lines, as some species appear to be vulnerable to collisions with power lines but not with wind turbines, e.g., indications are that bustards, which are highly vulnerable to power line collisions, are not prone to wind turbine collisions – a Spanish database of over 7000 recorded turbine collisions contains no Great Bustards *Otis tarda* (A. Camiña, *personal communications*, 12 April 21012). Similarly, in South

Africa, very few bustard collisions with wind turbines have been reported to date, all Ludwig's Bustards (Ralston-Patton & Camagu, 2019). No Denham's Bustards *Neotis denhami* turbine fatalities have been reported to date, despite the species occurring at several wind farm sites.

The priority species which could occur with some regularity at the Source Area can be classified as either terrestrial species, soaring species or occasional long-distance fliers. Terrestrial species spend most of the time foraging on the ground. They do not fly often and when they do, they generally fly for short distances at low to medium altitude. At the Source Area, Shelley's Francolin, and Black-bellied Bustard (Korhaan) fall into this category. Occasional long-distance fliers generally behave as terrestrial species but can and do undertake long distance flights. Species in this category are Black Stork and Woolly-necked Stork. Soaring species spend a significant time on the wing in a variety of flight modes including soaring, kiting, hovering and gliding at medium to high altitudes. At the Source Area, these include all the raptors which could occur regularly, such as African Fish Eagle, African Harrier Hawk, Bateleur, Black-chested Snake Eagle, Black-winged Kite, African Hawk-Eagle, Lanner Falcon, Martial Eagle, Jackal Buzzard, Brown Snake Eagle, Wahlberg's Eagle and White-backed Vulture. Based on the time spent potentially flying at rotor height, soaring species are likely to be at greater risk of collision.

5.2.1.6. Avoidance Behaviours

Three types of avoidance have been described (Cook et al., 2018; May, 2015):

- Macro-avoidance' or displacement, whereby the density of birds reduced around a wind farm due to long-term disturbance (Desholm & Kahlert, 2005; Furness et al., 2013; Plonczkier & Simms, 2012; Villegas-Patraca et al., 2014; Walker et al., 2005).
- 'Meso-avoidance' or anticipatory/impulsive evasion, whereby flying birds anticipate a perceived threat from a wind farm, or segments thereof and alter their flight paths to avoid these threats (Desholm & Kahlert, 2005; Healy & Braithwaite, 2010; Mueller & Fagan, 2008)
- 'Micro-avoidance' or escape, whereby birds in close proximity to the rotor swept zone perform last-second evasion manoeuvres, possibly reflexively, away from the rotors (Everaert, 2014; Frid & Dill, 2002; Mueller & Fagan, 2008).

This may differ between species and may have a significant impact on the size of the risk associated with a specific species. It is generally assumed that 95-98% of birds will successfully avoid the turbines (Scottish Natural Heritage, 2010).

It is anticipated that most birds at the Source Area will avoid the wind turbines, as is generally the case at all wind farms (Scottish Natural Heritage, 2010). Exceptions already mentioned are raptors that engage in hunting behaviour which may serve to distract them and place them at risk of collision, birds engaged in display behaviour or inter- and intraspecific aggressive interaction. It is unlikely that the entire regional/local population of each priority species present around the proposed WEF will engage in complete meso- and macro-avoidance strategies of the wind energy infrastructure.

5.2.1.7. Bird Abundance

Some authors suggest that fatality rates are related to bird abundance, density or site utilization rates (Carrete et al., 2012; Kitano & Shiraki, 2013; Smallwood & Karas, 2009), while others highlight as birds utilise territories in non-random ways, and so mortality rates do not depend on bird abundance alone (Ferrer et al., 2012; Hull et al., 2013). Instead, fatality rates depend on other factors such as discriminatory use of specific areas within a wind farm (De Lucas et al., 2008). For example, at Smøla, Norway, White-tailed Eagle flight activity is correlated with collision fatalities (Dahl et al., 2013). In the APWRA, California, Golden Eagles, Red-tailed Hawks and American Kestrels (*Falco spaverius*) have higher collision fatality rates than Turkey Vultures (*Cathartes aura*) and Common Raven (*Corvus corax*), even though the latter are more abundant in the area (Smallwood et al., 2009), indicating that fatalities are more influenced by each species' flight behaviour and turbine perception. Also, in southern Spain, bird fatality was higher in the winter, even though bird abundance was higher during the pre-breeding season (De Lucas et al., 2008).

The abundance of regularly occurring priority species at the Source Area will fluctuate depending on the seasonality and rainfall e.g., Black Stork and Wahlberg's Eagle.

5.2.1.8. SITE-SPECIFIC FACTORS

5.2.1.9. Landscape Features

Susceptibility to collision can also heavily depend on landscape features at a wind farm site, particularly for soaring birds that predominantly rely on wind updrafts to fly. Some landforms such as ridges, steep slopes and valleys may be more frequently used by some birds, for example for hunting or during migration (Barrios & Rodríguez, 2004; Drewitt & Langston, 2008; Healy & Braithwaite, 2010; Katzner et al., 2012; Thelander et al., 2003). In South Africa, Verreaux's Eagle is expected to incur higher fatality rates from at higher elevations and along steeper slopes (Murgatroyd et al., 2021). In Lesotho, Bearded Vultures preferentially forage upper mountain slopes and high ridges which are favourable sites for wind turbine construction (Rushworth & Krüger, 2014).

In APWRA, California, Red-tailed Hawk fatalities occur more frequently than expected by chance at wind turbines located on ridge tops and swales, whereas Golden Eagle fatalities are higher at wind turbines located on slopes (Thelander et al., 2003). Other birds may follow other landscape features, such as peninsulas and shorelines, during dispersal and migration periods. Kitano & Shiraki (2013) found that the collision rate of White-tailed Eagles along a coastal cliff was extremely high, suggesting an effect of these landscape features on fatality rates.

The topography and vegetation surrounding and within the Source Area provides opportunities for soaring by many of the raptors which regularly occur within and near the Source Area. Among these raptors are the Red List species such as Crowned Eagle, Martial Eagle, and White-backed Vulture.

Other significant landscape features at and near the Source Area from a collision risk perspective are dams/wetlands, and non-perennial drainage lines (when flowing). Surface water attracts many birds, including priority species such as Black Stork, Lanner Falcon, Martial Eagle, and Woolly-necked Stork.

5.2.1.10. Flight Paths

The foraging behaviour of breeding, or otherwise territorial, raptors is often constrained to the vicinity closes to the nest/home range (Watson et al., 2018). For example, in Scotland 98% of Golden Eagle movements were registered at ranges less than 6 km from the nest, and the core areas were located within a 2-3 km radius (McGrady et al., 2002). These results, combined with the terrain features selected by Golden Eagles to forage such as areas close to ridges, can be used to predict the areas used by the species to forage(McLeod et al., 2002), and therefore provide a sensitivity map and guidance to the development of new wind farms (Bright et al., 2006, 2008).

There are relatively few telemetry studies the foraging behaviour of breeding raptors in South Africa. Breeding Verreaux's Eagles largely forage within 3.7km of their nest (Brink, 2020), with turbine collision risk potential falling substantially further away from the nest, becoming a negligible concern after 8km (Murgatroyd et al., 2021). Breeding African Crowned Eagles demonstrate more restrictive foraging behaviour largely confined to 1.62km of their nest, whereas breeding Martial Eagle forage generally forage within 5.39km of their nests (Brink, 2020). Male Black Sparrowhawks have been observed to display year-round territoriality, mostly foraging within 2.27 (breeding) and 2.43km (non-breeding) of the nest (Brink, 2020; Sumasgutner et al., 2016). The home range size for foraging female Long-crested Eagles in KwaZulu-Natal undergo substantial contractions to within a close vicinity of the nest (<25ha for one observed female) during the breeding season (Maphalala et al., 2020). Breeding Black Harrier pairs forage further afield (within 7.1–33.4km of their nests) (Garcia-Heras et al., 2019), as do Bearded Vultures (10km of their nests), and especially Lappet-faced Vultures (110.98km of their nest) (Brink, 2020).

Martial Eagle display flight behaviour was observed over and just north of the Source Area during the pre-construction monitoring. This behaviour and observations indicate a high probability of a nest somewhere in the densely wooded valleys just north of the Source Area. Most of the recorded Martial Eagle flights at the Source Area were at medium altitude (within the turbine rotor swept area).

It is also suspected that a pair of Crowned Eagles are nesting in the wooded valleys near the Source Area. Display flights were observed over the source area and over the valleys immediately south of the Source area.

Bateleur flights were recorded over the source area.

Another distinctive potential flight paths identified at the Source Area are the drainage lines, which may serve as a flight path for waterbirds when they flow. However, they are dry most of the time.

5.2.1.11. Food Availability

Factors that increase the use of a certain area or that attract birds, like food availability; also play a role in collision risk. For example, the high density of raptors at the APWRA, California, and the high collision fatality due to collision with turbines is thought to result, at least in part, from high prey availability in certain areas (Hoover & Morrison, 2005; Smallwood et al., 2009). This may be particularly relevant for birds that are less aware of obstructions such as wind turbines while foraging (Krijgsveld et al., 2009; Smallwood et al., 2009). It is speculated that the mortality of three Verreaux's Eagles in 2015 at a wind farm site in South Africa may have been linked to the availability of food (Smallie, 2015).

The high amount of flight activity of priority species recorded within the Source Area strongly indicated high availability of prey animals for raptors, including the regularly occurring priority species: Black-chested Snake Eagle, Brown Snake Eagle, Lanner Falcon, Martial Eagle, Crowned Eagle and Bateleur.

In addition, the network of non-perennial drainage lines indicates that during wet conditions (i.e., above average rainfall) they may afford better foraging opportunities for several priority species and improve the wetland habitats for already regularly occurring priority species such as Black Stork and Woolly-necked Stork.

5.2.2. DISPLACEMENT OF AVIFAUNA DUE TO DISTURBANCE

The displacement of birds away from areas in and around wind farms due to visual intrusion and airspace disturbance can be considered functional habitat loss. This disturbances can be detrimental to migratory bird population if wind farms disrupt migration routes (Marques et al., 2020, 2021), or if impact the breeding productivity and population sizes of species which undergo macro-avoidance of wind farms (see Section 8.1.1.5). Displacement may occur during both the construction and operation phases of wind farms, manifesting from turbines themselves through visual, noise and vibration impacts, as well as vehicle and personnel movements related to site construction and maintenance (Campedelli et al., 2014; May, 2015). Disturbance magnitude varies across sites and species, necessitating assessments on a site-by-site basis (Dohm et al., 2019; Drewitt & Langston, 2006). A recent meta-analysis study found that of long-term studies into avian displacement around wind farms found that half ~50% of studies reported limited displacement from wind turbines, 46% reported a decrease in some bird populations, and 7.7% found an increased abundance of certain species around wind farms (Marques et al., 2021). Unfortunately, few studies provide comprehensive before-and-after and control-impact (BACI) assessments, limiting current inferential power.

The operational phase is thought to impose the greatest displacement threat to bird populations, although these impacts may in temporary (Dohm et al., 2019; Pearce-Higgins et al., 2012). Local raptor populations around wind farms may rebound within 7-8 years post-construction (Dohm et al., 2019). Bustards may retain high affinity for historic lek sites (courtship display areas) on wind farms, as has been document in Great Bustard in Spain (A. Camiña, *personal communications*, 17 November 2012) and Denham's Bustard in South Africa (Ralston-Paton et al., 2017). It should be noted that Great Bustard elsewhere in Europe can be displaced by 0.6km [Wurm & Kollar (2000), as quoted by Raab et al. (2009)] to 1km (Langgemach, 2008) of an operational wind farm, although Denham's Bustards populations do not appear to be displaced by wind farms in South Africa (Ralston-Paton et al., 2017). It should be noted that for raptors and large terrestrial species, site-fidelity and species longevity may mask short- and medium-term impacts that wind farms may have on these species, and that the true impact severity may only manifest in the long-term – such as through diminishing recruitment of new individuals over the course of multiple generations (Ferrer et al., 2012; Santos et al., 2020).

The limited research into shorter-lived bird species around wind farms may offer insights into the long-term response of birds more generally. Leddy et al. (1999) reported increased densities of breeding grassland passerines with increased distance (>80m) from wind turbines, and review study by (Hötker et al. (2006) found that the minimum avoidance distances of eleven breeding passerines species ranged 14–93m of wind turbines. However, Hale et al. (2014) and Stevens et al. (2013) found limited evidence for permanent displacement of grassland passerines in North America. Passerine resilience to wind farms is further observed in the UK in species such Skylark (despite some evidence of turbine avoidance) (Pearce-Higgins et al., 2012), and Thekla Lark populations in Southern Spain (Farfán et al., 2009). Across nine wind farms in Scotland, seven out of twelve birds species across a range of taxa exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with demonstrable turbine avoidance behaviour in a further two species (Pearce-Higgins et al., 2009). No species preferentially occurred close to the turbines, and breeding pair densities decreased 15-53% within 500m of wind turbines for several species. Follow-up monitoring reported breeding densities of certain species (such as Red Grouse) recovered post-construction, whereas others (such as Snipe and Curlew) did not. Conversely, breeding densities of certain species (such as Skylark and Stonechat) increased on wind farms during construction.

Species response to wind farm construction and operation appears highly idiosyncratic, and although the local populations of many bird species may recover, the long-term impacts of wind farms on bird populations remains to be better elucidated.

It is inevitable that a measure of displacement will take place for all priority species during the construction phase, due to the disturbance factor associated with the construction activities. This is likely to affect ground nesting species the most, as this could temporarily disrupt their reproductive cycle. Species which fall in this category are, Shelley's Francolin, Black-bellied Bustard, Short-tailed Pipit and Spotted Eagle-Owl.

Raptors that use trees as nesting sites might also be affected, such as both species of Snake Eagle, Crowned Eagle, and Wahlberg's Eagle.

Some species might be able to recolonise the area after the completion of the construction phase, although it cannot be assumed that population densities will recover to pre-construction levels, due to the disturbance factor of the operational turbines.

5.2.3. DISPLACEMENT OF AVIFAUNA DUE TO HABITAT LOSS

The scale of permanent habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, in general, it is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development site [Fox et al. (2006) as cited by Drewitt & Langston (2006)], with a further 3-14% of airspace altered by turbines (Marques et al., 2020). The effects of habitat loss could be more widespread where developments interfere with hydrological patterns or flows on wetland or peatland sites. Some changes could also be beneficial. For example, habitat transformation following the development of the Altamont Pass Wind Farm in California led to increased mammal prey availability for some species of raptor, such as higher abundance of Pocket Gophers *Thomomys bottae* burrows around turbine bases), although this may also have increased collision risk ([Thelander et al., (2003) as cited by Drewitt & Langston (2006)].

Despite overall habitat loss resulting from wind farm development may be limited, the associated infrastructure such as roads and powerlines fragment previously continuous tracts of habitat. Beyond the increased mortality risks to local bird populations posed by such infrastructure, the resulting habitat fragmentation can degrade adjacent habitats, potentially changing the way birds interact with the immediate (Fletcher et al., 2018). It remains disputed whether habitat fragmentation is always an environmental detriment (Fahrig et al., 2019), yet the effects of this landscape change have been observed in bird species vulnerable to wind farms. Lane et al. (2001) noted that Great Bustard flocks in Spain were significantly larger further from power lines than at control points. Shaw (2013) found that Ludwig's Bustard in South Africa generally avoid the immediate proximity of roads within a 500m buffer. Bidwell (2004) found that Blue Cranes in South Africa select nesting sites away from roads.

Marques et al. (2021) reviewed 71 peer-reviewed studies on displacement and compiled: (1) information on the geographical areas, type of wind farm, study design and bird groups studied; and (2) the evidence of displacement effects on different bird groups. They found that most studies have been conducted in Europe and North America, particularly in agricultural areas. About half of the studies did not find any effects, for wind farms both on land and at sea, while many studies (40.6%) found displacement effects, and a small proportion (7.7%) detected attraction, i.e., an increased abundance of birds around the wind farms. Relevant to this project, they found that raptors were significantly affected.

The possible network of roads is likely to result in habitat fragmentation, and it could have an effect on the density of several species, particularly terrestrial species such as Short-tailed Pipit, Shelley's Francolin, and Black-bellied Bustard. Additionally, raptors are also vulnerable to habitat transformation/fragmentation, due in part to loss of breeding/roosting habitats, as well as reduced ecological carrying capacity of preferred prey items.

5.2.4. ELECTROCUTION ON THE 33KV MEDIUM VOLTAGE NETWORK

Electrocution refers to instances where birds perch, or attempt to perch, upon electrical structure in a manner that physically bridges the air gap between live components and/or live and earthed components, causing a fatal electrical short circuit through the birds (Bevanger, 1994; van Rooyen, 2000). The electrocution risk is largely determined by the design of the electrical hardware, with medium voltage electricity poles posing a potential electrocution risk to raptors (Cole & Dahl, 2013; Haas et al., 2006; Loss et al., 2014).

While the intention is to place the 33kV reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the poles could potentially pose an electrocution risk to raptors.

5.2.5. COLLISIONS WITH THE 33KV MEDIUM VOLTAGE NETWORK.

Transmission line collisions arguably pose the greatest threat to birds in southern Africa (van Rooyen, 2004, Shaw et al., 2010). Most heavily impacted upon are bustards, storks, cranes and various species of waterbirds, and to a lesser extent, vultures (Shaw et al., 2010; van Rooyen, 2004). These species are mostly heavy-bodied birds with limited manoeuvrability, which makes it difficult for them to take the necessary evasive action to avoid colliding with transmission lines (van Rooyen, 2004).

From incidental record keeping by the Endangered Wildlife Trust in neighbouring South Africa, it is possible to give a measure of what species are generally susceptible to power line collisions in South Africa (Figure 5-3).

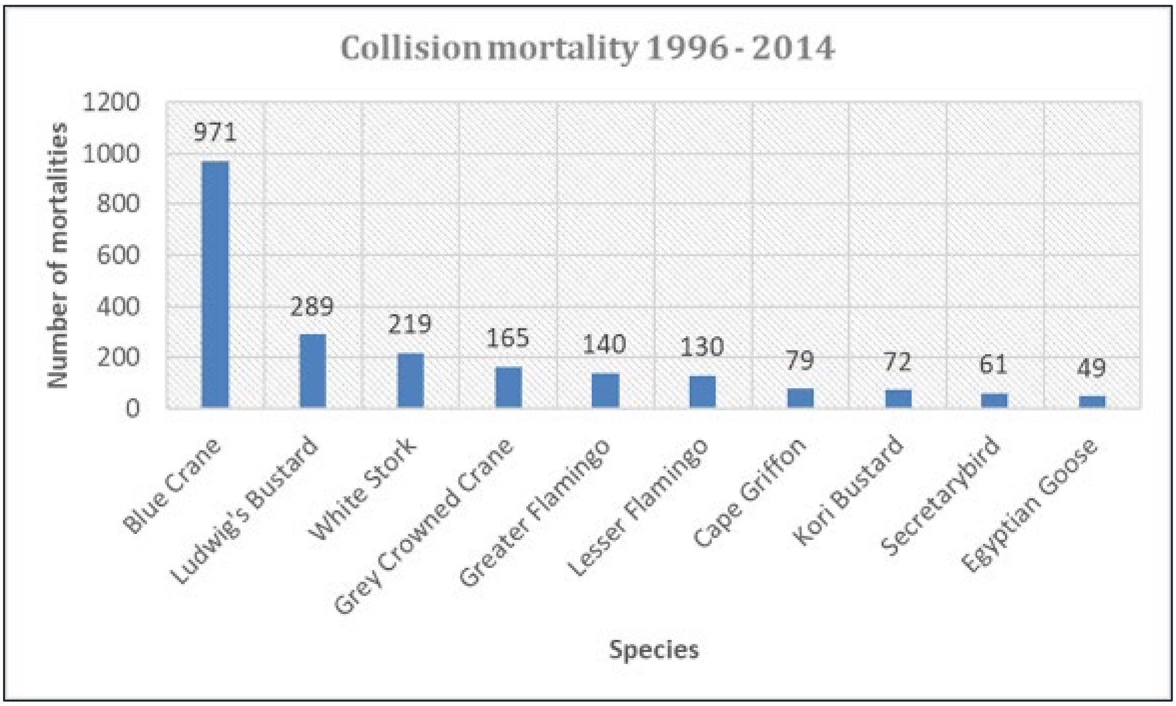


Figure 5-3: The top 10 collision prone bird species in South Africa, in terms of reported incidents contained in the Eskom/Endangered Wildlife Trust Strategic Partnership central incident register 1996 - 2014 (EWT unpublished data)

Powerline collisions are generally accepted as a key threat to bustards (Raab *et al*. 2009; Raab *et al*. 2010; Jenkins & Smallie 2009; Barrientos *et al*. 2012, Shaw 2013). In one study, carcass surveys were performed under high voltage transmission lines in the Karoo for two years, and low voltage distribution lines for one year (Shaw 2013). Ludwig's Bustard was the most common collision victim (69% of carcasses), with bustards generally comprising 87% of mortalities recovered. Karoo Korhaan was also recorded, but to a much lesser extent than Ludwig's Bustard. The reasons for the relatively low collision risk of this species probably include their smaller size (and hence greater agility in flight) as well as their more sedentary lifestyles, as local birds are familiar with their territory and are less likely to collide with power lines (Shaw 2013).

Using a controlled experiment spanning a period of nearly eight years (2008 to 2016), the Endangered Wildlife Trust (EWT) and Eskom tested the effectiveness of two types of line markers in reducing power line collision mortalities of large birds on three 400kV transmission lines near Hydra substation in the Karoo. Marking was highly effective for Blue Cranes, with a 92% reduction in mortality, and large birds in general with a 56% reduction in mortality, but not for bustards, including the endangered Ludwig's Bustard. The two different marking devices (spirals and flappers) were approximately equally effective (Shaw *et al*. 2017).

While the intention is to place the 33kV reticulation network underground where possible, there are areas where the lines might have to run above ground, for technical reasons. In these instances, the line could potentially pose a collision risk to various species.

In summary, the following priority species could be vulnerable to collisions with the 33kV medium voltage lines: African Fish Eagle, African Harrier-Hawk, African Hawk-Eagle, Bateleur, Black Stork,, Black-bellied Korhaan, Black-chested Snake Eagle, Black-winged Kite, Brown Snake Eagle, Common Buzzard, Crowned Eagle, Jackal Buzzard, Lanner Falcon, Martial Eagle, Peregrine Falcon, Shelley's Francolin, Short-tailed Pipit, Spotted Eagle-Owl, Wahlberg's Eagle, White-backed Vulture, Woolly-necked Stork.

5.3. SITE-SPECIFIC PREDICTED IMPACTS

5.3.1. CONSTRUCTION PHASE

The potential impacts on avifauna identified during the study are listed and assessed in the tables below:

5.3.1.1. Displacement due to disturbance associated with the construction of the wind turbines and associated infrastructure.

Issue	Displacement due to disturbance associated with the construction of the wind turbines and associated infrastructure	
Description of Impact		
Disturbances, dust unsettling, and noise pollution during the construction phase may displace priority bird species, resulting in temporary/long-term local population reductions of these species (see Section 6.1.2)		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Magnitude	Moderate	Reduced
Duration	Short-term	Short-term
Extent	Local	Site
Sensitivity	High	Average
Probability	Very Likely	Likely
Significance		
For Martial Eagles	High	Moderate
For Bateleur	High	Moderate
For Crowned Eagle	High	Moderate
For White-backed Vulture	Moderate	Reduced
For Other Priority Species	Moderate	Reduced

Degree to which impact can be reversed	This impact can potentially be reversed, especially if the recommended mitigation measures are implemented.
Degree to which impact may cause irreplaceable loss of resources	Species of conservation concern may be displaced from breeding/roosting/foraging habitats; it is possible that such local population reductions may not recover during the foreseeable future.
Degree to which impact can be mitigated	There is significant scope for mitigation as per the recommended mitigation measures below.
Mitigation Actions	
The following measures are recommended:	(1) Construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. (2) Measures to control noise and dust should be applied according to current best practice in the industry.
Monitoring	
The following monitoring is recommended:	Regular inspections by the Environmental Control Officer to assess if the above mitigation measures are adhered to by the contractor.

5.3.1.2. Displacement of priority species due to habitat transformation associated with the construction of the wind turbines and associated infrastructure.

Issue	Displacement of priority species due to habitat transformation associated with the construction of the wind turbines and associated infrastructure.	
Description of Impact		
Construction of the WEF and associated infrastructure could result in the loss, fragmentation, and degradation of habitats used by priority species for foraging, roosting, and/or breeding (see Section 6.1.3).		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Construction	
Criteria	**Without Mitigation**	**With Mitigation**
Magnitude	Moderate	Reduced
Duration	Short-term	Short-term
Extent	Local	Site
Sensitivity	High	Average
Probability	Very Likely	Likely
Significance		
For Martial Eagles	High	Moderate
For Bateleur	High	Moderate
For Crowned Eagle	High	Moderate

For White-backed Vulture	Moderate	Reduced
For Other Priority Species	Moderate	Reduced
Degree to which impact can be reversed	The impact can be reversed by following the mitigation measure below, and with rehabilitation of lost habitat.	
Degree to which impact may cause irreplaceable loss of resources	Species of conservation concern may be displaced from breeding/roosting/foraging habitats; it is possible that such local population reductions may not recover during the foreseeable future.	
Degree to which impact can be mitigated	There is significant scope for mitigation as per the recommended mitigation measures below.	
Mitigation Actions		
The following measures are recommended:	(1) Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction. (2) Construction of new roads should only be considered if existing roads cannot be used/upgraded. (3) The recommendations of biodiversity/botanical specialist studies must be strictly implemented, especially as far as limitation of the activity footprint is concerned.	
Monitoring		
The following monitoring is recommended:	Regular inspections by the Environmental Control Officer to assess if the above mitigation measures are adhered to by the contractor.	

5.3.2. OPERATIONS PHASE

5.3.2.1. Priority bird species mortality due to collisions with the wind turbines

Issue	Priority bird species mortality due to collisions with the wind turbines.	
Description of Impact		
Bird collisions with wind turbines pose mortality risks for bird species, especially wind priority species.		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Magnitude	High	High
Duration	Long-term	Long-term
Extent	National	National
Sensitivity	High	High
Probability	Very Likely	Likely
Significance		
For Martial Eagles	High	High*
For Bateleur	High	High*

For Crowned Eagle	High	High*
For White-backed Vulture	High	High*
For Other Priority Species	High	High*
Degree to which impact can be reversed	The reversibility of this impact is highly species dependent. For many priority bird species, population sizes and range extents can recover on their own. However, for Red List species within and near the Source Area, especially Endangered species, reversing this impact would require proactive conservation efforts to recover population sizes, and compensation for local/regional population losses and or displacements.	
Degree to which impact may cause irreplaceable loss of resources	Turbine collision-related mortalities can result in the significant population reduction and displacement of wind priority species, including several Red Data list species. Given the multiple priority species which are highly mobile, the mortalities due to the Namaacha WEF can impact ecosystems at a national and potentially international scale. Locally/regionally, turbine-related mortalities can result in the loss of Martial Eagle (Endangered), Crowned Eagle (Near Threatened), White-backed Vulture (Critically Endangered), Jackal Buzzard (Least Concern – regional endemic), and several other raptors from their nest sites in/around the Source Area (Project Site).	
Degree to which impact can be mitigated	It is unlikely that turbine collision related avifaunal mortalities can be completely avoided. Based on available information, the mitigation recommendations herein can only be expected to partially ameliorate the severity of this impact risk, until robust data derived from CRM of the post-mitigation scenario, and/or operation phase monitoring, is available.	
Mitigation Actions		
The following measures are recommended:	1.) Automated Shut-down-on-Demand (SDoD) using a camera system such as Identiflight® for all Red List Species. The automated system can also include an audible deterrent system that will use loud noise in an attempt to scare birds away. However, sound as a mitigation measure for birds has not been verified as being effective. 2.) Should a mortality of a Red List species be recorded, an observer led shutdown on demand (SDoD) programme should be considered in addition to the Automated Shut-down-on-Demand programme. 3.) Blade Painting – All wind turbines must have one blade painted according to a local civil aviation authority approved pattern to reduce the risk of raptor collisions. 4.) If estimated collision rates indicate unacceptable mortality levels of priority species additional mitigation measures will have to be implemented. 5.) Livestock carcass and prey-availability management programme (see Section 10 for more detail).	
Monitoring		

The following monitoring is recommended:	Operational phase monitoring should be implemented according to the Wind Guidelines or International Best Practice for a minimum of two years, and then every fifth year after that for the lifetime of the facility.

* Additional actions required to quantify the impacts and adequately define the implementation of mitigation measures:

- **Flight Risk Modelling (of all Red List raptors)** to create a spatially explicit risk profile and delineate a high-risk turbine exclusion zone.
  Collision Risk Modelling (CRM). The CRM should be used to calculate fatality estimates for the all the Red List raptors at the Source Area.

5.3.2.2. Priority bird species mortality due to electrocutions on the overhead sections of the internal 33kV cables

Issue	Priority bird species mortality due to electrocutions on the overhead sections of the internal 33kV cables.	
Description of Impact		
Bird electrocutions with overhead sections of internal 33kV lines pose mortality risks for priority bird species (see Section 6.1.4).		
Type of Impact	Direct	
Nature of Impact	Negative	
Phases	Operational	
Criteria	**Without Mitigation**	**With Mitigation**
Magnitude	High	Reduced
Duration	Long-term	Long-term
Extent	Local	Local
Sensitivity	High	Low
Probability	Very Likely	Unlikely
Significance		
For Martial Eagles	High	Reduced
For Bateleur	High	Reduced
For Crowned Eagle	High	Reduced
For White-backed Vulture	Moderate	Reduced
For Other Priority Species	High	Reduced
Degree to which impact can be reversed	The reversibility of this impact is highly species dependent. For many priority bird species, population sizes and range extents can recover on their own. However, for Red List species within the Source Area, especially Endangered species, reversing this impact would require proactive conservation efforts to recover population sizes, and compensation for local/regional population displacements.	

	The species most vulnerable to electrocution within the Source Area are the larger raptors, such as the Red List species Martial Eagle, Bateleur, Crowned Eagle, and White-backed Vulture.
Degree to which impact may cause irreplaceable loss of resources	Electrocution-related mortalities can cause priority bird species population reduction, although to a lesser degree than collision-related moralities with wind turbines and reticulation lines. Mortalities of Red List species present within the Source Area, especially Endangered species, can exacerbate national and international conservations for these bird species.
Degree to which impact can be mitigated	There is significant scope for mitigation as per recommended mitigation measures below.
Mitigation Actions	
The following measures are recommended:	(1) Underground cabling should be used as much as is practically possible. (2) If the use of overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted timeously to ensure that a raptor friendly pole design is used, and that appropriate mitigation is implemented pro-actively for complicated pole structures e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformers. (3) Regular inspections of the overhead sections of the internal reticulation network must be conducted during the operational phase to look for carcasses according to the applicable International Best Practice standards at the time.

5.3.2.3. Priority species mortality due to collisions with the overhead sections of the internal 33kV cables

Issue	Priority species mortality due to collisions with the overhead sections of the internal 33kV cables.	
Description of Impact		
Bird collisions with overhead sections of internal 33kV reticulation lines pose mortality risks for priority bird species (see Section 6.1.5).		
Type of Impact	**Direct**	
Nature of Impact	**Negative**	
Phases	**Operation**	
Criteria	**Without Mitigation**	**With Mitigation**
Magnitude	Moderate	Very low
Duration	Long-term	Long-term
Extent	Local	Local
Sensitivity	Medium	Low
Probability	Very Likely	Unlikely
Significance		
For Martial Eagles	Moderate	Reduced

For Bateleur	Moderate	Reduced
For Crowned Eagle	Moderate	Reduced
For White-backed Vulture	Moderate	Reduced
For Other Priority Species	Moderate	Reduced
Degree to which impact can be reversed	The reversibility of this impact is highly species dependent. For many priority bird species, population sizes and range extents can recover on their own. However, for Red List species within the Source Area, especially Endangered species, reversing this impact would require proactive conservation efforts to recover population sizes, and compensation for local/regional population displacements. The species most sensitive to this risk are larger terrestrial species such as Black-bellied Bustard, as well as waterbirds when the dams are full, and the drainage lines contain water, such as Black Stork and Woolly-necked Stork.	
Degree to which impact may cause irreplaceable loss of resources	Collision-related mortalities from overhead powerlines can cause priority bird species population reduction. Mortalities of Red List species present within the Source Area, especially Endangered species, can exacerbate national and international conservations for these bird species.	
Degree to which impact can be mitigated	There is significant scope for mitigation as per recommended mitigation measures below.	
Mitigation Actions		
The following measures are recommended:	Bird flight diverters should be installed on all the overhead line sections for the full span length according to the applicable International Best Practice standards at the time.	

5.3.3. DECOMMISSIONING

5.3.3.1. Displacement due to disturbance associated with the decommissioning (dismantling) of the wind turbines and associated infrastructure.

Issue	Displacement due to disturbance associated with the decommissioning (dismantling) of the wind turbines and associated infrastructure.	
Description of Impact		
Disturbances, dust unsettling, and noise pollution during the decommissioning phase may displace priority bird species, resulting in temporary/long-term local population reductions of these species (see Section 6.1.2.)		
Type of Impact	Indirect	
Nature of Impact	Negative	
Phases	Construction	

Criteria	Without Mitigation	With Mitigation
Magnitude	Moderate	Reduced
Duration	Short-term	Short-term
Extent	Local	Site
Sensitivity	High	Very low
Probability	Very Likely	Likely
Significance	High	Moderate
For Martial Eagles	High	Moderate
For Bateleur	High	Moderate
For Crowned Eagle	Moderate	Reduced
For White-backed Vulture	Moderate	Reduced
For Other Priority Species	Moderate	Reduced
Degree to which impact can be reversed	There is a potential of reversibility for this impact, especially if the recommended mitigation measures are followed.	
Degree to which impact may cause irreplaceable loss of resources	Species of conservation concern may be displaced from breeding/roosting/foraging habitats; it is possible that such local population reductions may not recover for the foreseeable future.	
Degree to which impact can be mitigated	There is significant scope for mitigation as per the recommended mitigation measures below.	
Mitigation actions		
The following measures are recommended:	(1) Dismantling activity should be restricted to the immediate footprint of the infrastructure as far as possible. (2) Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species. 3) Measures to control noise and dust should be applied according to current best practice in the industry.	

6. MITIGATION MEASURES

Several avifauna impact-specific mitigation measures were put forward in the existing impact assessment. These, and other broader impact minimisation measures, are described in more detail in this section, which is ordered according to the generally understood steps of the mitigation hierarchy. Note that a Biodiversity Action Plan (BAP) will be required to assess and determine the feasibility of achieving a net gain for the critical habitat triggers. As such, some of these measures may be refined during the development of this Plan.

6.1. AVOID

- Avoid some collision impacts as a result of high-risk turbines, through the use of exclusion zones identified through Flight Risk Modelling (of all Red List raptors) to inform the micro-siting or removal of high-risk turbines.
- Avoid exceeding the mortality thresholds as defined through Collision Risk Modelling (CRM). The CRM should be used to calculate fatality estimates for the all the Red List raptors at the Source Area.
- Underground cabling of the 33kV lines should be used as much as is practically possible.

6.2. MINIMISE

- Blade Painting – All wind turbines must have one blade painted according to a local civil aviation authority approved pattern to reduce the risk of raptor collisions.
- Based on the recorded flight activity of several priority and Red List species at the Source Area, including Crowned Eagle, Bateleur, White-backed Vulture and Martial Eagle, during the of pre-construction monitoring, all the areas within the Source Area that fall outside the designated high risk avoidance buffer zones should be classified as medium risk. Audible deterrents and automated SDoD is therefore compulsory for all areas outside designated turbine exclusion zones. Should a mortality of a Red List species be recorded, an observer led SDoD programme should be implemented in addition to the Automated SDoD system.
- A livestock carcass and prey-availability management programme should be implemented to eliminate and minimise the availability of food for vultures and raptors at the source area.
- WEF construction activity should be restricted to the immediate footprint of the infrastructure as far as possible. Access to the remainder of the area should be strictly controlled to prevent unnecessary disturbance of priority species.
- Removal of vegetation must be restricted to a minimum and must be rehabilitated to its former state where possible after construction.
- Measures to control noise and dust during WEF construction should be applied according to current best practice in the industry.
- Construction of new roads should only be considered if existing roads cannot be used/upgraded.
- If the use of 33kV overhead lines is unavoidable due to technical reasons, the Avifaunal Specialist must be consulted timeously to ensure that a raptor friendly pole design is used, and that appropriate mitigation is implemented pro-actively for complicated pole structures e.g., insulation of live components to prevent electrocutions on terminal structures and pole transformers.
- Bird flight diverters should be installed on all the overhead line sections for the full span length according to the applicable Internal Best Practice standards at the time.

- Regular inspections of the overhead sections of the internal reticulation network must be conducted during the operational phase to look for carcasses, as per the most recent edition of the Windfarm Guidelines.
- Live-bird monitoring and carcass searches should be implemented in the operational phase, as per the most recent edition of the Windfarm Guidelines at the time to assess collision rates.
- If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and BirdLife South Africa, additional measures will have to be implemented which could include shut down on demand or other proven measures.

6.3. REHABILITATE

- Vegetation must be rehabilitated to its former state to the degree possible after construction.

7. POST-CONSTRUCTION MONITORING PROGRAMME

Operation phase avifauna monitoring is a critical component of the impact assessment process for avifauna and WEF, to inform a quantitative assessment of the actualized residual impact (compared to the predicted residual impact) and dictate the requirement for implementation of further mitigation measures, should the need arise. The operational phase monitoring requirements are as follows:

The avifaunal post-construction monitoring at the proposed WEF must be conducted in accordance with international best practise standards at the time or the latest version (2015) of the *Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa* (Jenkins *et al*. 2015)[4].

7.1. AIM OF POST-CONSTRUCTION MONITORING

The avifaunal post construction monitoring aims to assess the impact of the WEF by comparing pre- and post- construction monitoring data and to measure the extent of bird fatalities caused by the WEF. Post-construction monitoring is therefore necessary to:

- Confirm as far as possible what the actual impacts of the WEF are on avifauna; and
- Determine what mitigation is required if need be (adaptive management).

The proposed post-construction monitoring can be divided into three categories:

- Habitat classification
- Quantifying bird numbers and movements (replicating baseline pre-construction monitoring)
- Quantifying bird mortalities.

Post-construction monitoring will aim to answer the following questions:

- How has the habitat available to birds in and around the WEF changed?
- How has the number of birds and species composition changed?
- How have the movements of priority species changed?
- How has the WEF affected priority species' breeding success?
- How many birds collide with the turbines? And are there any patterns to this?
- What mitigation is necessary to reduce the impacts on avifauna?

7.2. TIMING

Post-construction monitoring should commence as soon as possible after the first turbines become operational to ensure that the immediate effects of the facility on resident and passing birds are recorded, before they have time to adjust or habituate to the development. However, it should be borne in mind that it is also important to obtain an understanding of the impacts of the facility as they would be over the lifespan of the facility. Over time the habitat within the WEF may change, birds may

[4] Jenkins, A.R., Van Rooyen, C.S., Smallie, J.J., Anderson, M.D., & A.H. Smit. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy development sites in southern Africa. Produced by the Wildlife & Energy Programme of the Endangered Wildlife Trust & BirdLife South Africa.

become habituated to, or learn to avoid the facility. It is therefore necessary to monitor over a longer period than just an initial one year.

7.3. DURATION

Given the known sensitivity of the source area and the likelihood of high collision mortalities it is recommended that avifaunal monitoring should take place annually for the lifespan of the operational phase. After the first year of monitoring, the programme should be reviewed in order to incorporate significant findings that have emerged. This may entail the revision of the number of turbines to be searched, and the size of the search plots, depending on the outcome of the first year of monitoring. If significant impacts are observed, i.e. exceeding predetermined thresholds, and mitigation is required, the matter should be taken up with the operator to discuss potential mitigation.

7.4. HABITAT CLASSIFICATION

Any observed changes in bird numbers and movements at a WEF may be linked to changes in the available habitat. The avian habitats available must be mapped at least once a year (at the same time every year), using the same methods which were used during pre-construction.

7.5. BIRD NUMBERS AND MOVEMENTS

In order to determine if there are any impacts relating to displacement and/or disturbance, all methods used to estimate bird numbers and movements during baseline monitoring must be applied as far as is practically possible in the same way to post-construction work in order to ensure maximum comparability of these two data sets. This includes sample counts of small terrestrial species, counts of large terrestrial species and raptors, focal site surveys and vantage point surveys according to the current best practice.

7.6. COLLISIONS

The collision monitoring must have three components:

- Experimental assessment of search efficiency and scavenging rates of bird carcasses on the site.
- Weekly searches in the immediate vicinity of the wind farm turbines for collision casualties.
- Estimation of collision rates.

7.7. SEARCHER EFFICIENCY AND SCAVENGER REMOVAL

The value of surveying the area for collision victims is only valid if some measure of the accuracy of the survey method is developed. The probability of a carcass being detected and the rate of removal/decay of the carcass must be accounted for when estimating collision rates and when designing the monitoring protocol. This must be done in the form of searcher and scavenger trails at least twice a year.

7.8. COLLISION VICTIM SURVEYS

7.8.1. ALIGNING SEARCH PROTOCOLS

The search protocol must be agreed upon between the bat and bird specialists to constitute an acceptable compromise between the current best practice guidelines for bird and bat monitoring.

Searches must begin as early in the mornings as possible to reduce carcass removal by scavengers. A carcass searcher must walk in straight line transects, 6 m apart, covering 3 m on each side. A team of searchers and one supervisor must be trained to implement the carcass searches. The searchers must have a vehicle available for transport per site. The supervisor must assist with the collation of the data at each site and to provide the data to the specialist in electronic format on a weekly basis. The specialists must ensure that the supervisor is completely familiar with all the procedures concerning the management of the data. The following must be loaded on a cloud server on a weekly basis for the avifaunal specialist to access:

- Carcass fatality data (hardcopy and scans as well as data entered into Excel spreadsheets);
- Pictures of any carcasses, properly labelled
- GPS tracks of the search plots walked; and
- Turbine search interval spreadsheets.
- When a carcass is found, it must be bagged, labelled, and kept refrigerated for species confirmation when the specialist visits the site.

7.8.2. ESTIMATION OF COLLISION RATES

Observed mortality rates need to be adjusted to account for searcher efficiency and scavenger removal. There have been many different formulas proposed to estimate mortality rates. The available methodologies must be investigated, and an appropriate method will be applied. The current method which is used widely is the GenEst method.

7.9. DELIVERABLES

7.9.1. ANNUAL REPORT

An operational monitoring report must be completed at the end of each year of operational monitoring. As a minimum, the report must attempt to answer the following questions:

- How has the habitat available to birds in and around the WEF changed?
- How has the number birds and species composition changed?
- How have the movements of priority species changed?
- How has the WEF affected priority species' breeding success?
- What are the likely drivers of any changes observed?
- How many, and which species of birds collided with the turbines and
- associated infrastructure? And are there any patterns to this?
- What is the significance of any impacts observed?
- What mitigation measures are required to reduce the impacts?

7.9.2. QUARTERLY REPORTS

Concise quarterly reports must be provided by the avifaunal specialist with basic statistics and any issues that need to be addressed.

8. CONCLUSIONS AND RECOMMENDATIONS

The proposed Namaacha WEF will have several potential impacts on priority avifauna. The impacts are the following:

- Collision mortality of avifauna on the wind turbines
- Displacement of avifauna due to disturbance
- Displacement of avifauna due to habitat transformation
- Electrocution on the 33kV medium voltage overhead cables
- Mortality due to the collisions with the 33kV overhead lines.

During the monitoring at the Source Area, an exceptional abundance of priority species flights was recorded, which indicates a high likelihood of turbine collisions. The presence of Red Listed raptors, namely Martial Eagle and Crowned Eagle, and the suspected breeding of both species in close proximity to the Source Area, are of particular concern. Numerous other priority species, especially raptors, were also recorded flying for extensive periods over the Source area within the rotor swept zone. This indicates that the proposed facility is likely to have a high negative impact on priority avifauna in the area as a result of potential turbine collision mortalities, unless stringent mitigation measures are implemented for the operational lifespan of the facility.

The following additional analysis and associated mitigation measures are required to better understand and estimate the extent of the negative effects of the facility:

1. Given the high intensity of flight activity at the Source Area, it is recommended that the aggregate flight activity of all the Red List raptors at the Source Area is modelled to create a spatially explicit risk profile for the Source Area. The aim of the avian risk modelling will be to assess if any associations exist between observed high risk flight behaviour (i.e. flights within rotor sweep height) and underlying environmental and habitat conditions. A range of variables will be generated to characterise the environment within the Source Area. Subsequently, predictor variables will be generated related to various aspects of the topography, hydrology/drainage, vegetation (type and state). The processes to be used to characterise the underlying environment relates to topography, vegetation and hydrology and will follow the approaches used successfully in assessing habitat associations and suitability in previous avian studies (Colyn et al. 2020a; Colyn et al. 2020b; Colyn et al. 2020c).

   The modelled output will indicate high usage areas for the Red List raptors that should be used to inform the turbine layout to avoid the areas on the site where the highest turbine collision risk prevails.

   The purpose of this modelling is to evaluate if the turbine layout can be optimised to avoid high risk flight areas and to also help design where curtailment measures may be required, and how often these curtailment measures (e.g., Automated SDoD) will have to be implemented.

2. The flight risk modelling and spatial analysis should also include a Collision Risk Model (CRM). The CRM should be used to calculate fatality estimates for the all the Red List raptors and the Black Stork at the Source Area. Fatality estimates should be calculated for the following scenarios:
   a. Turbine layout without avoidance of high-risk flight areas derived by the modelled output in point 1 above.
   b. Optimised turbine layout avoiding high risk flight areas.

c. Optimised turbine layout avoiding high risk flight areas plus Shut Down on Demand (SDoD) curtailment measures (note that automated, camera-based SDoD coupled with an early warning audible deterrent system is the Project's current preference).

3. Blade Painting – All wind turbines must have one blade painted according to a local civil aviation authority approved pattern to reduce the risk of raptor collisions. It is acknowledged that blade painting as a mitigation strategy is still in an experimental phase, but research indicates that it could have a good chance of reducing raptor mortalities, based on research conducted in Norway (see Simmons et al. 2021 (**Appendix E**) for an explanation of this mitigation method).

4. If at any time estimated collision rates indicate unacceptable mortality levels of priority species, i.e., if it exceeds the mortality threshold determined by the avifaunal specialist after consultation with other avifaunal specialists and relevant local conservation agencies, additional measures will have to be considered and implemented.

5. Livestock carcass and prey-availability management programme:
    a. In the event of livestock deaths on, or in the immediate vicinity of the Source Area a carcass removal programme should be in place to locate and remove carcasses from the site immediately to prevent vultures from coming down to feed. Details of such a programme should be developed as part of the operational avifaunal management plan of the facility.
    b. Rock piles should be eliminated during construction, and infilling to construct roads should be compacted to avoid the creation of crevices and habitat for small mammals such as Rock Hyraxes *Procavia capensis* at the facility, that could potentially serve as a food source for birds of prey.

6. Live-bird monitoring and carcass searches should be implemented in the operational phase, as per international best practise standards at the time, for the lifespan of the facility.

7. An avifaunal specialist should be appointed to advise on the ongoing implementation and adaptive management of the avifaunal component of the operational programme at the facility.

The most significant residual impact of the proposed Namaacha WEF is the high likelihood of mortality of raptors due to collisions with the wind turbines. The residual impact (which by definition is an adverse environmental impact) of the project with respect to mortality of priority species remains high negative. This is due to the following constraints:

- To date, no Flight Risk Modelling has been performed, therefore no spatial avoidance of high-risk areas could have been taken into account i.e. the current turbine layout does not consider the high collision risk areas for collision mortalities of Red List bird species.
- Collision Risk Modelling (CRM) has not been conducted to determine mortality estimates. The CRM should estimate mortalities both pre and post mitigation (e.g. SDoD and Blade Painting) to assist in understanding the potential efficiency of the mitigation measures.

The residual impact can only be reassessed once the above aspects have been addressed, and will carry a degree of uncertainty due to the known efficacy of some of the proposed mitigations (e.g. SDoD 61.7% effective Ferrer et al. 2022; and the efficacy of blade painting in the African continent is as yet unknown). A considered opinion on the predicted post-mitigation (residual) impact of the proposed facility can then be made once a better understanding exists with respect to the avoidance and mitigation measures that will be implemented; after which a BAP which details the additional conservation actions that may be required for the project can then be developed.

9. REFERENCES

Ash, J. S., and J. Atkins (2009). Birds of Ethiopia and Eritrea: An Atlas of Distribution. Christopher Helm, London, UK.

Barrios, L., & Rodríguez, A. (2004). Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. Journal of Applied Ecology, 41(1), 72–81. https://doi.org/10.1111/j.1365-2664.2004.00876.x

Bernardino, J., Bispo, R., Costa, H., & Mascarenhas, M. (2013). Estimating bird and bat fatality at wind farms: A practical overview of estimators, their assumptions and limitations. New Zealand Journal of Zoology, 40(1), 63–74. https://doi.org/10.1080/03014223.2012.758155

Bevanger, K. (1994). Bird interactions with utility structures: collision and electrocution, causes and mitigating measures. Ibis, 136(4), 412–425.

Bidwell, M. T. (2004). Breeding habitat selection and reproductive success of Blue Cranes *Anthropoides paradiseus* in an agricultural landscape of the Western Cape, South Africa. In MSc (Conservation Biology) thesis, University of Cape Town.

Bright, J., Langston, R., Bullman, R., Evans, R., Gardner, S., & Pearce-Higgins, J. (2008). Map of bird sensitivities to wind farms in Scotland: A tool to aid planning and conservation. Biological Conservation, 141(9), 2342–2356. https://doi.org/10.1016/j.biocon.2008.06.029

Bright, J., Langston, R. H. W., Bullman, R., Evans, R. J., Gardner, S., Pearce-Higgins, J., & Wilson, E. (2006). Bird sensitivity map to provide locational guidance for onshore wind farms in Scotland. In RSPB Research Report (Vol. 20, Issue 20).

Brink, R. (2020). How well do buffer circles capture the ranging behaviours of territorial raptors? (Issue University of Cape Town).

Campedelli, T., Londi, G., Cutini, S., Sorace, A., & Tellini Florenzano, G. (2014). Raptor displacement due to the construction of a wind farm: Preliminary results after the first 2 years since the construction. Ethology Ecology and Evolution, 26(4), 376–391. https://doi.org/10.1080/03949370.2013.862305

Carrete, M., Sánchez-Zapata, J. A., Benítez, J. R., Lobón, M., & Donázar, J. A. (2009). Large scale risk-assessment of wind-farms on population viability of a globally endangered long-lived raptor. *Biological Conservation*, *142*(12), 2954–2961. https://doi.org/10.1016/j.biocon.2009.07.027

Carrete, M., Sánchez-Zapata, J. A., Benítez, J. R., Lobón, M., Montoya, F., & Donázar, J. A. (2012). Mortality at wind-farms is positively related to large-scale distribution and aggregation in griffon vultures. *Biological Conservation*, *145*(1), 102–108. https://doi.org/10.1016/j.biocon.2011.10.017

CEAGRN (2015). Mapeamento de Habitats de Moçambique. Centro de Estudos de Agricultura e Recursos Naturais. Maputo, Moçambique.

Cole, S. G., & Dahl, E. L. (2013). Compensating white-tailed eagle mortality at the Smøla wind-power plant using electrocution prevention measures. *Wildlife Society Bulletin*, *37*(1), 84–93. https://doi.org/10.1002/wsb.263

Colyn R.B., Henderson, CL., Altwegg, R., Smit-Robinson, HA. (2020c). Habitat transformation and climate change: Implications for the distribution, population status and colony extinction of Southern Bald Ibis (Geronticus calvus) in southern Africa. Condor: Ornithological Applications 122: 1-17.

Colyn, RB., Ehlers Smith, DA., Ehlers Smith YC., Smit-Robinson, HA., Downs, CT. (2020b). Predicted distributions of avian specialists: A framework for conservation of endangered forests under future climates. Diversity and Distributions, 1: 1-16.

Colyn, RB., Whitecross, MA., Howes, CA., Smit-Robinson, HA. (2020a). Restricted breeding habitat of the Critically Endangered White winged Flufftail in Ethiopia and its conservation implications. Ostrich 91: 204-213.

Dahl, E. L., May, R., Hoel, P. L., Bevanger, K., Pedersen, H. C., Røskaft, E., & Stokke, B. G. (2013). White-tailed eagles (Haliaeetus albicilla) at the Smøla wind-power plant, central Norway, lack behavioral flight responses to wind turbines. *Wildlife Society Bulletin*, *37*(1), 66–74. https://doi.org/10.1002/wsb.258

De Lucas, M., Janss, G. F. E., Whitfield, D. P., & Ferrer, M. (2008). Collision fatality of raptors in wind farms does not depend on raptor abundance. *Journal of Applied Ecology*, *45*(6), 1695–1703. https://doi.org/10.1111/j.1365-2664.2008.01549.x

Ferguson-Lees, J., and D. A. Christie (2001). Raptors of the World. Christopher Helm, London, UK.

Ferrer, M., Alloing, A., Baumbush, R., Morandini, V. Significant decline of Griffon Vulture collision mortality in wind farms during 13-year of a selective turbine stopping protocol. Global Ecology and Conservation 38, https://doi.org/10.1016/j.gecco.2022.e02203

Hancock, James; Kushlan, James A.; Kahl, M. Philip (2010). Storks, Ibises and Spoonbills of the World. London: Bloomsbury Publishing. pp. 70–74.

Hockey PAR, Dean WRJ and Ryan PG (2005). Roberts - Birds of southern Africa, VIIth ed. The Trustees of the John Voelcker Bird Book Fund, Cape Town

Hötker, H., Thomsen, K.-M. & H. Jeromin. 2006. Impacts on biodiversity of exploitation of renewable energy sources: the example of birds and bats - facts, gaps in knowledge, demands for further research, and ornithological guidelines for the development of renewable energy exploitation. Michael-Otto-Institut im NABU, Bergenhusen.

Howell, J.A. & DiDonato, J.E. 1991. Assessment of avian use and mortality related to wind turbine operations: Altamont Pass, Alameda and Contra Costa Counties, California, September 1988 Through August 1989. Final report prepared for Kenentech Windpower.

Hunt, W.G. 2001. Continuing studies of golden eagles at Altamont Pass. Proceedings of the National Avian-Wind Power Planning Meeting IV.

Hunt, W.G., Jackman, R.E., Hunt, T.L., Driscoll, D.E. & Culp, L. 1999. A Population Study of Golden Eagles in the Altamont Pass Wind Resource Area: Population Trend Analysis 1994–97. Report to National Renewable Energy Laboratory, Subcontract XAT-6-16459–01. Santa Cruz: University of California.

IFC, 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group.

IFC, 2019. Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group.

IUCN 2023. The IUCN Red List of Threatened Species. Version 2022-2. https://www.iucnredlist.org ISSN 2307-8235.

Jenkins A R; Van Rooyen C S; Smallie J J; Anderson M D & Smit H A. 2015. Best practice guidelines for avian monitoring and impact mitigation at proposed wind energy Project Sites in southern Africa. Endangered Wildlife Trust and Birdlife South Africa.

Jenkins, A. & Smallie, J. 2009. Terminal velocity: the end of the line for Ludwig's Bustard? Africa Birds and Birding. Vol 14, No 2.

Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. Avian collisions with power lines: a global review of causes and mitigation with a South African perspective. Bird Conservation International 20: 263-278.

Johnson, G.D., Strickland, M.D., Erickson, W.P. & Young, D.P. 2007. Use of data to develop mitigation measures for wind power impact on birds. In: De Lucas, M., Janss, G.F.E., & Ferrer, M eds: Birds and Wind Farms Risk Assessment and Mitigation. Quercus, Madrid.

Johnson, G.D., Strickland, M.D., Erickson, W.P., Sheperd, M.F. & Sheperd D. A. 2000. Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a four-year study. Technical Report prepared for Northern States Power Company, Minneapolis, MN 262pp.

Keskin, G., Durmus, S., Őzelmas, Ű and Karakaya, M. 2019. Effects of wing loading on take-off and turning performance which is a decisive factor in the selection of resting location of the Great Bustard (*Otis tarda*). Biological Diversity and Conservation 12(3):28-32. DOI: 10.5505/biodicon.2019.69875

Kruckenberg, H. & Jaene, J. 1999. Zum Einfluss eines Windparks auf die Verteilung weidender Bläßgänse im Rheiderland (Landkreis Leer, Niedersachsen). Natur Landsch. 74: 420–427.

Langgemach, T. 2008. Memorandum of Understanding for the Middle-European population of the Great Bustard, German National Report 2008. Landesumweltamt Brandenburg (Brandenburg State Office for Environment).

Langston, R.H.W. & Pullan, J.D. 2003. Wind farms and birds: an analysis of the effects of wind farms on birds, and guidance on environmental assessment criteria and site selection issues. Report written by Birdlife International on behalf of the Bern Convention. Council Europe Report T-PVS/Inf.

Larsen, J.K. & Madsen, J. 2000. Effects of wind turbines and other physical elements on field utilization by pink-footed geese (*Anser brachyrhynchus*): A landscape perspective. Landscape Ecol. 15: 755–764.

Leddy, K.L., Higgins, K.F., Naugle, D.E., 1999. Effects of wind turbines on upland nesting birds in conservation reserve program grasslands. Wilson Bulletin 11, 100–104.

Ledger, J. 1983. Guidelines for Dealing with Bird Problems of Transmission Lines and Towers. Eskom Test and Research Division. (Technical Note TRR/N83/005).

Madders, M & Whitfield, D.P. Upland raptors and the assessment of wind farm impacts. 2006. Ibis. Volume 148, Issue Supplement s1. pp 43-56.

Matos, Fonseca & Associados, 2022. Estudo de Impacto Ambiental da Central Eléctrica da Namaacha. Relatório Técnico Central Eléctrica da Namaacha, S.A. Novembro 2020 (modificado em Janeiro de 2022).

Orloff, S. & Flannery, A. 1992. Wind turbine effects on avian activity, habitat use and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989–91. California. Energy Commission.

Pearce-Higgins J.W, Stephen L, Langston R.H.W, Bainbridge, I.P.& R Bullman. The distribution of breeding birds around upland wind farms. Journal of Applied Ecology 2009, 46, 1323–1331.

Pearce-Higgins, J.W., Stephen, L., Douse, A., & Langston, R.H.W. Greater impacts on bird populations during construction than subsequent operation: result of multi-site and multi-species analysis. Journal of Applied Ecology 2012, 49, 396-394.

Pedersen, M.B. & Poulsen, E. 1991. Impact of a 90 m/2MW wind turbine on birds. Avian responses to the implementation of the Tjaereborg wind turbine at the Danish Wadden Sea. Danske Vildtunderogelser Haefte 47. Rønde, Denmark: Danmarks Miljøundersøgelser.

Perold V, Ralston-Paton S & Ryan P (2020): On a collision course? The large diversity of birds killed by wind turbines in South Africa, Ostrich, DOI: 10.2989/00306525.2020.1770889.

Raab, R., Julius, E., Spakovszky, P. & Nagy, S. 2009. Guidelines for best practice on mitigating impacts of infrastructure development and afforestation on the Great Bustard. Prepared for the Memorandum of Understanding on the conservation and management of the Middle-European population of the Great Bustard under the Convention on Migratory species (CMS). Birdlife International. European Dvision.

Raab, R., Spakovszky, P., Julius, E., Schütz, C. & Schulze, C. 2010. Effects of powerlines on flight behaviour of the West-Pannonian Great Bustard *Otis tarda* population. Bird Conservation International. Birdlife International.

Ralston-Patton S. 2017. Verreaux's Eagles and Wind Farms. Guidelines for impact assessment, monitoring and mitigation. BirdLife South Africa, March 2017.

Ralston-Patton, M & Camagu, N. 2019. Birds & Renewable Energy Update for 2019. Birds and Renewable Energy Forum, 10 October 2019. BirdLife South Africa.

Retief E.F., Diamond M, Anderson M.D., Smit, H.A., Jenkins, A & M. Brooks. 2012. Avian Wind Farm Sensitivity Map. Birdlife South Africa http://www.birdlife.org.za/conservation/birds-and-wind-energy/windmap.

Scottish Natural Heritage (2005, revised 2010) Survey methods for use in assessing the impacts of onshore windfarms on bird communities. SNH Guidance. SNH, Battleby.

Scottish Natural Heritage. 2010. Use of Avoidance Rates in the SNH Wind Farm Collision Risk Model. SNH Avoidance Rate Information & Guidance Note.

Shaw, J.M. 2013. Power line collisions in the Karoo: Conserving Ludwig's Bustard. Unpublished PhD thesis. Percy FitzPatrick Institute of African Ornithology, Department of Biological Sciences, Faculty of Science University of Cape Town May 2013.

Shaw, J.M., Pretorius, M.D., Gibbons, B., Mohale, O., Visagie, R., Leeuwner, J.L.& Ryan, P.G. 2017. The effectiveness of line markers in reducing power line collisions of large terrestrial birds at De Aar, Northern Cape. Eskom Research, Testing and Development. Research Report. RES/RR/17/1939422.

Simmons, R.E. 2018. Screening Analysis for the proposed FE Kudu WEF, Tankwa Karoo: Avian Assessment 2018. Unpublished report to ABO Wind renewable energies.

Smallwood, K. S. (2013), Comparing bird and bat fatality-rate estimates among North American wind-energy projects. Wildlife Society Bulletin, 37: 19–33. doi: 10.1002/wsb.260.

Stewart, G.B., Coles, C.F. & Pullin, A.S. 2004. Effects of Wind Turbines on Bird Abundance. Systematic Review no. 4. Birmingham, UK: Centre for Evidence-based Conservation.

Stewart, G.B., Pullin, A.S. & Coles, C.F. 2007. Poor evidence-base for assessment of windfarm impacts on birds. Environmental Conservation. 34, 1-11.

Thelander, C.G., Smallwood, K.S. & Rugge, L. 2003. Bird Risk Behaviours and Fatalities at the Altamont Pass Wind Resource Area. Report to the National Renewable Energy Laboratory, Colorado.

Ugoretz, S. 2001. Avian mortalities at tall structures. In: Proceedings of the National Avian Wind Power Planning Meeting IV pp. 165-166. National Wind Coordinating Committee. Washington DC.

Van Rooyen, C.S. 2000. An overview of Vulture Electrocutions in South Africa. Vulture News, 43: 5-22. (Vulture Study Group, Johannesburg, South Africa).

Van Rooyen, C.S. 2004. The Management of Wildlife Interactions with overhead lines. In: The fundamentals and practice of Overhead Line Maintenance (132kV and above), pp217-245. Eskom Technology, Services International, Johannesburg.

APPENDIX A: PRE-CONSTRUCTION MONITORING PROTOCOL

Fieldwork Methodology

1. General

The objective of the monitoring is to gather baseline data on the use of the Project Area by birds to measure potential displacement by the wind farm activities. The fieldwork consisted of four seasonal surveys conducted over a period of 8 months.

Table 0-1: Surveys conducted at Namaacha Wind Farm

Survey	Date	Season
1	9 – 17 November 2022	Spring
2	28 February to 6 March 2023	Summer
3	25 March to 2 April 2023	Autumn
4	30 May to 05 June 2023	Winter

The first survey was conducted in spring when many migrant raptor species are already present e.g. Common Buzzard and Wahlberg's Eagle. The second survey was conducted during late summer (end February – early March) when migratory species were still present. The autumn survey took place at the end of March early April while the dry season winter survey took place at the end of May – early June during the peak breeding season of most resident raptors. Weather conditions during surveys ranged from cloudy, partly cloudy to sunny but visibility was generally always good. Surveys were conducted during three time envelopes to cover all the daylight hours: morning, mid-afternoon and late afternoon. Nocturnal species were recorded on site before dawn and after dusk while travelling to / from vantage points.

The field team consist of two experienced observers using the following equipment:

- Binoculars
- Two-way radios
- Nikon D810 DSLR with a 600mm lens
- 4 x 4 vehicle

2. Survey Area

The surveys evaluated both the Source Area, (Project Area), and a Control Site. The Control Site is located between 6.4 and 10km to the north-east of the centre of the Source Area (see Figure 1). The Control Site was selected on the basis of (i) similar habitat (ii) ease of access to reduce travelling time (iii) security – largely uninhabited and (iv) low likelihood that land use will change in the medium term.

A Control Site is an area that is similar to the development site (i.e. the Source Area), but far enough away not to be affected by activities on the site – a key part of any Before (pre-construction) – After (post-construction) – Control – Impact (development) (BACI) study.

The data collected at the control site will be used to conduct a BACI (Before-After × Control-Impact) analysis once the site is operational to assess the effect of the facility on avifauna.

Figure 1 indicates the Source Area and Control Site where monitoring took place.

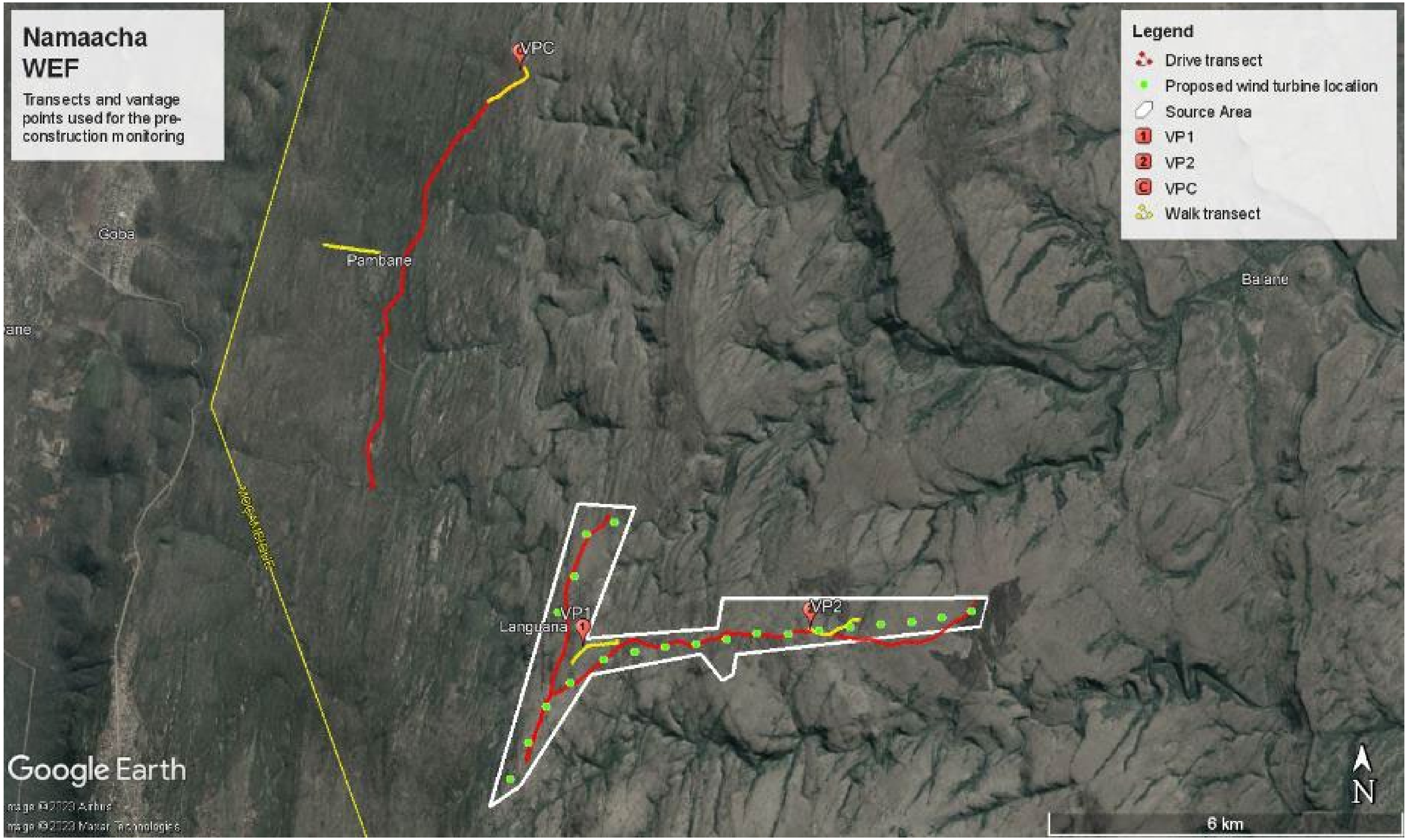


Figure 00-1: Area where monitoring is taking place, with position of VPs, drive transects, walk transects and development site. The area to the north-west of the Source Area is the Control Site.

3. Transects

Both driven and walked transects were conducted to identify avifauna sensitivities. The aim of drive transects is primarily to record large priority species (i.e. raptors and large terrestrial species), while walk transects are primarily aimed at recording small passerines. All efforts were made to avoid errors such as double counting and surveys were not performed when visibility was poor. The primary objective of the transect monitoring is to gather baseline data on the use of the site by birds to measure potential displacement by the wind farm activities.

3.1 Drive Transects

- Drives were performed in one direction only.
- One 14km drive transect survey was carried out within the Source Area. This route was selected because it covered the entire Source Area and represented all habitat types.
- One 8.35km drive transect survey was carried out in the Control Site. This route was selected because it represented similar habitat types as what was covered in the Source Area.
- The two surveyors drove the route slowly (± 10km/h) in a vehicle recording all birds on both sides of the transect.
- The surveyors stopped at regular intervals (i.e. every 500m) to scan the environment with binoculars. Drive transects are counted three times per sampling session, four times per year.

3.2 Walk Transects

- Two 1km walk transects were identified in the Source Area. These routes were selected because they represented all habitat types.
- Two 1km walk transects were identified in the Control Site. These routes were selected because they represented similar habitat types what was covered in the Source Area.
- All observed birds are recorded during walk transects.
- The transects are counted four times per each sampling survey, four times per year.

The following variables were recorded for all transects:

- Date
- Start time and end time
- Estimated distance from transect
- Wind direction
- Wind strength (estimated Beaufort scale)
- Weather (sunny; cloudy; partly cloudy; rain; mist)
- Temperature (cold; mild; warm; hot)
- Species
- Number of birds
- Behaviour (flushed; flying-display; perched; perched-calling; perched-hunting; flying-foraging; flying-commute; foraging on the ground) and
- Co-ordinates (priority species only)

Table 0-2: Time slots when transect surveys were conducted (rounded off)

	Date	Start Time	End Time
Survey 1			
Control Site Drive Transect	2022/11/15	10:16	11:59
	2022/11/16	11:53	13:43
	2022/11/17	08:49	11:01
Control Site Walk Transect 1	2022/11/14	17:32	18:05
	2022/11/15	07:42	08:20
	2022/11/16	14:52	15:31
	2022/11/17	11:57	12:36
Control Site Walk Transect 2	2022/11/15	14:59	15:34
	2022/11/16	07:06	07:43
	2022/11/16	10:10	10:45
Source Area Drive Transect	2022/11/10	08:45	11:01
	2022/11/12	15:07	17:04
	2022/11/13	11:32	13:58
Source Area Walk Transect 1	2022/11/09	11:57	12:32
	2022/11/11	16:54	17:30
	2022/11/12	07:32	08:21
	2022/11/12	11:46	12:28
Source Area Walk Transect 2	2022/11/10	17:25	17:58
	2022/11/11	05:11	05:53
	2022/11/11	10:12	10:59
	2022/11/12	14:07	14:42
Survey 2			
Control Site Drive Transect	2023/03/04	08:00	09:37
	2023/03/05	13:01	14:42
	2023/03/06	10:00	11:52
Control Site Walk Transect 1	2023/03/04	10:54	11:27
	2023/03/05	15:20	15:57
	2023/03/05	17:16	17:55
	2023/03/06	07:05	07:48
Control Site Walk Transect 2	2023/03/04	14:36	15:14
	2023/03/04	17:38	18:11
	2023/03/05	06:35	07:20
	2023/03/05	10:38	11:13
Source Area Drive Transect	2023/02/28	17:27	18:52
	2023/03/01	14:49	16:54
	2023/03/03	07:44	09:47
Source Area Walk Transect 1	2023/03/02	07:02	07:44
	2023/03/03	10:58	11:36
	2023/03/03	15:05	15:47
	2023/03/03	17:09	17:47
Source Area Walk Transect 2	2023/03/01	06:48	07:34
	2023/03/01	12:42	13:21
	2023/03/02	15:10	15:44
	2023/03/02	17:12	17:53

Survey 3			
Control Site Drive Transect	2023/03/28 2023/03/29 2023/03/30	07:31 12:55 09:36	09:10 14:20 11:43
Control Site Walk Transect 1	2023/03/28 2023/03/29 2023/03/29 2023/03/30	10:08 15:07 16:39 06:28	10:43 15:38 17:24 07:20
Control Site Walk Transect 2	2023/03/28 2023/03/28 2023/03/29	14:25 17:16 07:10	15:04 17:51 07:48
Source Area Drive Transect	2023/03/25 2023/03/25 2023/03/26	10:39 12:44 15:46	11:21 14:51 17:44
Source Area Walk Transect 1	2023/03/25 2023/03/26 2023/03/26 2023/03/27	16:57 07:37 10:25 08:36	17:35 08:21 11:06 10:45
Source Area Walk Transect 2	2023/03/24 2023/03/25 2023/03/25 2023/03/26 2023/03/27	17:02 06:49 10:56 14:15 14:19	17:48 07:31 11:36 14:56 14:59
Survey 4			
Control Site Drive Transect	2023/06/03 2023/06/04 2023/06/05	07:46 11:40 13:57	10:24 13:30 15:42
Control Site Walk Transect 1	2023/06/05 2023/06/05 2023/06/05 2023/06/05	07:34 10:42 12:49 16:35	08:21 11:10 13:29 16:55
Control Site Walk Transect 2	2023/06/03 2023/06/03 2023/06/04	14:12 16:40 07:04	14:43 17:19 07:48
Source Area Drive Transect	2023/06/04 2023/05/31 2023/06/01	10:18 12:46 07:24	10:55 14:33 09:14
Source Area Walk Transect 1	2023/06/01 2023/05/31 2023/06/01 2023/06/01	15:33 16:12 10:40 14:07	17:17 16:55 11:21 14:44
Source Area Walk Transect 2	2023/06/02 2023/05/30 2023/05/31 2023/05/31 2023/06/02	07:47 16:10 08:06 11:34 14:39	08:44 16:52 08:52 12:11 15:38

4. Vantage Points

The objective of vantage point counts is to assess the potential collision risk with the turbines. Two vantage points (VP1 and VP2) were identified from which the best view of the WEF site could be obtained, to record the flight altitudes and patterns of priority species. One vantage point (VPC) was also identified at a Control Site. The VP at the Control Site is located approximately 10km away from the centre of the WEF site. VP watches were conducted for 12 hours per vantage point, four times per year.

The following variables were recorded for each flight:

- Date
- Start time and end time
- Wind direction
- Wind strength (estimated Beaufort scale 1-7)
- Weather (sunny; cloudy; partly cloudy; rain; mist)
- Temperature (cold; mild; warm; hot)
- Species
- Number of birds
- Flight altitude (high i.e.>300m; medium i.e. 30 – 300m; low i.e. <30m)
- Flight mode (soar; flap; glide; kite; hover) and
- Flight time (in 15 second intervals).

Table 0-3: Time slots when vantage point watches were conducted (rounded off)

Survey 1			
Vantage Point	**Date**	**Start Time**	**End Time**
VP 1.1	11/11/2022	12:08	18:18
VP 1.2	12/11/2022	06:55	12:45
VP 2.1	09/11/2022	16:06	18:29
VP 2.2	10/11/2022	11:27	16:04
VP 2.3	11/11/2022	04:54	09:54
Control VP 1	15/11/2022	12:16	18:20
Control VP 2	16/11/2022	05:00	10:56
Survey 2			
VP 1.1	02/03/2023	05:52	12:21
VP 1.2	03/03/2023	13:07	18:38
VP 2.1	01/03/2023	05:43	12:14
VP 2.2	02/03/2023	13:10	18:39
Control VP 1	04/03/2023	12:35	18:35
Control VP 2	05/03/2023	05:45	12:27
Survey 3			
VP 1.1	25/03/2023	15:22	18:13
VP 1.2	26/03/2023	06:35	11:50
VP 1.3	27/03/2023	11:29	15:23
VP 2.1	24/03/2023	15:15	18:15
VP 2.2	25/03/2023	05:49	12:20
VP 2.3	26/03/2023	12:41	15:10
Control VP 1	28/03/2023	11:45	18:12

Control VP 2	29/03/2023	05:53	11:26
Survey 4			
VP 1.1	31/05/2023	15:04	17:21
VP 1.2	01/06/2023	09:44	14:48
VP 1.3	02/06/2023	06:17	10:56
VP 2.1	30/05/2023	15:08	17:32
VP 2.2	31/05/2023	06:12	12:12
VP 2.3	02/06/2023	13:20	16:56
Control VP 1	03/06/2023	10:22	17:26
Control VP 2	04/06/2023	06:17	11:13

5. Focal Points

No potential focal points (FPs) of bird activity were identified within the Source Area.

APPENDIX B: LIST OF SPECIES RECORDED DURING MONITORING

Priority Species	Scientific Name	Transects Source Area	Transects Control	Vantage Point Source Area	Vantage Point Control	Incidental sightings	Incidental sightings Control
African Fish Eagle	*Haliaeetus vocifer*				*	*	
African Harrier-Hawk	*Polyboroides typus*	*		*	*	*	*
African Hawk-Eagle	*Aquila spilogaster*	*	*	*	*		
Bateleur	*Terathopius ecaudatus*	*		*	*		
Black Stork	*Ciconia nigra*	*		*	*		
Black-bellied Korhaan	*Lissotis melanogaster*	*	*	*		*	*
Black-chested Snake Eagle	*Circaetus pectoralis*	*	*	*	*	*	*
Black-winged Kite	*Elanus caeruleus*	*	*	*	*		*
Brown Snake Eagle	*Circaetus cinereus*	*	*	*	*	*	
Common Buzzard	*Buteo buteo*	*	*	*	*	*	
Crowned Eagle	*Stephanoaetus coronatus*	*		*		*	
Jackal Buzzard	*Buteo rufofuscus*	*	*	*	*	*	*
Lanner Falcon	*Falco biarmicus*	*	*	*	*	*	
Martial Eagle	*Polemaetus bellicosus*	*	*	*	*		
Peregrine Falcon	*Falco peregrinus*	*					
Shelley's Francolin	*Scleroptila shelleyi*	*	*				
Short-tailed Pipit	*Anthus brachyurus*	*					
Spotted Eagle-Owl	*Bubo africanus*					*	*
Wahlberg's Eagle	*Hieraaetus wahlbergi*	*	*	*	*	*	*
White-backed Vulture	*Gyps africanus*		*		*	*	
Woolly-necked Stork	*Ciconia episcopus*			*		*	
Number of species: 21		**17**	**12**	**15**	**14**	**13**	**7**

Non-Priority Species	Scientific Name	Transects turbine	Transects control
Acacia Pied Barbet	*Tricholaema leucomelas*	*	*
African Cuckoo	*Cuculus gularis*		*
African Firefinch	*Lagonosticta rubricata*	*	*
African Golden Weaver	*Ploceus xanthops*	*	
African Goshawk	*Accipiter tachiro*		*
African Green Pigeon	*Treron calvus*	*	
African Hoopoe	*Upupa africana*	*	*
African Jacana	*Actophilornis africanus*	*	
African Palm Swift	*Cypsiurus parvus*		*
African Paradise Flycatcher	*Terpsiphone viridis*	*	*
African Pipit	*Anthus cinnamomeus*	*	*
African Stonechat	*Saxicola torquatus*	*	

Amethyst Sunbird	*Chalcomitra amethystina*	*	*
Arrow-marked Babbler	*Turdoides jardineii*	*	*
Ashy Flycatcher	*Muscicapa caerulescens*		*
Barn Swallow	*Hirundo rustica*	*	*
Bearded Scrub Robin	*Cercotrichas quadrivirgata*	*	
Bearded Woodpecker	*Chloropicus namaquus*		*
Black Crake	*Zaporina flavirostra*		*
Black Cuckoo	*Cuculus clamosus*	*	*
Black Cuckooshrike	*Campephaga flava*	*	*
Black Saw-wing	*Psalidoprocne pristoptera*	*	
Black-backed Puffback	*Dryoscopus cubla*	*	*
Black-collared Barbet	*Lybius torquatus*	*	*
Black-crowned Tchagra	*Tchagra senegalus*	*	*
Black-headed Heron	*Ardea melanocephala*	*	
Black-headed Oriole	*Oriolus larvatus*	*	*
Blue Waxbill	*Uraeginthus angolensis*	*	*
Brimstone Canary	*Crithagra sulphurata*	*	*
Bronze Mannikin	*Lonchura cucullata*	*	*
Brown-crowned Tchagra	*Tchagra australis*	*	*
Brown-hooded Kingfisher	*Halcyon albiventris*	*	*
Brubru	*Nilaus afer*	*	*
Buffy Pipit	*Anthus vaalensis*	*	
Burchell's Coucal	*Centropus burchellii*	*	*
Bushveld Pipit	*Anthus caffer*	*	*
Cape Glossy Starling	*Lamprotornis nitens*	*	*
Cape Sparrow	*Passer melanurus*		*
Cape Turtle Dove	*Streptopelia capicola*	*	*
Cape White-eye	*Zosterops virens*	*	*
Cardinal Woodpecker	*Dendropicos fuscescens*	*	*
Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*		*
Chinspot Batis	*Batis molitor*	*	*
Cinnamon-breasted Bunting	*Emberiza tahapisi*	*	*
Collared Sunbird	*Hedydipna collaris*	*	*
Common Buttonquail	*Turnix sylvaticus*	*	*
Common House Martin	*Delichon urbicum*	*	*
Common Scimitarbill	*Rhinopomastus cyanomelas*	*	*
Common Waxbill	*Estrilda astrild*	*	*
Crested Barbet	*Trachyphonus vaillantii*		*
Crested Francolin	*Ortygornis sephaena*	*	*
Croaking Cisticola	*Cisticola natalensis*	*	*
Crowned Hornbill	*Lophoceros alboterminatus*	*	*
Crowned Lapwing	*Vanellus coronatus*	*	
Cuckoo finch	*Anomalospiza imberbis*	*	
Dark Chanting Goshawk	*Melierax metabates*	*	*
Dark-capped Bulbul	*Pycnonotus tricolor*	*	*
Diederik Cuckoo	*Chrysococcyx caprius*	*	*

Dusky Indigobird	*Vidua funerea*		*	
Eastern Nicator	*Nicator gularis*	*		
Emerald-spotted Wood Dove	*Turtur chalcospilos*	*	*	
European Bee-eater	*Merops apiaster*	*	*	
European Honey Buzzard	*Pernis apivorus*	*		
European Nightjar	*Caprimulgus europaeus*	*		
European Roller	*Coracias garrulus*		*	
Fiscal Flycatcher	*Melaenornis silens*	*		
Flappet Lark	*Mirafra rufocinnamomea*	*	*	
Fork-tailed Drongo	*Dicrurus adsimilis*	*	*	
Gabar Goshawk	*Micronisus gabar*			
Garden Warbler	*Sylvia borin*	*	*	
Golden-breasted Bunting	*Emberiza flaviventris*	*	*	
Golden-tailed Woodpecker	*Campethera abingoni*	*	*	
Gorgeous Bushshrike	*Telophorus viridis*	*	*	
Greater Honeyguide	*Indicator indicator*	*	*	
Green Wood Hoopoe	*Phoeniculus purpureus*		*	
Green-backed Camaroptera	*Camaroptera brachyura*	*	*	
Green-winged Pytilia	*Pytilia melba*	*	*	
Grey Go-away-bird	*Crinifer concolor*		*	
Grey Penduline Tit	*Anthoscopus caroli*		*	
Grey-backed Camaroptera	*Camaroptera brevicaudata*		*	
Grey-headed Bushshrike	*Malaconotus blanchoti*	*	*	
Groundscraper Thrush	*Turdus litsitsirupa*	*	*	
Hadeda	*Bostrychia hagedash*	*	*	
Helmeted Guineafowl	*Numida meleagris*		*	
House Sparrow	*Passer domesticus*		*	
Jacobin Cuckoo	*Clamator jacobinus*	*	*	
Jameson's Firefinch	*Lagonosticta rhodopareia*		*	
Klaas's Cuckoo	*Chrysococcyx klaas*	*	*	
Kurrichane Thrush	*Turdus libonyana*	*	*	
Laughing Dove	*Spilopelia senegalensis*		*	
Lazy Cisticola	*Cisticola aberrans*	*	*	
Lesser Honeyguide	*Indicator minor*		*	
Lesser Masked Weaver	*Ploceus intermedius*	*	*	
Lesser Moorhen	*Paragallinula angulata*	*		
Lesser Striped Swallow	*Cecropis abyssinica*	*	*	
Levaillant's Cuckoo	*Clamator levaillantii*		*	
Lilac-breasted Roller	*Coracias caudatus*		*	
Little Bee-eater	*Merops pusillus*	*	*	
Little Rush Warbler	*Bradypterus baboecala*		*	
Little Sparrowhawk	*Accipiter minullus*	*	*	
Little Swift	*Apus affinis*	*	*	
Long-billed Crombec	*Sylvietta rufescens*	*	*	
Long-tailed Paradise Whydah	*Vidua paradisaea*	*	*	
Malachite Kingfisher	*Corythornis cristatus*		*	

Marsh Warbler	*Acrocephalus palustris*	*	*	
Natal Spurfowl	*Pternistis natalensis*	*	*	
Neddicky	*Cisticola fulvicapilla*	*	*	
Orange-breasted Bushshrike	*Chlorophoneus sulfureopectus*	*	*	
Pale Flycatcher	*Melaenornis pallidus*	*	*	
Pied Crow	*Corvus albus*	*		
Pink-throated Twinspot	*Hypargos margaritatus*	*	*	
Pin-tailed Whydah	*Vidua macroura*	*	*	
Purple Indigobird	*Vidua purpurascens*		*	
Purple-banded Sunbird	*Cinnyris bifasciatus*		*	
Purple-crested Turaco	*Gallirex porphyreolophus*	*	*	
Rattling Cisticola	*Cisticola chiniana*	*	*	
Red-backed Shrike	*Lanius collurio*	*	*	
Red-billed Firefinch	*Lagonosticta senegala*		*	
Red-billed Oxpecker	*Buphagus erythrorynchus*		*	
Red-billed Quelea	*Quelea quelea*	*	*	
Red-capped Robin-Chat	*Cossypha natalensis*	*		
Red-chested Cuckoo	*Cuculus solitarius*	*	*	
Red-collared Widowbird	*Euplectes ardens*	*	*	
Red-eyed Dove	*Streptopelia semitorquata*	*	*	
Red-faced Cisticola	*Cisticola erythrops*	*	*	
Red-faced Mousebird	*Urocolius indicus*	*	*	
Red-fronted Tinkerbird	*Pogoniulus pusillus*		*	
Red-headed Weaver	*Anaplectes rubriceps*		*	
Red-throated Wryneck	*Jynx ruficollis*	*		
Retz's Helmetshrike	*Prionops retzii*		*	
Rock Martin	*Ptyonoprogne fuligula*	*	*	
Rufous-naped Lark	*Mirafra africana*	*	*	
Sabota Lark	*Calendulauda sabota*		*	
Scarlet-chested Sunbird	*Chalcomitra senegalensis*	*	*	
Sombre Greenbul	*Andropadus importunus*	*	*	
Southern Black Flycatcher	*Melaenornis pammelaina*	*	*	
Southern Black Tit	*Melaniparus niger*	*	*	
Southern Boubou	*Laniarius ferrugineus*	*	*	
Southern Fiscal	*Lanius collaris*	*		
Southern Grey-headed Sparrow	*Passer diffusus*	*	*	
Southern Masked Weaver	*Ploceus velatus*	*	*	
Southern Red Bishop	*Euplectes orix*	*	*	
Southern Yellow-billed Hornbill	*Tockus leucomelas*		*	
Speckled Mousebird	*Colius striatus*	*	*	
Spectacled Weaver	*Ploceus ocularis*	*	*	
Spotted Flycatcher	*Muscicapa striata*		*	
Spotted Thick-knee	*Burhinus capensis*	*		
Square-tailed Drongo	*Dicrurus ludwigii*	*		
Streaky-headed Seedeater	*Crithagra gularis*	*	*	
Striped Kingfisher	*Halcyon chelicuti*		*	

Striped Pipit	*Anthus lineiventris*	*		
Tawny-flanked Prinia	*Prinia subflava*	*	*	
Terrestrial Brownbul	*Phyllastrephus terrestris*	*		
Thick-billed Weaver	*Amblyospiza albifrons*	*	*	
Trumpeter Hornbill	*Bycanistes bucinator*	*		
Village Weaver	*Ploceus cucullatus*		*	
Violet-backed Starling	*Cinnyricinclus leucogaster*	*	*	
Wailing Cisticola	*Cisticola lais*	*		
Wattled Starling	*Creatophora cinerea*		*	
White-backed Duck	*Thalassornis leuconotus*	*		
White-bellied Sunbird	*Cinnyris talatala*	*	*	
White-browed Robin-Chat	*Cossypha heuglini*	*	*	
White-browed Scrub Robin	*Cercotrichas leucophrys*	*	*	
White-crested Helmetshrike	*Prionops plumatus*	*	*	
White-faced Whistling Duck	*Dendrocygna viduata*	*		
White-rumped Swift	*Apus caffer*	*	*	
White-throated Robin	*Irania gutturalis*		*	
White-throated Robin-Chat	*Cossypha humeralis*	*	*	
White-winged Widowbird	*Euplectes albonotatus*	*	*	
Willow Warbler	*Phylloscopus trochilus*	*	*	
Woodland Kingfisher	*Halcyon senegalensis*		*	
Yellow Weaver	*Ploceus subaureus*	*		
Yellow-bellied Eremomela	*Eremomela icteropygialis*	*	*	
Yellow-bellied Greenbul	*Chlorocichla flaviventris*	*	*	
Yellow-billed Kite	*Milvus aegyptius*	*		
Yellow-breasted Apalis	*Apalis flavida*	*	*	
Yellow-fronted Canary	*Crithagra mozambica*	*	*	
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*		*	
Yellow-rumped Tinkerbird	*Pogoniulus bilineatus*		*	
Yellow-throated Longclaw	*Macronyx croceus*	*	*	
Yellow-throated Petronia	*Gymnoris superciliaris*	*	*	
Zitting Cisticola	*Cisticola juncidis*	*		
Number of species: 182	**Subtotal**	**140**	**151**	
Total number of species: 203	**Grand total**	**157**	**163**	

APPENDIX C: BIRD HABITAT AT THE SOURCE AREA

Figure 1: Savanna woodland habitat at the Source Area.

Figure 2: Surface water/wetland habitat at the Source Area.

APPENDIX D: FLIGHT ACTYIVITY AT THE SOURCE AREA SURVEYS 1–4

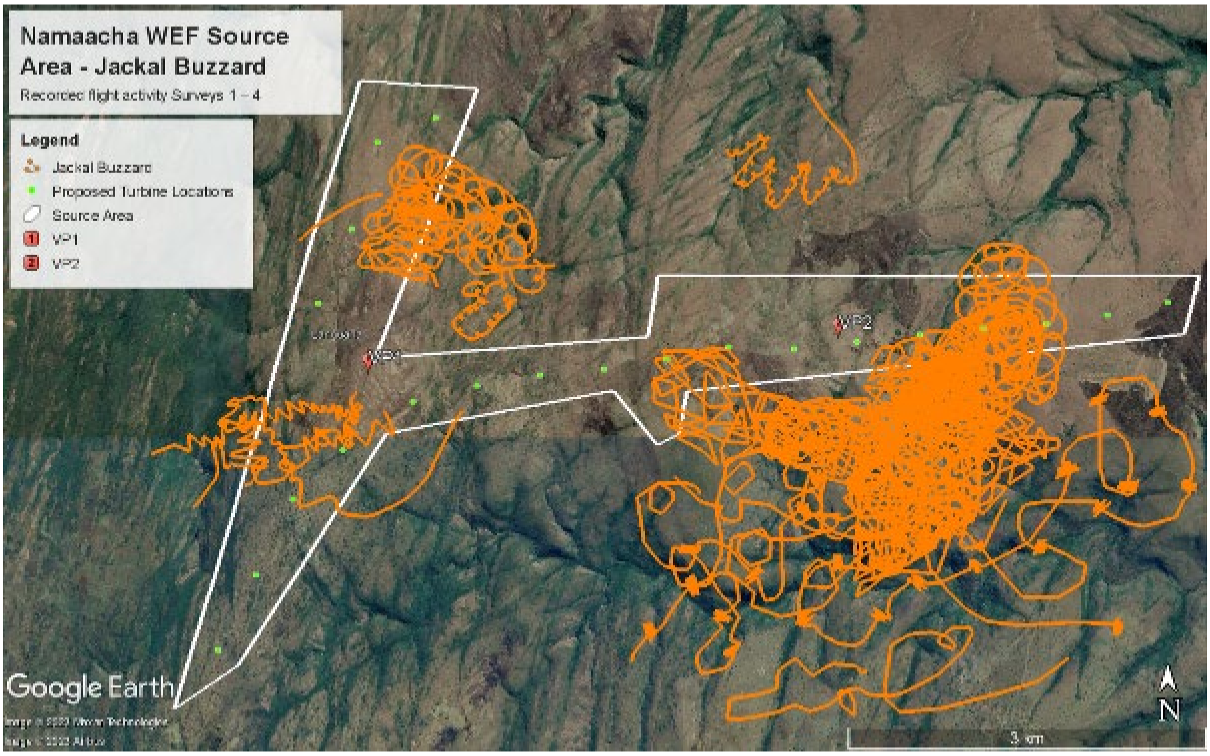


Figure 1: Flight activity of Jackal Buzzard after four surveys

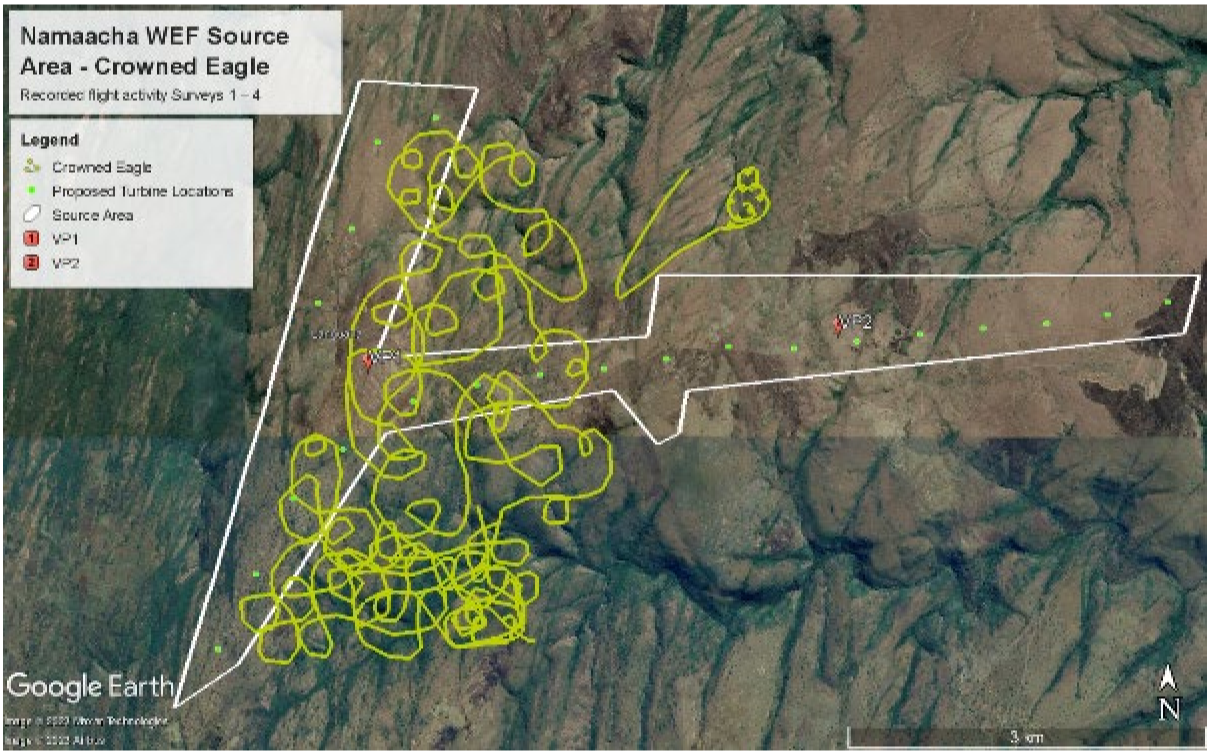


Figure 2: Flight activity of Crowned Eagle after four surveys

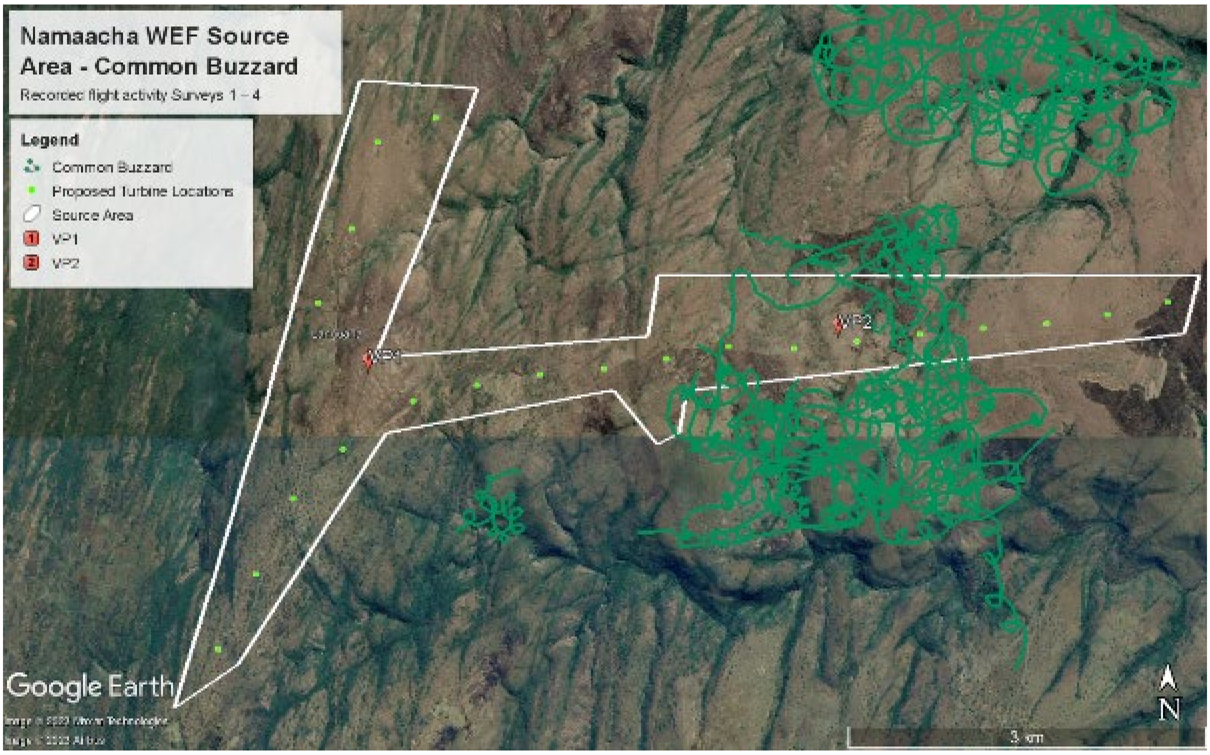


Figure 3: Flight activity of Common Buzzard after four surveys

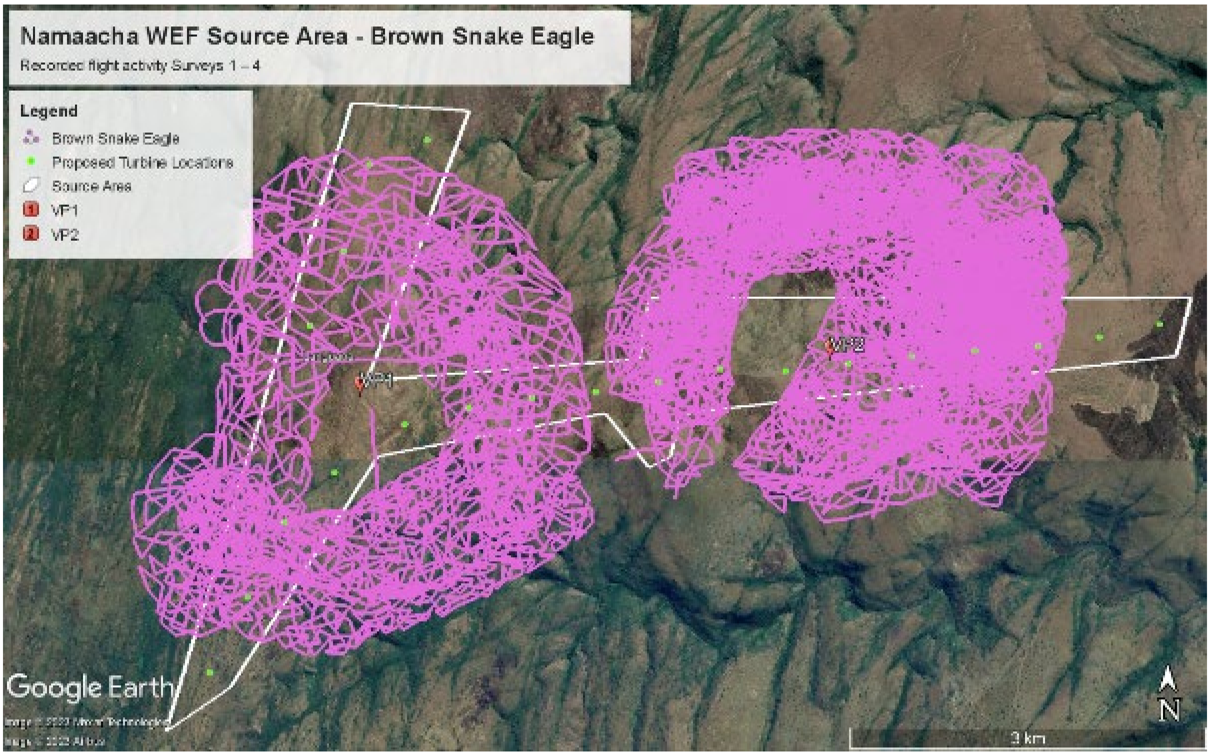


Figure 4: Flight activity of Brown Snake-Eagle after four surveys

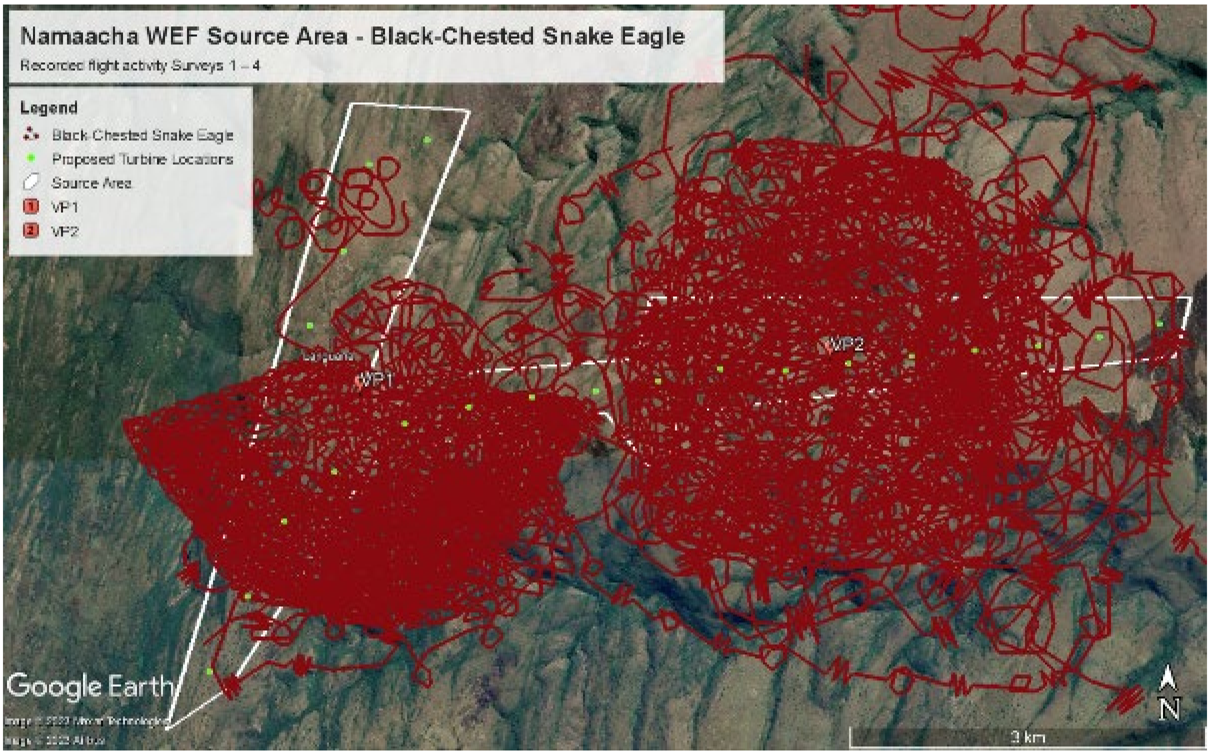


Figure 5: Flight activity of Black-chested Snake-Eagle after four surveys

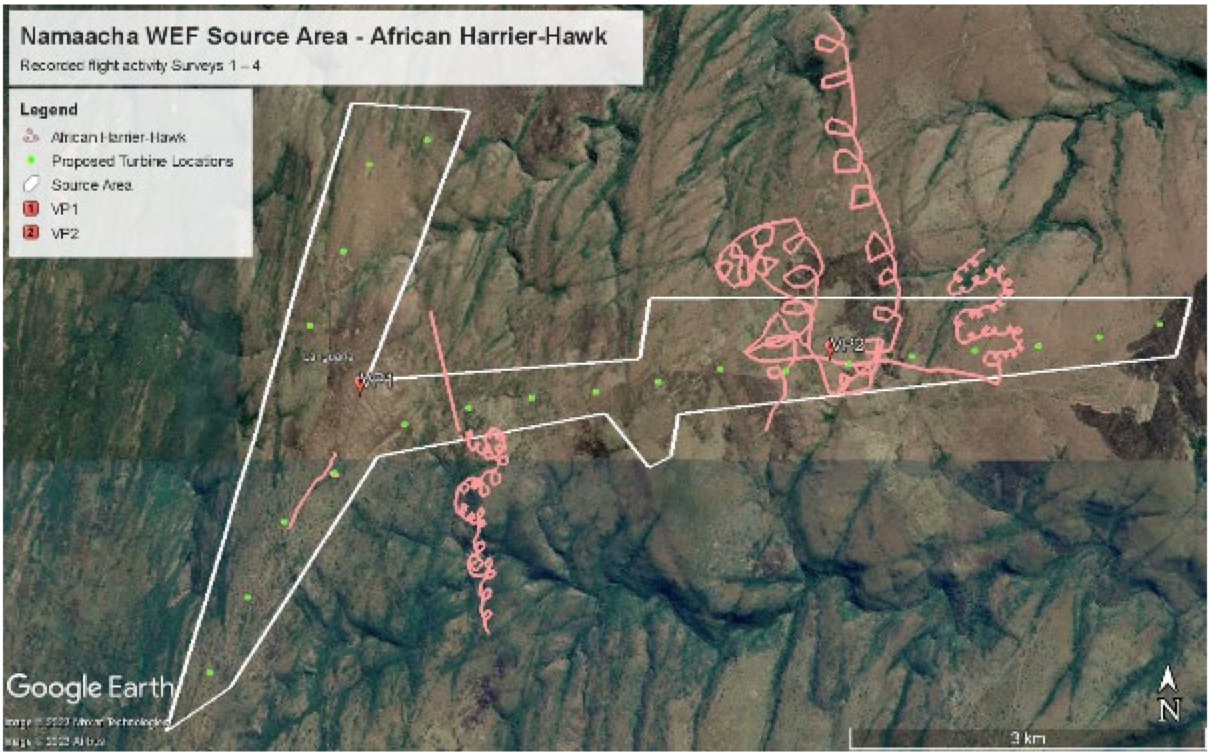


Figure 6: Flight activity of African Harrier-Hawk after four surveys

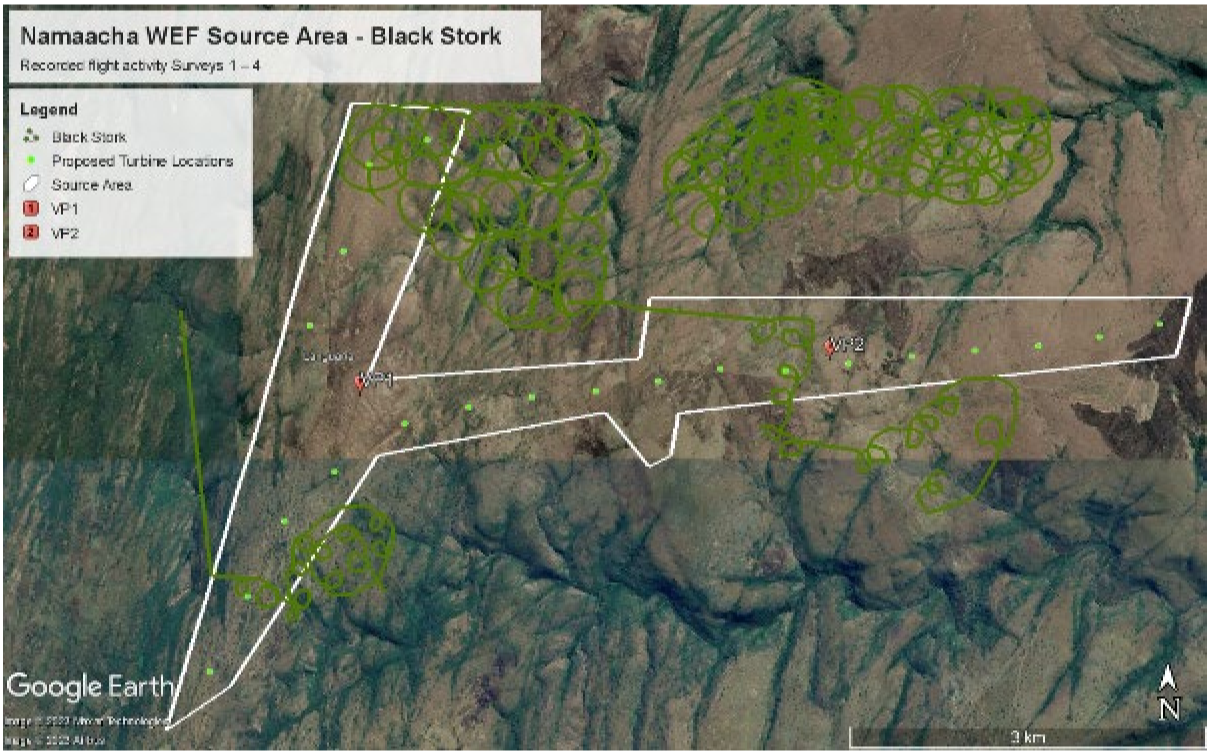


Figure 7: Flight activity of Black Stork after four surveys

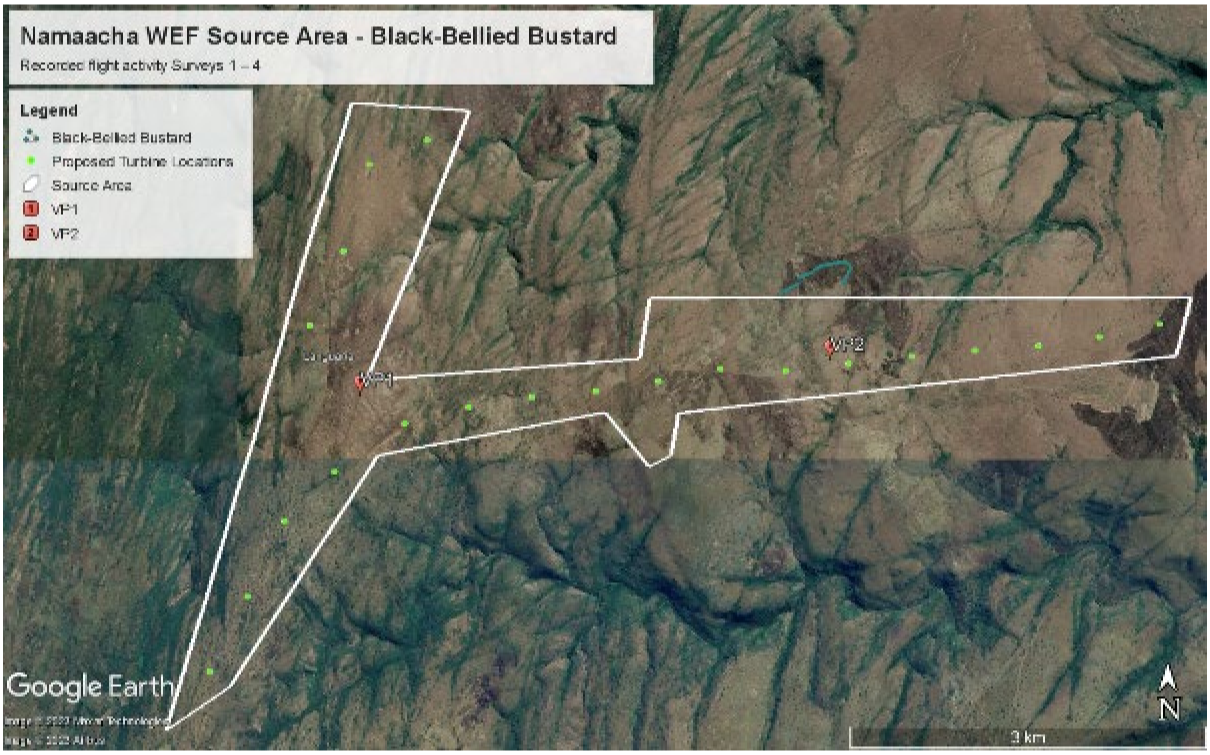


Figure 8: Flight activity of Black-bellied Bustard after four surveys

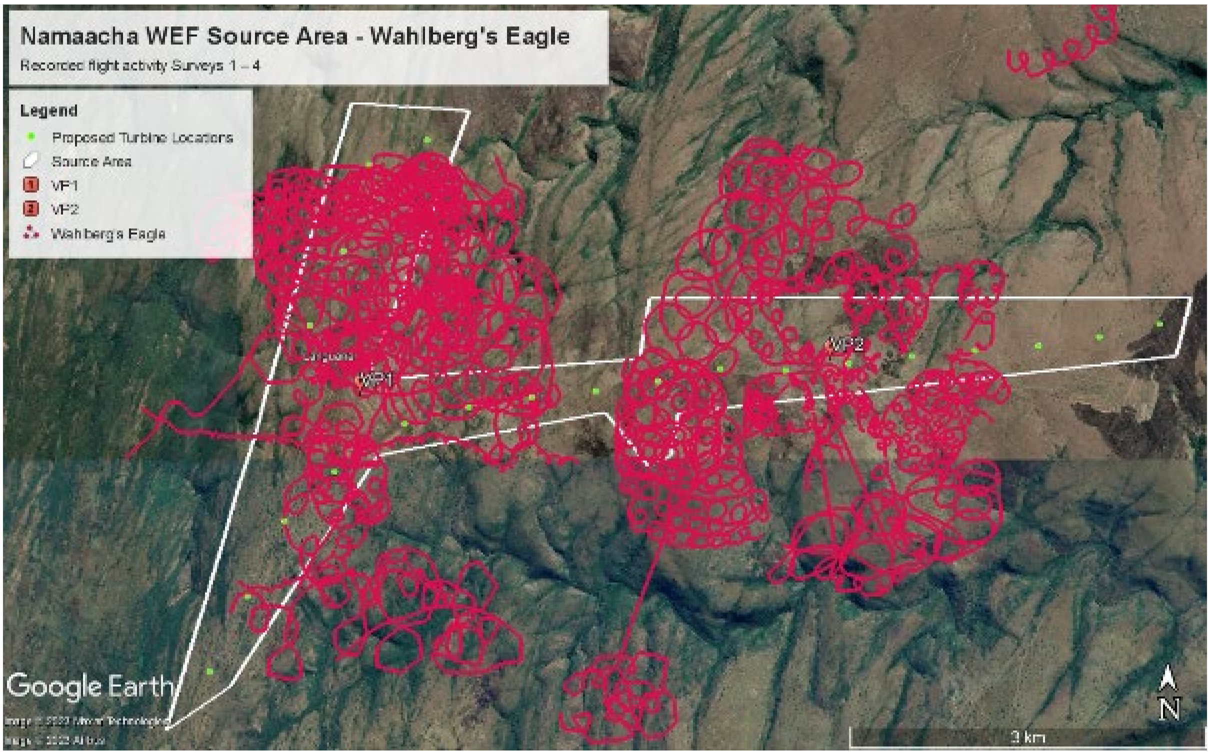


Figure 9: Flight activity of Wahlberg's Eagle after four surveys

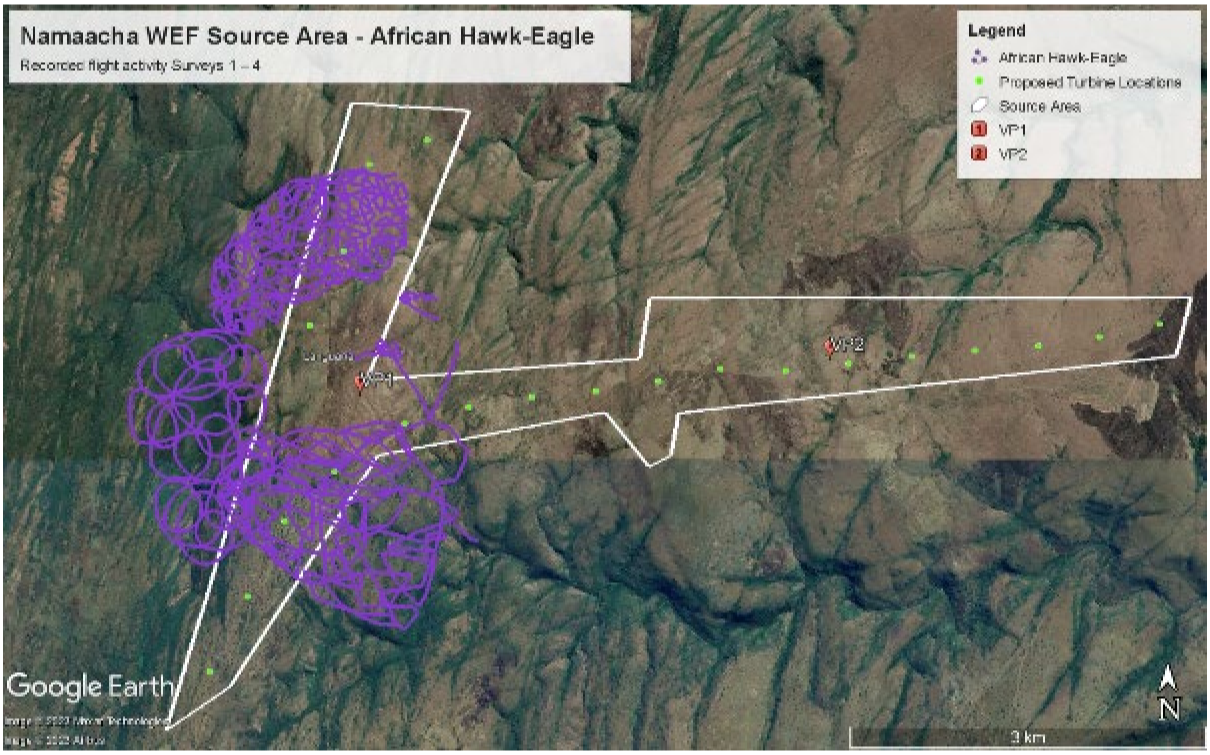


Figure 10: Flight activity of African Hawk-Eagle after four surveys

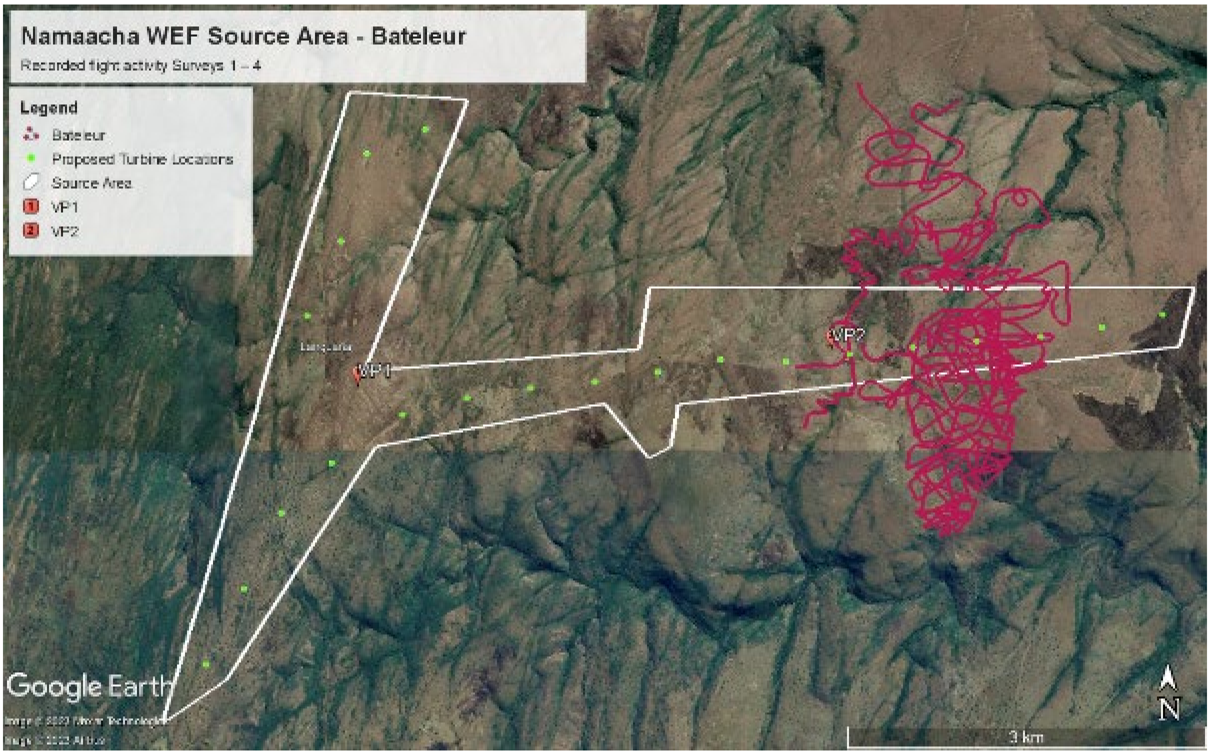


Figure 11: Flight activity of Bateleur after four surveys

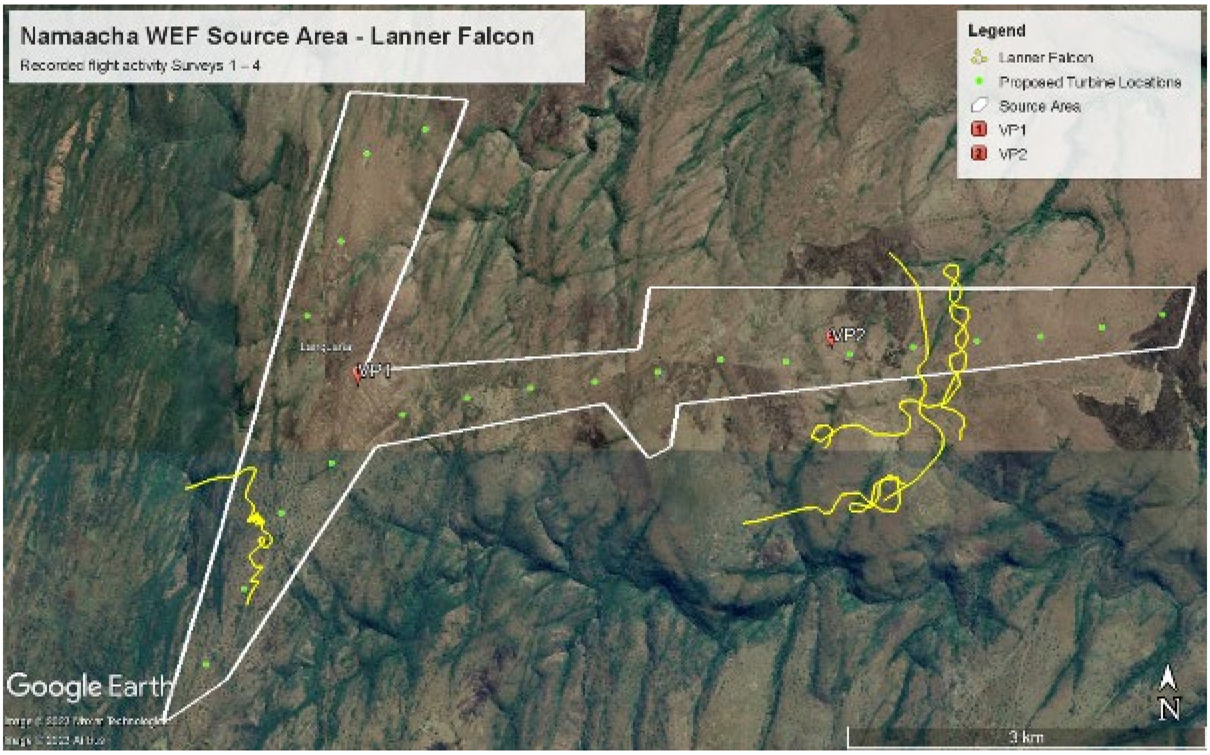


Figure 12: Flight activity of Lanner Falcon after four surveys

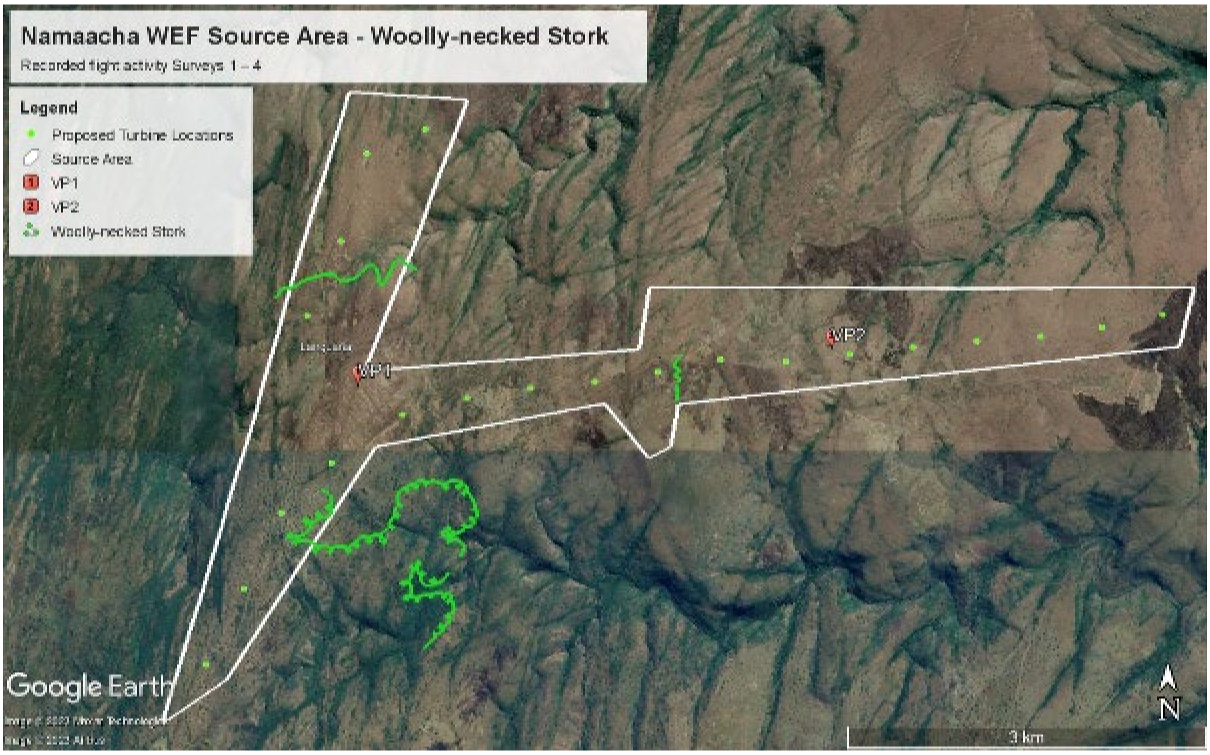


Figure 13: Flight activity of Woolly-necked Stork after four surveys

Globeleq

ECOSYSTEM SERVICES IMPACT ASSESSMENT

Namaacha WEF

41104276_
AUGUST 2023

CONFIDENTIAL

Globeleq

ECOSYSTEM SERVICES IMPACT ASSESSMENT

Namaacha WEF

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 41104276

OUR REF. NO. 41104276_

DATE: AUGUST 2023

Globeleq

ECOSYSTEM SERVICES IMPACT ASSESSMENT

Namaacha WEF

WSP

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

Phone: +27 11 254 4800

WSP.com

CONTENTS

TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report consists of an Ecosystem Services Impact Assessment for the proposed Namaacha Wind Energy Project. The presence of the Project in the landscape, vegetation clearance, and possible entry of sediment loaded stormwater to adjacent aquatic systems, were identified as some of the main ways in which the project may impact ecosystems providing priority ecosystem services. Priority ecosystem services identified were mainly provisioning ecosystems services such as wild foods, subsistence hunting and cultural ecosystem services relating to ethical and spiritual values. Overall, application of the recommended mitigation measures and the maintenance of the Project's social licence to operate from the affected beneficiaries will aid in ensuring that supply of priority ecosystem services to beneficiaries is maintained.

Contact name Aisling Dower

Contact details +27 11 313-1076 | aisling.dower@wsp.com

1 INTRODUCTION

This report consists of an Ecosystem Services Impact Assessment for the proposed Namaacha Wind Energy Project, a wind farm of an approximate capacity of 120MW (the "Project") located near the town of Namaacha, 50 km West of Maputo, Mozambique, and in close proximity to the border with South Africa and Eswatini (Swaziland) (Figure 1-1).

A comprehensive ecosystem service baseline description is provided in the existing Environmental Impact Assessment (EIA) (Matos, Fonseca & Associados, 2022). That report describes the ecosystem services supplied by the various land cover types in the Project Area of Influence, and the benefits that the local community gains from them under existing conditions.

This report builds on the existing ecosystem service review, by classifying the identified ecosystem services according to Project impact (Type 1) and Project dependence (Type 2). The potential Project impacts on Type 1 priority ecosystem services (Landsberg, et al., 2013) are assessed, and mitigation measures proposed for any adverse impacts on ecosystems supplying priority ecosystem services, and their beneficiaries.

1.1 THE CONCEPT OF ECOSYSTEM SERVICES

Ecosystem services consist of all the natural products and processes that contribute to human well-being, as well as the personal and social enjoyment derived from nature (Landsberg et al., 2013).

For example, some rivers provide habitat for fish which serves as a source of food for the local population, and provides an opportunity to gain income through sale at local markets. Wetlands provide grazing for livestock and act as nursery areas for juvenile fish at the edges of large open water systems. Wetlands often support populations of waterfowl, which can provide tourism and recreation opportunities for bird watchers; they may also help to mitigate climate change by sequestering carbon, and help reduce floods by storing rainwater (Macfarlane, et al., 2008).

Since different ecosystems provide different ecosystem services, there are trade-offs and synergies amongst ecosystem services - for example, conversion of forest to agriculture lowers the wood supply and potentially the water flow regulation, but it increases food production from crops. On the other hand, restoring a wetland may remove more pollutants from drinking water supplies and increase recreation benefits for bird watching (Landsberg, et al., 2013). The benefits of ecosystems are passed on at many levels, and to many different beneficiaries. Examples of the benefits provided at different scales include:

- Local scale: ecosystem services may be the basis for rural livelihoods and subsistence; particularly for the poor; for example, artisanal fishing of inland lakes provides both cash income and food for low-income families; and
- Regional scale: the provision of water to communities and businesses from a forested watershed.
- Global scale: ecosystems regulate climate and act as a reservoir of biodiversity that underpins biological production of all types, including agriculture.

1.2 ECOSYSTEM SERVICES AND THE INTERNATIONAL FINANCE CORPORATION

The International Finance Corporation's (IFC) Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6) (IFC, 2012), and its Guidance Notes (IFC, 2019) - defines ecosystem services as **the benefits that people**, **including businesses**, **derive from ecosystems**. The IFC define two types of ecosystem services;

- Type I: Ecosystem services on which the Project operations are most likely to have an impact and, therefore, which result in adverse impacts to affected communities (beneficiaries); and
- Type II: Ecosystem services on which the Project is directly dependent for its operations, for example, water.

Although ecosystem services are largely addressed by IFC PS 6, the assessment of ecosystem services is spread throughout the environmental and social Performance Standards (PS) because the potential effects of a project on ecosystem services relates to all aspects of peoples' relationship with the environment, including health and safety risks, land ownership or usage, and cultural heritage. The other specific PS that contain provisions for ecosystem services assessment, and as such were referred to in compiling this report, are:

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety, and Security;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.

1.3 REPORT STRUCTURE

The report is structured sequentially:

- The terms of reference are provided in Section 2.0 which provide the context for the study;
- Relevant international and national legislation and policy are summarised in Section 3.0;
- Methods used in the identification of ecosystem services and beneficiaries within the Local Study Area, prioritisation of ecosystem services and impact assessment are detailed in Section 4.0;
- Section 5.0 provides the summarised results of the ecosystem service review for the local study area (Matos, Fonseca & Associados, 2022), and the results of the prioritisation of ecosystem services exercise are provided in Section 6.0;
- Section 7.0 describes the assessment of Project impact on Priority ecosystem services within the Project Area of Influence; including recommended mitigation measures;
- Study conclusions are drawn in Section 8.0; and
- References for the study are given in Section 9.0.

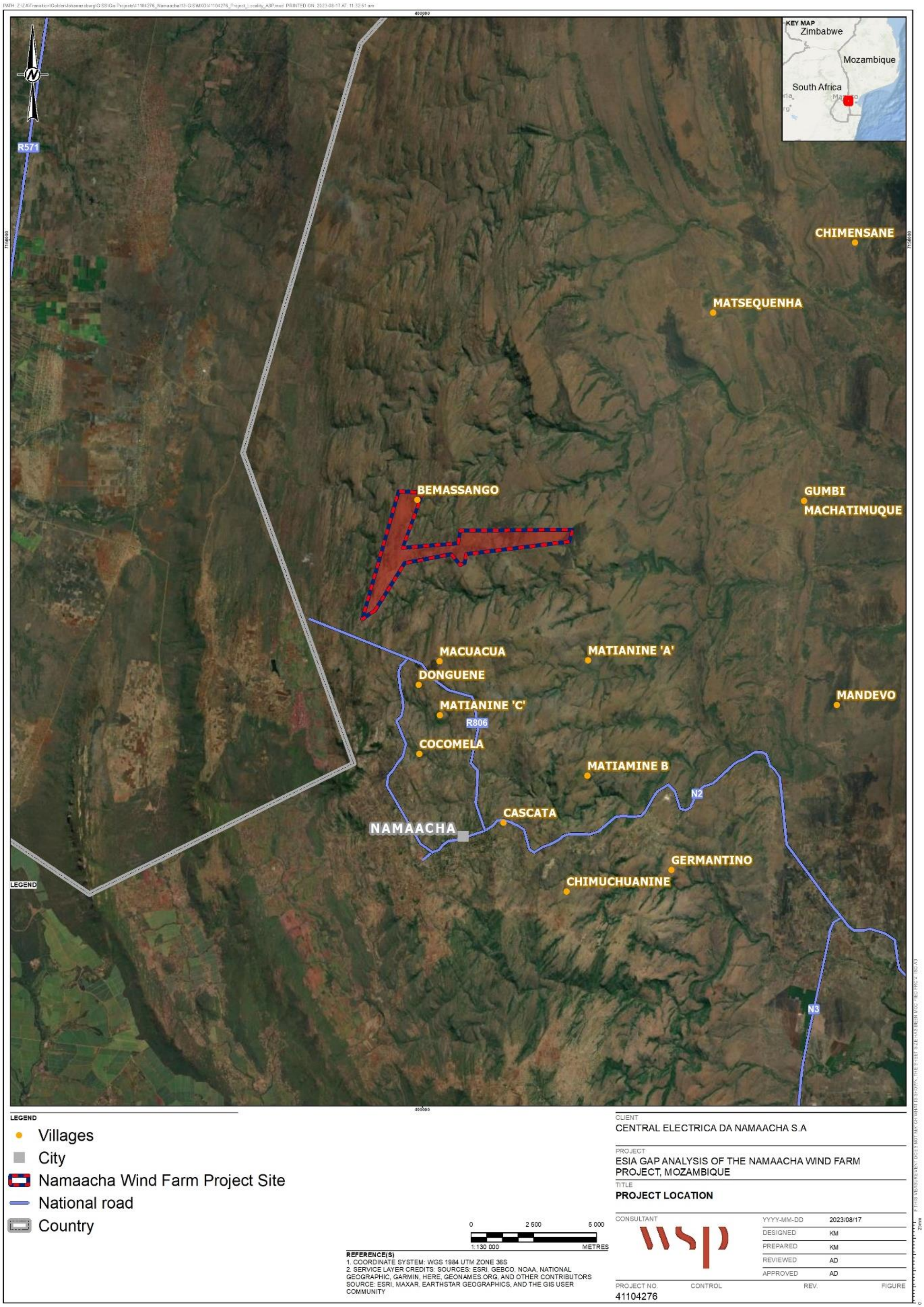


Figure 1-1 - Project location

2 TERMS OF REFERENCE

In line with the Corrective Action Plan (CAP) developed based on the findings of the gap analysis, a prioritisation of the (already identified) baseline ecosystem services supplied and utilised within the Project Area of Influence must be undertaken; and Project impacts on priority ecosystem services assessed.

In determining the requirements for prioritisation of the ecosystem services identified in the 2022 EIA, and subsequent assessment of impacts, reference was made to the international guidance document 'Weaving Ecosystem Services into Impact Assessment' (Landsberg et al., 2013), appropriate Mozambique legislation and guidance, as well as international standards and guidance. National policy and international standards pertaining to the Project are detailed in Section 3.0.

The impact assessment concentrates on assessing predicted changes in ecosystems and ecosystem function, physical and aesthetic changes, changes in socioeconomic factors and any subsequent changes in ecosystem service supply/demand as a result within the Local Study Area (LSA).

2.1 OBJECTIVES

The aim of this ecosystem services prioritisation and impact assessment study is to:

- Identify priority ecosystem services and goods currently supplied in the context of the area in which the Project will be located;
- Qualify the relationship between ecosystem services, the ecosystems that provide them, and the condition of those systems, and the current drivers of change of those systems;
- Identify beneficiaries of the services, that is, the Project and/or the people who benefit from the goods and services supplied, and their level of dependence on the ecosystem services;
- Identify potential impacts on priority ecosystem services arising from the Project and propose mitigation measures; and
- Identify any necessary additional areas of investigation.

2.2 LIMITATIONS

- This assessment is a desk-based study, based on the data gathered as part of the biological, sociocultural and physical baseline studies conducted in support of the original EIA (Matos, Fonseca & Associados, 2022).
- Despite these limitations, the conclusions contained within this report are based upon a robust and transparent procedure and represent an accurate evaluation and assessment of likely impacts on priority ecosystem services.

3 LEGISLATIVE AND POLICY CONTEXT

The ESIA must be aligned to the requirements of the World Bank Environmental & Social Framework; World Bank Group (WBG) Environmental, Health and Safety Guidelines (EHSG) both for general and sector; the IFC Performance Standards; and Good International Industry Practices (GIIP) and Mozambican legislation and applicable regulations.

Biodiversity-related legislation, policy, and standards that were used to guide this impact assessment are summarised in the sections that follow.

3.1 NATIONAL STRATEGY AND ACTION PLAN OF BIOLOGICAL DIVERSITY OF MOZAMBIQUE (2015-2035)

One of the four strategic objectives of the National Strategy and Action Plan of Biological Diversity of Mozambique (NSAPBDM) 2015-2035 is to improved the benefits sharing from biodiversity and ecosystem services for all sectors of Mozambican society, Actions that have been identified towards achieving this objective include the development of tools to value ecosystem services, and defining sustainable levels of extraction for the main ecosystem services which are listed as firewood, charcoal, honey, wood, building materials, hunting and agriculture.

To the extent possible, the mitigation measures devised as part of the ecosystem services impact assessment process presented in this report aim to align with the NSAPBDM such that sustainable use of ecosystem services by local beneficiaries can continue throughout the construction and operation phases of the Project.

3.2 IFC PERFORMANCE STANDARDS 2012

At the project financing level, the assessment and management of ecosystem services is largely dealt with in PS 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC, 2012a); however, elements of PS 1, 3, 4, 5, 7 and 8 are also relevant to ES assessment. Relevant parts of the PSs are briefly summarised as follows.

PS 6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources

PS 6 directly relates to the four types of ecosystem services, as one of the three major objectives of PS 6 is to maintain the benefits of ecosystem services. It establishes objectives and requirements to avoid, minimise and, where residual impacts remain, compensate/offset for risks and impacts to ecosystem services within a project's area of influence. It puts an onus on project developers (the 'client') to carry out a systematic review (including participation of beneficiaries) of all ecosystem services a project will impact, or is dependent upon, to identify priority ecosystem services, and avoid, minimise, and mitigate impacts on priority ecosystem services for which a client has direct management control or significant influence.

PS 1 – Assessment and Management of Environmental and Social Risks and Impacts

This PS requires that all reasonably expected risks and impacts related to ecosystem services are identified, and broader definition of a project's area of influence be used. Indirect project impacts on ecosystem services upon which beneficiaries' livelihoods are dependent should be included in the assessment.

PS 4 – Community Health, Safety and Security

This PS establishes the requirement for the assessment of impacts on priority ecosystem services that may result in adverse health and safety risks to beneficiaries.

PS 5 – Land Acquisition and Involuntary Resettlement

PS5 relates to project situations where restrictions on land use, access to natural resources, and use of natural resources, such as aquatic resources, timber products and fresh water, impact affected beneficiaries of ecosystem services. The client must assess impacts on, and compensate for, loss of provisioning ecosystem services resulting from land acquisition and involuntary resettlement.

PS 7 – Indigenous Peoples

PS7 addresses impacts on lands and natural resources that may be subject to traditional ownership, or under customary use. Such use may be seasonal/cyclical, and may be ceremonial, cultural, or economic in nature. PS7 requires that adverse impacts on affected Communities of Indigenous Peoples should be avoided where possible; or otherwise be subject to appropriate application of the mitigation hierarchy to minimise adverse impacts.

PS8 – Cultural Heritage

PS8 deals with the protection of tangible and intangible Cultural Heritage, and sets out requirements for avoidance, or the application of an appropriate mitigation hierarchy to minimise adverse impacts. When replicable cultural heritage is removed and avoidance is not possible, restoration measures including the maintenance of ecosystem services required to support the cultural heritage must be taken, either in situ or in a different location. Non-replicable cultural heritage should not be removed unless several specific conditions are met. The Project should not remove or significantly alter or damage critical cultural heritage.

Project Relevance

In the case of its direct investments (including project and corporate finance provided through financial intermediaries), the IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts so that development opportunities are enhanced. Together, the Performance Standards establish standards that the Project has to meet throughout the life of an investment by IFC. As stated above, Performance Standards 1, 4, 5, 6, 7 and 8 have components that directly relate to ecosystem services and maintenance of their supply regardless of any potential project impact. Therefore, in order to secure Project funding from IFC, the Project must demonstrate that it is in compliance with the requirements of each of the abovementioned performance standards.

3.3 INTERNATIONAL CONVENTIONS

Mozambique is a signatory to various international conventions pertaining to natural resource use, biodiversity and ecosystem services. The conventions, as well as project relevance is discussed below:

3.3.1. The Convention on Biological Diversity (1992)

Under the convention, each contracting party is expected to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity. Mozambique is a signatory to the convention on biological diversity (CBD) (1992). This convention aims for the conservation of biodiversity, its sustainable use, and sharing of the benefits of biodiversity.

Project relevance

As a signatory to the CBD, Mozambique's Government is committed to develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity, implemented through the National Strategy and Action Plan of Biological Diversity of Mozambique. The Project will need to demonstrate alignment with the provisions of this strategy in order to satisfy Government obligations as a signatory to the CBD.

3.3.2. The Convention for the Protection of the World's Cultural and Natural Heritage (1972)

The convention encourages national efforts at protecting cultural and natural heritage and promotes international recognition and cooperation in safeguarding the heritage of the world. Mozambique is a signatory to this convention.

Project relevance

The Project will need to demonstrate alignment with the provisions of the convention in order to satisfy Government obligations as a signatory to the convention, through identifying and protecting cultural heritage by ensuring that internationally recognised practices for the protection, field-based study, and documentation of cultural heritage are implemented.

3.3.3. The Convention for the Safeguarding of the Intangible Cultural Heritage (2003)

Mozambique is a signatory to the United Nations Educational, Scientific and Cultural Organisation's (UNESCO's) Convention for the Safeguarding of Intangible Cultural Heritage. The Convention seeks to raise awareness of threats to intangible heritage and encourages member states in the identification, protection and management of such assets, ensuring respect for those individuals and communities concerned.

Project relevance

The Project will need to demonstrate alignment with the provisions of the convention in order to satisfy Government obligations as a signatory to the convention, through identifying and protecting intangible cultural heritage and cultural practices by ensuring that internationally recognised practices for the protection, field-based study, and documentation of cultural heritage are implemented.

4 METHODOLOGY

Ecosystem services are the benefits that people and/or a project (the beneficiaries) obtain from ecosystems. In the strictest sense, without those beneficiaries, there are no ecosystem services. The benefits gained can be either physical or psychological, and can be obtained actively or passively, directly or indirectly.

For the purposes of this assessment, the definitions of ecosystem services were based on those developed by the Millennium Ecosystem Assessment, and described in more detail in ecosystem service impact assessment guidance (Landsberg et al., 2013) (Table 4-1). These definitions were chosen to keep consistency with the ecosystem services description provided in the 2022 EIA, as well as IFC's Performance Standards, and because they are widely recognised.

Ideally, the Project should maintain the value and functionality of priority ecosystem services to those beneficiaries directly dependent upon them, through direct management control. As such, ecosystem services whose beneficiaries are at the global scale, and to a lesser extent, the regional scale, are not covered by this assessment.

Table 4-1 - Ecosystem services categories

Broad categories	Definition
Supporting services	Natural processes essential to resilience, and functioning of ecosystems. *e.g., primary production*
Regulating services	Control of the natural environment *e.g., maintenance of key ecological processes, protected areas, habitat of special value, groundwater recharge, catchments*
Provisioning services	Supporting human needs *e.g., traditional hunting grounds, medicinal plants and minerals, water sources, fishing grounds, fire wood*
Cultural services	Aesthetic, spiritual, recreational, and other cultural values. *e.g., sacred sites, recreation, sense of place*

As mentioned, without the beneficiaries (that is, the local community (Type I) and the Project (Type II)), there are no ecosystem services. In terms of a project's setting, that is, its location, an understanding of the ecosystem processes occurring in the area is important, as it enables an understanding of how those processes affect the supply and demand of the ecosystem services arising from such processes, and the value the ecosystem services eventually offer to beneficiaries (that is, the supply side). A conceptual ecosystem services flow path illustrating these supply linkages, using photosynthesis and the functions, services and benefits that flow from it as an example, is shown in Figure 4-1.

Figure 4-1 - The flow of ecosystem services to beneficiaries

Given the above and given that the assessment of ecosystem services is also concerned with the social aspects of the benefits of services (that is, the demand side), data gathered during the stakeholder engagement processes carried out as part of the socio-economic baseline study and the cultural heritage baseline study was considered for the assessment of ecosystem services.

The approach taken to conducting the ecosystem services review is based on Steps 1 to 3 of the method put forward by Landsberg et al. (2013). The approach to impact assessment consisted of a combination of the Project impact assessment on priority ecosystem services method in Landsberg et al. (2013), and the prescribed impact assessment method being used for the ESIA (Section 4.4).

4.1 STEP 1: IDENTIFICATION OF ECOSYSTEM SERVICES RELEVANT TO THE PROJECT

The ecosystem services that that Project could impact were identified in Chapter 1.1.8 of the ecology impact assessment chapter of the EIA (Matos, Fonseca & Associados, 2022). This was done based on primary data on natural resource use gathered during all field trips done during the baseline phase of the EIA, as well as data gathered during focussed campaigns carried out in October 2018 and February 2019. This information was supplemented by that obtained from review of all other social and cultural studies done in support of the original EIA, during the current study.

- A comprehensive list of each of the four main categories of ecosystem services was developed, linked to mapped vegetation communities.
- An assessment of the importance of different vegetation units in terms of supply of linked ecosystem services was made, based on condition of assessed communities.

4.2 STEP 2: PRIORITISATION OF ECOSYSTEM SERVICES

Priority ecosystem services are:

- Services for which Project impacts could affect beneficiaries' livelihoods, health, safety or culture (Type I);
- Services that could prevent the Project from achieving operational performance (i.e. impact the Project) (Type II).

Priority ecosystem services, upon which the impact assessment was focussed, were derived from the full list of ecosystem services generated in Step 1, via an ecosystem service prioritisation exercise which was carried out using the WRI Impact and Dependence Scoping tools, and current guidance regarding conducting an Ecosystem Services Review (Landsberg, et al., 2013).

- Type I priority ecosystem services were identified and defined by:

- Identifying potential Project-caused drivers of ecosystem change.
- Identifying potentially impacted ecosystems and associated ecosystem services, and potentially affected beneficiaries.
- Assessment of Project's impact on the ecosystem services.

- Type II priority ecosystem services were identified and defined based on the Project's requirements as outlined in the Project Description.

4.3 STEP 3: DELINEATION OF THE PROJECT AREA OF INFLUENCE

The Project area of influence is the area relevant to the assessment of project impacts and dependencies on priority ecosystem services; it includes the ecosystems that supply the priority ecosystem services, and the locations where the Project and affected stakeholders access priority ecosystem services (Landsberg, et al., 2013).

The Project area of influence was set by firstly mapping the locations of Project infrastructure and activities against the mapped vegetation units that supply priority ecosystem services to identify those land cover types that may be impacted by the proposed construction, operation and decommissioning of the Project. Secondly, the locations where the beneficiaries of the identified priority ecosystem services access those services were then mapped and used to define the boundary of the Project Area of Influence for Impact Assessment.

The study area for the impact assessment was therefore defined as follows:

- Local Study Area (LSA): The proposed development footprint plus all areas encompassed by the Project site boundary, within which direct impacts on ecosystems supplying services (e.g. direct habitat loss, disturbance) could occur (Figure 4-2).

- Regional Study Area (RSA) was aligned with the wider social study area, and was considered to be the area within which indirect impacts on beneficiaries of ecosystems services could occur.

4.4 IMPACT ASSESSMENT

The receptors for impact assessment included ecosystem services that the Project could impact (Type I) only. Since Type II ecosystem services relate to Project operational performance, but not Project impact, these are listed in Section 6.2 for reference, but are not considered in the impact assessment.

The environmental impact assessment was conducted for the construction and operation phases of the Project, considering four essential aspects:

- **Description of the impact** – All identified impacts were described based on the current state of the environment. Once the technical description of each impact was completed, it was analytically characterized by applying the descriptors presented in Table 4-2. For every impact, a scale was assigned for each of the descriptors, i.e., for each impact, the type of impact was defined (positive/negative; direct/indirect/secondary). The extent, duration, reversibility and probability of each impact was also defined;
- **Impact assessment** – For each identified impact, a significance level was assigned according to the criteria described in Table 4-3. The degree of significance of each impact was assigned by evaluating and defining two essential aspects: The magnitude of the impact, and the sensitivity of the resource or receiver that is impacted. After characterizing the magnitude impact and sensitivity

of the receiving medium, the respective degree of significance was assigned, according to Table 4-4;

- **Mitigation measures** – In order to comply with IFC requirements, minimization measures must be implemented whenever possible. According to the IFC hierarchy, the focus is to avoid the impacts, but when it is not possible, the impacts must be minimized, and the impacts compensated residuals that remain;
- **Residual impact assessment** – After all acceptable minimization measures and technically feasible to be identified, a degree of significance was assigned to the impact residual. The significance level assignment process is the same as described above in the impact assessment stage taking into account the reduction of the impact (or increase if it is positive) after the implementation of recommended mitigation measures.

Table 4-2 – Description of impact

Descriptor	Scale	Explanation
Nature of impact	Positive	Impact that represents an improvement of the baseline situation or introduces a positive change.
	Negative	Impact that represents an adverse change from the baseline situation or introduces an undesirable factor.
	Direct	Impact arising directly from activities that are an integral part of the project (e.g., new infrastructure).
	Indirect	Impact that arises indirectly from activities that are not an integral part of the project (e.g., noise due to the movement of vehicles and machinery).
	Secondary	Secondary or change-induced impact due to the Project (e.g., employment opportunities due to material and labour requirements).
Scope	Site	The impact will be limited to the work site.
	Local	The impact will be limited to the local area.
	Regional	The impact will be limited to the region.
	National	The impact will be national.
	International	The impact will be international.
Duration	Temporary	The impact is expected to be very short-lived (days) and/or intermittent/occasional.
	Short-term	The impact is expected to be short term (0 to 5 years).
	Medium-term	The impact is expected to last 5 to 15 years.
	Long term	The impact will prevail over the life of the project. It will disappear when the project ends operations, ie deactivated (normally >15 years).
	Permanent	Impact that causes a permanent and irreversible change in the affected recipient or resource.

Descriptor	Scale	Explanation
Probability	Unlikely	Impact not likely to happen.
	Likely	There is a possibility that the impact will occur.
	Very likely	It is very possible that the impact will happen.
	Right	The impact will occur regardless of any preventive measures.
Reversibility	Immediate	The impact is immediately reversible.
	Reversible	The impact is reversible within 2 years after the cause of the impact is removed.
	Irreversible	The activity will lead to an impact that in all practical terms will be permanent.

Table 4-3 - Magnitude of impact and vulnerability of the receiving environment

Descriptor	Definition	Scale	Explanation
Impact magnitude	Describes the expected intensity of change to the resource/receiver as a result of the impact	Negligible	Impact is minimal and will have no effect on the environment.
		Reduced	The impact is reduced and will result in the processes continuing in an altered form. Reduced environmental changes. No involuntary resettlement. Good information and high awareness of potential environmental factors influencing impact. High degree of confidence.
		Moderate	The impact is moderate, and processes will be significantly changed and may be temporarily halted. Moderate environmental changes. Involuntary resettlement and limited economic displacement. Reasonable amount of information and relatively good perception of potential environmental factors influencing impact. Reasonable degree of confidence.
		High	The impact is high and results in the complete destruction of patterns and permanent interruption of processes. Destruction of rare or endangered species. Depreciation of the character or quality of important historical, archaeological, architectural or aesthetic resources or the character of a community/ neighbourhood. Negative effects on vulnerable or disadvantaged communities. Involuntary resettlement and substantial economic displacement. Limited information and limited insight into potential environmental

Descriptor	Definition	Scale	Explanation
			factors influencing impact. Low degree of confidence.
Sensitivity	The importance of the environmental attribute in question, the distribution of change in time and space. The magnitude of the change and the feasibility in which that change was predicted or measured	Low	Disturbance of degraded areas, with little conservation value or unimportant as a resource for humans. Affected species are not listed or protected. The importance of an environmental resource or attribute is based on knowledge, technical, or scientific or appreciation of the characteristics of critical resources.
		Average	Disturbance of areas with conservation value at the local or regional level or with potential use for humans. Audience segments recognize the importance of an environmental feature or attribute. Public recognition can take the form of support, conflict or opposition. Public action can be expressed formally or informally. The environment is susceptible to change
		High	Disturbance of areas with regional or national conservation value and important human resource. The importance of an environmental feature or attribute is recognized by law, plans or policy statements from government agencies or private groups. The environmental resource affected is significant. The environment is sensitive to change.

Table 4-4 – Impact significance matrix

Significance		Sensitivity		
		Low	Average	High
Magnitude	Insignificant	Insignificant	Negligible	Negligible
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High
	Positive impacts			
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High

Table 4-5 - Description of the degrees of significance of impacts

Impact rating	Description
Negative impacts	
Insignificant	The receiving environment will not be affected by the activity. Impacts do not require further assessment.
Negligible	The effect of an activity on the receptive environment is not significant enough to be observed. Impacts do not need to be minimized and are not a concern in decision-making processes.
Reduced	Detectable changes in the baseline situation are expected, in addition to natural variations, but difficulties, degradation or damage to the function and value of the resource/receptor are not expected. The significance of impacts is within the applicable parameters.
Moderate	Moderate significance indicates that an impact may reach the threshold of legal limits. Substantial impacts that could result in lasting changes to the baseline are anticipated. These impacts are a priority in minimizing, in order to prevent or reduce the significance of the impact.
High	A high degree of significance means that legal limits or standards have been exceeded, or impacts of high magnitude have occurred in highly sensitive environments or affected people. Residual impacts with high significance can be considered a fatal project failure. High residual impacts must be further avoided or minimized, in order to avoid severe impacts on the receiving environment.
Positive impacts	
Reduced	Impacts of reduced significance are noticeable, but do not permanently and radically improve the receiving environment, or benefit those affected. There is compliance with all standards and legislation.
Moderate	Positive impacts are felt and results in measurable improvements relative to baseline. There is compliance with all standards and legislation.
High	Impacts of high significance that provide substantial benefits where large improvements are felt over an extended period of time. There is compliance with all standards and legislation.

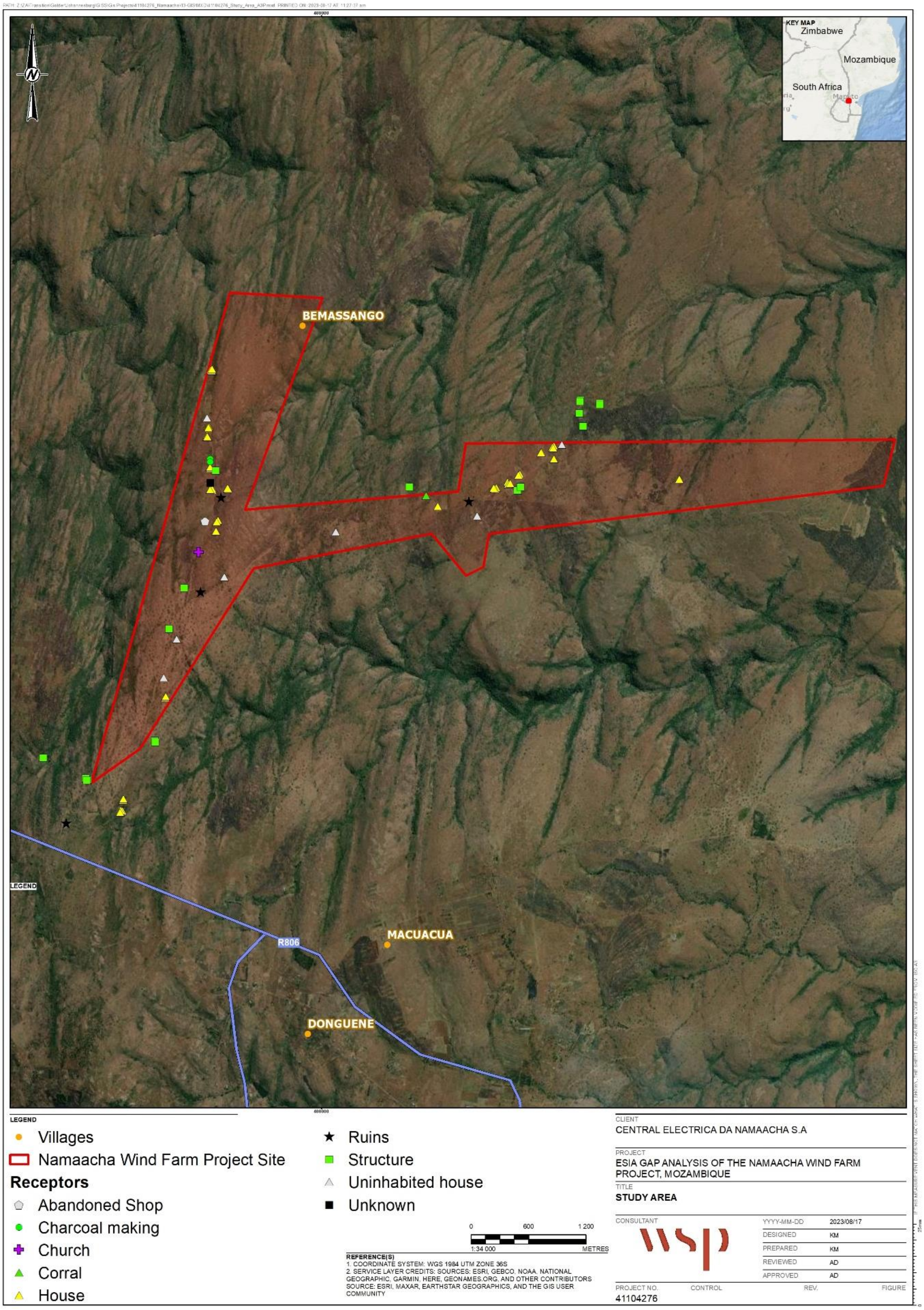


Figure 4-2 - Local study area

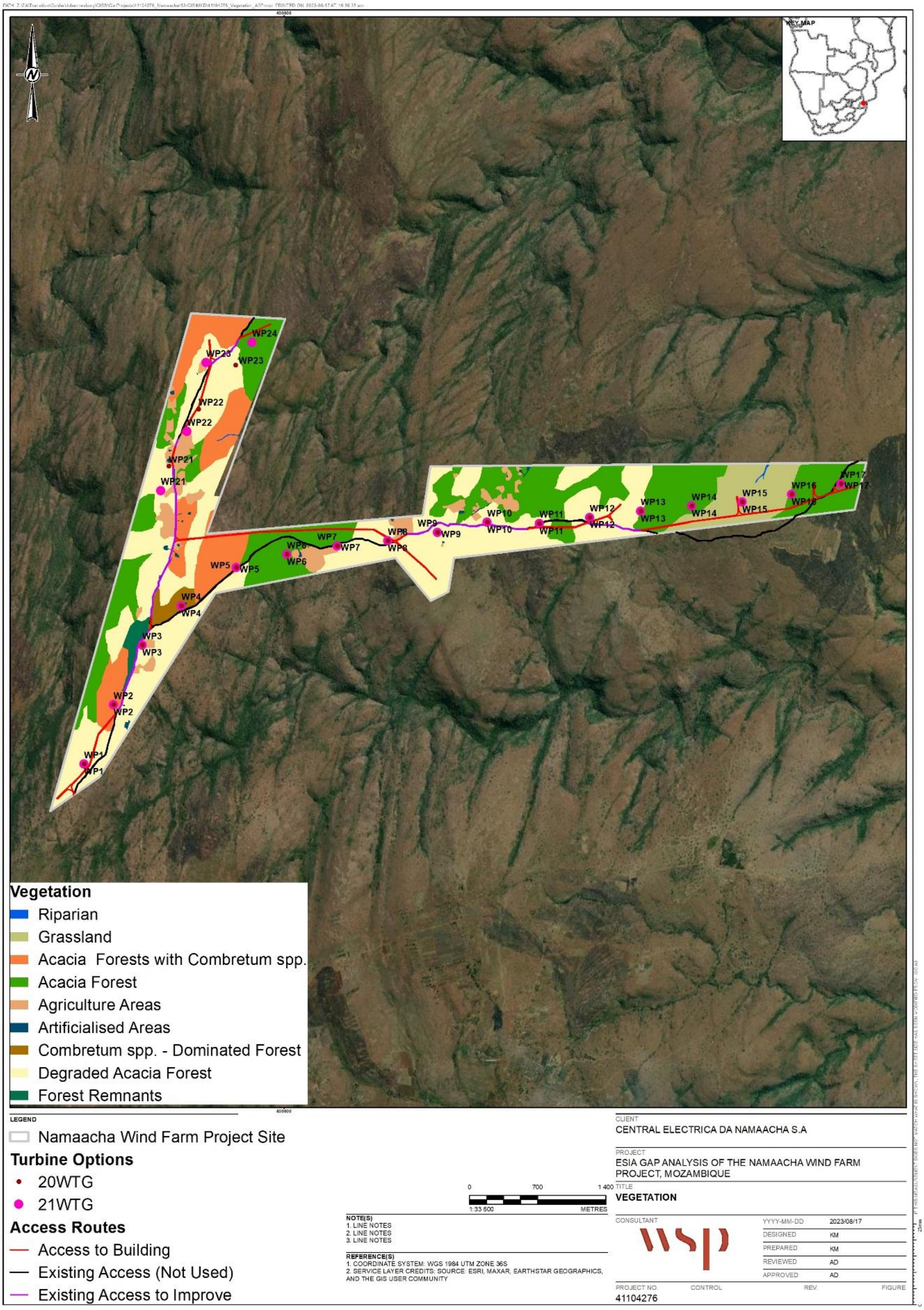


Figure 4-3 - Vegetation communities

5 ECOSYSTEM SERVICES AND BENEFICIARIES

The Project is located in in Montes Libombos, Namaacha district, Maputo province, close to its border with South Africa and Swaziland. The village of Namaacha is located 10 km south of the Project. Nine vegetation units were identified within the study area including; acacia forest, degraded acacia forest, acacia forest with *Combretum sp*., *Combretum sp*.-dominated forest, forest remnants, drainage line (riparian), grassland, agricultural areas and artificial areas. Field work done in the study area confirmed that the vegetation communities are degraded, with degraded acacia forest the most abundant vegetation community. These ecosystems however still provide various ecosystem services to the local population, such as natural medicine and wild foods, as well as habitat for flora and fauna, and regulatory services.

5.1 ECOSYSTEM SERVICES SUPPLIED WITHIN THE LSA

The LSA is currently dominated by savanna with scattered trees and shrubs, interspersed with patches of forest typically associated with drainage lines. Nine vegetation units were mapped in the study area (Figure 4-3): acacia forest, degraded acacia forest, acacia forest with *Combretum* sp., *Combretum* sp.-dominated forest, forest remnants, wetland, grassland, agricultural areas and artificial areas (Table 5-1).

Table 5-1 – Extent of mapped vegetation units within the LSA

Vegetation units	Area (ha)	%
Acacia forest	295.63	32.36
Degraded Acacia forest	377.22	41.29
Acacia forest with *Combretum* sp.	113.99	12.48
***Combretum* sp.- dominated forest**	10.43	1.14
Forest remnants	7.77	0.85
Wetlands	0.76	0.08
Grasslands	52.02	5.69
Agricultural areas	45.20	4.95
Artificial areas	10.49	1.15
Total	**913.51**	**100**

The identified ecosystem services linked to each of these vegetation units, and their importance in terms of usage by beneficiaries as described by Matos, Fonseca & Associados (2022), are listed in Appendix A. These, and additional ecosystem services identified in this updated study, are summarised in Table 5-2.

5.2 BENEFICIARIES OF ECOSYSTEM SERVICES

Several homesteads with adjoining machambas (farms used for agricultural cultivation, or keeping livestock) occur throughout the LSA, as does the village of Macuacua. The nearest urban settlement is the village of Namaacha, which is situated approximately 10 km to the south of the LSA. The reported degree of natural resource utilisation in the region is relatively high, with people using these resources for building traditional homes, fuel, and agricultural practices.

The beneficiaries who use the services that are supplied by ecosystems within the LSA, and as such could be affected by the Project (Table 5-2), fall into the following categories:

Local beneficiaries:

- Local subsistence farmers: People utilising machambas in the LSA.
- Local communities: People living in the village of Macuacua and other homes within the LSA.

Regional beneficiaries:

- Residents of Namaacha and Namaacha District.
- Downstream users of Mangave (S) and Muhololo (N) river catchments.

Table 5-2 – Ecosystem services that the Project could potentially impact (MFA, 2022), and beneficiaries of those services

Ecosystem Service	Supplying Ecosystems	Definition of Service	Beneficiaries
Provisioning			
Food	Agricultural areas	**Subsistence food crops**: various crops such as maize, sweet potato, cassava, millet, beans, peas, pumpkins and watermelon are grown on a subsistence basis in machambas. Crops are generally for domestic consumption and are not sold.	Local subsistence crop farmers
	Grassland Forest (intact and degraded) Agricultural areas	**Livestock grazing**: livestock farming is the primary economic activities in the LSA, with cattle and goats being raised – primarily for sale rather than domestic consumption (MFA, 2021). Grazing livestock were observed throughout the LSA over the course of various surveys.	Local subsistence cattle farmers: Cattle farmers utilising grazing resources in the LSA. Local/regional communities: People purchasing livestock raised in the LSA.
	Acacia forest Degraded Acacia forest Acacia forest with Combretum sp. Combretum sp.- dominated forest Forest remnants	**Subsistence hunting** for bush meat including monkeys, hare and small antelope was reported. The meat is used as a dietary supplement and excess may be sold in nearby villages. Some inhabitants also hunt birds with slingshots for meat. **Wild foods** are also foraged, including fruits of Capparis tomentosa, *Syzgium cumini, Pappea capensis, Mimusops zeheri, Manilkara discolor*, and *Strychnos madagascariensis*. Marula nuts (*Sclerocarya birrea*) are fermented to produce a widely-consumed alcoholic beverage. Foraged foods are for personal consumption only and are not sold.	Local communities Residents of Namaacha and Namaacha district
	Riparian	Drainage lines in the LSA are too small to support fish. Some **fishing** could take place in the downstream river catchments of the RSA, although this is not confirmed.	Downstream users of Mangave (S) and Muhololo (N) river catchments

Ecosystem Service	Supplying Ecosystems	Definition of Service	Beneficiaries
Biomass fuel	Forest (intact and degraded)	Wood is harvested for firewood and to produce charcoal for personal and commercial use, which is sold in nearby villages and towns.	Local communities Residents of Namaacha and Namaacha District
Biological raw materials	Forest (intact and degraded) Grassland	Wood (mostly Combretum sp.) is harvested for construction materials for traditional homes. The wood of *Afzelia quanzensis* is used to make pestles. Palm tree leaves are harvested for use in production of mats. Tall grasses are harvested from grassland habitats for use as thatching material, baskets and sisal from Agave plants is used to make rope.	Local communities Residents of Namaacha and Namaacha District
Fresh water	Groundwater wells Riparian habitat	Freshwater is collected from a groundwater well in the LSA. Regional users avail of water from the catchment. Ffreshwater is used for consumption, cooking, growing crops, hygiene and laundry.	Local communities Downstream water users
Medicinal plants	Acacia forest Degraded Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants	Several plant species are collected for medicinal purposes, including *Aloe* and *Lippia javanica* for skin problems, *Abru precatorisu subsp africanus* for fever and cough, *Petersian senna* for malaria, *Gymnosporia heterophylla* and *Elephantorrhiza elephantina* for menstrual pain and diarrhoea, and *Antidesma venosum* and *Pappea capensis* for abdominal pain.	Local communities Residents of Namaacha and Namaacha District
Regulating			
Regulation of air quality	Forest (intact and degraded) Grassland	Leaves of trees, shrubs and forbs trap air pollutants, especially near industrial and urban areas, and along roadsides	Local communities Residents of Namaacha and Namaacha District

Ecosystem Service	Supplying Ecosystems	Definition of Service	Beneficiaries
Regulation of water flow patterns and timing	Forest (intact and degraded) Grassland Riparian	Soils of woodland and grassland areas are permeable and so facilitate aquifer recharge, while vegetated riparian areas contribute to reduced flooding frequency.	Local communities Residents of Namaacha and Namaacha District Regional downstream water users
Water purification and waste treatment	Forest (intact and degraded) Grassland Riparian	Drainage lines and rivers play an important role in dilution, decomposition and assimilation of organic wastes in lieu of inadequate provision of piped water and sanitation to households within the RSA	Local communities Residents of Namaacha and Namaacha District Regional downstream water users
Regulation of disease	Riparian	Drainage lines and rivers play a role in water purification and waste treatment contributes to reduced incidence of e.g. water-borne diseases.	Local communities Residents of Namaacha and Namaacha District Regional downstream water users
Regulation of pests	Forest (intact and degraded) Grassland Riparian	Predatory animals from adjoining natural habitats (e.g. bats, birds, snakes) consume crop pests	Local subsistence crop farmers
Soil stability and erosion control	Forest (intact and degraded) Grassland Riparian	Vegetation cover within the study area reduces soil loss and prevents erosion.	Local subsistence crop farmers
Pollination	Forest (intact and degraded) Grassland	Subsistence agriculture is reliant on pollination by bees for fruit and vegetable growth	Local subsistence crop farmers

Ecosystem Service	Supplying Ecosystems	Definition of Service	Beneficiaries
Cultural			
Ethical and spiritual values (sacred places, sites)	Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Riparian	A Christian church, built with traditional materials, is situated within the LSA.	Local communities
Educational and inspirational values (intangible cultural heritage)	Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Riparian	Local people's sense of place is informed by the natural landscape.	Local communities
Recreational services	Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Riparian	Use of the landscape for outdoor sports and recreation	Local communities Residents of Namaacha and Namaacha District
Supporting			
Habitat	Acacia forest Degraded Acacia forest	Drainage lines provide habitat for aquatic species and contribute to landscape connectivity for fauna via their role as a wildlife	Local communities Regional downstream water users

Ecosystem Service	Supplying Ecosystems	Definition of Service	Beneficiaries
	Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Grassland	corridor. Remnant woodlands support indigenous fauna and plant species.	
Nutrient cycling	Acacia forest Degraded Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Grassland	The flow of nutrients through ecosystems, e.g. transfer of nitrogen from plants → soil → surface water systems → the atmosphere → plants	Subsistence crop farmers Local communities
Primary production	Acacia forest Degraded Acacia forest Acacia forest with Combretum sp, Combretum sp.- dominated forest Forest remnants Grassland	Formation of biological material by plants through photosynthesis and nutrient assimilation – critical in forming the base of the food chain for plant-eating animals	Subsistence crop farmers Local communities
Water cycling	Riparian	Flow of water through ecosystems – the drainage lines of the upper catchment of the Mangave and Muhololo rivers are located within the LSA.	Local communities Regional downstream users

6 PRIORITY ECOSYSTEM SERVICES

6.1 TYPE I ECOSYSTEM SERVICES

Ecosystem services were prioritised according to project impact by answering three key questions:

1) Could the Project affect the ability of others to benefit from this ecosystem service?

2) Is the ecosystem service important to beneficiaries' livelihoods, health, safety or culture?

3) Do beneficiaries have viable alternatives to this ecosystem service?

Following the prioritisation process, six Priority Type I ES were identified as ecosystem services that could be impacted by the Project and thus have implications for the livelihoods of the local population:

- **Wild foods** (including plants and meat obtained from foraging and hunting): these are a priority ecosystem service for those who use wild plants and bushmeat as a dietary supplement, or source of income.
- **Grazing for livestock**: use of the study area for grazing livestock is a priority ecosystem service for pastoralists who rely on cattle as a dietary supplement, means of traction (pulling carts, agricultural machinery) or source of income.
- **Medicinal plants**: these are a priority ecosystem service for those who cannot afford to purchase western medicines.
- **Biomass fuel**: communities within the LSA have few alternatives to the free availability of wood for firewood and charcoal production, for both household use (heating and cooking) and income generation purposes.
- **Fresh water**: The quality of fresh water for drinking may be compromised (during construction) for downstream water users.
- **Ethical and spiritual values:** The presence of the WEF infrastructure, activities and employees could affect the view/perception of the landscape and its contribution to people's sense of place.

The loss of areas of some vegetation units, particularly the loss of some areas of acacia and *Combretum sp*., grassland, *Combretum sp*. and acacia forest implies the loss of ecosystem services mentioned above. Based on the consultations with some of the local community members held during baseline data gathering activities, it was noted that the latter vegetation units provide wild foods, natural medicine, and wood to local beneficiaries. These beneficiaries also practise subsistence hunting in the latter ecosystems.

6.2 TYPE II ECOSYSTEM SERVICES

Type II ES were prioritised according to project ***dependence*** (operational risks to project performance) by answering two key questions:

1) Could this ecosystem service change in ways that could affect operational performance?

2) Does the Project have viable alternatives to this ecosystem service?

One priority Type II ES according to operational risk to Project performance was identified. The Project itself is a **Type II** beneficiary of the following priority ecosystem services within the study area:

- **Ethical and spiritual values**: The Project is reliant on the 'social license to operate' granted by communities within the viewshed of the WEF, whose view/perception of the landscape and its contribution to people's sense of place may be altered by the presence of the WEF.

As mentioned previously (Section 4.4), the ecosystem services on which the Project depends on are highlighted in this document and included for completeness, but are not included in the impact assessment, which deals with Type I ecosystem services, i.e. those that may be ***impacted*** by the Project, only.

7 ASSESSMENT OF PROJECT IMPACT ON TYPE I PRIORITY ECOSYSTEM SERVICES

The priority ES are generally tied to land cover/vegetation types and associated loss to the Project footprint (provisioning and cultural ES), which will be in effect for the lifetime of the Project, from construction through to closure. However, some potential impacts on ES are considered more specific to a particular Project phase (for example, 'freshwater supply' is more likely to be affected during the construction phase of the Project as a result of earthworks), therefore, the impact assessment is separated according to phase (construction and operation phases) and grouped by Project impact.

The ratings presented in the impact analysis summary tables are based on the anticipated impacts on ES, both before and after specific mitigation measures have been applied. Mitigation measures provided include those from the initial baseline and impact assessment studies that are specific to potential impacts on the supply of ES, and additional mitigation measures as required.

7.1 CONSTRUCTION PHASE

Impacts on the supply of priority ecosystem services are expected to occur mainly during the construction phase, through construction of roads, clearing of land for installation of turbines and other associated machinery. These activities will also limit access to ecosystems supplying priority ecosystem services for beneficiaries. The anticipated loss of mapped vegetation communities, and linked priority ES, are summarised in Table 7-1.

Table 7-1 – Extent of loss of mapped vegetation units within the LSA

Vegetation units	Total Area (ha)	Project loss (ha)	% loss
Acacia forest	295.63	10.56	3.6
Degraded Acacia forest	377.22	19.81	5.3
Acacia forest with *Combretum* sp.	113.99	4.26	3.7
***Combretum* sp.- dominated forest**	10.43	1.63	15.6
Forest remnants	7.77	1.07	13.8
Riparian/wetland	0.76	0.00	0.0
Grasslands	52.02	2.63	5.0
Agricultural areas	45.2	2.57	5.7
Artificial areas	10.49	0.30	2.8
TOTAL	**913.51**	**42.81**	

7.1.1 Wild Foods

Loss of approx. 37 ha of woodland/forest vegetation communities which supply wild foods (see Table 5-2), due to direct loss within the project footprint may reduce the availability of foraged wild foods for local beneficiaries; in addition, access to wild food gathering areas may be restricted during construction phase (e.g. site security, fencing etc). Access to preferred wild food gathering areas could be restricted during construction phase (e.g. site security, fencing etc). While this could potentially result in an impact of moderate significance for a temporary period during construction, the application of the recommended mitigation measures will reduce the predicted impact magnitude so that the residual impact is one of negligible significance (Table 7-2).

Table 7-2: Impact of loss of vegetation on availability of wild foods

<table>
<tr><th colspan="4">Ecosystem service: Wild foods</th></tr>
<tr><td>Impact</td><td colspan="3">Loss of approx. 37 ha of woodland/forest vegetation communities to the project footprint may reduce the availability of wild foods for local beneficiaries</td></tr>
<tr><td>Project Phase</td><td colspan="3">Construction</td></tr>
<tr><td>Nature of Impact</td><td colspan="3">Direct</td></tr>
<tr><td>Extent</td><td colspan="3">Local</td></tr>
<tr><td>Probability</td><td colspan="3">Definite</td></tr>
<tr><td>Duration</td><td colspan="3">Long term</td></tr>
<tr><td>Reversibility</td><td colspan="3">Irreversible</td></tr>
<tr><td>Impact assessment</td><td>Impact before mitigation</td><td>Mitigation measures</td><td>Residual impact</td></tr>
<tr><td>Magnitude</td><td>Reduced</td><td rowspan="3">• Limit the removal of vegetation to the areas strictly necessary for the execution of the work – these must be demarcated for construction workers.</td><td>Insignificant</td></tr>
<tr><td>Sensitivity</td><td>Low</td><td>Low</td></tr>
<tr><td>Classification of Significance</td><td>Negligible</td><td>Insignificant</td></tr>
</table>

Similarly, while direct access to hunting grounds may be restricted during construction, it is anticipated that any access limitations would be surmountable via use of alternative traversing routes – these are not expected to present a significant challenge to beneficiaries' ability to hunt in the area. Changes in wildlife use of the LSA during construction as a result of disturbance could temporarily limit the use of the LSA for hunting wildlife for subsistence purposes, which is considered an impact of moderate significance. The application of the required mitigation measures is anticipated to reduce the significance of the residual impact to an acceptable level.

Table 7-3: Loss of subsistence hunting grounds

Ecosystem service: Subsistence hunting			
Impact	Clearing of vegetation, construction activities and presence of people/machinery could affect access to hunting grounds, and cause a reduction in hunting opportunities in the LSA due to wildlife disturbance		
Project Phase	Construction		
Nature of Impact	Direct		
Extent	Local		
Probability	Highly likely		
Duration	Short term		
Reversibility	Reversible		
Impact Assessment	**Impact before mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Moderate	• Minimise wildlife disturbance by completing construction work to schedule. • Provide mess facilities for construction workers and ban hunting by workforce.	Insignificant
Sensitivity	Low		Low
Classification of Significance	Moderate		Insignificant

7.1.2 Grazing for Livestock

The LSA is used by local beneficiaries to graze cattle, which are traditionally used for domestic consumption, pulling machinery, and more recently, commercial purposes (source of income). Loss/reduced access to vegetation communities of the LSA used by cattle for grazing during construction of the WEF could potentially affect local pastoralist's ability to move livestock throughout the landscape; the magnitude of which is expected to be moderate, with an overall impact of potentially high significance prior to mitigation. Although a residual impact of moderate significance is anticipated during the construction phase, the impact is expected to be negligible once the WEF is operational and construction work ceases.

Table 7-4: Loss of grazing areas for livestock.

Ecosystem service: Grazing for livestock			
Impact	Vegetation clearance and site fencing/activities may reduce available grazing area for livestock		
Project Phase	Construction		
Nature of Impact	Direct		
Extent	Local		
Probability	Highly likely		
Duration	Short term		
Reversibility	Reversible		
	Impacts without measures of mitigation	Mitigation measures	Residual impact
Magnitude	Moderate	• Limit vegetation clearing to new access tracks, and turbine footings. • Limit the use of security fencing to laydown areas, site offices only. • Maintain access through fenced roads/areas via agreed crossing points. • Any economic displacement experienced by impacted pastoralists will be addressed via a Resettlement Action Plan.	Reduced
Sensitivity	High		High
Classification of Significance	High		Moderate

7.1.3 Biomass Fuel

The majority of the population in the LSA use wood fuel as their main source of energy, which is harvested from woodland and bush areas. Reductions in vegetation communities that supply this ecosystem service due to Project construction may negatively affect the supply of this ecosystem service, however, given the relatively small loss in extent of supplying communities in the context of the wider area, the magnitude of the potential impact is considered to be reduced. The sensitivity of the ecosystem service is high, because there are almost no viable alternatives to the use of firewood and charcoal by beneficiaries, and it is not easily replaceable. The significance of potential Project impacts on the supply of this ecosystem service is considered moderate; successful application of the recommended mitigation measures would reduce the impact magnitude and the ecosystem service sensitivity would also be lowered due to the availability of an affordable substitute to charcoal/wood harvest, resulting in minor residual impacts, post-mitigation.

Table 7-5: Loss in extent of ecosystems supplying fuel wood

<table>
<tr><th colspan="4">Ecosystem service: Wood</th></tr>
<tr><td>Impact</td><td colspan="3">Loss in extent of woodlands/vegetation communities from which people obtain firewood.</td></tr>
<tr><td>Project Phase</td><td colspan="3">Construction</td></tr>
<tr><td>Nature of Impact</td><td colspan="3">Direct</td></tr>
<tr><td>Extent</td><td colspan="3">Local</td></tr>
<tr><td>Probability</td><td colspan="3">Likely</td></tr>
<tr><td>Duration</td><td colspan="3">Long term</td></tr>
<tr><td>Reversibility</td><td colspan="3">Irreversible</td></tr>
<tr><td>Impact Assessment</td><td>Impact prior to mitigation</td><td>Mitigation measures</td><td>Residual impact</td></tr>
<tr><td>Magnitude</td><td>Reduced</td><td rowspan="3">• Limit vegetation clearing to new access tracks, and turbine footings.
• Protect and maintain alternative areas where the local community can access wood.</td><td>Negligible</td></tr>
<tr><td>Sensitivity</td><td>High</td><td>Average</td></tr>
<tr><td>Classification of Significance</td><td>Moderate</td><td>Negligible</td></tr>
</table>

7.1.4 Biological Raw Materials

Beneficiaries in the LSA utilise natural materials to construct homesteads, as well as the local Christian church. The extent of loss of ecosystems supplying these materials is relatively small (Table 7-1), therefore the magnitude of the potential impact is considered to be reduced. The sensitivity of the ecosystem service is considered moderate; as a result, an impact of reduced significance is predicted. Successful implementation of the recommended mitigation measures is expected to result in an insignificant residual impact.

Table 7-6: Loss in extent of ecosystems supplying biological raw materials

Ecosystem service: biological raw materials			
Impact	Loss in extent of woodland/grassland vegetation communities from which people obtain biological raw materials.		
Project Phase	Construction		
Nature of Impact	Direct		
Extent	Local		
Probability	Likely		
Duration	Long term		
Reversibility	Irreversible		
Impact Assessment	**Impact prior to mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Reduced	• Limit vegetation clearing to new access tracks, and turbine footings. • Protect and maintain alternative areas where the local community can access biological raw materials within the LSA.	Negligible
Sensitivity	Average		Average
Classification of Significance	Reduced		Negligible

7.1.5 Medicinal Plants

Some use of medicinal plants by local beneficiaries is reported, although the importance of the LSA in supplying these is considered limited to areas of natural vegetation, the loss of which is expected to be minimal (Table 7-1). While reductions in vegetation communities that supply this ecosystem service due to Project construction may negatively affect the supply of this ecosystem service, given the relatively small loss in extent of supplying communities in the context of the wider area, the magnitude of the potential impact is considered to be reduced. The sensitivity of the ecosystem service is considered moderate since local beneficiaries are also likely to have access to pharmaceutical medicines in nearby towns (e.g. Namaacha). The impact prior to mitigation is therefore expected to be of reduced significance; reducing to a residual impact of negligible significance with the application of mitigation measures.

Table 7-7: Loss in extent of ecosystems supplying medicinal resources

Ecosystem service: Medicinal resources			
Impact	Loss in extent of woodlands/vegetation communities from which people obtain medicinal plants.		
Project Phase	Construction		
Nature of Impact	Direct		
Extent	Local		
Probability	Highly likely		
Duration	Long term		
Reversibility	Irreversible		
Impact Assessment	**Impact prior to mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Reduced	• Limit vegetation clearing to new access tracks, and turbine footings. • Protect and maintain alternative areas where the local community can access biological raw materials within the LSA.	Negligible
Sensitivity	Moderate		Average
Classification of Significance	Reduced		Negligible

7.1.6 Freshwater

Temporary impacts on the quality of water supply where Project infrastructure intercepts drainage lines, streams in the upper catchment of the Mangave and Muhololo rivers could occur during construction, affecting downstream users' ability to utilise clean freshwater for domestic and agricultural purposes. Sediment-loaded water could enter these systems during the construction phase as a result of earthworks for road and turbine footprint construction, resulting in regional downstream impacts. Although potentially regional in extent, the impact would be temporary/intermittent (occurring during peak flow periods / heavy rains). The potential magnitude could be moderate as significant sedimentation flushes could temporarily affect beneficiaries' ability to use clean freshwater for domestic and agricultural purposes.

The sensitivity of the ecosystem service is high, as freshwater supply in the necessary quantities and to the required quality standards is not easily substitutable. The significance of potential Project Impacts on the supply of this ecosystem service is thus considered high. The magnitude of the potential impacts can be reduced by appropriate storm water management, sediment control and monitoring mechanisms, reducing the predicted impact post-mitigation to negligible significance.

Table 7-8: Changes in quality of freshwater supply

Ecosystem service: Medicinal resources			
Impact	Changes in quality of freshwater supply due to sediment release during earthworks		
Project Phase	Construction		
Nature of Impact	Direct		
Extent	Local		
Probability	Likely		
Duration	Temporary		
Reversibility	Reversible		
Impact Assessment	**Impact prior to mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Moderate	• Implement stormwater management plan and sediment traps. • Monitor water quality throughout construction and employ additional mitigation measures (adaptive management) as required. • Schedule earthworks during periods of low rainfall (dry season).	Insignificant
Sensitivity	High		High
Classification of Significance	High		Negligible

7.2 OPERATION PHASE

Operation phase impacts on priority ecosystem services are predicted as a result of the physical presence of the Project in the landscape, and shadow-flicker – potentially affecting beneficiaries' sense of space, and the value of cultural sites.

7.2.1 Ethical and Spiritual Values, Educational and Inspirational Values

These ES are considered together given that they are rooted in the same cultural landscapes and are potentially affected and demanded by the Project in the same ways. These ecosystem services may be impacted by the Project, and the Project also relies on the maintenance of the supply of these ecosystem services in order to prevent potential impacts on its social licence to operate.

Sacred sites (e.g. the traditional church) and intangible cultural heritage are inextricably linked with the landscapes and natural ecosystems of the LSA, and are important in terms of beneficiaries' sense of identity and heritage. The Project could impact the benefit that people derive from these ecosystem services, largely due to the visual presence of the Project itself in these landscapes; which could affect beneficiaries' perception of the value of such sites.

The magnitude of predicted impacts on peoples' ethical, spiritual, educational and inspirational values is expected to be moderate. The effect will extend to beneficiaries whose views of the landscape are located in the Project viewshed and to any sacred or cultural sites that are affected by shadow flicker. The duration will be long-term, extending throughout the Project's operational lifetime. The value of the affected components to beneficiaries is considered moderate. The overall impact prior to mitigation is one of moderate significance.

During the expected operational lifespan of the Project, mitigation of direct impacts on sacred sites/and or sense of space due to changes in the visual amenity of the landscape is not likely to be possible; however, implementation of staff sensitisation programmes so that maintenance activities do not impinge on cultural sites or activities, and ongoing consultation with local communities/provision of a grievance mechanism is recommended.

Table 7-9: Changes in visual amenity of the landscape and sacred sites

Ecosystem service: Medicinal resources			
Impact	Changes in visual amenity of the landscape affecting cultural sites and sense of place		
Project Phase	Operation		
Nature of Impact	Direct		
Extent	Local		
Probability	Highly likely		
Duration	Long-term		
Reversibility	Reversible		
Impact Assessment	**Impact prior to mitigation**	**Mitigation measures**	**Residual impact**
Magnitude	Moderate		Reduced

Sensitivity	Average	• Limit vegetation clearing to access tracks and immediate vicinity of turbine footings. • Protect and maintain alternative areas where the local community can access biological raw materials within the LSA.	Moderate
Classification of Significance	Moderate		Reduced

8 CONCLUSION

The Project will impact priority ecosystem services in three main ways;

- Vegetation clearance and associated loss in extent of ecosystems supplying ecosystem services during construction;
- Possible entry of sediment loaded stormwater to the Mangave and Muhololo rivers via drainage lines in their upper catchment; and
- Presence of the Project in the landscape.

The loss in extent, and reduction in condition of ecosystems supplying ecosystem services is expected to limit the ability of site-based and local beneficiaries to benefit from provisioning ecosystem services. However, the application of the recommended mitigation measures, together with the compensation of subsistence crop farmers / provision of electricity to local communities, is expected to address the majority of the predicted impacts on supply of these resources. A residual impact of moderate significance on the supply of grazing for livestock during the construction phase is anticipated, as a result of the reduced extent of supply areas, and temporary changes in access to grazing areas; however, this impact is expected to be confined to the construction phase and will resolve once the WEF is operational.

The presence of the wind energy facility is likely to affect ethical and spiritual values of beneficiaries whose cultural heritage is closely linked to the natural environment, particularly natural woodlands, grasslands and riparian areas. This impact is difficult to mitigate, and a reduced residual impact is predicted.

The Project's effect on the quality of fresh water in the Mangave and Muhololo rivers has the potential to impact the quality of fresh water supply to downstream users. Adherence to the recommended mitigation measures and monitoring water quality during construction will ensure that earthworks do not significantly interfere with the quality of freshwater supply, protecting local and downstream users.

Other than the actual direct and indirect effects of Project infrastructure and activities, maintenance of the Project's social licence to operate from affected beneficiaries is critical. It is therefore crucial that the mitigation hierarchy is followed and all efforts to avoid and minimise impacts on the downstream water quality, subsistence croplands and grazing areas, and ethical and spiritual are made. In some cases, commitment to the delivery of innovative and sustainable community development programmes for local beneficiaries is expected to be the most effective tool in terms of ensuring that supply of priority ecosystem services to beneficiaries is maintained, and Project-induced pressures on the ecosystems that supply those services are alleviated.

9 REFERENCES

IFC, 2012. Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group.

IFC, 2019. Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group.

IPIECA (2011). Ecosystem services guidance. Biodiversity and ecosystem services guide and checklists. OGP Report Number 461.

IPIECA (2016). Biodiversity and Ecosystem Service Fundamentals. Guidance document for the oil and gas industry. IOGP Report 554.

Landsberg, F., S. Ozment, M. Stickler, N. Henninger, J. Treweek, O. Venn, (2013). Weaving ecosystem services into impact assessment. A Step-by-Step Method. Abbreviated Version 1.0. Online at https://www.wri.org/publication/weaving-ecosystem-services-into-impact-assessment

Matos, Fonseca & Associados, 2022. Estudo de Impacto Ambiental da Central Eléctrica da Namaacha. Relatório Técnico Central Eléctrica da Namaacha, S.A. Novembro 2020 (modificado em Janeiro de 2022)

Appendix A

ECOSYSTEM SERVICES SUPPLIED IN LSA

Table A-1 – Ecosystem services, and importance of mapped vegetation communities for supply

Ecosystem service	Acacia forest	Degraded Acacia forest	Acacia forest with Combretum sp.	Combretum sp. Woodland	Forest remnants	Riparian	Grassland	Agricultural areas	Artificial areas
Provisioning									
Food - Hunting	High	Average	High	High	High	Low	Average	Average	n/a
Wild foods	High	Average	High	High	Average	Low	Low	Low	n/a
Fishing	n/a	n/a	n/a	n/a	n/a	Low	n/a	n/a	n/a
Grazing/ Cattle	Average	High	Average	Average	Low	n/a	High	High	Average
Agriculture	Low	Low	Low	Low	Low	n/a	Low	High	n/a
Honey	Low	Low	Low	Low	Low	n/a	Low	Low	n/a
Freshwater	n/a	n/a	n/a	n/a	n/a	High	n/a	n/a	n/a
Biomass fuel	Average	Average	High	High	High	Low	Low	Low	n/a
Biological raw materials	Average	Average	Average	Average	Average	Low	High	Low	n/a
Medicinal plants	High	Average	High	High	High	Low	Low	Average	n/a
Supporting									
Photosynthesis and primary production	High	Average	High	High	Average	High	High	High	n/a
Soil formation	Average	Average	Average	Average	Average	High	High	Low	n/a
Cycles of nutrients and water	Average	Average	Average	Average	Average	High	High	Average	n/a
Regulating									

Soil protection and erosion control	Average	Average	Average	Average	Average	Average	Low	Low	n/a
Local climate regulation	Average	Average	Average	Average	High	Low	Low	Low	n/a
Water purification and waste treatment	Average	Low	Average	Average	Average	High	Low	Low	n/a
Air quality	High	Average	High	High	High	Low	Low	Low	Low
Regulation of water flow patterns and timing	Average	Average	Average	Average	Average	High	Average	Low	n/a
Pollination	High	Average	High	High	High	Low	Average	Low	Low
Prevention and control of disease and pests	Average	Low	Average	Average	Average	Low	Low	n/a	n/a
Supporting									
Habitat maintenance	Average	Low	Average	Average	High	Average	Low	Low	n/a
Photosynthesis and primary production									
Water cycle regulation	Low	Low	Low	Low	Low	High	Low	Low	n/a
Cultural									
Recreational services	Average	Average	Average	Average	High	High	Average	Low	Low
Tourism	High	Average	Average	Average	Average	Average	High	Low	Low
Education	Average	Average	Average	Average	Average	Average	Average	Average	Low
Scientific research	High	Low	Average	Average	Average	Average	High	Low	Low

Appendix B

PRIORITISATION MATRIX

Priority ecosystem services are those services for which the answers to questions 1 and 2 are “Yes” or “Unknown”, and “No” or “Unknown” to question 3.

Table B-1 – Prioritisation of ecosystem services according to project impact

Ecosystem service	Supplying vegetation communities	Definition of service	Potentially affected beneficiaries	1.Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries, livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternatives to this ES? (Y/N/?)	Priority ES?
Provisioning							
Wild foods	Acacia Forest Acacia forest and Combretum sp woods Forest remnant Degraded Acacia forest	Wild fruits and nuts are foraged for personal consumption.	Local community	Y	Y	?	Y
Subsistence hunting	Acacia Forest Acacia forest and Combretum sp wood Grassland Forest remnant Degraded Acacia forest Agricultural areas	Subsistence hunting for bush meat including monkeys, hare and small antelope was reported. The meat is used as a dietary supplement and excess may be sold in nearby villages	Local community Residents of Namaacha and Namaacha district	Y	Y	?	Y
Food- Grazing for livestock	Acacia Forest Acacia forest and Cambretum sp Combretum sp woods Grassland Degraded Acacia forest. Agricultural areas Artificial areas	Livestock grazing: livestock farming is the primary economic activities in the LSA, with cattle and goats being raised – primarily for sale rather than domestic consumption	Local subsistence cattle farmers: Cattle farmers utilising grazing resources in the LSA. Local/regional communities: People purchasing livestock raised in the LSA.	Y	Y	?	Y
Cultivated crops	Agricultural areas	Various crops such as maize and cassava are grown on a subsistence basis, and are not sold	Local subsistence crop farmers	N	Y	Y	N
Freshwater	Drainage lines	Freshwater is collected from groundwater wells in the LSA. The freshwater is used for consumption, cooking, growing crops and washing,	Local community	N - no groundwater drawdown anticipated	Y	Y	N
Freshwater	Drainage lines	Freshwater is obtained from rivers downstream in the catchment	Downstream water users	Y - construction phase earthworks	Y	N	Y

Ecosystem service	Supplying vegetation communities	Definition of service	Potentially affected beneficiaries	1.Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries, livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternatives to this ES? (Y/N/?)	Priority ES?
Biomass fuel	Acacia Forest Acacia forest and Combretum sp woods Remnant of forest Degraded Acacia forest	Wood is harvested for firewood and to produce charcoal for personal and commercial use, which is sold in nearby villages and towns.	Local community	Y	Y	N	Y
Biological raw materials	Acacia Forest Acacia forest and Combretum sp woods Grassland Forest remnant Degraded Acacia forest.	Tall grasses are harvested from grassland habitats for use as thatching material. Wood is harvested for construction materials for traditional homes	Local community	Y	Y	Y	Y
Medicinal plants	Acacia forest Acacia forest and Combretum sp wood Agricultural areas Forest remnant Degraded Acacia forest	Several plant species are collected for medicinal purposes, including Aloe and Lippia javanica for skin problems, Abru precatorisu subsp africanus for fever and cough, Petersian senna for malaria, Gymnosporia heterophylla and Elephantorrhiza elephantina for menstrual pain and diarrhoea, and Antidesma venosum and Pappea capensis for abdominal pain.	Local community	Y	Y	N	Y
Regulating							
Soil protection and erosion control	Acacia forest Acacia forest and Combretum sp woods Riparian Forest remnant Degraded Acacia forest	Vegetation cover within the study area reduces soil loss and prevents erosion	Local community	N	n/a	n/a	N
Local climate regulation	Acacia forest Acacia forest and Combretum sp wood Forest remnant Degraded Acacia forest	Trees and vegetation moderate temperatures whil forests/woodlands influence rainfall patterns and water availability.	Local community	N	n/a	n/a	N

Ecosystem service	Supplying vegetation communities	Definition of service	Potentially affected beneficiaries	1.Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries, livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternatives to this ES? (Y/N/?)	Priority ES?
Water purification and waste treatment	Acacia forest Acacia forest and Combretum sp woods Forest remnant Riparian	Drainage lines contribute to transport/dilution of organic wastes in lieu of absent piped water/sanitation	Local community	N	Y	?	N
Air quality	Acacia forest Acacia forest and Cambretum sp Combretum sp woods Remnant of forest Degraded Acacia woods	Leaves of trees, shrubs and forbs trap air pollutants, especially near settlements, and along roadsides	Local community	N	n/a	n/a	N
Regulation of water flow patterns and timing	Acacia Forest Acacia forest and Combretum sp woods Riparian Grassland Forest remnant Degraded Acacia forest	Uncompacted soils in natural ecosystems are permeable and so facilitate aquifer recharge, while vegetated riparian areas/drainage lines contribute to reduced flooding frequency in lower catchment	Local community Regional downstream water users	N	n/a	n/a	N
Pollination	Acacia Forest Acacia forest and Combretum sp woods Degraded Acacia forest Riparian Forest remnant Grassland	Subsistence agriculture is reliant on pollination by bees for fruit and vegetable growth	Local subsistence crop farmers	N	n/a	n/a	N
Prevention and control of pests	Acacia Forest Acacia forest and Combretum sp woods Degraded Acacia forest Riparian Forest remnant Grassland	Predatory animals from adjoining natural habitats (e.g. bats, birds, snakes) consume crop pests	Local community Residents of Namaacha and Namaacha district	N	n/a	n/a	N
Prevention and control of diseases	Riparian	Drainage lines and rivers play a role in water purification and waste treatment contributes to reduced incidence of e.g. water-borne diseases.	Local community Residents of Namaacha and Namaacha district	N			
Supporting							

Ecosystem service	Supplying vegetation communities	Definition of service	Potentially affected beneficiaries	1.Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries, livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternatives to this ES? (Y/N/?)	Priority ES?
Habitat maintenance	Acacia Forest Acacia forest and Combretum sp woods Water line Forest remnant	Drainage lines provide refugia-type habitat for flora and fauna, and contributes to landscape connectivity for terrestrial fauna through their role as a wildlife corridor. Forest and woodlands supports fauna, providing refuge for species moving in and out of the LSA and the surrounding landscape	Local community	N	N	n/a	N
Photosynthesis and primary production	Acacia Forest Acacia forest and Combretum sp woods Riparian Grassland Agricultural areas Remnant of forest Degraded Acacia forest	Formation of biological material by plants through photosynthesis and nutrient assimilation – critical in forming the base of the food chain for plant-eating animals	Local subsistence crop farmers Local community	N	Y	Y	N
Water cycle regulation	Riparian	Flow of water through ecosystems	Local community Regional downstream water users	N	n/a	n/a	N
Cultural							
Recreational services	Acacia Forest Acacia forest and Combretum sp woods Degraded Acacia forest Riparian Forest remnant Grassland	Use of the landscape for outdoor sports and recreation	Local community, regional community	N	Y	Y	N
Ethical and spiritual values (sacred places, sites)	Acacia Forest Acacia forest and Combretum sp woods Degraded Acacia forest Riparian Forest remnant Grassland	A Christian church, built with traditional materials, is situated within the LSA.	Local community	Y	Y	?	Y

Ecosystem service	Supplying vegetation communities	Definition of service	Potentially affected beneficiaries	1.Could the project affect the ability of others to benefit from this ES? (Y/N/?)	2. Is this ES important to beneficiaries, livelihoods, health, safety or culture? (Y/N/?)	3. Do beneficiaries have viable alternatives to this ES? (Y/N/?)	Priority ES?
Ethical and spiritual values (intangible CH - rituals, sense of place etc)	Acacia Forest Acacia forest and Combretum sp woods Degraded Acacia forest Riparian Forest remnant Grassland	Local people's sense of place is informed by the natural landscape.	Local community	Y	Y	?	Y

Building 1, Maxwell Office Park
Magwa Crescent West, Waterfall City
Midrand, 1685
South Africa

wsp.com

CENTRAL ELÉCTRICA DA NAMAACHA, S.A.

NAMAACHA WIND ENERGY FACILITY

ENVIRONMENTAL ACOUSTIC SPECIALIST STUDY

23 AUGUST 2023

NAMAACHA WIND ENERGY FACILITY

ENVIRONMENTAL ACOUSTIC SPECIALIST STUDY

CENTRAL ELÉCTRICA DA NAMAACHA, S.A.

REPORT (FINAL)

PROJECT NO.: 41104276
DATE: AUGUST 2023

WSP
BUILDING 1, MAXWELL OFFICE PARK
MAGWA CRESCENT WEST, WATERFALL CITY
MIDRAND, 1685
SOUTH AFRICA

T: +27 11 361 1380
F: +086 606 7121
WSP.COM

GLOSSARY OF TERMS

Sound	Sound is small fluctuations in air pressure, measured in Newtons per square meter (N/m2) or Pascals (Pa) that are transmitted as vibrational energy via a medium (air) from the source to the receiver. The human ear is a pressure transducer, which converts these small fluctuations in air pressure into electrical signals, which the brain then interprets as sound.
Noise	Noise is generally defined as unwanted sound.
Sound or noise level	A sound or noise level is a sound measurement that is expressed in decibels (dB or dB(A)).
dB or dB(A)	The human ear is a sensitive instrument that can detect fluctuations in air pressure over a wide range of amplitudes. This limits the usefulness of sound quantities in absolute terms. For this reason, a sound measurement is expressed as ten times the logarithm of the ratio of the sound measurement to a reference value, 20 micro (millionth) Pa. This process converts a scale of constant increases to a scale of constant ratios and considerably simplifies the handling of sound measurement quantities. The attached 'A' indicates that the sound measurement has been A-weighted.
dB(Z)	Historically sound levels were read off a hand-held meter and the noise levels were noted in dB, after the development of different weighting curves sound levels were noted as Z-weighting or dB(Z) to reduce the confusion with different type of weighting applied noise levels. dB(Z) refers to linear noise levels.
A-weighting	The human ear is not equally sensitive to sound of all frequencies, i.e., it is less sensitive to low pitched (or 'bass') than high pitched (or 'treble') sounds. In order to compensate when making sound measurements, the measured value is passed through a filter that simulates the human hearing characteristic. Internationally this is an accepted procedure when working with measurements that relate to human responses to sound/noise.
Ambient sound level	Ambient noise will be defined as the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities.
Sound pressure	Sound pressure is the force of sound exerted on a surface area perpendicular to the direction of the sound and is measured in N/m² or Pa. The human ear perceives sound pressure as loudness and can also be expressed as the number of air pressure fluctuations that a noise source creates.
Sound pressure level	The sound pressure level is a relative quantity as it is a ratio between the actual sound pressure and a fixed reference pressure. The reference pressure is usually the threshold of hearing, namely 20 microPascals (µPa).
Sound power	Sound power is the rate of sound energy transferred from a noise source per unit of time in Joules per second (J/s) or Watts (W).
Sound power level	The sound power level is a relative quantity as it relates the sound power of a source to the threshold of human hearing (10^{-12} W). Sound power levels are expressed in dB(A), as they are referenced to sound detected by the human ear (A-weighted).
Noise nuisance	Noise nuisance means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.

Octave bands	The octave bands refer to the frequency groups that make a sound. The sound is generally divided in to nine groups (octave bands) ranging from 32 Hertz (Hz) to 8,000 Hz. The lower frequency ranges of a sound have a vibrating character where the higher frequency of sound has the character of high-pitched sound. In viewing the total octave bands scale from 32 Hz to 8000 Hz the character of the sound can be described.

ACRONYMS AND ABBREVIATIONS

CadnaA	Computer Aided Noise Abatement
dB	Decibel
dB(A)	A-weighted sound measurement
dB(C)	C-weighted sound measurement
dB(Z)	Z-weighted sound measurement
EHS	Environmental Health and Safety
ESIA	Environmental and Social Impact Assessment
ETSU	Energy Technology Support Unit
ha	Hectare
Hz	Hertz
IFC	International Finance Corporation
km	Kilometre
L_{A90}	Noise level exceeded for 90% of the measurement period
L_{Aeq}	Equivalent continuous sound pressure level
$L_{R,dn}$	Equivalent continuous day/night rating level
$L_{Req,d}$	Equivalent continuous rating level for day-time
$L_{Req,n}$	Equivalent continuous rating level for night-time
$L_{Req,T}$	Typical noise rating levels
m	Metre
m/s	Meters per second
MW	Megawatt
OECD	Organisation for Economic Co-operation and Development
SACNASP	South African Council for Natural Scientific Professions
SANS	South African National Standards
WEF	Wind Energy Facility
WHO	World Health Organisation
WSP	WSP Group Africa (Pty) Ltd

EXECUTIVE SUMMARY

Wind turbines have the potential to generate noise and as such a specialist Environmental Acoustic Impact Assessment is required as part of the Environmental and Social Impact Assessment (ESIA) update for the Namaacha Wind Energy Facility (WEF). WSP Group Africa (Pty) Ltd) (WSP) was appointed to undertake the Environmental Acoustic Impact Assessment for the proposed Namaacha WEF.

In line with the International Finance Corporation (IFC) Environmental Health and Safety (EHS) Guidelines for Wind Energy a preliminary modelling exercise was executed using a simple model which assumes hemispherical propagation of noise from each turbine to determine potential impact on receptors within a 2 km radius of the turbines. If L_{A90} noise levels at all sensitive receptors are below 35 decibels (dB(A)) at a wind speed of 10 m/s (at a height of 10 m) during day and night times, this would be sufficient to assess the noise impact of the proposed facility, offering adequate protection of amenity at these receptors. If L_{A90} levels at any receptor location are above 35 dB(A), then impacts at these receptors may be perceived and potential turbine relocations may need to be considered. The IFC EHS Guidelines for Wind Energy is partly based on the ETSU-R-97 report published in 1996. The IFC could be considered an improvement on the methods described in the ETSU-R-97; however, some of the methodology remains unchanged. The Namaacha WEF study used a combination of the IFC and ETSU methodologies in the model setup and output analysis. The IFC limit of 35 dB(A) was used for determining the impacted receptors and the impact rating.

Fifty-nine occupied sensitive receptors were provided by Source Energy based on ground-truthing exercise conducted by their Team in August 2023.

Construction and Decommissioning Phase Impacts:

- During the construction phase of the facility various noise sources will be present onsite including earth-moving equipment (trucks, cranes, scrapers and loaders), generators, rotary drills, concrete mixers and materials handling activities among others. All of these sources will generate substantial amounts of noise and may impact on neighbouring sensitive receptors.
- It is anticipated that the decommissioning phase noise levels would be similar to those associated with the construction phase activities.
- Due to the erratic and transient nature of construction activities, no detailed construction and decommissioning plans, the environmental acoustic impacts from the construction and decommissioning phases of the facility cannot be determined quantitatively.
- As there is the potential for substantial impacts over a short-term, mitigation interventions are advised during these phases. Mitigation possibilities include both management and technical options. Such techniques include planning construction and decommissioning activities; limiting the number of simultaneous activities; using noise control devices; selecting equipment with the lowest possible sound power levels; and ensuring equipment is well-maintained to avoid additional noise generation.

Based on WSP's preliminary model (following the IFC methodology), the following was determined for the operational phase:

- Predicted L_{A90} noise levels during both day and night are above the IFC threshold of 35 dB(A) at all receptors.
- Complaints are anticipated as a result of the operation of the Namaacha WEF.
- Because this modelling suggests that turbine noise is likely to be above an L_{A90} of 35 dB(A) at all sensitive receptors at a wind speed of 10 m/s (at 10 m height) during day and night times, in line with the IFC methodology more detailed modelling should be undertaken including background ambient noise measurements. However, many of the receptors are located within the immediate vicinity of various turbines (<150 m), that it is anticipated that the results of a detailed modelling study will not add further value.
- Based on the screening study results alone, the facility will need to relocate residents and implement mitigation measures to reduce noise if a buffer zone of at least 1 km cannot be established. Where relocation is not feasible then financial incentives may need to be considered. If financial incentives are considered, the L_{A90} levels at those receptors must remain below the 45 dB(A) ETSU threshold.
- To reduce the amount of residents to be resettled, the facility should consider selecting wind turbines with lower sound power levels; higher hub heights; and operating the turbines in reduced noise mode.

The resultant environmental acoustic risks associated with the construction and decommissioning phase of the Project are anticipated to be “low” to “very low” with general mitigation options employed. For the operational phase, impacts are anticipated to be “moderate”. With implementation of a buffer of 1 km and relocation of existing receptors within this area, the operational phase impacts reduce to “low”.

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Central Eléctrica da Namaacha, S.A. (CEN) are currently developing the Namaacha Wind Energy Project, a Wind Energy Facility (WEF) of an approximate capacity of 120 MW (the "Project") located near to the town of Namaacha, 50 km west of Maputo, Mozambique. The Namaacha WEF has two possible operational designs, with two different turbine layouts, which include:

1. A WEF comprising 21 Nordex N163 5.9 MW wind turbines with a 118 m hub height.
2. A WEF comprising twenty Goldwind 165 6.0 MW wind turbines with a hub height of 120 m.

WSP has been appointed to undertake the Environmental Acoustic Impact Assessment for the Project. Wind turbines have the potential to generate noise and as such a specialist Environmental Acoustic Impact Assessment is required as part of the Environmental and Social Impact Assessment (ESIA) process for the WEF[1]. This report presents the findings of the Screening-Level Environmental Acoustic Impact Assessment performed for the Namaacha WEF. It is noted that noise impacts are anticipated from the wind turbines, however, noise from the powerlines will be negligible and as such impacts for these have not been assessed.

1.1 TERMS OF REFERENCE

The terms of reference, designed to best meet the project requirements, are summarised below:

- Execution of a preliminary modelling exercise using a simple model which assumes hemispherical propagation of noise from each turbine to determine potential impact on receptors within a 2 km radius of the turbines.
- If L_{A90} noise levels at all sensitive receptors are below 35 dB(A) at a wind speed of 10 m/s (at a height of 10 m) during day and night times, this would be sufficient to assess the noise impact of the proposed facility. If L_{A90} levels at any receptor location are above 35 dB(A) then impacts at these receptors may be perceived and potential turbine relocations may need to be considered.
- Presentation of modelled results in the form of an Environmental Acoustic Impact Assessment Report (this report).

1.2 DECLARATION OF INDEPENDENCE

Natasha Shackleton (née Gresse) is a registered Professional Natural Scientist with the South African Council for Natural Scientific Professions (SACNASP) (registration number 116335). Natasha is also a member of the South African Society for Atmospheric Sciences (SASAS) and the National Association for Clean Air (NACA). Natasha Shackleton is a consultant with a BSc Honours Degree in Meteorology obtained from the University of Pretoria. She is currently employed by WSP and has conducted environmental noise monitoring and data analysis since 2011 and environmental acoustic impact assessments and management plans since 2015 She has experience in ambient and sources noise sampling; emissions quantification for a range of source types; simulations using SANS 10201, CONCAWE, and DataKustik CadnaA; impact assessments; and management plans.

She has provided acoustic consulting support to various client industries including for mining, metallurgical complexes, crematorium, power generation, and transportation, among others. Please see **Appendix A** for a short CV detailing project experience.

I hereby declare that I am fully aware of my responsibility to remain independent and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultant's fees.

[1] GLOBELEQ appointed WSP to complete a gap analysis on the existing ESIA for the Project in accordance with the International Finance Corporation (IFC) Environmental and Social Performance Standards (PS). Based on the findings of the gap analysis, a Corrective Action Plan (CAP) was developed which detailed the supplementary environmental and social studies necessary to prepare the ESIA to meet lender's standards. It was determined during the GAP analysis that the existing Environmental Acoustic Impact Assessment had not been undertaken according to the relevant IFC guidelines and ETSU-R-97 (described in the sections that follow) and no reference for the methodology used.

Name	Natasha Anne Shackleton
Company	WSP Group Africa (Pty) Ltd
Telephone number	+27 11 300 6083
Email Address	Natasha.Shackleton@wsp.com
Signature	

2 BACKGROUND

2.1 LOCALITY

Central Eléctrica da Namaacha, S.A. is proposing to construct the Namaacha WEF, near Namaacha, 50 km west of Maputo in Mozambique (**Figure 1**). The site covers an area of approximately 857 ha. The site encompasses natural vegetation with a few isolated homesteads comprising of between one and five houses. Within 2 km of the proposed boundary there is also some agricultural areas and villages.

2.2 TOPOGRAPHY

The surrounding landscape has a rolling hill topography which is suitable for the development of a wind project. The turbines are located on flat, high-lying landscape that has the highest wind resource within the immediate area. The proposed Nordex N163 wind turbines will be located between 371.84 m and 522.33 m above mean sea level (msl). The proposed Goldwind 165 wind turbines will be located between 417.68 m and 522.33 m above msl. A map showing the typical terrain across the area is presented in **Figure 2**.

2.3 SENSITIVE RECEPTORS

Sensitive receptors are identified as areas that may be impacted negatively due to noise associated with the proposed WEF. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, office blocks and residential areas. Being such a remotely located site, dominant receptors in the area surrounding the site include small homesteads.

Data was provided from a census undertaken for the previous ESIA. The data provided receptor locations, types and occupancy status. All of these receptors were considered in this study as required for the resettlement study. Additional potential receptors were identified by WSP based on satellite imagery; these sites did not form part of any of the homesteads, charcoal manufacturing, and abandoned structures included in the census data; therefore, the types and occupancy were unknown and required verification.

The current (August 2023) occupancy of the identified sites was verified by Source Energia and the data provided to WSP. It is assumed that Source Energia undertook inspections at all of the locations identified, that the type and habitation status was correctly captured against the associated identified receptor ID; and that there were no other receptors in addition to those provided (as per the data). The sensitive receptors locations in relation to the turbines are presented in **Figure 3** and **Figure 4**.

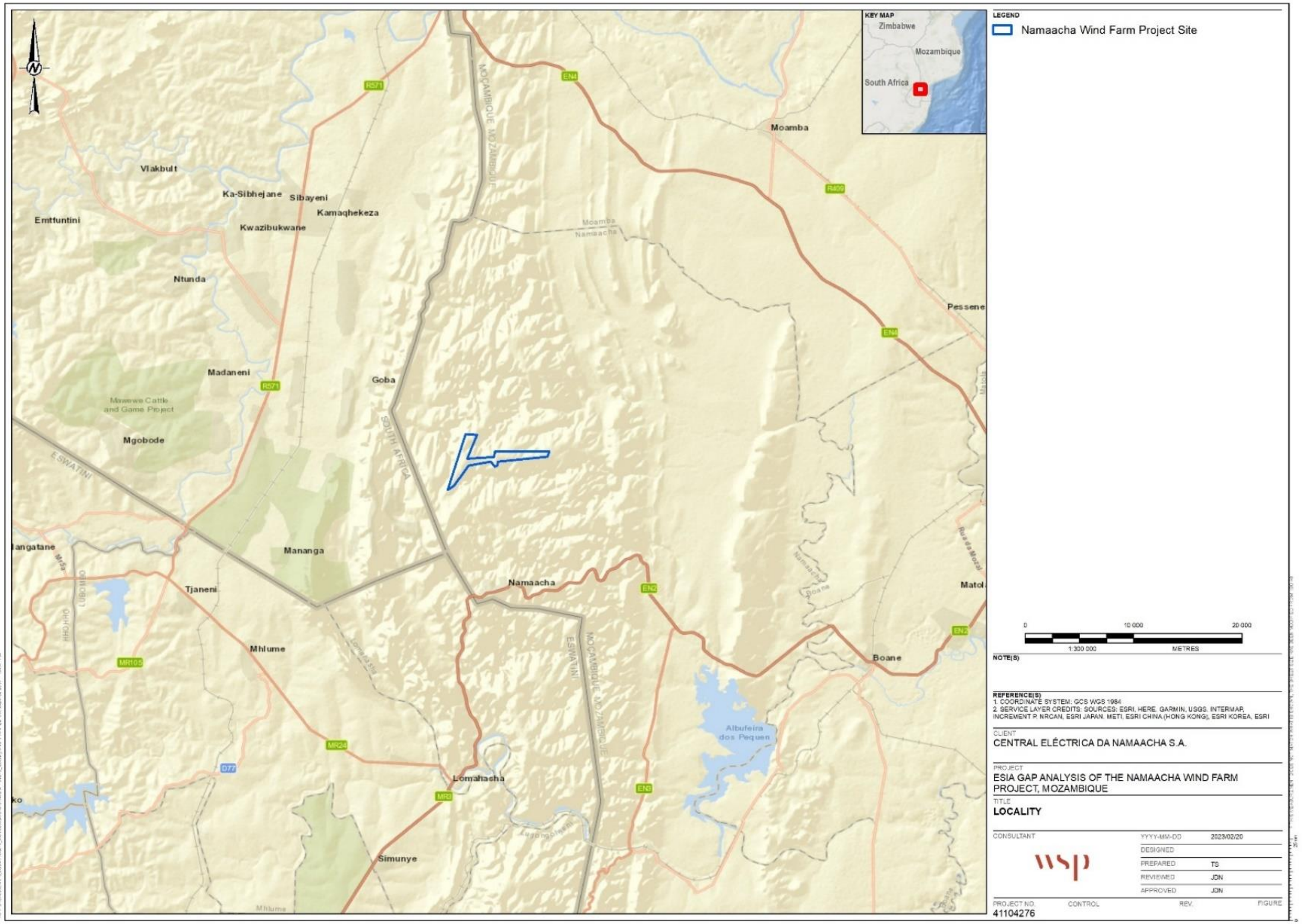


Figure 1: Locality map

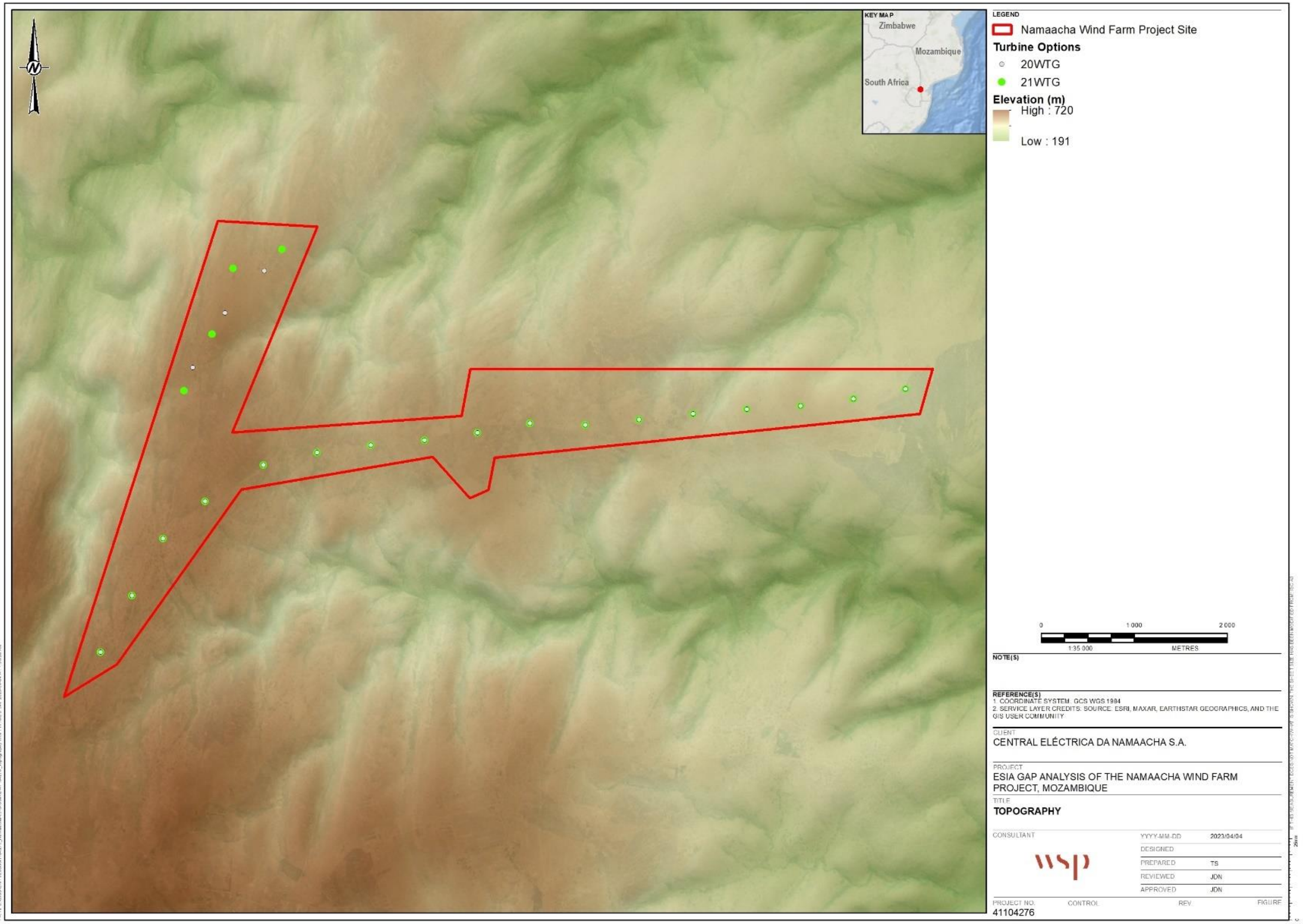


Figure 2: Topography map

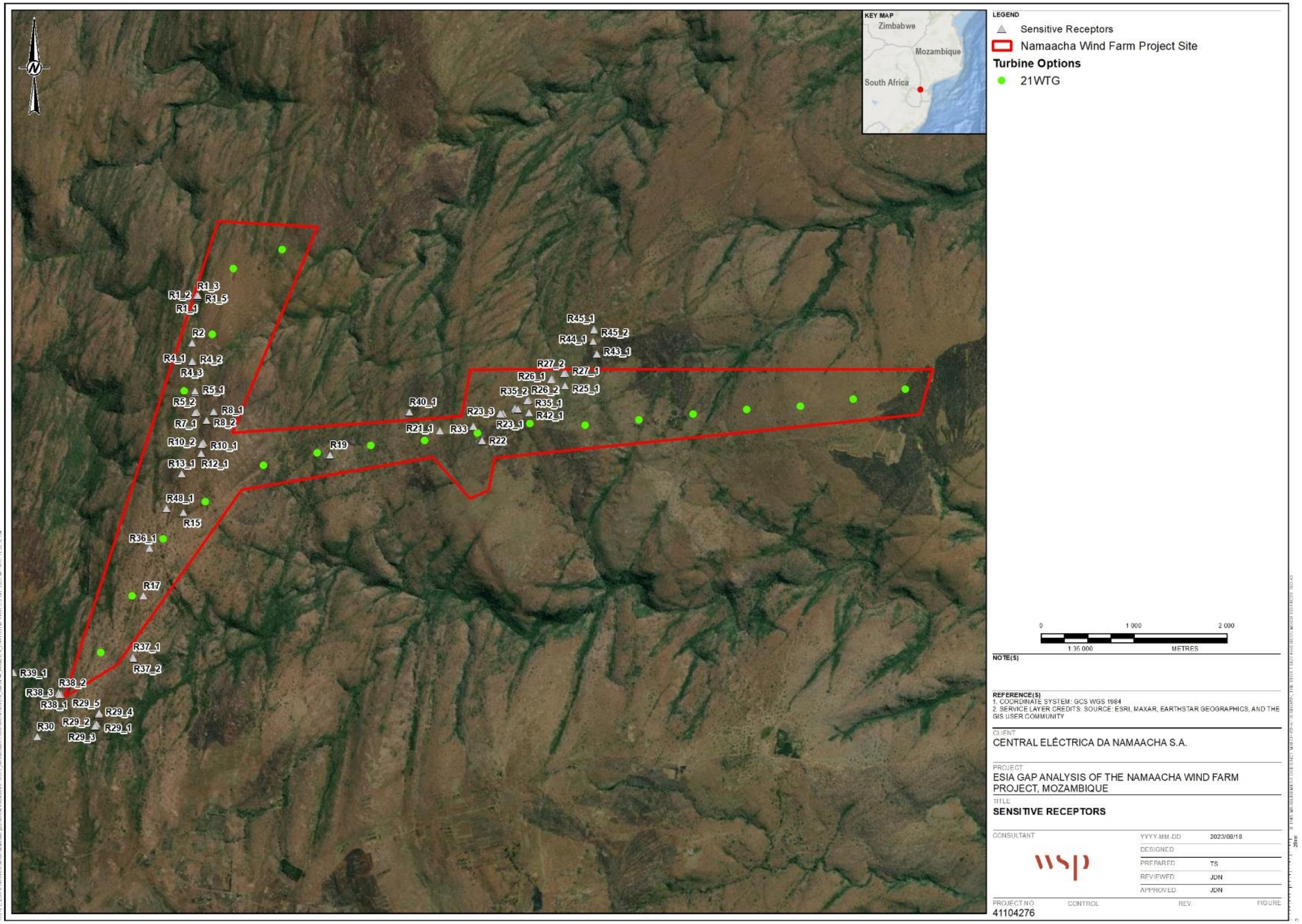


Figure 3: Receptor map with proposed Nordex N163 wind turbines layout

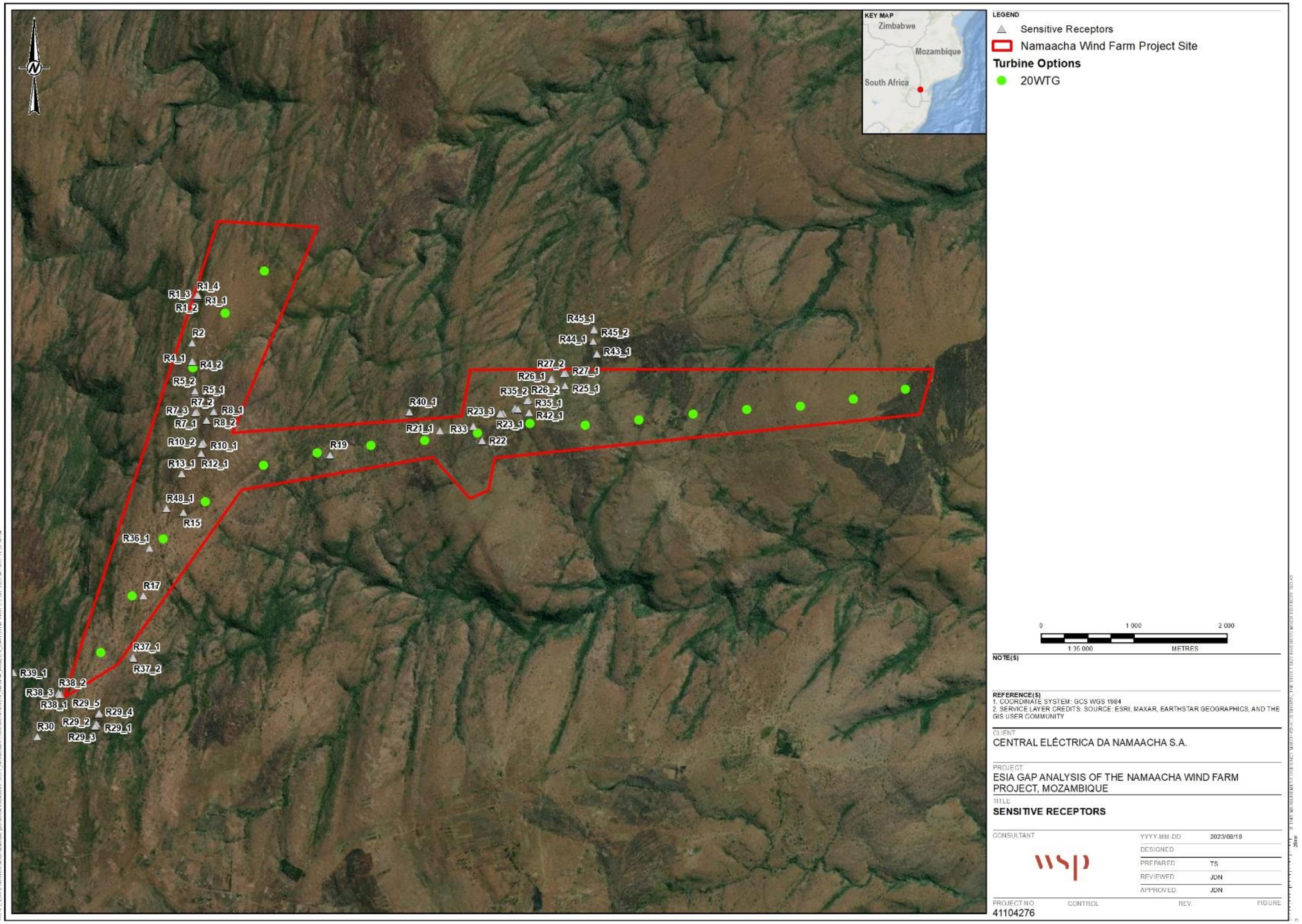


Figure 4: Receptor map with proposed Goldwind 165 wind turbines layout

2.4 PROJECT DESCRIPTION

2.4.1 WIND ENERGY POWER GENERATION PROCESS

Wind power is the conversion of wind energy into a useful form of energy, such as electricity, using modern and highly reliable wind turbines. Wind power is non-dispatchable, meaning that for economic operation, all of the available output must be taken when it is available.

The main components of a modern utility-scale wind turbine are illustrated in **Figure 5**. When the wind blows around the blades, the shape of the blades creates aerodynamic lift and drag. These forces are used to generate torque, which causes the blades to spin the rotor on its axis, creating mechanical power that is converted into electricity in a generator housed in the nacelle (Council of Canadian Academics, 2015).

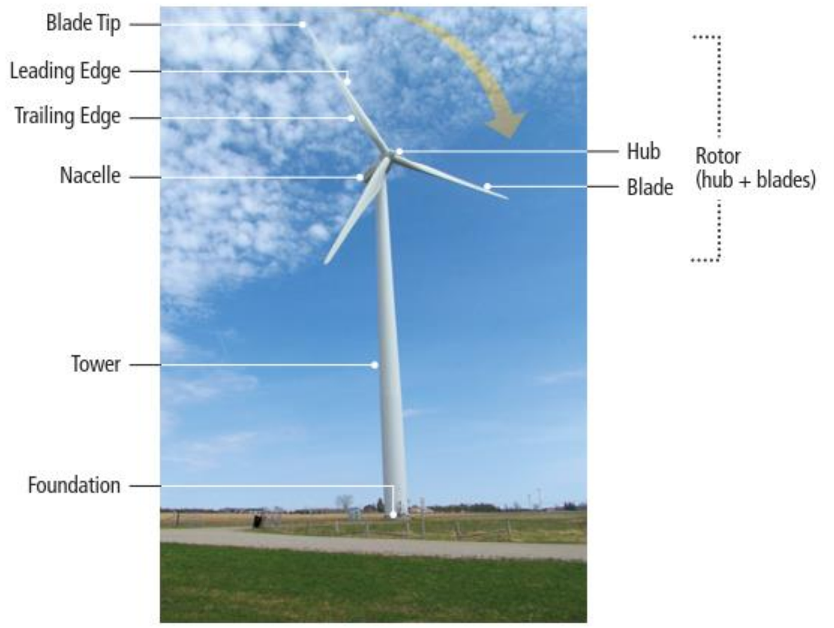


Figure 5: Components of a typical wind turbine (Council of Canadian Academics, 2015)

The electricity generated by the wind turbines is passed through a step-up transformer and then transmitted via either underground or overhead cables to a central substation, which connects the wind energy facility to a high voltage network. Wind turbines are designed to operate automatically with minimal maintenance for approximately 20-25 years.

2.4.2 PROJECT INFRASTRUCTURE

The details of the Namaacha WEF operational designs, as applicable to the acoustic impact assessment, are outlined in **Table 1**. The wind turbine coordinates and foundation heights for the operational design using the Nordex N163 turbines and the Goldwind 163 turbines, are presented in **Table 2** and **Table 3**, respectively. A map indicating the locations of the wind turbines for both operational designs is presented in **Figure 6**.

Table 1: Summary of the Namaacha WEF turbines

Turbine Make and Model	Nordex N163	Goldwind 165
Extent	857 ha	857 ha

Turbine Make and Model	Nordex N163	Goldwind 165
Capacity	Up to 123.9 MW (5.9 MW per turbine)	Up to 120 MW (6 MW per turbine)
Number of Turbines	21	20
Turbine Hub Height	118 m	120 m
Rotor Diameter	163 m	165 m
Sound Power Level (at 10 m/s)	109.2 dB(A)	111.6 dB(A)

Table 2: Siting of the Nordex N163 wind turbines

Nordex N163 Wind Turbines					
ID	**Latitude [decimal degree][a]**	**Longitude [decimal degree][a]**	**Easting [m][b]**	**Northing [m][b]**	**Base elevation [m][c]**
WP1	-25.89691	31.98114	397942.19	7135335.97	483.11
WP2	-25.89143	31.98420	398244.02	7135945.27	475.67
WP3	-25.88592	31.98720	398540.25	7136558.18	496.64
WP4	-25.88231	31.99126	398943.62	7136961.12	522.33
WP5	-25.87880	31.99691	399507.41	7137354.43	475.80
WP6	-25.87760	32.00211	400027.48	7137491.41	463.13
WP7	-25.87686	32.00728	400544.74	7137577.41	468.66
WP8	-25.87641	32.01249	401066.17	7137630.96	452.24
WP9	-25.87567	32.01761	401578.84	7137716.55	396.32
WP10	-25.87477	32.02270	402087.87	7137820.47	478.55
WP11	-25.87491	32.02806	402624.31	7137808.95	514.62
WP12	-25.87438	32.03324	403143.68	7137870.71	490.66
WP13	-25.87384	32.03849	403668.55	7137934.71	509.18
WP14	-25.87340	32.04370	404190.30	7137987.25	501.67
WP15	-25.87306	32.04890	404711.04	7138028.47	445.19
WP16	-25.87238	32.05399	405221.08	7138107.47	480.08
WP17	-25.87143	32.05904	405725.71	7138216.31	417.68
WP21	-25.87159	31.98921	398729.90	7138146.71	399.77
WP22	-25.86613	31.99196	398999.99	7138753.64	481.00
WP23	-25.85975	31.99400	399199.38	7139462.36	467.97
WP24	-25.85791	31.99871	399669.30	7139669.08	371.84

Notes:

(a) World Geodetic System (WGS84) Ellipsoid, Unprojected Lat/Long.
(b) WGS84 Ellipsoid, Universal Transverse Mercator (UTM) Projection System, Zone 36S.
(c) Height of the base of the turbine above mean sea level; i.e. this is ground level and does not incorporate the height of the turbine.

Table 3: Siting of the Goldwind 165 wind turbines

Nordex N163 Wind Turbines					
ID	**Latitude [decimal degree][(a)]**	**Longitude [decimal degree][(a)]**	**Easting [m][(b)]**	**Northing [m][(b)]**	**Base elevation [m][(c)]**
WP1	-25.89691	31.98114	397942.19	7135335.97	483.11
WP2	-25.89143	31.98420	398244.02	7135945.27	475.67
WP3	-25.88592	31.98720	398540.25	7136558.18	496.64
WP4	-25.88231	31.99126	398943.62	7136961.12	522.33
WP5	-25.87880	31.99691	399507.41	7137354.43	475.80
WP6	-25.87760	32.00211	400027.48	7137491.41	463.13
WP7	-25.87686	32.00728	400544.74	7137577.41	468.66
WP8	-25.87641	32.01249	401066.17	7137630.96	452.24
WP9	-25.87567	32.01761	401578.84	7137716.55	396.32
WP10	-25.87477	32.02270	402087.87	7137820.47	478.55
WP11	-25.87491	32.02806	402624.31	7137808.95	514.62
WP12	-25.87438	32.03324	403143.68	7137870.71	490.66
WP13	-25.87384	32.03849	403668.55	7137934.71	509.18
WP14	-25.87340	32.04370	404190.30	7137987.25	501.67
WP15	-25.87306	32.04890	404711.04	7138028.47	445.19
WP16	-25.87238	32.05399	405221.08	7138107.47	480.08
WP17	-25.87143	32.05904	405725.71	7138216.31	417.68
WP21	-25.86934	31.99006	398812.75	7138396.77	434.81
WP22	-25.86406	31.99318	399120.58	7138983.61	485.11
WP23	-25.86001	31.99700	399500.12	7139435.75	444.95

Notes:

(a) World Geodetic System (WGS84) Ellipsoid, Unprojected Lat/Long.
(b) WGS84 Ellipsoid, Universal Transverse Mercator (UTM) Projection System, Zone 36S.
(c) Height of the base of the turbine above mean sea level; i.e. this is ground level and does not incorporate the height of the turbine.

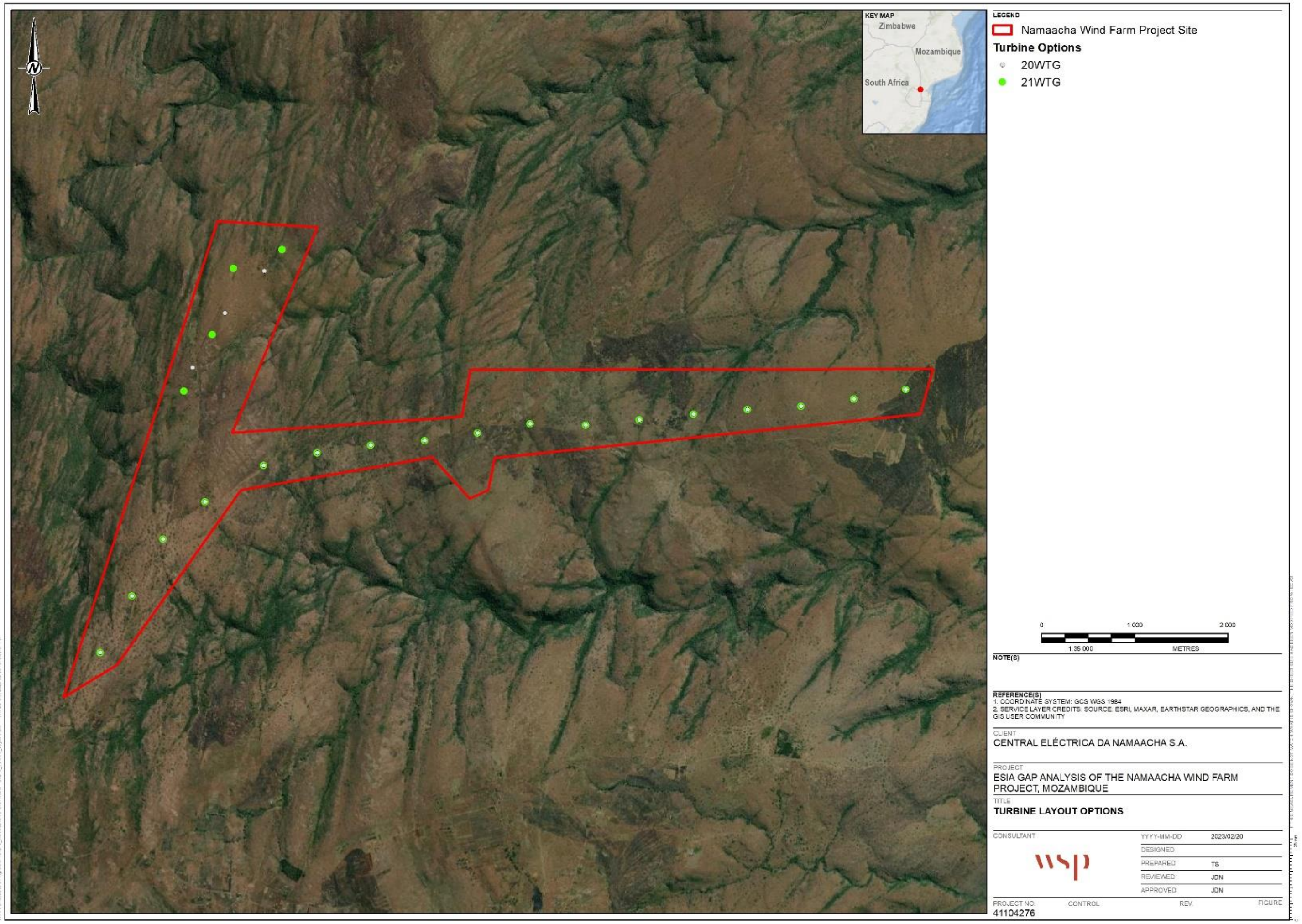


Figure 6: Turbine layouts

2.5 WIND TURBINES AND NOISE

Noise from wind turbines can be classified into two categories, namely mechanical noise generated from the turbine's mechanical components and aerodynamic noise, produced by flow of air over the turbine blades.

2.5.1 MECHANICAL NOISE

The mechanical noise generated by a wind turbine is predominantly tonal (dominated by a narrow range of frequencies), but may also be broadband in character, displaying a wide range of frequencies (Council of Canadian Academics, 2015). Such noise is produced by the physical movement of the following components:

- Gearbox
- Generator
- Yaw drives
- Cooling fans
- Auxiliary equipment.

Over time, appropriate design and manufacturing have reduced the mechanical noise produced from wind turbines. As such, the aerodynamic noise from the blades has become the dominant source of noise for modern turbines, however, low frequency tones associated with mechanical sources are audible for some turbines (Hau, 2006; Manwell *et al*., 2009; Oerlemans, 2011).

2.5.2 AERODYNAMIC NOISE

Aerodynamic noise is typically broadband in nature and is generated by the interaction between air flow and different parts of the turbine blades. These interactions depend on the speed and turbulence of the wind; the shape of the blade; the angle between the blade and relative wind velocity flowing over the blade; and the distance from the hub. The noise levels produced are relative to the velocity of the air flow, with higher rotor speeds resulting in higher noise levels. Specifically, parts of the blade closer to the tips move faster than those closer to the hub, resulting in faster relative air velocities and create higher aerodynamic noise levels. As such, most of the aerodynamic noise is produced near (but not at) the blade tips. This is partly why turbines with longer blades have a higher sound power level (Oerlemans, 2011).

Aerodynamic noise from wind turbines also has a strong directional component, projecting primarily downward, upward, or even perpendicular depending on the dominant mechanism (Oerlemans, 2011). As such, noise levels measured at a particular location can vary depending on the direction, speed and turbulence of the prevailing wind. Furthermore, as the rotor turns, the orientation of each blade changes in relation to a stationary receiver. As such, the noise levels at the receiver will vary as the blades rotate, resulting in periodic regular changes in noise levels over time (Renewable UK, 2013).

As wind speed increases, the aerodynamic noise of the turbines also increases. At low speeds the noise created is generally low and increases to a maximum at a certain speed (around 10 m/s) where it either remains constant or can even slightly decrease.

2.5.3 LOW FREQUENCY NOISE AND INFRASOUND

In addition to the noise discussed above, wind turbines also produce some steady, deep, low frequency sounds (between 1 – 100 Hz), particularly under turbulent wind conditions. Sound waves below 20 Hz are called infrasound. These infrasound levels are only audible at very high sound pressure levels. Older wind turbines that had downwind rotors created noticeable amounts of infrasound. Levels produced by modern-day, up-wind style turbines are below the hearing threshold for most people (Jakobsen, 2005).

The human ear is substantially less sensitive to sound at very low or very high frequencies. For most people, a very low pitch sound (20 Hz) must have a sound pressure level of 70 dB to be audible. Levels of infrasound near modern commercial wind turbines are far below this level and are generally not perceptible to people (Leventhall, 2006).

Low frequency sound, like all other sound, decreases as it travels away from the source. Siting wind turbines further away from sensitive receptors will therefore decrease the risk of infrasound. It is, however, important to note that in flat terrain, low frequency sound can travel more effectively than high frequency sound. Most environmental sound measurements and noise regulations are based on the A-weighed decibel scale (dB(A)), which under-weights low frequency sounds in order to mimic the human ear. Thus, noise limits based on the dB(A) levels do not fully regulate infrasound. The dB(C) scale offers an alternative of measuring sound that provides more weight to lower frequencies (Jakobsen, 2005; Bolin *et al*., 2011).

2.5.4 SUBSTATION AND TRANSFORMER NOISE

In addition to the noise from wind turbines, wind farms require a substation and transformers, which produce a characteristic "hum" or "crackle" noise. Utility companies have experience with building and siting such sources to minimise their impact. Substation-related noise is relatively easy to mitigate should this be required, based on the use of acoustic shielding and careful planning regarding placement away from sensitive receptors. As such, noise associated with this source is not considered in this assessment.

2.6 EXISTING NOISE CLIMATE

The existing noise climate surrounding the Namaacha WEF is predominantly rural and very low baseline noise levels are anticipated. Noise sources may include birds, insects, livestock and the activities of small-scale (subsistence) farming and charcoal making. Vehicular influences may include traffic on local roads.

3 ACOUSTIC FUNDAMENTALS

3.1 PRINCIPLES

Sound is defined as any pressure variation (in air, water or other medium) that the human ear can detect. Noise is defined as “unwanted sound”. Noise can lead to health impacts and can negatively affect people’s quality of life. Hearing impairment is typically defined as a decrease in the threshold of hearing. Severe hearing deficits may be accompanied by tinnitus (ringing in the ears). Noise-induced hearing impairment occurs predominantly in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz. With increasing L_{Aeq} and increasing exposure time, noise-induced hearing impairment occurs even at frequencies as low as 2,000 Hz. However, hearing impairment is not expected to occur at L_{Aeq} levels of 75 dB(A) or below, even for prolonged occupational noise exposure.

Speech intelligibility is adversely affected by noise. Most of the acoustical energy of speech is in the frequency range of 100 to 6,000 Hz, with the most important cue-bearing energy being between 300 and 3,000 Hz. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Environmental noise may also mask other acoustical signals that are important for daily life such as doorbells, telephone signals, alarm clocks, music, fire alarms and other warning signals.

Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after night-time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning and the primary effects of sleep disturbance are: (a) difficulty in falling asleep; and (b) awakenings and alterations of sleep stages or depth. The difference between the sound levels of a noise event and background sound levels, rather than the absolute noise level, may determine the reaction probability.

The annoyance due to a given noise source is subjective from person to person and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener’s economy (wellbeing), and his or her personal opinion of the source. Increased exposure to noise can have negative effects on individuals, both physiological (influence on communication, productivity and even impaired hearing) and psychological effects (stress, frustration and disturbed sleep). As such, noise impacts need to be understood to mean one or a combination of negative physical, physiological or psychological responses experienced by individuals, whether consciously or unconsciously, caused by exposure to noise.

More technically, noise impacts are defined as the capacity of noise to induce annoyance depending upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. During daytime, individuals may be annoyed at L_{Aeq} levels below 55 dB(A), while very few individuals are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5 to 10 dB(A) lower than during the day (World Health Organisation, 1999).

Table 4: Typical noise levels

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130	threshold of pain	intolerable
120 110	heavy rock concert grinding on steel	extremely noisy
100 90	loud car horn at 3 m construction site with pneumatic hammering	very noisy
80 70	kerbside of busy street loud radio or television	loud
60 50	department store general office	moderate to quiet
40 30	inside private office inside bedroom	quiet to very quiet
20	unoccupied recording studio	almost silent

3.2 NOISE PROPAGATION

Sound is a pressure wave that diminishes with distance from source. Depending on the nature of the noise source, sound propagates at different rates. The three most common categories of noise are point sources (specified single point of noise generation), line sources (multiple linear noise generating points, such as a road) and area sources (specified single area of noise generation). The most important factors affecting noise propagation are:

- The type of source (point, line or area).
- Obstacles such as barriers and buildings.
- Distance from source.
- Atmospheric absorption.
- Ground absorption.
- Reflections.

Research has shown that doubling the distance from a noise source results in a proportional decline in noise level. Sound propagation in air can be compared to ripples on a pond. The ripples spread out uniformly in all directions, decreasing in amplitude as they move further from the source. An acoustically hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground cover provides little or no attenuation. The standard attenuation rate for hard site conditions is 6 dB(A) per doubling of distance for point sources. Thus, if you are at a position one meter from the source and move one meter further away from the source, the sound pressure level will drop by 6 dB(A), moving to 4 meters, the drop will be a further 6 dB(A), and so on. When ground cover or normal unpacked earth (i.e., a soft site) exists between the source and receptor, the ground becomes absorptive to sound energy. Absorptive ground results in an additional noise reduction of approximately 1.5 dB(A) per doubling of distance.

This methodology is only applicable when there are no reflecting or screening objects in the sound path. When an obstacle is in the sound path, part of the sound may be reflected, and part absorbed, and the remainder may be transmitted through the object. How much sound is reflected, absorbed and/or transmitted depends on many factors, including the properties of the object. When receptor locations are not in the line of sight of the noise source, there may be up to 20 dB(A) attenuation for broadband noise, with a further 10 to 15 dB(A) attenuation when inside the average residence and the windows are open.

3.3 CHARACTERISTICS OF NOISE

The human ear simultaneously receives sound (normal un-weighted sound or Z-weighting dB(Z)) at many frequencies (octave bands) at different amplitudes. The ear then adjusts its sensitivity based on the amplitude of the sound observed. This focuses the sound and makes it audible by adjusting the amplitude of the low, middle and high frequencies. To measure how a person experiences sound, an electronic weighting adjusted to the Z-weighted sound was developed, including three different weighting curves, namely:

- A-weighting - This measurement is often noted as dB(A) and this weighting curve attempts to make the noise level meter respond closely to the characteristics of a human ear. It adjusts the frequencies at low and high frequencies. Various national and international standards relate to measurements recorded in the A-weighting of sound pressure levels.
- B-weighting - is similar to A-weighting but with less attenuation. The B-weighting is very seldom, if ever, used. The B-weighting follows the C-weighted trend.
- C-weighting - is intended to represent how the ear perceives sound at high decibel levels. C-weighted measurements are reported as dB(C).
- Z-weighting - this refers to linear, un-weighted noise levels.

The weighting is employed by arithmetically adding a table of values (**Table 5**), listed by octave bands, to the measured linear sound pressure levels for each specific octave band. The resulting octave band measurements are logarithmically added to provide a single weighted value describing the sound, based on the applied weighting curve (**Figure 7**). Thus, if the A-weighted curve was applied to the sound, the noise level is noted as dB(A).

Table 5: Frequency weighting table for the different weighting curves

Frequency (Hz)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	1.1
B-weighting	-17.1	-9.3	-4.2	-1.3	-0.3	0	-0.1	-0.7	-2.9
C-weighting	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting	0	0	0	0	0	0	0	0	0

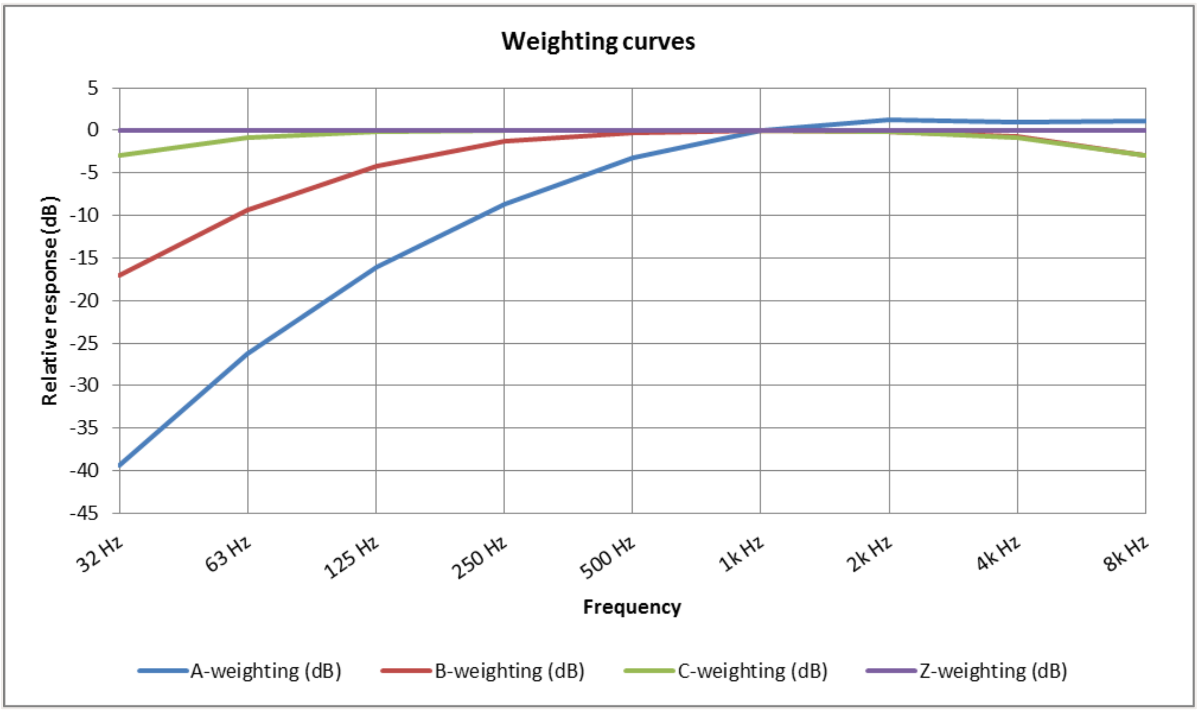


Figure 7: Weighting curves

4 PROJECT STANDARDS

4.1 MOZAMBICAN LEGISLATION

Mozambique legislation considers noise in Decree no. 18/2004 but does not provide permitted noise levels. There is no Mozambican legislation applicable to WEFs. International guidelines should therefore be used for assessing the impact of the Namaacha WEF. Relevant guidelines are included below.

4.2 WORLD HEALTH ORGANISATION GUIDELINES FOR COMMUNITY NOISE

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of the outdoor day-time equivalent continuous A-weighted sound pressure level (L_{Aeq}) in residential districts:

— At 55 - 60 dB(A) noise creates annoyance.
— At 60 - 65 dB(A) annoyance increases considerably.
— Above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise

The WHO therefore recommends a maximum outdoor daytime (07:00 – 22:00) L_{Aeq} of 55 dB(A) in residential areas and schools in order to prevent significant interference with normal activities. It further recommends a maximum night-time (22:00 – 07:00) L_{Aeq} of 45 dB(A) outside dwellings. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

The WHO guideline for industrial noise is set at 70 dB(A) over a period of 24 hours. Anything above this level would cause hearing impairment, however, a peak noise level of 110 dB(A) is allowable on a fast response measurement.

In the case of this Project, these guidelines are most appropriate for the assessment of the construction and decommissioning phases impacts.

4.3 INTERNATIONAL FINANCE CORPORATION GUIDELINES

4.3.1 PERFORMANCE STANDARDS

The Performance Standards on Environmental and Social Sustainability (EHS) of the International Finance Corporation (IFC Performance Standards) relevant to this project include the following:

— Performance Standard 1: Assessment and Management of Social and Environmental Risks and Impacts.
— Performance Standards 3: Resource Efficiency and Pollution Prevention.
— Performance Standards 4: Community Health, Safety and Security.

To minimise the significance of the project related impacts, the IFC states that the levels should not reach or exceed the nationally legislated standards or in their absence, the WHO Guidelines or other internationally recognised sources. When host country regulations differ from the levels and measures presented in the EHS guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS guidelines are appropriate, in view of specific Project circumstances, a full and detailed justification for any presented alternative is needed as part of the site-specific environmental assessment. The most stringent of the WHO guidelines or national limits will be applicable and will apply for this assessment.

4.3.2 GENERAL ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES

From the International Finance Corporation (IFC) General Environmental, Health and Safety (EHS) Guidelines, the impacts of noise beyond the property boundary of a facility are addressed in section 1.7 (IFC, 2007). The noise guidelines stipulated by the IFC are grouped into two categories, namely "Residential; institutional; educational" and "Industrial; commercial" (**Table 6**). Such guidelines are in-line with the WHO guidelines as discussed above and are as such applicable to this assessment. Noise impacts should not exceed these levels or result in a maximum increase in background noise levels of 3 dB(A) at the nearest off site receptor location.

Table 6: IFC Environmental Noise Level Guidelines

Receptor	One-hour L_{Aeq} (dB(A))	
	Daytime (07:00 – 22:00)	Night-time (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The guideline also states that highly intrusive noise, such as noise from aircraft flyovers and passing trains should not be included when establishing background noise levels.

As with the WHO guidelines, for this Project, the IFC General EHS guidelines are most appropriate for the assessment of the construction and decommissioning phases impacts.

4.3.3 WIND FACILITIES ENVIRONMENTAL, HEALTH AND SAFETY GUIDELINES

The IFC (industry) EHS Guidelines for wind energy (IFC, 2015) provide the following requirements for impact assessments relating to the operation of wind facilities:

- Receptors should be chosen according to environmental sensitivity.
- Preliminary modelling assuming hemispherical propagation should be carried out to determine whether or not detailed investigation is required.
- If this modelling suggests that turbine noise is likely to be below an LA_{90} of 35 decibels (dB(A)) at all sensitive receptors at a wind speed of 10 m/s at 10 m during day and night times, no additional modelling is required. If this is not the case, then more detailed modelling should be undertaken including background ambient noise measurements.
  - The background noise should be measured in 10-minute intervals, using wind screens. At least five of these 10-minute measurements should be taken for each integer wind speed.
  - If background noise is being measured, this should be done in the absence of any wind turbines and at one or more receptors.
- All modelling should take account of the cumulative noise from all wind energy facilities in the vicinity that could potentially increase noise levels.

4.4 THE ASSESSMENT AND RATING OF NOISE FROM WIND FARMS (ETSU)

The IFC Industry EHS Guidelines is partly based on the ETSU-R-97 report published in 1996. The IFC could be considered an improvement on the methods described in the ETSU-R-97; however, some of the methodology remains unchanged. ETSU-R-97 "The assessment and Rating of Noise from Wind Farms" describes the framework for the measurement of noise associated with wind farms and provides indicative noise levels that offer a reasonable degree of protection to communities surrounding wind farm developments, without placing unreasonable restrictions on the wind farm developers. The assessment was developed by a Working Group on

Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. The key findings identified in the assessment include:

- Absolute noise limits applied at all wind speeds are not suited to wind farms. Limits set relative to background noise are more appropriate.
- The L_{A90} descriptor is much more accurate when monitoring and assessing wind turbine noise.
- Limits should be set on noise over a range of wind speeds up to 12 m/s when measured at 10 m height.
- The effects of other wind energy facilities in a specific area should be added to the effect of the proposed wind energy facility in order to determine the cumulative effect.
- Increases in noise levels as a result of a wind energy facility should be restricted to 5 dB(A) above the current ambient noise level at a specified receptor location.
- Noise from wind farms should be limited to a range between 35 and 40 dB(A) (daytime) in a low noise environment. A fixed limit of 43 dB(A) should be implemented during night-time. This should increase to 45 dB(A) (day and night) if the potential receptors have financial investments in the facility.
- For turbines spaced further apart, if noise is limited to an L_{A90} of 35 dB(A) at wind speeds up to 10 m/s (at 10 m height), then this condition alone offers sufficient protection of amenity and background noise surveys would not be necessary.

The ETSU-R-97 provides a noise level for if an affected party is financially vested in the development which IFC does not. ETSU-R-97 suggested that for receptors that will have a financial gain from the development of the WEF the less stringent level of 45 dB(A) should be applied in determining the extent of impacts rather than the 35 dB(A) level adopted by the IFC.

5 METHODOLOGY

The IFC EHS guidelines for Wind Energy were followed for this assessment, which is primarily based on the ETSU-R-97 report. Such guidance stipulates that a preliminary modelling exercise should be carried out using a simple model which assumes hemispherical propagation of noise from each turbine to determine potential impact on receptors within a 2 km radius of the turbines.

The CadnaA (Computer Aided Noise Abatement) acoustic model was used to calculate noise levels at specific receivers (sensitive receptors). The CadnaA software provides an integrated environment for noise predictions under varying scenarios and calculates the cumulative effects of various sources. The model uses ground elevations in the calculation of the noise levels in a grid and uses standard meteorological parameters that have an effect on the propagation of noise. CadnaA has been utilised in many countries across the globe for the modelling of environmental noise and town planning. It is comprehensive software for three-dimensional calculations, presentation, assessment and prediction of environmental noise emitted from industrial plants, parking lots, roads, railway schemes or entire towns and urbanized areas.

The IFC EHS guidance then indicates that if the model results indicate L_{A90} noise levels at all sensitive receptors are below 35 dB(A) at a wind speed of 10 m/s (at a height of 10 m) during day and night times, this would be sufficient to assess the noise impact of the proposed facility, offering adequate protection of amenity at these receptors. If L_{A90} levels at any receptor location are above 35 dB(A), then impacts at these receptors may be perceived and potential turbine relocations should be considered.

In low noise environments, the ETSU-R-97 report itself, however, stipulates that noise from wind farms should be limited to a range between 35 and 40 dB(A) (daytime). Additionally, a fixed limit of 43 dB(A) should be implemented during night-time. This should increase to 45 dB(A) (day and night) if the potential receptors have financial investments in the facility.

With the Namaacha WEF being located within a low noise environment a combination of the IFC and ETSU methodology was followed in this assessment.

6 ASSUMPTIONS AND LIMITATIONS

In this Environmental Acoustic Impact Assessment, various assumptions were made and limitations experienced that may impact on the results obtained. These include:

- The turbine specifications provided are assumed to be representative of what will be installed in reality.
- The turbine locations provided are assumed to be an accurate representation of where these will be located in reality.
- Identification of sensitive receptors is based on
  - Data provided from a census undertaken for the previous ESIA. The data provided used a single coordinate / location for homesteads, several consisting of between two and five houses, the locations of the individual houses were identified using GoogleEarth[RT].
  - Other structures that did not appear to form part of any of the homesteads, charcoal manufacturing, abandoned structures or ruins included in the census data were identified by WSP using GoogleEarth[RT].
  - A survey was undertaken by Source Energia in August 2023 to verify the sensitive receptor locations including type and.
  - It is assumed that Source Energia undertook inspections at all of the locations identified, that the type and habitation status was correctly captured against the associated identified receptor ID; and that there were no other receptors in addition to those provided (as per the data).
- Impact assessment methodology
  - The purpose of this study is to provide input data required for the Resettlement Action Plan (RAP). The RAP will concentrate in the impacted inhabited receptors; therefore, only the inhabited sensitive receptors as of August 2023 have been included in the results tables and discussion. It is recommended that prior to initiation of operations, the habitation status of those sites identified as uninhabited during the survey conducted in August 2023 be verified and the necessary updates be made to the relevant studies and strategies.
  - It is understood that none of the receptors have direct interest and are vested in the Project, thus the ETSU blanket threshold value of 45 dB(A) (day and night) does not apply.
  - The original receptor names and ID have been used to enable cross-referencing to the census data and Source Energia ground truthing data, if required.

7 RESULTS

7.1 CONSTRUCTION PHASE

Unlike general industry, construction activities are not always stationary and in one location. Construction activities at the proposed site will include civil works (including surveying), reinforced concrete works, masonry works, façade works, floor works, general construction activities including mechanical, electrical, and plumbing installation works. Construction phase operations would take place for a short period and the impact duration is considered short-term as impacts associated with the operations will cease after the construction phase. Due to the erratic and transient nature of such construction activities as well as the fact that detailed construction phase plans have not yet been developed for the proposed Project, noise impacts from the construction phase of the facility could not be quantified.

During the construction phase of the facility various noise sources will be present onsite including earth-moving equipment (trucks, cranes, scrapers and loaders), compressors and generators, pumps, rotary drills, concrete mixers and materials handling activities among others. All of these sources will generate substantial amounts of noise and may impact on neighbouring sensitive receptors. As such, mitigation interventions are advised during the construction phase. These mitigation recommendations are detailed in the section that follows.

7.1.1 MITIGATION RECOMMENDATIONS

To minimise the acoustic impacts from the construction phase of the proposed Project, various mitigation techniques can be employed. These options include both management and technical options:

- Planning construction activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance. Information regarding construction activities should be provided to identified and nearby receptors likely to be affected. Such information includes:
  - Proposed working times.
  - Anticipated duration of activities.
  - Explanations on activities to take place and reasons for activities.
  - Contact details of a responsible person on site should complaints arise.
- When working near a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as practical.
- Using noise control devices, such as temporary noise barriers and deflectors for high impact activities, and exhaust muffling devices for combustion engines.
- Selecting equipment with the lowest practical sound power levels whilst still being suitable for the specific task.
- Ensuring equipment is maintained in accordance with manufacturer recommendations to avoid additional noise generation.

7.2 OPERATIONAL PHASE

Only the inhabited sensitive receptors as of August 2023 have been included in the results tables and discussion and will be used as input into the Resettlement Action Plan (RAP). It is recommended that prior to initiation of operations, the habitation status of those sites identified as uninhabited during the survey conducted in August 2023 be verified and the necessary updates be made to the relevant studies and strategies. It is understood that none of the receptors have direct interest and are vested in the Project, thus the ETSU blanket threshold value of 45 dB(A) (day and night) does not apply.

7.2.1 OPERATIONAL DESIGN USING NORDEX N163 WIND TURBINES

Table 7 presents the predicted noise levels from 21 turbines (with a hub height of 118 m and sound power level of 109.2 dB(A)); where the values in red indicate that the predicted L_{A90} noise level is excess of the IFC threshold. The preliminary model was run taking the surrounding terrain into account. Results indicate that predicted L_{A90} noise levels during both day and night are above the 35 dB(A) threshold, as stipulated in the IFC EHS guidance for Wind Facilities, at all 59 inhabited receptors. This indicates that noise from the turbines could create a nuisance or impact at the receptors.

Table 7: Predicted noise levels at sensitive receptors resulting from the operation of the Nordex N163 wind turbines

Name	Type	ID	Description	Distance from closest Turbine (m)	Closest Turbine	Predicted L_{Aeq} noise level	Predicted L_{A90} noise level	L_{A90} below 35 dB(A) (IFC)
R1	Homestead	R1_1	House	420	WP22	49.1	47.1	No
		R1_2	House	427	WP22	49.0	47.0	No
		R1_3	House	434	WP22	49.0	47.0	No
		R1_4	House	438	WP22	48.7	46.7	No
		R1_5	House	440	WP22	49.0	47.0	No
R2	Homestead	R2_1	House	216	WP22	52.7	50.7	No
R4	Homestead	R4_1	House	338	WP21	51.4	49.4	No
		R4_2	House	326	WP21	51.4	49.4	No
		R4_3	House	322	WP21	51.4	49.4	No
		R4_4	House	326	WP21	51.4	49.4	No
R5	Homestead	R5_1	House	112	WP21	55.4	53.4	No
		R5_2	House	107	WP21	55.5	53.5	No
R7	Homestead	R7_1	House	268	WP21	51.5	49.5	No
		R7_2	House	258	WP21	51.7	49.7	No
		R7_3	House	257	WP21	51.7	49.7	No
R8	Homestead	R8_1	House	372	WP21	49.2	47.2	No
		R8_2	House	362	WP21	49.3	47.3	No
R10	Homestead	R10_1	House	586	WP21	48.5	46.5	No
		R10_2	House	595	WP21	48.4	46.4	No
R12	Homestead	R12_1	House	990	WP3	48.4	46.4	No
R13	Homestead	R13_1	House	378	WP4	48.9	46.9	No
R17	Homestead	R17_1	House	109	WP2	54.5	52.5	No
R18	Homestead	R18_1	House	236	WP2	51.7	49.7	No
		R18_2	House	231	WP2	51.8	49.8	No
R19	Homestead	R19_1	House	124	WP6	55.0	53.0	No
R21	Homestead	R21_1	House	184	WP8	54.5	52.5	No
R22	Homestead	R22_1	House	91	WP9	56.6	54.6	No
R23	Homestead	R23_1	House	284	WP10	52.2	50.2	No
		R23_2	House	297	WP10	52.2	50.2	No
		R23_3	House	310	WP10	52.1	50.1	No
R24	Homestead	R24_1	House	225	WP10	52.3	50.3	No
		R24_2	House	203	WP10	52.8	50.8	No
		R24_3	House	196	WP10	52.8	50.8	No

Name	Type	ID	Description	Distance from closest Turbine (m)	Closest Turbine	Predicted L_{Aeq} noise level	Predicted L_{A90} noise level	L_{A90} below 35 dB(A) (IFC)
R25	Homestead	R25_1	House	467	WP11	48.2	46.2	No
R26	Homestead	R26_1	House	529	WP10	47.4	45.4	No
		R26_2	House	519	WP10	47.6	45.6	No
R27	Homestead	R27_1	House	591	WP11	47.0	45.0	No
		R27_2	House	590	WP11	47.1	45.1	No
R29	Homestead	R29_1	House	773	WP1	40.5	38.5	No
		R29_2	House	766	WP1	40.9	38.9	No
		R29_3	House	790	WP1	40.6	38.6	No
		R29_4	House	660	WP1	42.6	40.6	No
		R29_5	House	647	WP1	42.5	40.5	No
R35	Homestead	R35_1	House	252	WP10	51.5	49.5	No
		R35_2	House	246	WP10	51.6	49.6	No
R36	Homestead	R36_1	House	166	WP3	54.4	52.4	No
R37	Homestead	R37_1	House	319	WP1	49.5	47.5	No
		R37_2	House	325	WP1	49.4	47.4	No
R38	Homestead	R38_1	House	590	WP1	42.9	40.9	No
		R38_2	House	593	WP1	42.8	40.8	No
		R38_3	House	599	WP1	42.7	40.7	No
R39	Homestead	R39_1	Structure	875	WP1	40.1	38.1	No
R40	Homestead	R40_1	Structure	344	WP8	49.2	47.2	No
R42	Structure	R42_1	Structure	123	WP10	55.2	53.2	No
R43	Structure	R43_1	Structure	771	WP11	40.9	38.9	No
R44	Structure	R44_1	Structure	902	WP11	37.9	35.9	No
R45	Structure	R45_1	Structure	1041	WP11	40.3	38.3	No
		R45_2	Structure	1028	WP11	38.5	36.5	No
R48	Structure	R48_1	Structure	332	WP3	51.2	49.2	No

Notes: L_{A90} calculation based on guidance from the ETSU-R-97 report.
Values in red indicate that the predicted L_{A90} noise level is excess of the IFC threshold.

7.2.2 OPERATIONAL DESIGN USING GOLDWIND 165 WIND TURBINES

Table 7 presents the predicted noise levels from twenty turbines (with a hub height of 120 m and sound power level of 111.6 dB(A)); where the values in red indicate that the predicted L_{A90} noise level is excess of the IFC threshold. The preliminary model was run taking the surrounding terrain into account. Results indicate that predicted L_{A90} noise levels during both day and night are above the 35 dB(A) threshold, as stipulated in the IFC EHS guidance for Wind Facilities, at all 59 inhabited receptors. This indicates that noise from the turbines could create a nuisance or impact at the receptors.

Table 8: Predicted noise levels at sensitive receptors resulting from the operation of the Goldwind165 wind turbines

Name	Type	ID	Description	Distance from closest Turbine (m)	Closest Turbine	Predicted L_{Aeq} noise level	Predicted L_{A90} noise level	L_{A90} below 35 dB(A) (IFC)
R1	Homestead	R1_1	House	420	WP22	52.2	50.2	No
		R1_2	House	427	WP22	52.1	50.1	No
		R1_3	House	434	WP22	52.0	50.0	No
		R1_4	House	438	WP22	51.8	49.8	No
		R1_5	House	440	WP22	52.0	50.0	No
R2	Homestead	R2_1	House	521	WP21	54.3	52.3	No
R4	Homestead	R4_1	House	338	WP21	60.1	58.1	No
		R4_2	House	326	WP21	60.5	58.5	No
		R4_3	House	322	WP21	60.5	58.5	No
		R4_4	House	326	WP21	60.5	58.5	No
R5	Homestead	R5_1	House	112	WP21	52.3	50.3	No
		R5_2	House	107	WP21	52.5	50.5	No
R7	Homestead	R7_1	House	268	WP21	49.9	47.9	No
		R7_2	House	258	WP21	50.0	48.0	No
		R7_3	House	257	WP21	49.9	47.9	No
R8	Homestead	R8_1	House	372	WP21	49.3	47.3	No
		R8_2	House	362	WP21	49.3	47.3	No
R10	Homestead	R10_1	House	631	WP4	50.0	48.0	No
		R10_2	House	618	WP4	50.0	48.0	No
R12	Homestead	R12_1	House	521	WP4	50.3	48.3	No
R13	Homestead	R13_1	House	378	WP4	51.3	49.3	No
R17	Homestead	R17_1	House	109	WP2	56.9	54.9	No
R18	Homestead	R18_1	House	236	WP2	54.1	52.1	No
		R18_2	House	231	WP2	54.2	52.2	No
R19	Homestead	R19_1	House	124	WP6	57.3	55.3	No
R21	Homestead	R21_1	House	184	WP8	56.9	54.9	No
R22	Homestead	R22_1	House	91	WP9	58.9	56.9	No
R23	Homestead	R23_1	House	284	WP10	54.5	52.5	No
		R23_2	House	297	WP10	54.6	52.6	No
		R23_3	House	310	WP10	54.5	52.5	No
R24	Homestead	R24_1	House	225	WP10	54.6	52.6	No
		R24_2	House	203	WP10	55.1	53.1	No
		R24_3	House	196	WP10	55.2	53.2	No

Name	Type	ID	Description	Distance from closest Turbine (m)	Closest Turbine	Predicted L_{Aeq} noise level	Predicted L_{A90} noise level	L_{A90} below 35 dB(A) (IFC)
R25	Homestead	R25_1	House	467	WP11	50.6	48.6	No
R26	Homestead	R26_1	House	529	WP10	50.0	48.0	No
		R26_2	House	519	WP10	50.1	48.1	No
R27	Homestead	R27_1	House	591	WP11	49.4	47.4	No
		R27_2	House	590	WP11	49.5	47.5	No
R29	Homestead	R29_1	House	773	WP1	43.5	41.5	No
		R29_2	House	766	WP1	43.3	41.3	No
		R29_3	House	790	WP1	43.0	41.0	No
		R29_4	House	660	WP1	45.0	43.0	No
		R29_5	House	647	WP1	45.0	43.0	No
R35	Homestead	R35_1	House	252	WP10	53.8	51.8	No
		R35_2	House	246	WP10	53.9	51.9	No
R36	Homestead	R36_1	House	319	WP3	56.8	54.8	No
R37	Homestead	R37_1	House	325	WP1	51.9	49.9	No
		R37_2	House	590	WP1	51.8	49.8	No
R38	Homestead	R38_1	House	593	WP1	45.3	43.3	No
		R38_2	House	599	WP1	45.2	43.2	No
		R38_3	House	875	WP1	45.1	43.1	No
R39	Homestead	R39_1	House	344	WP1	42.5	40.5	No
R40	Homestead	R40_1	House	94	WP8	51.6	49.6	No
R42	Homestead	R42_1	House	771	WP10	57.6	55.6	No
R43	Homestead	R43_1	House	902	WP11	43.3	41.3	No
R44	Homestead	R44_1	House	1041	WP11	40.3	38.3	No
R45	Homestead	R45_1	House	1028	WP11	42.7	40.7	No
		R45_2	House	971	WP11	42.7	40.7	No
R48	Homestead	R48_1	House	319	WP3	53.6	51.6	No

Notes: L_{A90} calculation based on guidance from the ETSU-R-97 report.
Values in red indicate that the predicted L_{A90} noise level is excess of the IFC threshold.

7.2.3 MITIGATION RECOMMENDATIONS

Based on this screening study, the results indicate that predicted L_{A90} noise levels during both day and night are above the IFC threshold of 35 dB(A) at all inhabited receptors. As such, complaints are anticipated as a result of the operation of the Namaacha WEF.

Based on the screening study results alone, the facility will need to relocate residents and implement mitigation measures to reduce noise if a buffer zone of at least 1 km cannot be established. Where relocation is not feasible then financial incentives may need to be considered.

The following mitigation measures should be considered to reduce the amount of residents to be resettled:

— Selecting proposed turbines with higher hub heights.
— Selecting turbines with lower noise levels.
— Operating the turbines in reduced noise mode.

7.3 CUMULATIVE ASSESSMENT

No other WEFs were identified in the area of the Namaacha WEF. Cumulative noise impacts would not be noted.

8 ASSESSMENT OF IMPACTS

The purpose of this Environmental Acoustic Impact Assessment is to identify the potential impacts and associated risks posed by the operation of the proposed Namaacha WEF on the noise climate of the area. The outcomes of the impact assessment will provide a basis to identify the key risk drivers and make informed decisions on the way forward in order to ensure that these risks do not result in unacceptable social or environmental risk.

All impacts of the operation of the proposed project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the extent, reversibility, duration and probability of occurrence. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix B**. Key localised acoustic impacts associated with the project include:

— Construction phase impacts of noise on sensitive receptors.
— Operational phase impacts of noise on sensitive receptors.
— Decommissioning phase impacts of noise on sensitive receptors.

Outcomes of the Environmental Acoustic Impact Assessment are contained within **Table 9** outlining the impact of each parameter and the resulting risk level. It is noted that as there are no receptors with a financial interest in the Project, therefore the respective ETSU limit for this was not used and the assessment is based on the more stringent IFC limit value.

Table 9: Impact assessment of risks associated with the Namaacha WEF

Description	Without Mitigation							Mitigation Measures	With Mitigation						
	Magnitude	Extent	Reversibility	Duration	Probability of Occurrence	Significance	Risk Level		Magnitude	Extent	Reversibility	Duration	Probability of Occurrence	Significance	Risk Level
Construction phase impacts of noise on sensitive receptors	3	2	1	1	3	21	Low	– Planning construction activities. – Limit the number of simultaneous activities. – Using noise control devices, such as temporary noise barriers and deflectors, and exhaust muffling devices. – Selecting equipment with the lowest possible sound power levels whilst still being suitable for the specific task. – Ensuring equipment is well-maintained to avoid additional noise generation.	2	2	1	1	2	12	Very Low
Operational phase impacts of noise on sensitive receptors	4	2	1	5	3	36	Moderate	Resettlement (1km buffer)	2	2	1	5	2	20	Low
								– Selecting proposed turbines with higher hub heights. – Selecting turbines with lower noise levels. – Operating the turbines in reduced noise mode.	3	2	1	5	3	33	Moderate
Decommissioning phase impacts of noise on sensitive receptors	3	2	1	1	3	21	Low	– Planning decommissioning activities. – Limit the number of simultaneous activities. – Using noise control devices, such as temporary noise barriers and deflectors, and exhaust muffling devices. – Selecting equipment with the lowest possible sound power levels whilst still being suitable for the specific task. – Ensuring equipment is well-maintained to avoid additional noise generation.	2	2	1	1	2	12	Very Low

9 CONCLUSIONS

Wind turbines have the potential to generate noise and as such a specialist Environmental Acoustic Impact Assessment is required as part of the ESIA update for the Namaacha WEF. WSP was appointed to undertake the Environmental Acoustic Impact Assessment for the proposed Namaacha WEF.

In line with the IFC Environmental Health and Safety EHS Guidelines for Wind Energy a preliminary modelling exercise was executed using a simple model which assumes hemispherical propagation of noise from each turbine to determine potential impact on receptors within a 2 km radius of the turbines. If L_{A90} noise levels at all sensitive receptors are below 35 dB(A) at a wind speed of 10 m/s (at a height of 10 m) during day and night times, this would be sufficient to assess the noise impact of the proposed facility, offering adequate protection of amenity at these receptors. If L_{A90} levels at any receptor location are above 35 dB(A), then impacts at these receptors may be perceived and potential turbine relocations may need to be considered. The IFC EHS Guidelines for Wind Energy is partly based on the ETSU-R-97 report published in 1996. The IFC could be considered an improvement on the methods described in the ETSU-R-97; however, some of the methodology remains unchanged. The Namaacha WEF study used a combination of the IFC and ETSU methodologies in the model setup and output analysis. The IFC limit of 35 dB(A) was used for determining the impacted receptors and the impact rating.

Fifty-nine occupied sensitive receptors were provided by Source Energy based on ground-truthing exercise conducted by their Team in August 2023.

Construction and Decommissioning Phase Impacts:

- During the construction phase of the facility various noise sources will be present onsite including earth-moving equipment (trucks, cranes, scrapers and loaders), generators, rotary drills, concrete mixers and materials handling activities among others. All of these sources will generate substantial amounts of noise and may impact on neighbouring sensitive receptors.
- It is anticipated that the decommissioning phase noise levels would be similar to those associated with the construction phase activities.
- Due to the erratic and transient nature of construction activities, no detailed construction and decommissioning plans, the environmental acoustic impacts from the construction and decommissioning phases of the facility cannot be determined quantitatively.
- As there is the potential for substantial impacts over a short-term, mitigation interventions are advised during these phases. Mitigation possibilities include both management and technical options. Such techniques include planning construction and decommissioning activities; limiting the number of simultaneous activities; using noise control devices; selecting equipment with the lowest possible sound power levels; and ensuring equipment is well-maintained to avoid additional noise generation.

Based on WSP's preliminary model (following the IFC methodology), the following was determined for the operational phase:

- Predicted L_{A90} noise levels during both day and night are above the IFC threshold of 35 dB(A) at all receptors.
- Complaints are anticipated as a result of the operation of the Namaacha WEF.
- Because this modelling suggests that turbine noise is likely to be above an L_{A90} of 35 dB(A) at all sensitive receptors at a wind speed of 10 m/s (at 10 m height) during day and night times, in line with the IFC methodology more detailed modelling should be undertaken including background ambient noise measurements. However, many of the receptors are located within the immediate vicinity of various turbines (<150 m), that it is anticipated that the results of a detailed modelling study will not add further value.
- Based on the screening study results alone, the facility will need to relocate residents and implement mitigation measures to reduce noise if a buffer zone of at least 1 km cannot be established. Where relocation is not feasible then financial incentives may need to be considered. If financial incentives are considered, the L_{A90} levels at those receptors must remain below the 45 dB(A) ETSU threshold.
- To reduce the amount of residents to be resettled, the facility should consider selecting wind turbines with lower sound power levels; higher hub heights; and operating the turbines in reduced noise mode.

The resultant environmental acoustic risks associated with the construction and decommissioning phase of the Project are anticipated to be "low" to "very low" with general mitigation options employed. For the operational phase, impacts are anticipated to be “moderate”. With implementation of a buffer of 1 km and relocation of existing receptors within this area, the operational phase impacts reduce to “low”.

BIBLIOGRAPHY

- Bolin, K. Bluhm, G. Eriksson, G. and Nilsson, M.E. (2011): Infrasound and low frequency noise from wind turbines: exposure and health effects. Environ. Res. Lett 6 035103.
- Council of Canadian Academics (2015): understanding the Evidence: Wind Turbine Noise. Ottawa (ON): The Expert Panel on Wind Turbine Noise and Human Health, Council of Canadian Academies.
- ETSU (1996): The Assessment and Rating of Wind Farm Noise. The Working Group on Noise from Wind Turbines. ETSU-R-97.
- Hau, E. (2006): Wind Turbines Fundamentals, Technologies, Application, Economics (2nd ed.). New York (NY): Springer.
- Holms, G. B., Pommen, L. W., & Cf, P. (1999, September). State of Water Quality of Columbia River at Birchbank . Retrieved December 4, 2013, from State of Water Quality of Columbia River at Birchbank : http://www.env.gov.bc.ca/wat/wq/quality/birchbank/index.htm
- International Finance Corporation (IFC) (2007): Environmental, Health and Safety Guidelines: 1.7 Noise, 52 – 53.
- International Finance Corporation (IFC) (2015): Environmental, Health and Safety Guidelines for Wind Energy, 4 – 5.
- Jakobsen, J. (20015): Infrasound emission from wind turbines. Journal of Low Frequency Noise Vibration and Active Control. 24: 145-155.
- Leventhall, G. (2006): Infrasound from wind turbines – fact, fiction or deception. Canadian Acoustics 34(2):29-36.
- Manwell, J. F., McGowan, J. G., & Rogers, A. L. (2009): Wind Energy Explained: Theory, Design and Application (2nd ed.). Chichester, United Kingdom: John Wiley & Sons Ltd.
- Oerlemans, S. (2011): Chapter 2. Primary Noise Sources. In D. Bowdler & G. Leventhall (Eds.), Wind Turbine Noise. Essex, United Kingdom: Multi-Science Publishing Company, Ltd.
- Renewable UK, (2013): Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect. London, United Kingdom: RenewableUK.
- World Health Organisation (WHO) (1999): Guidelines for Community Noise. Available online at: http://www.who.int/docstore/peh/noise/guidelines2.html.

APPENDIX

A SPECIALIST CV

Natasha Anne Shackleton

Earth & Environment – Air Quality, Principal Consultant

CAREER SUMMARY

Natasha is a registered Professional Natural Scientist (Pr. Nat. Sci.) with the South African Council for Natural Scientific Professions (SACNASP) currently employed as Principal Consultant at WSP Group Africa (Pty) Ltd. Natasha has over 12 years of experience in air quality studies and the development of air quality management plans including monitoring and sampling data analysis, emissions quantification, simulations using a range of dispersion models, impacts assessment and health risk screening assessments. Natasha has been conducted environmental noise monitoring and data analysis since 2011 and environmental acoustic impact assessments and management plans since 2015. She has experience in ambient and sources noise sampling; emissions quantification for a range of source types; simulations using SANS 10201, CONCAWE, and DataKustik CadnaA; impact assessments; and management plans. Although she been undertaking greenhouse gases emissions estimation for various projects as required prior to 2017, she has been undertaking climate change specialist studies for 5 years.

Whilst most of his working experience has been in South Africa, she has worked on many projects within various countries in Africa which required international financing, providing her with an inclusive knowledge base of IFC guidelines and requirements pertaining to air quality, noise and greenhouse gases emissions.

<1 year with WSP

>12 years of experience

Area of expertise

Air Quality

Acoustics

Climate Change

Language

English – Fluent

Afrikaans – Limited Working Proficiency

EDUCATION

BSc Hons., Meteorology, University of Pretoria - Research project title: Retrieval of Relative Humidity and Cloud Thickness from CSIR-NLC Mobile LIDAR Backscatter Measurements - Research project supervisor: Dr S Venkataraman. 2011

BSc, University of Pretoria 2010

PROFESSIONAL MEMBERSHIPS

NACA - National Association for Clean Air 2020 – present

AMS – American Meteorological Society 2017 and 2018

SASAS – South African Society for Atmospheric Sciences 2016 – present

Golden Key International Honour Society 2011 – present

SACNASP - Certified Professional Natural Scientist with the South African Council for Natural Scientific Professions – Member No. 116335 2018 - present

Natasha Anne Shackleton

Earth & Environment – Air Quality, Principal Consultant

PROFESSIONAL HISTORY

WSP Group Africa (Pty) Ltd	May 2022 – present
Airshed Planning Professionals (Pty) Ltd	2011 – 2022

PROFESSIONAL EXPERIENCE

Air Quality

Genmin Limted, Baniaka Iron Ore Project, Gabon
2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study required for the Environmental Authorisation application process for an iron ore mine and processing operations.

Dolphin Coast Landfill Management (Pty) Ltd, DCLM KwaDukuza Landfill Atmospheric Impact Report, KwaZulu-Natal, South Africa
2022
Air Quality Specialist
Air Quality Specialist Study in the format of an Atmospheric Impact Report for a hazardous waste handling and co-disposal site in fulfilment of the requirements of a NEM:AQA Section 30 directive issued by iLembe District Municipality.

National Ministry of Environment, UPL Cornubia Warehouse Fire, Durban, Kwa-Zulu Natal Province, South Africa
2022
Assisting Air Quality Specialist
Atmospheric Dispersion Modelling for the Air Quality Specialist Study used as input for a fire incident at a chemical storage facility.

Prime Resources (Pty) Ltd, Interwaste Klinkerstene Landfill Site Waste Management Licence Variation (inclusion of Class A landfill operations), Mpumalanga, South Africa
2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study required for the Environmental Authorisation application process as well as the Waste Management Licence Variation application process for a hazardous and general waste handling and monocell disposal site.

Prime Resources (Pty) Ltd, Tawana Investment Holdings (Pty) Ltd Manganese Mine, Northern Cape, South Africa
2021-2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study required for the Environmental Authorisation application process for opencast manganese mining and processing operations.

Transnet Port Terminals, Transnet Port Terminals Multipurpose Terminal Expansion, Saldanha Bay, Western Cape Province, South Africa
2021 - 2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for additional manganese storage at TPT multipurpose terminal operations at the Port of Saldanha. Study including the bulk storage terminal operations at the Port of Saldanha.

SLR Consulting (Pty) Ltd, Impala Platinum Rustenburg Operations Second Flash Dryer Project, Rustenburg, North-West Province, South Africa
2021 - 2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study required for the Environmental Authorisation application process for platinum concentrate drying operations and support facilities including underground mining, processing and smelting operations. As well as the compilation of an Atmospheric Impact Report as part of the Atmospheric Emission Licence Variation application process.

SLR Consulting (Pty) Ltd, Cape Ocean Terminals Fuel Storage Facility, Saldanha Bay, Western Cape Province, South Africa
2021 - 2022
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation amendment application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for petroleum products storage and distribution facility.

National Ministry of Environment, Shongweni Landfill, Durban, KwaZulu-Natal Province, South Africa
2017
Assisting Air Quality Specialist
Atmospheric Dispersion Modelling for the Air Quality Specialist Study used as input for a Court Case for a waste handling, disposal, recovery and treatment of hazardous waste operations

Environmental Impact Management Services (Pty) Ltd (Environmental Assessment Practitioner) on behalf of Eskom SOC Ltd (Applicant), Medupi Power Station and Matimba Power Station Postponement Applications, Lephalale, Limpopo Province, South Africa
2019 - 2020
Project Manager and Air Quality Specialist
Undertaking the dispersion modelling and Public Participation representation as well as being involved in the air quality and meteorological data analysis, emissions estimation, model results analysis and report writing. Atmospheric Impact Reports with dispersion modelling were required as part of the Matimba Power Station and Medupi Power Station Minimum Emission Standards Compliance Postponement Applications.

Environmental Impact Management Services (Pty) Ltd, Acacia Peaking Power Station, Cape Town, Western Cape Province, South Africa
2019 - 2020
Project Manager and Air Quality Specialist
Atmospheric Impact Report with dispersion modelling was required as part of the Acacia Peaking Power Station Minimum Emission Standards Compliance Postponement Application.

Environmental Impact Management Services (Pty) Ltd, Port Rex Peaking Power Station, East London, Eastern Cape Province, South Africa
2019 - 2020
Project Manager and Air Quality Specialist
Atmospheric Impact Report with dispersion modelling was required as part of the Port Rex Peaking Power Station Minimum Emission Standards Compliance Postponement Application.

The Limpopo Economic Development Agency, Musina-Makhado Special Economic Zone (SEZ), Vhembe District, Limpopo Province, South Africa
2019
Project Manager and Air Quality Specialist
Air Quality Specialist Study required as part of the Environmental Authorisation Application.

Impala Platinum Rustenburg Operations, Smelter Postponement Application, Rustenburg, North-West Province, South Africa
2019

Air Quality Specialist
Atmospheric Impact Reports required as part of the Minimum Emission Standards Compliance Postponement Application.

HATCH, Nyanza TiO2 Pilot Plant, Richard Bay, KwaZulu-Natal Province, South Africa
2019
Project Manager and Air Quality Specialist
Air Quality Specialist Study for the Environmental Authorisation application process for a titanium dioxide pilot plant.

EarthTies Environmental, Sublime Technologies Silicon Carbide Plant, Kriel, Mpumalanga Province, South Africa
2018
Project Manager and Air Quality Specialist
Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for silicon carbide production facility.

West African Resources Ltd., Sanbrado Project, Burkina Faso
2018
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation and international funding process for opencast gold mining and processing operations.

Environmental Impact Management Services (Pty) Ltd., Bundu Mining, Diepsloot, Gauteng Province, South Africa
2019
Project Manager and Air Quality Specialist
Air Quality Specialist Study for the Environmental Authorisation application process for quarrying and crushing operations.

Thungela Resources Limited (then Anglo-American Coal), Goedehoop Air Quality Management Plan
2017
Project Manager and Air Quality Specialist
Air Quality Specialist Study for the updated Air Quality Management Plan for underground coal mining, waste dumps reclamation, and processing operations

Ministry of Environment, Shongweni Landfill, Saldanha Bay, Western Cape Province, South Africa
2017
Assisting Air Quality Specialist
Atmospheric Dispersion Modelling for the Air Quality Specialist Study used as input for a Court Case for a waste handling, disposal, recovery and treatment of hazardous waste operations

SLR Consulting (Pty) Ltd, Tri-K Gold Project, Mandiana region, Guinea
2016
Air Quality Specialist
Air Quality Specialist Study for Authorisation application process for gold mining and processing operations.

EPOC Resources, Tete Iron Ore Project / Tete Steel and Vanadium Project, Mandiana region, Guinea
2016
Air Quality Specialist
Air Quality Specialist Study for Authorisation application process for a steel and vanadium processing operations, as well as conventional and cogeneration power generation facility.

SLR Consulting (Pty) Ltd, Green Oil and Lubricants Plant, Saldanha Bay, Western Cape Province, South Africa
2016
Project Manager and Air Quality Specialist

Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for used oil recycling and petroleum products storage.

SLR Consulting (Pty) Ltd, Cape Ocean Terminals Fuel Storage Facility, Saldanha Bay, Western Cape Province, South Africa
2016
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for petroleum products storage and distribution facility.

SLR Consulting (Pty) Ltd, Phakisa Project, Saldanha Bay, Western Cape Province, South Africa
2015
Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process for an offshore vessel maintenance facility and petroleum products storage and distribution facility (inland).

SRK Consulting (South Africa) (Pty) Ltd, Tormin Mineral Sands, De Punt, Western Cape Province, South Africa
2015 - 2016
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process for heavy mineral sand mining expansion and processing operations.

SRK Consulting (South Africa) (Pty) Ltd, Tronox Smelter AEL, Saldanha Bay, Western Cape Province, South Africa
2015
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for ilmenite, natural rutile and zircon smelter facility.

SRK Consulting (South Africa) (Pty) Ltd, Tronox Namakwa Sands Mineral Separation Plant LNG Project, Lutzville / Vredendal, Western Cape Province, South Africa
2015
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for heavy mineral sand processing operations with on-site LNG decompression facility for natural gas use as fuel for the dryers.

SRK Consulting (South Africa) (Pty) Ltd, Tronox Namakwa Sands Un-Attritioned Magnetic Material Plant LNG Project, Brand-se-Baai, Western Cape Province, South Africa
2015
Project Manager and Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Impact Report as part of the Atmospheric Emission Licence application process for heavy mineral sand mining and drying operations with on-site LNG decompression facility for natural gas use as fuel for the dryer

SLR Consulting (Pty) Ltd, Ibhubesi Gas Project, Saldanha Bay, Western Cape Province, South Africa
2015
Air Quality Specialist Study
Air Quality Specialist Study for Environmental Authorisation application process for gas pipeline.

ERM, Moz Environmental Industrial Landfill, Tete, Mozambique

2013
Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process.

SRK Consulting (South Africa) (Pty) Ltd, Tronox Namakwa Sands Un-Attritioned Magnetic Material Plant, Brand-se-Baai, Western Cape Province, South Africa
2012
Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process for heavy mineral sand mining and drying operations; including modelling for input into radiation study.

SRK Consulting (South Africa) (Pty) Ltd, Transnet Port Terminals Bulk Terminal Tippler 3, Saldanha Bay, Western Cape Province, South Africa
2012
Air Quality Specialist
Air Quality Specialist Study for Environmental Authorisation application process as well as the Atmospheric Emission Licence application process for the handling of iron ore at TPT bulk terminal operations at the Port of Saldanha. Study including the surrounding industries and port operations.

EPOC Resources Ltd, Perkoa Zinc Mine, Sanguie, Burkina Faso
2011 – 2012
Air Quality Specialist
Air Quality Specialist Study for the Environmental Authorisation for expansion of underground and opencast base metal mining and processing operations.

EPOC Resources Ltd, Estima Coal Mine, Tete Province, Mozambique
2011
Air Quality Specialist
Air Quality Specialist Study for the Environmental Authorisation for opencast coal mining and processing operations.

Exxaro, Matla Mine Air Quality Management Plan
2011
Air Quality Specialist
Air Quality Specialist Study for the updated Air Quality Management Plan for underground coal mining and processing operations.

EPOC Resources Ltd, Mkuju River Project, Ruvuma Region, Tanzania
2011
Air Quality Specialist Study
For the Environmental Authorisation for opencast uranium mining and processing operations; including modelling for input into radiation study.

South African Emissions Reporting on National Atmospheric Emission Inventory System (NAEIS) and South African Greenhouse Gas Emissions Reporting System (SAGERS) for mines and industries, as well as emissions estimation, mass balance calculations and compilation of supporting documents for these systems if mines and industries are compiling the submission online.

- Bidvest Tank Terminals Durban, Isando and Richards Bay Facilities (2023): NAEIS and SAGERS
- Bidvest Tank Terminals Richards Bay Facilities (2023): NAEIS
- Thungela Resources Limited Zibulo Colliery (2020 to 2023): NAEIS
- Thungela Resources Limited Greenside Colliery (2021 and 2022): NAEIS
- Thungela Resources Limited Goedehoop Colliery (2021 and 2022): NAEIS

- Impala Platinum Rusteburg Operations (2020 to 2022): partial emissions inventory for NAEIS
- Sublime Technologies Silicon Carbide Production Facility (2021 and 2022): detailed emissions inventory including furnace mass balance for NAEIS and SAGERS
- GfE-MIR Alloys and Minerals SA Pty Ltd (2021): detailed emissions inventory for NAEIS
- GfE-MIR Alloys and Minerals SA Pty Ltd (2022): NAEIS
- Lead and Solder Sales cc (2022 and 2023): NAEIS
- Atmospheric Emission Licence applications on the South African Atmospheric Emission Licensing and Inventory Portal (SAAELIP) and hard-copy for industries.
- Gravimetric particulate matter (PM) sampling; dustfall sampling; passive diffusive gaseous pollutant sampling; continuous ambient air quality monitoring; environmental noise sampling; and source noise sampling for mines and industries.

Environmental Acoustics

Genmin Limted, Baniaka Iron Ore Project, Gabon
2022
Project Manager and Environmental Acoustics Specialist
Environmental Acoustics Specialist Study required for the Environmental Authorisation application process for an iron ore mine and processing operations.

Prime Resources (Pty) Ltd, Tawana Investment Holdings (Pty) Ltd Manganese Mine, Northern Cape, South Africa
2021-2022
Project Manager and Environmental Acoustics Specialist Environmental Acoustics Specialist Study required for the Environmental Authorisation application process for opencast manganese mining and processing operations.

Transnet Port Terminals, Transnet Port Terminals Multipurpose Terminal Expansion, Saldanha Bay, Western Cape Province, South Africa.
2021 - 2022
Project Manager and Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for Environmental Authorisation application process for additional manganese storage at TPT multipurpose terminal operations at the Port of Saldanha. Study including the bulk storage terminal operations at the Port of Saldanha.

West African Resources Ltd., Sanbrado Project, Burkina Faso
2018
Project Manager and Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for the Environmental Authorisation and international funding process for opencast gold mining and processing operations.

Environmental Impact Management Services (Pty) Ltd., Bundu Mining, Diepsloot, Gauteng Province, South Africa
2019
Project Manager and Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for the Environmental Authorisation application process for quarrying and crushing operations.

SLR Consulting (Pty) Ltd, Tri-K Gold Project, Mandiana region, Guinea
2016
Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for Authorisation application process for gold mining and processing

operations.

EPOC Resources, Tete Iron Ore Project / Tete Steel and Vanadium Project, Mandiana region, Guinea
2016
Assistant Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for Authorisation application process for steel and vanadium processing operations, as well as conventional and cogeneration power generation facility.

EPOC Resources Ltd, Estima Coal Mine, Tete Province, Mozambique
2011
Assistant Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for the Environmental Authorisation for opencast coal mining and processing operations.

EPOC Resources Ltd, Mkuju River Project, Ruvuma Region, Tanzania
2011
Assistant Environmental Acoustics Specialist
Environmental Acoustics Specialist Study for the Environmental Authorisation for opencast uranium mining and processing operations; including modelling for input into radiation study.

Climate Change

Prime Resources (Pty) Ltd, Tawana Investment Holdings (Pty) Ltd Manganese Mine, Northern Cape, South Africa
2021-2022
Project Manager and Climate Change Specialist
Greenhouse gases emissions estimation and climate change impacts study for the Environmental Authorisation application process for opencast manganese mining and processing operations.

West African Resources Ltd., Sanbrado Project, Burkina Faso
2018
Project Manager and Climate Change Specialist
Greenhouse gases emissions estimation and climate change impacts study for Environmental Authorisation and international funding process for opencast gold mining and processing operations.

SRK Consulting (South Africa) (Pty) Ltd, Tormin Mineral Sands, De Punt, Western Cape Province, South Africa
2015 - 2016
Project Manager and Climate Change Specialist
Greenhouse gases emissions estimation and climate change impacts study for Environmental Authorisation application process for heavy mineral sand mining expansion and processing operations.

CONFERENCES ATTEND, ARTICLES PUBLISHED

Workshop

GCRF Mine Dust and Health Network Stakeholders Workshop: Mine Dust and Gold Tailings (March 2022)

Conferences

NACA (October 2021)

NACA (November 2020)

Innovation Bridge and Science Forum South Africa (December 2019)

NACA (October 2018), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).

Natasha Anne Shackleton

Earth & Environment – Air Quality, Principal Consultant

NACA (October 2017), attended and presented a paper (Correlating Dust Concentration Measurements aloft with Opencast Mining Surface Operations).

Articles

Published Article: Beukes, JP; Van Zyl, PG; Sofiev, M; Soares, J; Liebenberg-Enslin, H; Shackleton, N; Sundstrom, AM (2018). The use of satellite observations of fire radiative power to estimate the availabilities (activity patterns) of pyrometallurgical smelters. Journal of the Southern African Institute of Mining and Metallurgy, 118(6), 619-624., co-author.

APPENDIX

B IMPACT SIGNIFICANCE METHODOLOGY

APPENDIX

The assessment of impacts and mitigation evaluates the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts. The assessment considers direct[2], indirect[3], secondary[4] as well as cumulative[5] impacts.

A standard risk assessment methodology is used for the ranking of the identified environmental impacts pre-and post-mitigation (i.e. residual impact). The significance of environmental aspects is determined and ranked by considering the criteria[6] presented in **Table B-1**.

Table B-1: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low: No impact on processes	Low: Slight impact on processes	Medium: Processes continue but in a modified way	High: Processes temporarily cease	Very High: Permanent cessation of processes
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probability	Definite
Significance (S) is determined by combining the above criteria in the following formula:	$[S = (E + D + R + M) \times P]$ $Significance = (Extent + Duration + Reversibility + Magnitude) \times Probability$				
IMPACT SIGNIFICANCE RATING					
Total Score	**4 to 15**	**16 to 30**	**31 to 60**	**61 to 80**	**81 to 100**
Environmental Significance Rating (Negative (-))	**Very low**	**Low**	**Moderate**	**High**	**Very High**
Environmental Significance Rating (Positive (+))	**Very low**	**Low**	**Moderate**	**High**	**Very High**

[2] Impacts that arise directly from activities that form an integral part of the Project.
[3] Impacts that arise indirectly from activities not explicitly forming part of the Project.
[4] Secondary or induced impacts caused by a change in the Project environment.
[5] Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.
[6] The definitions given are for guidance only, and not all the definitions will apply to all the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

APPENDIX

IMPACT MITIGATION

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the proposed development's actual extent of impact and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the development. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this report.

The mitigation measures chosen are based on the mitigation sequence/hierarchy which allows for consideration of five (5) different levels, which include avoid/prevent, minimise, rehabilitate/restore, offset and no-go in that order. The idea is that when project impacts are considered, the first option should be to avoid or prevent the impacts from occurring in the first place if possible, however, this is not always feasible. If this is not attainable, the impacts can be allowed, however they must be minimised as far as possible by considering reducing the footprint of the development for example so that little damage is encountered. If impacts are unavoidable, the next goal is to rehabilitate or restore the areas impacted back to their original form after project completion. Offsets are then considered if all the other measures described above fail to remedy high/significant residual negative impacts. If no offsets can be achieved on a potential impact, which results in full destruction of any ecosystem for example, the no-go option is considered so that another activity or location is considered in place of the original plan.

The mitigation sequence/hierarchy is shown in **Figure B-1** below.

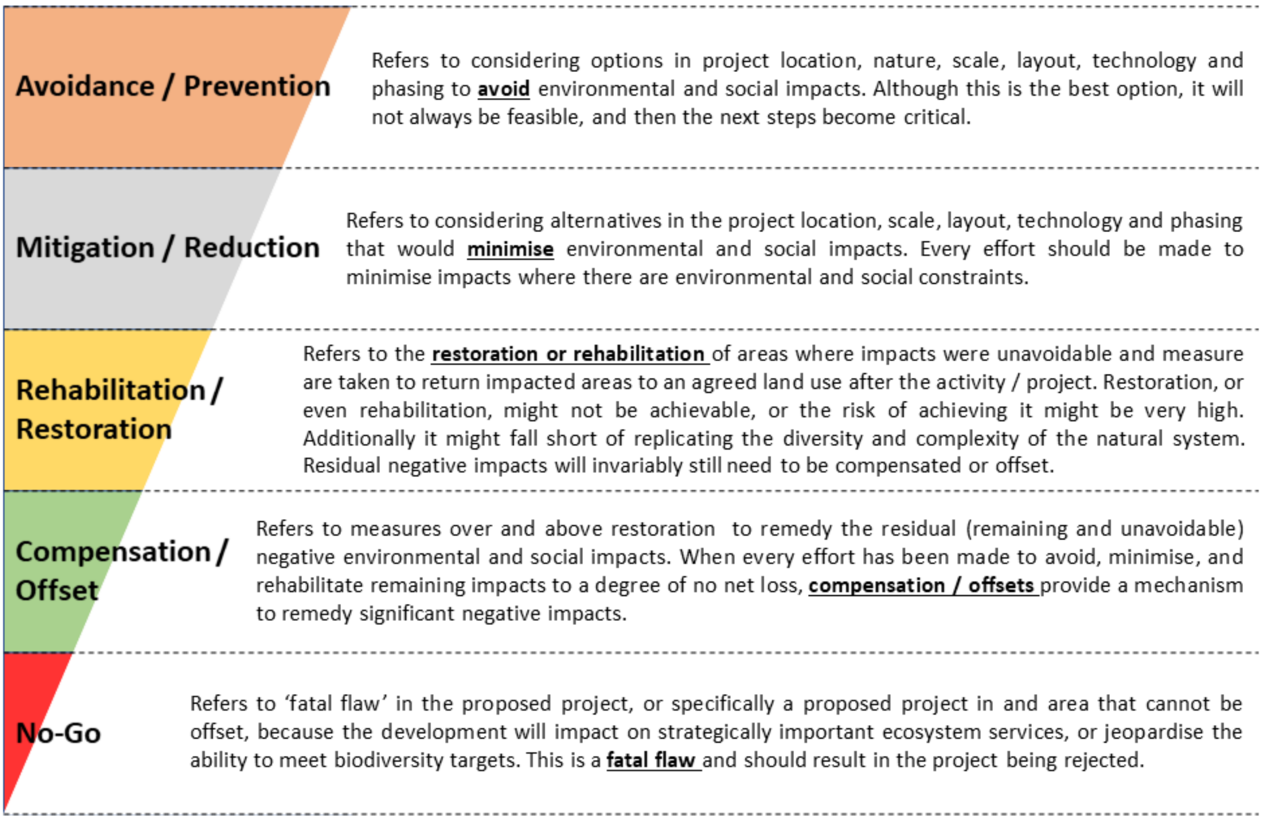


Figure B-1: Mitigation Sequence/Hierarchy

APPENDIX

C MAPS DISPLAYING THE PREDICTED L_{A90} NOISE LEVELS

APPENDIX

C-1 NORDEX N163 WIND TURBINES

APPENDIX

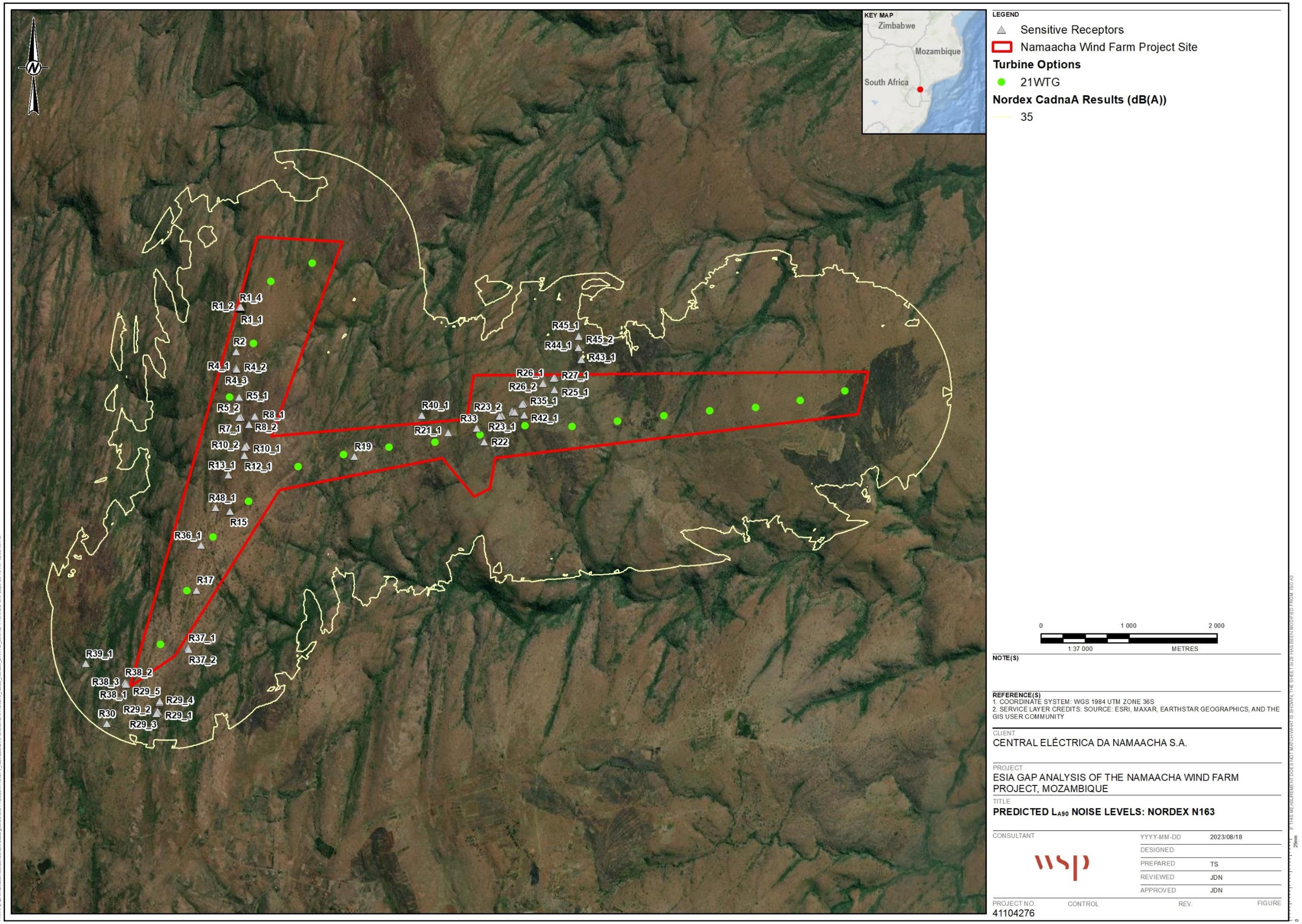


Figure C-1: Nordex N163 operational design - map depicting the isoline for the predicted (L_{A90}) 35 dB(A) level

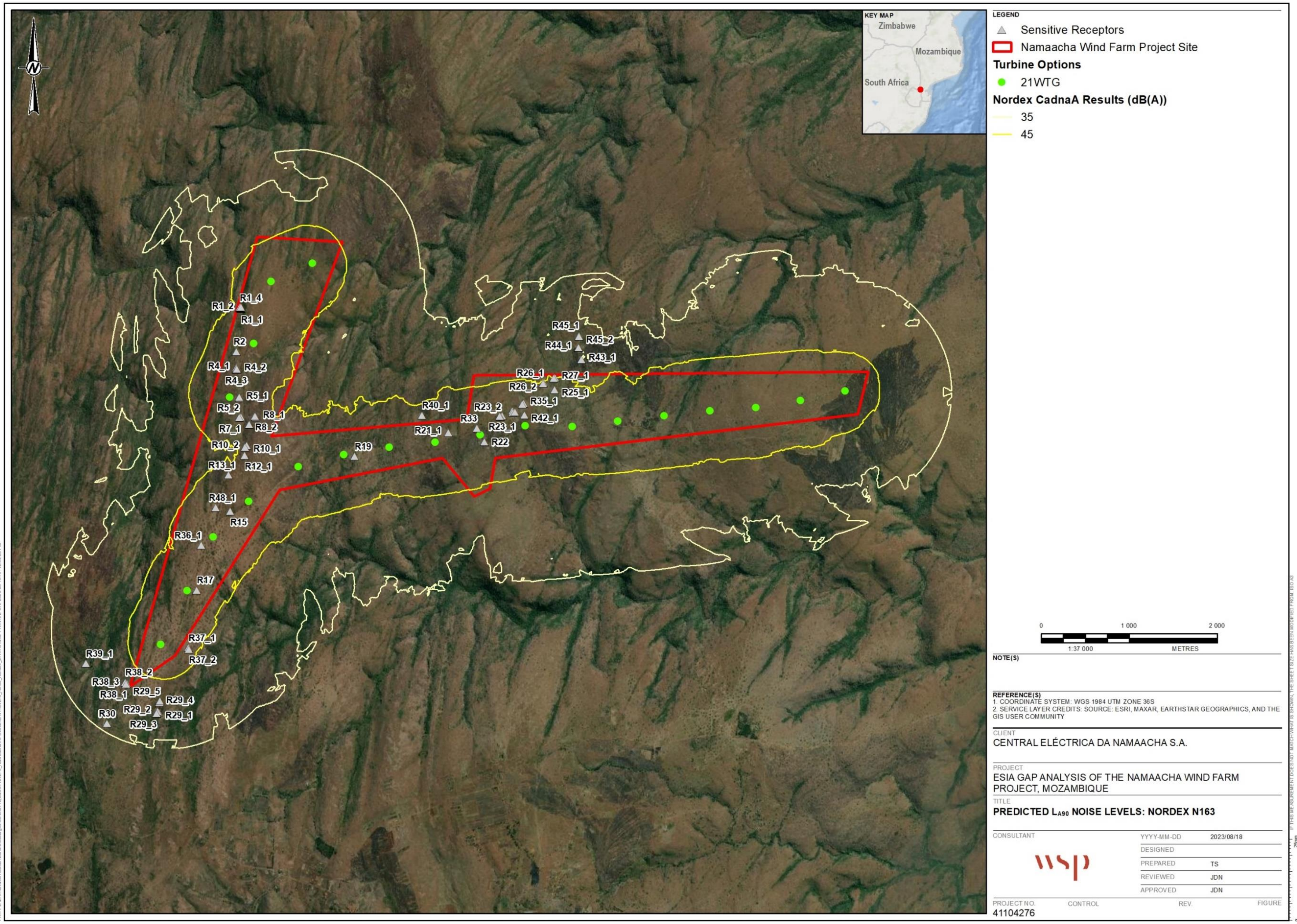


Figure C-2: Nordex N163 operational design - map depicting the isolines for the predicted (L_{A90}) 35 dB(A) and 45 dB(A) levels

APPENDIX

C-2 *GOLDWIND 165 WIND TURBINES*

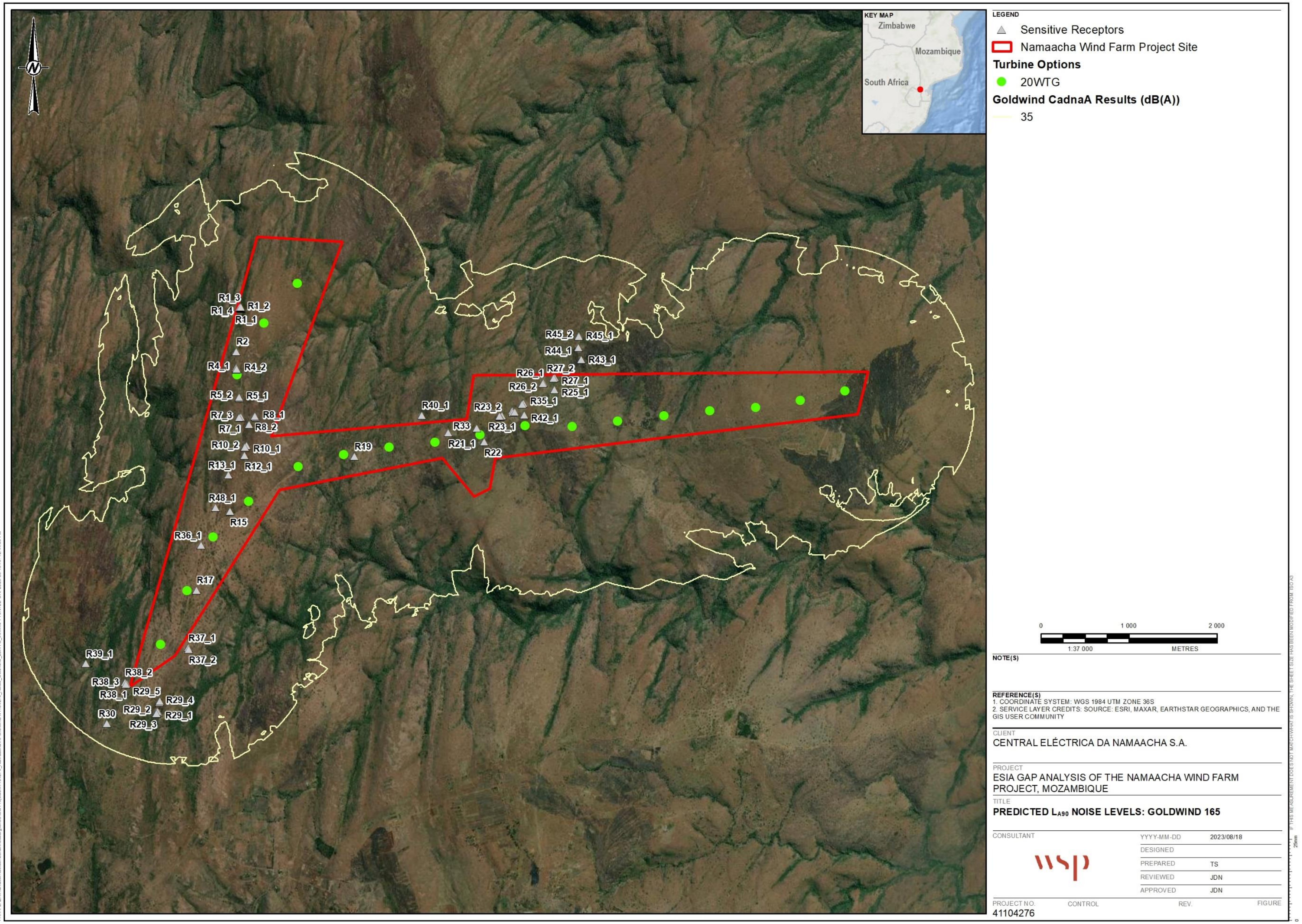


Figure C-3: Goldwind 165 operational design - map depicting the isoline for the predicted (L_{A90}) 35 dB(A) level

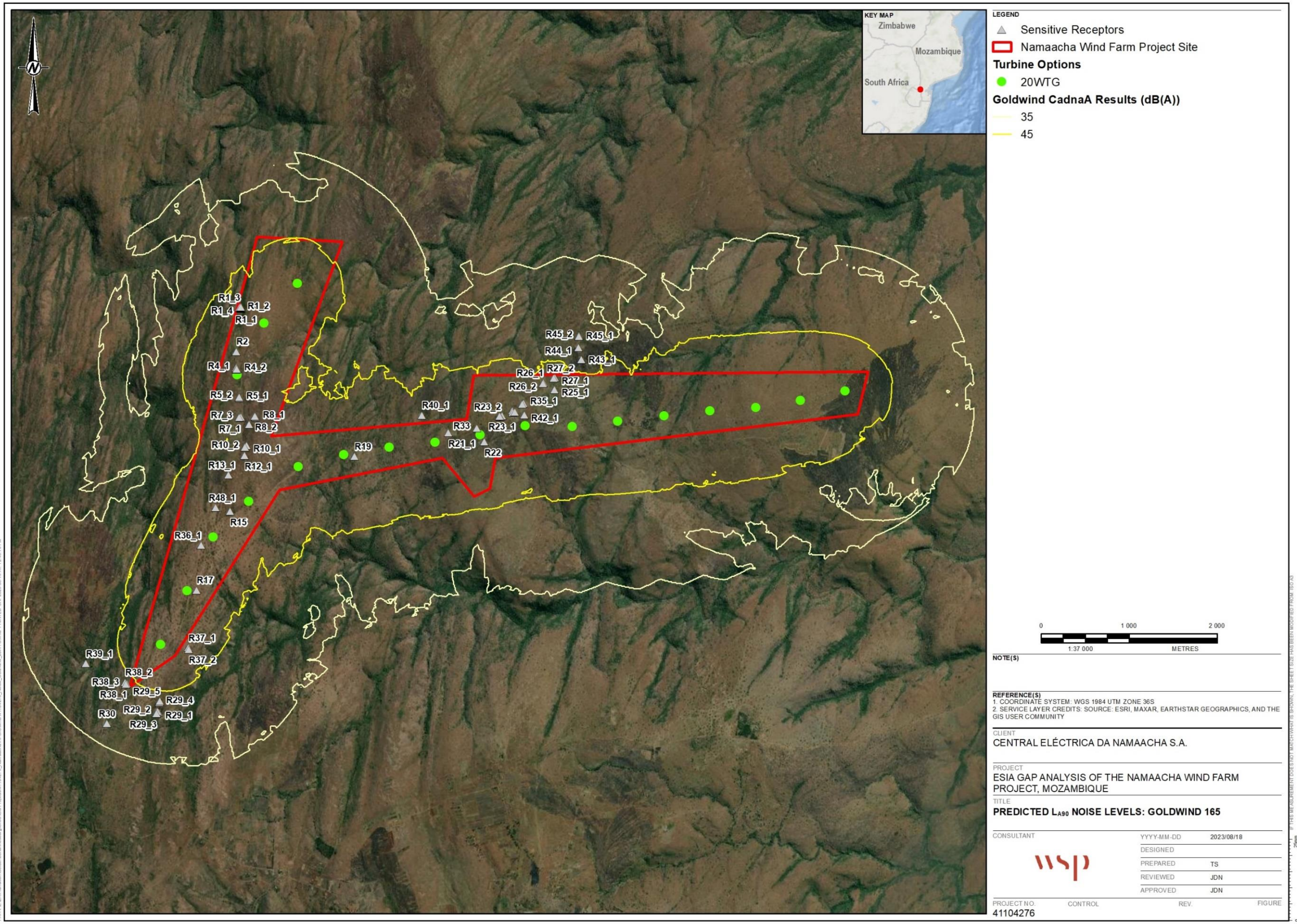


Figure C-4: Goldwind 165 operational design - map depicting the isolines for the predicted (L_{A90}) 35 dB(A) and 45 dB(A) levels

Central Electrica Da Namaacha SA

PROPOSED 120 MW NAMAACHA WIND FARM PROJECT IN NAMAACHA, MOZAMBIQUE

Chapter 7.12: Cultural Heritage Impact Assessment

70103179
AUGUST 2023

CONFIDENTIAL

Central Electrica Da Namaacha SA

PROPOSED 120 MW NAMAACHA WIND FARM PROJECT IN NAMAACHA, MOZAMBIQUE

Chapter 7.12: Cultural Heritage Impact Assessment

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70103179

OUR REF. NO. 70103179

DATE: AUGUST 2023

WSP

First Floor
3 Wellington Place
Leeds
LS1 4AP

Phone: +44 113 395 6200

WSP.com

CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

WSP has been appointed by Central Electrica Da Namaacha SA (hereafter, the Client) to provide an Environmental and Social Impact Assessment (ESIA) Addendum in support of the proposed Namaacha Wind Farm Project (the Project), in accordance with Mozambican law (10/88) and international best practice guidelines (International Finance Corporation's Performance Standards (IFC), 2012).

This ESIA Addendum presents an assessment of the potential Project impacts on cultural heritage and sets out recommendations for their avoidance or minimisation, where necessary. This ESIA Addendum is compiled with reference to a cultural heritage impact assessment initially undertaken by Matos, Fonseca and Associates (MFA) in 2019 (and later approved in 2022) and an updated baseline study completed by WSP in May 2023.

The detailed results of the baseline survey are included in Section 2. For the purposes of this assessment 'cultural heritage' encompasses archaeological and historic resources, cultural resources (e.g., sacred sites) and related intangible practices, in line with the definitions set out in the National Legislation for the Protection of the Cultural Heritage (1986), Mozambican Law (10/88), the UNESCO World Heritage Convention (1972; ratified by Mozambique in 1982) and the International Finance Corporation's (IFC's) Performance Standard (PS) 8 (2012). Further clarification is provided in Section 2.1.

2 CULTURAL HERITAGE BASELINE SUMMARY

2.1 OVERVIEW

This section of the ESIA Addendum presents a summary of the cultural heritage baseline for the proposed Project. A comprehensive baseline is required to enable the appropriate assessment of the Project's potential impacts, and their significance, on cultural heritage resources (as assessed in Section 3.0: Impact Assessment). A summary of the baseline is presented in this section, informed by WSP's May 2023 field reconnaissance visit (visual inspection) and previously collated data supporting the 2022 ESIA (MFA, 2022). The 2023 baseline field report can be found in Appendix A and a gazetteer of identified resources in Appendix B. Figure C-1(Appendix C) presents the location cultural heritage receptors identified in this chapter in relation to the proposed Project components.

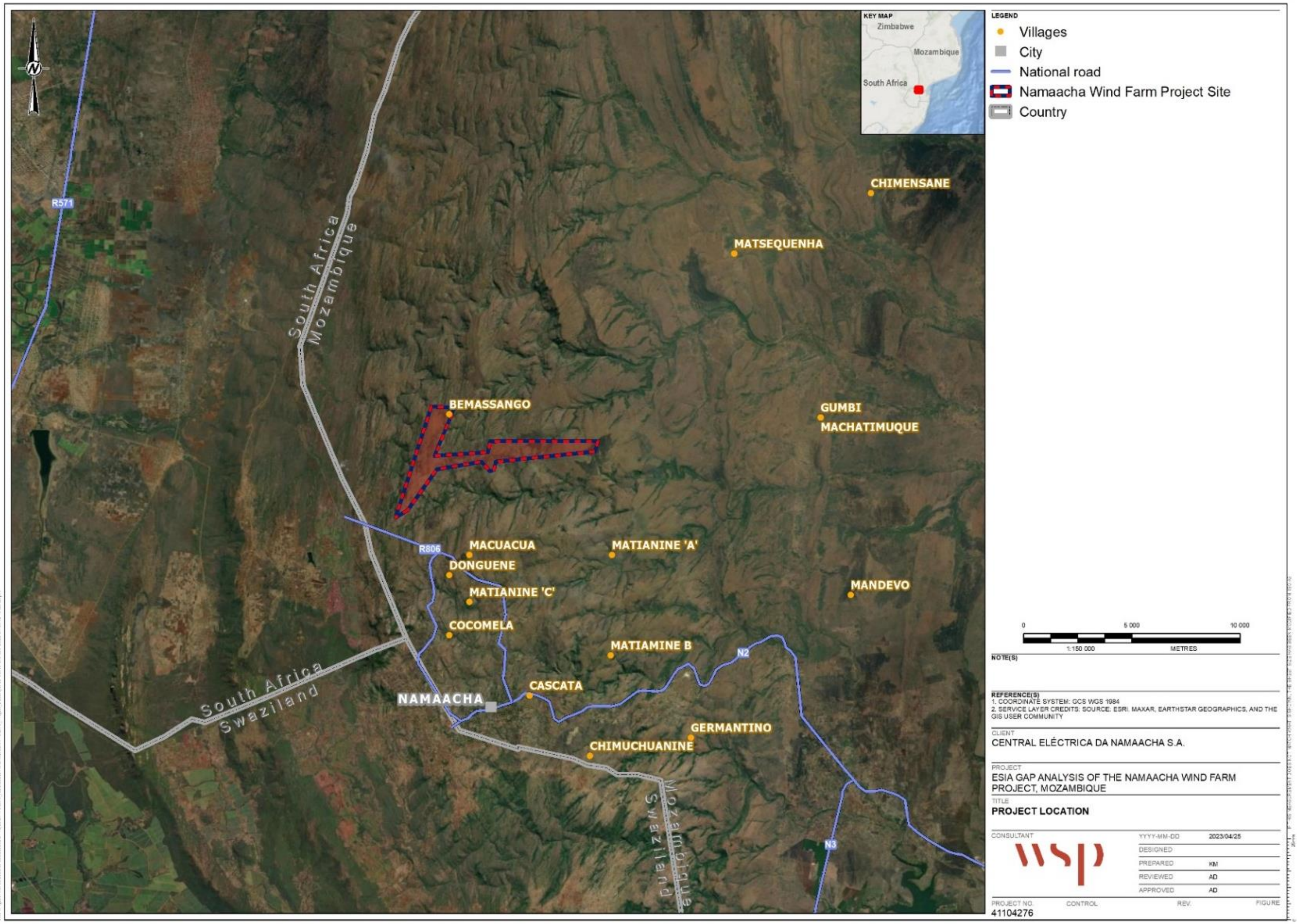
2.2 STUDY AREA

The site boundary of the proposed Namaacha windfarm Project forms the core baseline study area ('the study area') for cultural heritage. This core area not only includes the wind turbine locations but their immediate vicinity, where there may be direct (physical) impacts to heritage assets through associated construction works (e.g., temporary compounds/access, cable trenches etc).

A wider study area (the 'wider study area') surrounding the core study area has been included in the assessment for the purposes of identifying possible indirect (non-physical) impacts to cultural heritage receptors. This might include, for example, visual and noise impacts that could significantly affect how a heritage resource is understood and experienced. The 2022 ESIA did not set out the criteria for defining this wider study area, and it is presumed that professional judgement was applied. For the purposes of this update, it has been retained.

As described in Section 2, villages local to the Project were consulted with specific reference to local cultural resources, these include two small communities at Livevene and Mugudo. The study area for cultural heritage is presented in Figure 2-1.

Figure 2-1 - Cultural Heritage Study Area



2.3 BASELINE METHODOLOGY

The ESIA undertaken by Matos, Fonseca, and Associates (MFA, 2022) was supported by desk-based research including a review of archival records and literature. Cartographic resources were studied, including aerial photographs and satellite images, in order to note the location of known cultural heritage resources and identify areas of archaeological potential. The methodology also states that consultation with community leaders had taken place in order to gather further cultural heritage information. The results of the preliminary baseline data identified a Christian church within the footprint of the Project and a national monument/museum beyond the Project boundary. Cultural landscape resources beyond the proposed footprint were also noted (but not located) including the Namaacha waterfalls and the Lebombo Mountains (Montes Libombos).

A gap analysis undertaken by WSP (2022) identified several issues with the original ESIA which would require addressing in order to meet the requirements of IFC PS 8 (2012a). The following gaps were noted:

- The heritage baseline made no reference to buried heritage (archaeological) resources and the likelihood of their presence in the area of the proposed Project;
- There was no evidence of formal consultation with the affected communities;
- Lack of criteria on how the wider study area for cultural heritage was defined;
- The absence of a heritage impact assessment, in-line with internationally recognised good practice, undertaken by a suitably qualified professional.

As a result of the findings from the gap analysis, WSP's Cultural Heritage Team were required to prepare a programme of works in order to prepare an ESIA Addendum to sufficiently meet the requirements of IFC PS 8 (2012a). To facilitate this, a Cultural Heritage Work Plan (WSP, 2023) was prepared for the local consultant in Mozambique (Marta J. Langa), to set out the guiding principles of a targeted baseline study and agree on the deliverables and reporting programme. Tasks for the curation of the baseline update included:

- A rapid desktop review to identify potential cultural heritage receptors and inform the targeted field survey to follow;
- Field reconnaissance through a targeted walkover (visual survey) within the proposed Project boundary, specifically in areas of ground disturbance such as turbine locations, access tracks, new roads, and service trenches etc. The objective was to record evidence of past human activity visible on the ground (e.g., archaeological, and historical remains). The walkover also extended to the wider study area for the purposes of identifying previously unrecorded heritage assets that might be affected indirectly; and,
- Undertake targeted consultation, in participation with the local community within and surrounding the Project boundary, to sensitively record locations of cultural receptors, (e.g., cemeteries and natural sites of spiritual significance, e.g., medicinal plants, sacred forest or watercourses).

The updated 2023 baseline included a review of tangible and intangible resources, identified through desk-based research, archaeological reconnaissance, and community consultation. The targeted reconnaissance survey was undertaken between 12th and 19th of May 2023. Tangible resources related to the Project comprised grave sites. Intangible resources related to the Project comprised traditional practices. The updated baseline methodology conformed to the requirements of IFC PS 8

(2012a) and sought to take corrective action to address the issues identified from the gap analysis (WSP, 2022).

In the text to follow all cultural heritage resources are attributed site numbers. Those prefixed with MFA (e.g., **MFA-1**) include those identified during the 2022 ESIA, resources recorded in 2023 have been prefixed with 'CH' (e.g., **CH-1**). All resources are described in the accompanying Field Report (Appendix A), listed in the cultural heritage gazetteer (Appendix B) and their locations illustrated in Figure C-1and Figure C-2 (Appendix C).

2.4 LIMITATIONS

Any subsequent design changes and/or alterations, including changes to the site extent, may require new surveys to be conducted (e.g., if the proposed infrastructure layout is changed substantially). The site work and the survey coverage were, in parts, subject to the constraints imposed by:

- Health and safety considerations;
- Adverse weather;
- Poor ground visibility (bush cover); and
- Inaccessibility (dense vegetation, flooding, remoteness).

These constraints are typical of baseline field data collection and as a whole did not negatively impact on the objectives of the survey. Gaining site access in particularly rural areas of dense vegetation was a considerable issue and it should be noted that there remains a limited potential for (as yet unrecorded) features of archaeological interest across the study area.

It should also be reiterated that the archaeological survey comprised ground inspection only, no intrusive, below-ground, activity was undertaken, and those sites identified during the baseline field survey include only those readily visible on the surface i.e., as indicated by artefactual material. It is possible therefore that other, more significant remains may survive in sub-surface deposits, or in areas inaccessible at the time of survey. Furthermore, the information gathered in relation to traditional cultural places and intangible heritage is also limited to that which the community was willing to share with the field team. Although the sites recorded were not considered to be 'secret', and access was freely granted, there may be places known only to a small section of the community and/or some which are too sensitive to share. Consequently, there is a potential for unidentified features of cultural importance within the study area.

2.5 BASELINE SUMMARY

The archaeological heritage of the Maputo District is poorly studied. In general terms the archaeology of southeastern Africa has provided insight into human origins and pre-historic societal development from the early Stone Age or Palaeolithic period (2.5 million years ago (Mya)). Some of the oldest identified hominid fossils ever found (dated to 2.5 to 2 Mya), along with evidence of discernible material culture, were located at the Olduvai Gorge, northern Tanzania. Similar material culture has been found at sites throughout the southern African region, including the Tete province, in northwestern Mozambique. These communities appear to have exploited ecotonal environments, such as lakesides and savannahs, taking advantage of the abundant resources and elevated biodiversity associated with such locales to support their hunter-gatherer lifestyle (Deacon & Deacon 1999).

The evolution of modern homo-sapiens occurred within the context of the climatic volatility of the Pleistocene, with cyclical variations in precipitation inducing shifts in vegetation, resulting in population movements and subsistence changes. Ultimately, these changes may have resulted in a 'revolution' in subsistence, with greater sedentism and an increased reliance on cereals which in turn led to the agricultural-based societies. Associated with this transition are the developments of pottery traditions and the eventual emergence of metallurgy. Evidence from the Matola area of southern Mozambique, which is approximately 60km east of Namaacha, provides one of the earliest dates for the Iron Age in southern Africa and the development of metallurgy (dated to c. 70 AD) (Morais, 1988).

2.5.1. Statutory Protected Features

Cultural heritage sites of national significance are recorded on the National Archaeological Database in Mozambique (and are protected by the National Board of Cultural Heritage). No such statutory protected features exist within the core study area or wider study area. The Iron Age site at Matola is the closest to the Project, approximately 60km east.

2.5.2. Baseline Field Survey Results

The Project is located in an area (along the Mozambique - Eswatini border) of known precolonial settlement, with some potential for lithics and ceramics (M. Langa, 2023). However, no archaeological resources were identified as part of the 2022 ESIA study (though this was not considered by that assessment), nor during the 2023 baseline updates. The site walkover carried out for this update identified fragments of a recently made ceramic vessel with wavy incisions, close to a modern grave, at the eastern end of the study area (**CH-9**; Figure 2-2). These ceramic sherds were however placed as part of a local burial practice, purposefully positioned (to provide water for the deceased) and without archaeological or historic provenance.

Figure 2-2 - Decorated Ceramic Sherds Near Modern Grave CH-9 (Photo Courtesy of Marta Langa, 2023)

The lack of archaeological resources identified during the baseline update survey might suggest a relatively low archaeological potential for the study area, although this may simply reflect that nature of the resource (buried and not visible above ground) and the lack of any known intrusive investigation in the study area in the past. There is some potential (albeit limited) for surface artefacts to occur, including those associated with below-ground remains (e.g., indicating historic settlement or workshop/production sites), particularly in previously inaccessible areas of dense vegetation. The presence of ceramic sherds may indicate a nearby grave, rather than provide evidence of transient settlement or sub-surface archaeological features.

2.5.3. Settlement History

Two communities were identified within the proposed Project boundary, at Livevene and Mugudo. Focus group consultations determined that the Machaelela family originally settled the area, prior to 1977. The residents fled to Eswatini during the civil war (1977 - 1992). When the war ended groups from the Inhambane Province populated the area, primarily engaging in agriculture and charcoal production. The current residents of the town are less familiar with the history, customs and cultural legacy of the area, particularly prior to the civil war and prior to colonisation.

2.5.4. Samora Machel Monument

The Samora Machel Monument (**MFA-2**) is located approximately 2 to 3 km southwest of the Project boundary (and within South Africa). The monument marks the location of a 1986 plane crash which killed 35 people, including the then president of Mozambique, Samora Machel. The monument has incorporated remains of the plane wreckage. A museum, library, statue, and helipad have been added to the site in recent years.

2.5.5. Sanctuary of Nossa Senhora de Fátima

The Sanctuary of Nossa Senhora de Fátima (**MFA-4**, Figure 2-3) is located approximately 10 km to the south of the Project boundary area. The sanctuary was constructed in 1942, for the 25th anniversary of the Marian apparitions to three children in Fátima, Portugal. At the time of the construction and inauguration, Mozambique was an oversees Portuguese province. The sanctuary was built in the Manueline style of architecture, reflecting a Portuguese, late gothic style from the 16th century. Pilgrims from Maputo, Gaza and Inhambe visit the site annually from 13th May.

Figure 2-3 - Sanctuary of Nossa Senhora de Fátima (MFA-4) (MFA, 2022)

2.5.6. Modern Graves

Fourteen modern grave sites were identified within and around Livevene, during the baseline update survey undertaken in May 2023 (**CH-1 - CH-14**). All are within 60 m of the proposed Project boundary.

The identified graves were demarcated with reddish-brown boulders or flat stones. Graves **CH-1, CH-4, CH-6, CH-7, CH-9, CH-11, CH-12, CH-13** and **CH-14** appeared to be demarcated with stones in a circular, sub-circular or horse-shoe shaped arrangement. Grave **CH-2** was notably different in that the stones formed a small mound. Grave sites **CH-1** and **CH-11** included stones were laid on top of each other to form courses (Figure 2-4). Graves **CH-3, CH-5, CH-8** and **CH-10** were marked with stones but were not as clearly demarcated as the others. The average dimensions of the individual graves were c. 70cm by c. 150cm, generally located in areas of low-level scrub and grasses.

Figure 2-4 - Grave CH-1 with Courses of Flat Stones Demarcating the Grave. (Photo Courtesy of Marta Langa 2023)

Twelve of the grave sites were characterised as singular. However, **CH-1** and **CH-11** had three and five individual graves respectively. **CH-11** contained three graves which were in close proximity to each other (Figure 2-5), with the remaining two approximately 20m apart.

Figure 2-5 - Three of Five Graves Comprising CH-11. (Photo Courtesy of Marta Langa 2023)

Six graves (**CH-1, CH-3, CH-9, CH-11, CH12** and **CH-13**) were noted during the site walkover survey as either being within the grounds of a property or close to a dwelling. In the case of **CH-9**, the dwelling was no longer present. As noted in Section 2.2, sherds of a decorated, ceramic vessel were present in the vicinity of grave **CH-9**.

2.5.7. Pai Nosso Christian Church

The Pai Nosso Christian church (**MFA-1**) was identified within the proposed Project boundary as part of the 2022 baseline (MFA, 2022); however, based on a 2023 survey of the project area, this church is no longer being used by the community. The church was rectangular with a grass roof and posters on the exterior wall (Figure 2-6). A flagpole with a red flag was positioned at one of the gable ends. The size of the church suggests that it served the immediate community. No information regarding the construction of the church was noted.

Figure 2-6 - Pai Nosso Christian Church (MFA-1) (MFA, 2022)

2.5.8. Namaacha Waterfalls

The Namaacha waterfalls (**MFA-3**) were recorded in the 2022 baseline and located approximately 15km to the south of the Project boundary and to the north-east of Namaacha village. These waterfalls are a regional tourist attraction and a cultural heritage asset (Figure 2-7).

Figure 2-7 - Namaacha Waterfalls (MFA, 2022)

2.5.9. Libombos Mountains

The Libombos mountains (**MFA-5**) are located over 40km from the southern Project boundary. The mountains were recorded as a notable landscape feature, with natural, tourist and religious interest, Mount M'ponduíne is the highest point at 800m (MFA, 2022).

2.5.10. Intangible Cultural Heritage

In the context of the Project, intangible heritage is defined as the traditional practices, cultural norms and knowledge transmitted from one generation to the next, which communities or individuals recognise as part of their cultural heritage.

Intangible heritage has been considered in the 2023 Update, following discussions with local community representatives. It is a sample only, collated from information that the consulted participants were willing to share. There may be confidential spaces, other local rules governing certain places, or ceremonial practices that were considered too sensitive to share with the survey team.

According to the MFA 2022 baseline, the majority of the local population are Christian with the church (**MFA-1**) an example of a local, formal worship site for the community. The Sanctuary of Nossa Senhora de Fátima (**MFA-4**) is a focal point of national pilgrimage. There are a small number of Muslims, though no mosque was observed in the communities local to the Project.

Traditional religious practices were also observed to co-exist alongside Christian and Muslim faiths, identified during the community consultations. Traditional ceremonies were recorded including those undertaken to guarantee a good harvest and the wellbeing of the communities of Mugudo and Livevene. This ceremony is performed annually, in the Chief's home. Ingredients required for the festivities are maize flour, poultry and a beverage called oputso.

Natural resources were identified as integral to the intangible cultural heritage of the area. The 2022 MFA baseline describes the exploitation of natural resources for food, medicines, construction and local crafts. Grasses are used for roofs, baskets and ropes. Local plants are also used for traditional medicines to treat skin problems, coughs, malaria, menstrual pain, stomach complaints and insect repellents.

2.6 BASELINE CONCLUSION

The combined baseline study has determined that the Project area has possibly a low potential for archaeological resources, bearing in mind the considerable limitations to this assessment, and high potential for sacred and cultural resources.

In order to facilitate the impact assessment, the recorded sites identified from the 2022 and 2023 baseline studies were rated based on their cultural heritage value. A summary table of valuation is presented to follow (Table 2-1).

This baseline value was derived from a consideration of each feature or site in terms of its form, survival, condition, complexity, context, and period. Value was also calculated in terms of a perceived research worth and with reference to Mozambican designations ('movable' and 'immovable') and IFC categories ('replicable', 'non-replicable' and 'critical'). It also considers the scale at which the site matters (e.g., local, regional, or national etc) and their rarity. The results of the valuation process, for every site identified, is presented in Appendix B. The values ranged between very high to low, as detailed below:

- **High**: Archaeological and historic sites considered to be of national importance or international importance with the greatest potential for further, significant associated discoveries. Cultural / sacred resources considered to be of the highest value to the local community, frequented for longstanding cultural purposes. Resources which are non-moveable (e.g., associated with natural landscape features). Cultural heritage defined as 'critical' or 'non-replicable' by IFC PS 8 (2012a).
- **Medium**: Archaeological and historic sites considered to be of regional importance with limited potential for further discoveries, including sites which may have been subject to partial disturbance. Cultural sites which may be no longer in use but are known to the community and associated with settlement history/oral history. Cultural resources which are common and potentially moveable and 'replicable' (as defined by IFC PS 8, 2012)[1].
- **Low**: Archaeological and historical features considered to be of local importance including features which are very common and well understood, or those which are very poorly preserved and / or badly disturbed, offering limited potential for further research. Cultural sites which are very common or moveable and 'replicable' - in the sense that new buildings (e.g., churches) can be established or cultural sites which are not in current use, with no enduring local importance or historic value.

[1] Replicable cultural heritage is defined as tangible forms of cultural heritage that can themselves be moved to another location or that can be replaced by a similar structure or natural features to which the cultural values can be transferred by appropriate measures (IFC, 2012).

2.6.1. Archaeological Resources

The archaeological potential of the baseline study area is considered to be possibly low, with the caveat and limitations noted above in Section 2.4. Proposed ground disturbance for the Project, including temporary works, has the potential to have an impact upon possible, previously unrecorded archaeological remains (‘Chance Finds’). The presence of ceramic pottery sherds may be indicative of a nearby grave, transient settlement or sub-surface archaeological features. Due to the paucity of baseline archaeological research in the local area to date, the cultural heritage value of any Chance Finds encountered could range from low to high.

2.6.2. Cultural and Sacred Resources

The significance of the cultural sites recorded during the baseline survey has been calculated in terms of the impact on the local community and within the region, should the sites be negatively impacted by the Project. As such, access to local cultural sites would allow for the maintenance of the ‘cultural norm’ (i.e., continuation of normal cultural activity within the community or region).

The baseline study area has two cultural resources of high value; the Samora Machel Monument (**MFA-2**) and the Sanctuary of Nossa Senhora de Fátima (**MFA-4**). These sites are of national importance and of significant cultural value to both communities in Mozambique, frequented for long standing cultural purposes. They are considered to be immovable and non-replicable, as defined by IFC PS (8 2012a).

Seventeen locally sacred sites were recorded within the baseline study area, of which fourteen were modern graves (**CH-1 - CH-14**). The graves are defined as high value, in account of their local community valuation. The graves are considered as non-replicable.

Namaacha waterfalls (**MFA-3**) and Libombos mountains (**MFA-5**) were also considered to be of high value as they are frequented by the local community for long standing cultural purposes and are non-movable and non-replicable, as defined by IFC PS 8 (2012a).

The Pai Nosso Christian church (**MFA-1**) was considered to be of low value as a common cultural site without historic value and enduring local importance. As verified in 2023, this church is no longer being used by the local community.

There is also some potential, albeit limited, for the occurrence of graves and/or other cultural resources that have not yet been identified during the previously phases of baseline study. The cultural heritage value of any previously unknown cultural resources (accidently) encountered could range from low to high.

Table 2-1 - Cultural Heritage Resources: Baseline Valuation

Resource Type	Sub Type	Summary Description	Cultural Heritage Valuation
Archaeological	Unknown / previously undiscovered	Previously undiscovered resources, including surface artefacts (archaeological “chance finds”) and subsurface remains.	Low to High
Cultural and Sacred	Memorial monument	Samora Machel Monument (**MFA-2**)	High

Resource Type	Sub Type	Summary Description	Cultural Heritage Valuation
	Sanctuary	Sanctuary of Nossa Senhora de Fátima (**MFA-4**)	High
	Graves	Modern-dated graves with associated ceramic sherds (**CH-1 – CH-14**)	High
	Cultural landscape features	Namaacha waterfalls (**MFA-3**) and Libombos mountains (**MFA-5**)	High
	Previously undiscovered resources	Previously undiscovered cultural and sacred resources (e.g., graves)	Low to High

3 IMPACT ASSESSMENT

3.1 IMPACT ASSESSMENT METHODOLOGY

The cultural heritage impact assessment is compiled with reference to the baseline environment, summarised in Section 2 and Appendix A and Appendix B. The baseline considered resources within an Area of Direct Influence (ADI) aligned with the core baseline study area and an Area of Indirect Influence (AII) aligned with the wider study area. The ADI is defined as the geographic area where the effects of the direct physical impacts of the project materialise. Direct impacts are associated with vegetation and clearance and any groundworks, i.e., associated with underground cables, access routes, wind turbine foundations and associated facilities. The AII is defined as the surrounding area where indirect impacts will occur, resulting from the direct impacts within the ADI. Indirect impacts are associated with changes to the environmental setting, such as from visual disturbance, increase in traffic-related noise or dust, from the movement of people, machinery and equipment. Secondary impacts include demographic changes resulting from Project-driven influx and people seeking employment opportunities and indirect benefits.

This assessment is carried out for the Construction, Operational and Deactivation phases of the proposed Project. The methodology adopted to carry out the impact assessment is described below in Table 3-1, Table 3-2, Table 3-3 and Table 3-4 aligned with the methodology presented in the existing ESIA (MFA, 2022).

Table 3-1 - Description of Impact

Descriptor	Scale	Explanation
Nature of Impact	Positive	Impact that represents an improvement of the baseline situation or introduces a positive change.
	Negative	Impact that represents an adverse change from the baseline situation or introduces an undesirable factor.
	Direct	Impact arising directly from activities that are an integral part of the project (e.g., new infrastructure).
	Indirect	Impact that arises indirectly from activities that are not an integral part of the project (e.g., noise due to the movement of vehicles and machinery).
	Secondary	Secondary or change-induced impact due to the Project (e.g. employment opportunities due to material and labour requirements).
Scope	Site	The impact will be limited to the Project site.
	Local	The impact will be limited to the local area.
	Regional	The impact will be limited to the region.
	National	The impact will be national.
	International	The impact will be international.

Descriptor	Scale	Explanation
Duration	Temporary	The impact is expected to be very short-lived (days) and/or intermittent/occasional.
	Medium-term	The impact is expected to be short term (0-5 years).
	Long-term	The impact will prevail over the life of the project. It will disappear when the project ends operations, i.e., deactivated (normally >15 years)
	Permanent	Impact that causes a permanent and irreversible change in the affected recipient or resource.
Probability	Unlikely impact	Not likely to happen.
	Likely	There is a possibility that the impact will occur.
	Very likely	It is very possible that the impact will happen.
	Certain	The impact will occur regardless of any preventative measures.
Reversibility	Immediate	The impact is immediately reversible.
	Reversible	The impact is reversible within 2 years after the cause of the impact is removed.
	Irreversible	The activity will lead to an impact that in all practical terms will be permanent.

Table 3-2 - Magnitude of Impact and Vulnerability of The Receiving Environment: Cultural Heritage

Descriptor	Definition	Scale	Explanation
Impact Magnitude	Describes the expected intensity of change to the resource/receiver as a result of the impact	Negligible impact	Impact is minimal and will have no effect on the receiving environment.
		Reduced	The impact is reduced and will result in the processes continuing in an altered form. Reduced environmental changes. No involuntary resettlement. Good information and high awareness of potential environmental factors influencing impact. High degree of confidence.
		Moderate	The impact is moderate, and processes will be significantly changed and may be temporarily halted. Moderate environmental changes. Involuntary resettlement

Descriptor	Definition	Scale	Explanation
			and limited economic displacement. Reasonable amount of information and relatively good perception of potential environmental factors influencing impact. Reasonable degree of confidence.
		High	The impact is high and results in the complete destruction of patterns and permanent interruption of processes. Destruction of rare or endangered species. Depreciation of the character or quality of important historical, archaeological, architectural or aesthetic resources or the character of a community/ neighbourhood. Negative effects on vulnerable or disadvantaged communities. Involuntary resettlement and substantial economic displacement. Limited information and limited insight into potential environmental factors influencing impact. Low degree of confidence.
Sensitivity	The importance of the environmental attribute in question, the distribution of change in time and space. The magnitude of the change and the feasibility in which that change was predicted or measured	Low	Disturbance of degraded areas, with little conservation value or unimportant as a resource for humans. Affected species are not listed or protected. The importance of an environmental resource or attribute is based on knowledge, technical or scientific or appreciation of the characteristics of critical resources. **Cultural Heritage Sensitivity:** • Archaeological considered to be of local importance including features which are very common and well understood, or those which are very poorly preserved. • Cultural sites which are very common or moveable and 'replicable'.
		Medium / Average	Disturbance of areas with conservation value at the local or regional level or with potential use for humans. Audience segments recognize the importance of an

Descriptor	Definition	Scale	Explanation
			environmental feature or attribute. Public recognition can take the form of support, conflict or opposition. Public action can be expressed formally or informally. The environment is susceptible to change. **Cultural Heritage Sensitivity:** • Archaeological and historic sites considered to be of regional importance, with limited potential for further discoveries. • Cultural sites which may be no longer in use but are known to the community and associated with settlement history/oral history, including cultural sites which are common and potentially moveable and 'replicable' under the right conditions.
		High	Disturbance of areas with regional or national conservation value and important human resource. The importance of an environmental feature or attribute is recognized by law, plans or policy statements from government agencies or private groups. The environmental resource affected is significant. The environment is sensitive to change. **Cultural Heritage Sensitivity:** • Archaeological and historic resources considered to be of national or international importance with the greatest potential for further, significant discoveries. • Cultural sites which have been frequented by the local community for longstanding cultural purposes and those which attract visitors from further afield. Including 'non-replicable' and 'critical' cultural heritage sites. • Intangible cultural heritage that it integral to the identity and normal cultural activity

Descriptor	Definition	Scale	Explanation
			of an affected community, that may be entirely lost from one generation to the next.

Table 3-3 - Impact Significance Matrix

Significance		Sensitivity		
Magnitude		**Low**	**Medium**	**High**
	Negative impacts			
	Insignificant	Insignificant	Negligible	Negligible
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High
	Positive impacts			
	Reduced	Negligible	Reduced	Moderate
	Moderate	Reduced	Moderate	High
	High	Moderate	High	High

Table 3-4 - Description of The Degrees of Significance of Impacts

Impact Rating	Description
Negative impacts	
Insignificant	The receiving environment will not be affected by the activity. Impacts do not require further assessment.
Negligible	The effect of an activity on the receptive environment is not significant enough to be observed. Impacts do not need to be minimized and are not a concern in decision-making processes.
Reduced	Detectable changes in the baseline situation are expected, in addition to natural variations, but difficulties, degradation or damage to the function and value of the resource/receptor are not expected. The significance of impacts is within the applicable parameters.
Moderate	Moderate significance indicates that an impact may reach the threshold of legal limits. Substantial impacts that could result in lasting changes to the baseline are anticipated. These impacts are a priority in minimizing, in order to prevent or reduce the significance of the impact.

Impact Rating	Description
High	A high degree of significance means that legal limits or standards have been exceeded or impacts of high magnitude have occurred in highly sensitive environments or affected people. Residual impacts with high significance can be considered a fatal project failure. High residual impacts must be further avoided or minimized, in order to avoid severe impacts on the receiving environment.
Positive impacts	
Reduced	Impacts of reduced significance are noticeable, but do not permanently and radically improve the receiving environment, or benefit those affected. There is compliance with all standards and legislation.
Moderate	Positive impacts are felt and results in measurable improvements relative to baseline. There is compliance with all standards and legislation.
High	Impacts of high significance that provide substantial benefits where large improvements are felt over an extended period of time. There is compliance with all standards and legislation.

4 IMPACT ASSESSMENT RESULTS

4.1 CONSTRUCTION PHASE IMPACTS

4.1.1. Archaeological and Historic Resources - Construction Phase

Direct Impacts

Although no archaeological or historic resources were identified as part of the baseline study, there is a potential for as yet unknown archaeological resources, including surface artefacts and sub-surface features, to be identified as a result of preparatory works and construction phase activities. These include direct impacts from vegetation clearance and grading, machine movement, foundation piling, compound construction and associated infrastructure, such as access tracks and service trenches. At worst case, this would result in the direct permanent loss of highly sensitive non-renewable resources. The severity of the impact on any receptors would depend on the nature, date, survival, and heritage significance of the remains.

4.1.2. Proposed Mitigation Measures - Archaeological and Historic Resources

To manage potential impacts to previously unknown resources a Chance Find Procedure (CFP) is required under Mozambican cultural heritage legislation (Law. No. 10/88 and Decree No. 27/94) and IFC best practice guidelines (IFC PS 8, 2012a and b).

The Client has specific legal responsibilities in the event that features of archaeological significance are recovered on the project site. In summary, The Archaeological Assets Protection Regulations (27/94), which apply to both “immoveable” and “moveable” assets, require the finder of any accidental archaeological elements (through prospecting and/or excavation) to communicate this finding within 48 hours to the local authority. The Archaeological Assets Protection Regulations also state that, in the event that the discovery occurs during any project-related activity, the Proponent will be responsible for all expenses required to protect and safeguard any archaeological findings, as determined by the relevant authorities.

The CFP will provide a mechanism to address archaeological discoveries during Project activities when a Cultural Heritage Expert is not present. The CFP will apply for the lifetime of the Project, throughout the entirety of the footprint and during any / all ground works, including vegetation clearance. The CFP clarifies the exact steps to be taken by the Client (and Contractors) in the event of any accidental archaeological discovery. Through the effective implementation of the CFP the Project cultural heritage team would decide on the appropriate next steps, in accordance with the national Law of Mozambique (1994).

A Chance Find Procedure (CFP) will be implemented through the Project’s Environmental and Social Management System (ESMS).

The implementation of the recommended mitigation would result in a Negative Reduced impact, as outlined in Table 4-1.

Table 4-1 - Construction Phase Impacts: Archaeological Resources

Construction phase impacts: archaeological resources			
Direct physical impacts from ground clearance, turbine bases installation, machine movement, compound and laydown areas and associated infrastructure such as access tacks and service trenches. This may result in direct, permanent loss of non-renewable resources that may range from low to high in terms of their sensitivity (with an average medium sensitivity value). The probability of impact is unlikely, since the overall archaeological potential of the Project site is considered to be low.			
Project Phase	Construction (including pre-construction)		
Nature of Impact	Direct; Negative		
Scope	Site		
Probability	Unlikely		
Duration	Permanent		
Reversibility	Irreversible		
	Impacts without mitigation measures	**Mitigation measures**	**Residual impact**
Magnitude	High	Avoidance and Minimisation – implementation of the Chance Find Procedure	Reduced
Sensitivity	Low to High		Low to High
Classification of Significance	Moderate (average)		Reduced (average)

4.1.3. Cultural and Sacred Resources - Construction Phase

Nineteen cultural and sacred resources were identified in the baseline study area, including graves (**CH-1 - CH-14**), a sanctuary (**MFA-4**), a monument (**MFA-2**) and natural features (**MFA-3** and **MFA-5**).

Direct Impacts

Direct changes to the land surface within the ADI during the construction phase (including pre-construction preparatory works) have the potential to impact the following receptors within the proposed Project boundary area: graves (**CH1 - CH14**). These sites are shown in relation to the proposed turbine options on Figure C-1. All turbines are currently sited over 25m from all identified cultural heritage resources. The proposed locations of all supporting infrastructure (e.g., access tracks) is in development and will be informed by the findings of the ESIA Addendum.

Prior to the implementation of mitigation, adverse conditions resulting from direct impacts to receptors **CH1 - CH-14** may arise through land clearance activities, turbine installation, access track creation, compound foundations, service trenches and plant movements. This could result in the loss or damage to highly sensitive, non-renewable resources, including previously unidentified graves.

Indirect Impacts

Predicted indirect impacts during the construction phase include changes in the local environmental setting, such as noise, dust/air quality or loss of safe local access, particularly in relation to the graves (**CH-1 - CH-14**) that lie within the proposed Project boundary. There are also no predicted construction phase impacts to resources beyond the ADI since the closest resource (**MFA-2**) is 2 to 3 km southeast of the Project boundary[2].

Indirect changes on graves sites (that are directly avoided during ground works) associated with the construction phase would be site-based in extent, temporary (throughout the construction phase) and reversible in nature.

4.1.4. Proposed Mitigation Measures - Cultural and Sacred Resources

Adverse environmental impacts resulting from direct impacts to cultural and sacred resources will be avoided through the construction phase (including preparatory works) implemented through the preparation of a Cultural Heritage Management Plan (CHMP). The CHMP will include the following:

- Cultural heritage avoidance plans (constraints mapping) to locate tangible cultural heritage receptors (**CH-1 - CH-14**), and suitable buffers, to inform final Project design, such as the relocation of access tracks, compounds etc in order to avoid sites and to allow for continual community access, if necessary, in consultation with local custodians.
- A programme for scheduled / ongoing engagement with the Affected Communities local to the Project, to provide a forum to identify any unanticipated impacts and assess the effectiveness of these mitigation measures proposed.

These recommended mitigation measures will reduce the impact on highly sensitive receptors (graves) to Negative, Moderate.

Table 4-2 - Construction Phase Impacts: Cultural and Sacred Resources

Construction phase impacts to cultural and sacred resources	
Direct impacts to the graves associated with ground clearance, turbine placement, access tracks, plant movement and service trenches resulting in loss or damage to sensitive, non-renewable resources and disruption of normal cultural activities. Indirect impacts through temporary changes to the environmental setting of graves within the ADI. Potential loss of community access.	
Project Phase	Construction (including pre-construction)
Nature of Impact	Direct and Indirect; Negative
Scope	Site
Probability	Probable

[2] The visual impact of turbine construction is assessed for the Operations phase of the Project

Construction phase impacts to cultural and sacred resources			
Duration	Permanent (direct impacts) and Temporary (indirect impacts)		
Reversibility	Irreversible – (direct impacts) and Reversable (indirect impacts)		
	Impacts without mitigation measures	**Mitigation measures**	**Residual impact**
Magnitude	Graves (CH-1 – CH-14) High (direct impact) Graves (CH-1 – CH-14) Moderate (indirect impact)	Avoidance and Minimisation – through implementation of the Cultural Heritage Management Plan	Reduced
Sensitivity	Graves (CH-1 – CH-14) High		Graves (CH-1 – CH-14) High
Classification of Significance	High		Moderate

4.1.5. Intangible Cultural Heritage - Construction Phase

The intangible cultural heritage identified during baseline consultations undertaken for the Project includes unique local belief systems related to ancestor worship, religious pilgrimage, formal religion, and traditional ceremonial activities. In the context of the Project area, intangible heritage is defined, in accordance with IFC PS 8 as the normal cultural behaviour and knowledge transmitted from one generation to the next, which communities or individuals recognise as part of their cultural heritage that may or may not be, tied to a physical cultural heritage resource.

Intangible heritage has the potential, without mitigation, to be impacted during the construction phase through disruption of normal cultural behaviours and particularly through the loss of access to grave sites (**CH-1 - CH-14**). Without the implementation of appropriate mitigation measures the endurance of traditional ceremonies and other activities impacted through general Project-induced disturbance, particularly population influx. The impact of the Project in relation to ecosystem services, including cultural services, in the context of medicinal plants, and spiritual / recreational services is discussed in Chapter 9.8.1.3 of the EIS Addendum.

Selecting the severity of impacts is subjective, with change from the local cultural norm perceived as potentially positive or negative. In the context of the Project, a loss, deviation, or dilution of intangible cultural heritage is considered a negative impact. Furthermore, an influx of migrants may either strengthen or weaken local cultural practices over the Project lifetime. If construction phase impacts are to occur, they could be of unknown and, therefore, high intensity (on a worst-case basis) and permanent in duration. Societal changes are considered irreversible in the context of intangible cultural heritage since they may be entirely lost from one generation to the next.

4.1.6. Recommended Mitigation Measures

Adverse indirect impacts to intangible cultural heritage will be managed through successful implementation of the CHMP. The CHMP will set out a strategy for maintaining community access to tangible sacred resources and facilitating respect for local intangible cultural heritage (traditions and taboos) to ensure that the negative socio-cultural effects are effectively mitigated. Measures specific to intangible heritage will include the following:

- The physical demarcation of known grave sites by establishing suitable buffers, in consultation with local custodians, to ensure continued safe access.
- The CHMP will outline a programme for cultural heritage awareness training to be incorporated into the site induction process for all site staff and contractors.
- A programme for scheduled / ongoing engagement with the Affected Communities local to the Project, to provide a forum to identify any unanticipated impacts and assess the effectiveness of these mitigation measures proposed.
- Linkage to the overall Project Grievance Mechanism.

The implementation of the recommended mitigation measures will reduce the impact on intangible cultural heritage to Negative Moderate.

Table 4-3 - Construction Phase Impacts: Intangible Cultural Heritage

Construction phase impacts to intangible cultural heritage			
Disruption to normal cultural behaviours, loss of access to cultural sites			
Project Phase	Construction (including pre-construction)		
Nature of Impact	Indirect; Negative		
Scope	Local		
Probability	Probable		
Duration	Permanent		
Reversibility	Irreversible		
	Impacts without mitigation measures	**Mitigation measures**	**Residual impact**
Magnitude	High (worst case)	Minimisation - Implementation of the CHMP	Reduced
Sensitivity	High		High
Classification of Significance	High		Moderate

4.2 OPERATIONAL PHASE IMPACTS

4.2.1. Archaeological and Historic Resources – Operational Phase

No (additional) direct physical impacts to archaeological resources during the operational phase of the Project are anticipated since no groundworks are predicted. The CFP will remain in place for the lifetime of the Project.

4.2.2. Cultural and Sacred Resources - Operational Phase

Direct Impacts

No direct physical impacts to cultural and sacred resources during the operational phase of the Project are anticipated since no groundworks are predicted. The CFP will remain in place for the lifetime of the Project.

Indirect Impacts

Indirect impacts to graves sites (**CH-1 - CH-14**) may result during the operational phase of the Project. Potential concurrent impacts include the loss of safe site access, visual disturbance from the erected turbines and noise / dust from maintenance vehicles, resulting in (cumulative) change to the local 'sense of place'. Prior to mitigation, these impacts would be locally felt, long term in duration and high in magnitude, upon receptors of high cultural heritage sensitivity.

The project sits within an undulating landscape and the visual assessment area defined for the MFA ESIA was approximately 2km from the Project boundary. The closest identified cultural resource within the ADI is the memorial/monument (**MFA-2**) located 2 to 3km southwest of the Project, all other resources are over 10 km to south and screened by interim topography. However, visual impacts in the nearby AII are difficult to quantify and subjective in nature and no concerns regarding the visual impact of the Project have so far been raised by the local community. It is predicted that the memorial/monument (**MFA-2**) may experience minor negative visual impacts and a change in 'sense of place' due to its relative proximity to the Project. Prior to mitigation, these impacts could be local in extent, long term in duration and moderate in magnitude, upon a receptor of high cultural heritage sensitivity.

4.2.3. Mitigation Recommendations

The Project Environmental Management Plan (EMP) will provide ongoing measures to minimise negative Project effects throughout the operational phase of the Project. Specifically, this should include:

- The physical demarcation of known grave sites by establishing suitable buffers, in consultation with local custodians, to ensure continued safe access.
- A programme for scheduled / ongoing engagement with the Affected Communities local to the Project, to provide a forum to identify any unanticipated impacts and assess the effectiveness of these mitigation measures proposed, linked to the Project's Stakeholder Engagement Plan (SEP) and Community Grievance Redress Mechanism.
- The Project CFP.

With mitigation measures in place, the impact would be Negative Negligible (memorial, **MFA-2**) and Negative Moderate (Graves, **CH-1 - 14**).

Table 4-4 - Mitigation Measures: Cultural and Sacred Resources

Operational phase impacts: cultural and sacred resources
Visual disturbance, noise / dust from maintenance vehicles, restricted local access

Operational phase impacts: cultural and sacred resources			
Project Phase	Operation and maintenance		
Nature of Impact	Indirect; Negative		
Scope	Local		
Probability	Probable		
Duration	Long-term		
Reversibility	Reversible		
	Impacts without mitigation measures	**Mitigation measures**	**Residual impact**
Magnitude	Graves (CH-1 – CH-14): Moderate Memorial (MFA-2): Reduced	Implementation of the Project EMP: The physical demarcation of known grave sites by establishing suitable buffers, in consultation with local custodians, to ensure continued safe access. Implementation of the Project's Stakeholder Engagement Plan (SEP) and Community Grievance Redress Mechanism. Implementation of the Project's CFP.	Graves (CH-1 – CH-14): Reduced Memorial (MFA-2): Insignificant
Sensitivity	High		High
Classification of Significance	High (Graves CH-1 – CH-14) Moderate (Memorial, MFA-2)		Moderate (Graves CH-1 – CH-14) Negligible (Memorial, MFA-2)

4.2.4. Intangible Cultural Heritage

During the operational phase of the Project, the erection of safety and security fencing could disrupt the usual access route to cultural resources, resulting in a disruption to traditional practice and usual cultural activity. Without the implementation of appropriate mitigation measures, access to graves may be restricted and the endurance of traditional ceremonies and other activities (e.g., gathering of medicinal plants, traditional foods) affected.

If operation and maintenance phase impacts are to occur, they would be of moderate intensity (on a worst-case basis) and permanent in duration. Societal changes are considered irreversible in the context of intangible cultural heritage since they may be entirely lost from one generation to the next. However, during the operational phase of the Project the sensitivity value of intangible cultural heritage is reduced from high (at construction) to medium to account for the lesser ‘shock’ of the Project on normal cultural behaviour at this phase in the Project Lifecyle.

4.2.5. Mitigation Measures

The EMP will provide ongoing measures to minimise negative Project effects through the operational phase of the Project, including the maintenance of safe local access. Assuming the effectiveness of these measures, and importantly, the prior success of the construction phase mitigation programme (the CHMP) to ensure, as far possible, the endurance of intangible cultural heritage in the locality, the longer-term operational impacts would be Negative, Reduced.

Table 4-5 - Mitigation Measures: Intangible Cultural Heritage

<table>
<tr><th colspan="4">Operations and Maintenance Impacts: Intangible cultural heritage</th></tr>
<tr><td colspan="4">Restricted access to cultural sites and disruption of normal cultural behaviours associated with traditional grave maintenance, related ceremonies and the gathering of plants and medicine.</td></tr>
<tr><td>Project Phase</td><td colspan="3">Operations and maintenance</td></tr>
<tr><td>Nature of Impact</td><td colspan="3">Indirect; Negative</td></tr>
<tr><td>Scope</td><td colspan="3">Site</td></tr>
<tr><td>Probability</td><td colspan="3">Probable</td></tr>
<tr><td>Duration</td><td colspan="3">Permanent</td></tr>
<tr><td>Reversibility</td><td colspan="3">Irreversible</td></tr>
<tr><td></td><td>Impacts without mitigation measures</td><td>Mitigation measures</td><td>Residual impact</td></tr>
<tr><td>Magnitude</td><td>Moderate</td><td rowspan="3">Implementation of the Project EMP:
The physical demarcation of known grave sites by establishing suitable buffers, in consultation with local custodians, to ensure continued safe access.
Implementation of the Project’s Stakeholder Engagement Plan (SEP) and Community Grievance Redress Mechanism.</td><td>Reduced</td></tr>
<tr><td>Sensitivity</td><td>Medium</td><td>Medium</td></tr>
<tr><td>Classification of Significance</td><td>Moderate</td><td>Reduced</td></tr>
</table>

4.3 DECOMMISSIONING PHASE IMPACTS

No additional impacts to cultural heritage resources are highlighted for the decommissioning phase of the Project. The CFP will provide the necessary mitigation strategy for any accidental finds recovered during this phase. No additional decommissioning-specific measures are anticipated for cultural and/or sacred resources. At the time of decommissioning, a comprehensive Decommissioning Plan will be prepared that will be developed after assessing potential environmental and social impacts based on conditions at that time.

5 CONCLUSIONS

The baseline study did not identify any archaeological or historical receptors within the Project footprint. As a result, the archaeological potential within the ADI was assessed as possibly low, with the caveat that very little is currently known in the absence of any systematic intrusive archaeological investigation. However, environmental impacts during the construction phase on as yet unknown archaeological and historical receptors was assessed as having potential high significance from direct, physical impacts, prior to the implementation of mitigation. With the effective implementation of a CFP, the significance of impact was determined as Reduced.

The baseline study identified 19 cultural and sacred receptors; 14 of which were located within the ADI. These comprised modern-dated graves (**CH-1 - CH-14**). One grave was distinct from the rest with associated ceramic sherds / remnants of a vessel, placed to offer water for the deceased. These sites are defined as non-replicable and immoveable and may experience direct physical impacts and/or indirect impacts from a change in visual and environmental setting or restricted access, during both the construction and operations phases (without the implementation of effective mitigation). Without mitigation, impacts were assessed as high adverse, as a result of an impact upon highly sensitive receptors. With successful implementation of a CHMP to provide for the avoidance of direct impacts (through the preparation of constraints mapping) and the minimisation of indirect impacts (through on-going management and consultation), this significance is effectively reduced from High to Moderate. All grave sites are currently over 25m from the proposed turbine locations, the routing of associated infrastructure is yet to be determined and will be informed as the outcomes of this assessment are disseminated to the design team.

Four cultural and sacred resources were identified in the wider AII. These are at sufficient distance from the proposed Project (over 2 km) to avoid indirect impacts in relation to noise and dust. The visual impact of the operating windfarm on the nearby monument / memorial site (**MFA-2**), 2 to 3 km southwest, is considered to be limited, with no specific concerns raised during stakeholder consultations completed for the Project. Any unexpected grievances will be handled via the ongoing SEP and Community Grievance Redress Mechanism. Following the implementation of these recommended mitigation measures, these impacts are reduced to Negligible.

Locally occurring intangible heritage was noted to include ancestral devotion, traditional ceremonies, the gathering of traditional medicines and religious pilgrimage. Intangible heritage is noted to be sensitive to changes to local demographics / influx at construction and the land acquisition process which may restrict local access and disrupt normal cultural activity. In all phases, the magnitude of impact was high (on a worst-case basis) but reduced to Moderate through effective implementation of management measures at construction and Reduced during operation.

The preparation of bespoke CHMP for the construction phase is recommended to be prepared in consultation with the local community as appropriate. It should include measures to avoid and minimise potential impacts on local cultural resources through the demarcation (and buffering) of ‘no go’ sensitive areas (e.g., graves) and continued safe local access. The Project EMP will provide ongoing measures to minimise negative Project effects throughout the operational phase via continued local engagement and in alignment with the Project Grievance Mechanism. The EMP will seek to address any unforeseen issues regarding the preservation of cultural and sacred resources throughout the lifetime of the Project, should they arise.

6 REFERENCES

Água da Namaacha (2023), Namaacha Water, Sociedade de Águas de Moçambique, Lda, http://www.aguadanamaacha.co.mz/, accessed 15/06/2023

Deacon, H.J. e Deacon, J. 1999. Human beginnings in South Africa: uncovering the secrets of the Stone Age. Cape Town: David Philip Publishers.

Ĺndico (2020) Sanctuary of Our Lady of Fátima, Pilgrimage as a Sacrifice, https://www.indico-lam.com/en/2021/04/22/sanctuary-of-our-lady-of-fatima/, accessed 15/06/2023

International Finance Corporation (IFC) (2012a) *Performance Standard 8, Cultural Heritage*, [online] https://www.ifc.org/wps/wcm/connect/a02b1f32-1d64-4454-a7c4-aac49c9daa04/PS8_English_2012.pdf?MOD=AJPERES&CVID=jiVQJ7k, accessed 31/05/2023

IFC (2012b) *Guidance Note 8, Cultural Heritage*, [online] https://www.ifc.org/wps/wcm/connect/cce98f3d-f59e-488f-be59-6456c87d3366/Updated_GN8-2012.pdf?MOD=AJPERES&CVID=nXqnqf5, accessed 31/05/2023

Morais, 1988, *The Early Farming Communities of Southern Mozambique*, Eduardo Mondlane University, Mozambique

Matos, Fonseca & Associates (2022) *Estudo de Impacto Ambiental da Central Eléctrica da Namaacha Relatório Técnico,* January 2022

WSP (2022) *Proposed 63 MW Namaacha Wind Farm Project in Namaacha, Mozambique. ESIA and RAP Gap Analysis*, unpublished client document

WSP (2023) *Proposed Namaacha Wind Farm Project in Namaacha, Mozambique. Cultural Heritage Work Plan (Draft for Comment)*, unpublished client document

Appendix A

CULTURAL HERITAGE FIELD REPORT

Proposed 63MW Namaacha Wind Farm Project in Namaacha, Mozambique

Cultural Heritage Baseline Field Survey

PREPARED BY:

MARTA J. LANGA

PREPARED FOR

Golder Associados Moçambique Limitada (WSP Golder)

June, 2023

INTRODUCTION

This report details the results of the cultural heritage baseline surveys carried out in support of the Environmental and Social Impact Assessment (ESIA) for the proposed 63MW Namaacha Wind Farm. The project and study areas are in Namaacha, in Maputo Province, in the south of Mozambique. The baseline surveys were carried out from May 12 to 19, 2023 and supplement previous baseline studies completed by Matos Fonseca and Associates in 2019.

During the cultural heritage survey, fourteen grave sites were identified in consultation with local communities at Livevene and Mugudo villages within the proposed project boundary. Thirteen are within the local study area, and one is outside the proposed project boundary. There is a decorated ceramic relic near one of the graves (CH-09) within the proposed project boundary in Livevene village.

Unique intangible cultural heritage was also recorded in consultation with the communities at Livevene and Mugudo villages, including ceremonies to guarantee a prosperous harvest and the wellbeing of the communities.

STUDY OBJECTIVES

The objectives of the study of cultural and archaeological heritage is to identify cultural and archaeological heritage in the area of the proposed Namaacha Wind Farm. This baseline report of the existing baseline conditions will inform the impact assessment to follow.

The specific objectives of the study are the following:

- Identify tangible and intangible resources of the existing cultural and archaeological heritage in the proposed project area;
- Determine the importance of cultural and archaeological resources involving local communities and their representatives;
- Locate existing graves in the area directly affected by pre-construction, construction, and project operation activities: and
- Identify and record the physical and intangible cultural resources within the areas that may be directly and indirectly affected by the proposed project.

STUDY APPROACH

METHODS

In accordance with Mozambican Law 10/88, the International Finance Corporation Performance Standard 8 on cultural heritage (2012) and WSP's Work Plan (2023) the following methodology was adopted to identify cultural and archaeological heritage resources and intangible cultural heritage:

- Carry out a literature review, including analysis of maps, with a view to obtaining relevant information on the potential of cultural and archaeological heritage in Maputo Province and with particular focus on the study area in Namaacha.
- Presentation to the authorities in Namaacha District as well as to community leaders to request authorization from local authorities to carry out the community consultations and cultural heritage and archaeological survey. Before carrying out the community consultations, interviews, and survey, the team introduced itself to the local authorities and the community and explained the objectives of the study and the importance of preserving cultural heritage. The team also requested permission to record focus group discussions during community consultations as well as document cultural heritage sites in the study area.
- Cultural and archaeological survey on site, with a view to identifying the occurrence of evidence of cultural and archaeological heritage in the area reserved for the wind farm and infrastructure associated with the farm. During field research, the team was accompanied by the chief of Livevene. Livevene and Mugudo villages are within the proposed project boundary. Both villages are also part of Namaacha District.
- Community consultations with members of the local community to identify cultural and archaeological heritage sites, collect oral history information about the communities, clarify the use of sacred sites, and cemeteries, as well as assess their significance and importance as locations for communities. Consultation involved focus groups with the local community with the aim of sensitively and respectfully identifying and recording the tangible cultural (sacred) sites that are considered to lie within or near to the proposed Project footprint. The team organized two focal groups, one with males and the other with females.
- After completing the field survey, the team prepared a preliminary report, considering the cultural heritage sensitivity characteristics (Table 2.1) and, the evidence identified at the sites.

Table A-1 - Characteristics of Sensitivity of Cultural Heritage

Sensitivity of cultural heritage resources	Definition of Sensitivity
Low	The resource is classified as replicable cultural heritage. It may be moved to another location or replaced by a similar resource, or it is of a common type in the surrounding region; has limited or no cultural value to local, national, or international stakeholders; it has limited scientific value; or similar information can be obtained from various resources.
Medium	The resource is classified as “non-replicable cultural heritage."

Sensitivity of cultural heritage resources	Definition of Sensitivity
	It may be moved or replaced, or data and artifacts retrieved in consultation with interested parties; has considerable cultural or historical value to local and/or national stakeholders; and/or has substantial scientific value, but similar information can be obtained from a limited number of other resources.
High	The resource is fundamentally classified as "non-replicable cultural heritage." Additional studies would be needed to determine which of these resources are critical cultural heritage. Critical cultural heritage cannot be moved or replaced without major loss of cultural or historic value; site-specific legal status specifically prohibits direct impacts on the resource or encroachment on resources and/or buffer zones; has substantial value to local, national, and international stakeholders; and/or has outstanding scientific value; and similar resource types are rare or non-existent.

STUDY LIMITATIONS

The study's main weakness stems from the community members' limited familiarity with the region's rich cultural legacy. As non-natives, the contemporary inhabitants of Livevene and Mugudo are less familiar with the region's history, traditions, and cultural heritage, especially prior to the civil war.

LEGAL AND REGULATORY FRAMEWORK

NATIONAL LEGISLATION OF CULTURAL HERITAGE

In Mozambique, archaeological sites are protected by law, with emphasis on Law 10/88 of December 22nd and Decree 27/94 of July 27th, against damage and destruction of archaeological and cultural sites. For example, earthworks are prohibited in places close to archaeological sites already identified and known. In cases where archaeological sites are identified during pre-construction or construction, the law dictates that activities be stopped until the site has been assessed and, if necessary, excavated. This study took into account the following legislation on cultural heritage in force in Mozambique:

- Law No. 10/88 of December 22: This law determines the legal protection of tangible and intangible assets of Mozambican cultural heritage.
- Decree No. 27/94 of July 20: This decree approves the Regulation for the Protection of Archaeological Heritage and the composition of the National Council for Cultural Heritage.
- Decree No. 55/2016 of November 28: This decree approves the Regulation on the Management of Real Estate Cultural Assets.
- Resolution No. 12/97 of June 10: This resolution approves the Cultural Policy of Mozambique and the Strategy for its Implementation.
- Law 10/99 on the Protection of Forests and Wildlife (Decree 12/2002): this law provides, among other things, for the existence of *zones of use and historical-cultural value*.
- Law No. 13/2009 of February 25: This law establishes the system of protection of goods related to the National Liberation Struggle in Mozambique.
- Resolution No. 11/2010 of June 2: This resolution approves the Museums Policy.
- Resolution No. 12/2010 of June 2: This resolution approves the Monuments Policy.

INTERNATIONAL LEGISLATION OF CULTURAL HERITAGE

As for international legislation on the protection and preservation of cultural heritage, the study considered the four UNESCO Conventions, namely:

- The 1972 Convention on the Protection of the World Cultural and Natural Heritage[3];
- The 2001 Convention on the Protection of Underwater Cultural Heritage[4]];

[3] UNESCO (1972). Convention on the Protection of the World Cultural and Natural Heritage, Paris: WHC: https://whc.unesco.org/en/convention/.

[4] UNESCO. (2001). Convention on the Protection of Underwater Cultural Heritage, Paris: WHC, https://en.unesco.org/underwater-heritage/2001.

- The 2003 Convention for the Safeguarding of the Intangible Cultural Heritage[5] and
- The 2005 Convention on the Promotion of the Diversity of Cultural Expressions[6]

The study also considered IFC's (2012) Performance Standards on Environmental and Social Sustainability.

[5] UNESCO (2003) Convention for the Safeguarding of the Intangible Cultural Heritage, Paris: WHC: https://unesdoc.unesco.org/ark:/48223/pf0000132540.

[6] UNESCO (2005) Convention on the Promotion of the Diversity of Cultural Expressions, Paris: WHC: https://unesdoc.unesco.org/ark:/48223/pf0000246264?2=null&queryId=66b269fa-de62-410d b606-7872ce8de904.

STUDY RESULTS

COMMUNITY CONSULTATIONS

The community consultations were carried out in the form of a focus group, considering the issue of representativeness. The team organized two focus groups, one with males and one with females, within Livevene and Mugudo villages in proximity to the proposed project, including Livevene village and Mugudo village. Before carrying out community consultations and cultural and archaeological survey, the team explained the objectives of the study and the importance of preserving cultural heritage. The team also asked participants for permission to record focus group discussions during the community consultations and to later visit and document cultural heritage sites in the study area mentioned during the community consultations.

The Machalela family (of the chief) originally settled in Mugudo, but during the 16-year civil war, this village's residents fled to what is now Eswatini, formerly Swaziland. When the Mozambican civil war came to an end in 1992, Mugudo began to be populated by non-natives yearning for better living conditions, primarily from the Province of Inhambane. These started devoting their time to agriculture and the production of charcoal.

The following is the succession line related to the chiefs who assumed control of this settlement after Mozambique gained its independence in 1975:

Macamo → Mbiza → Armando Muhove → Manuel Lichate → Castigo Nguenze

Traditional ceremonies are held in the chief's home for the people of Mugudo and Livevene. These rituals often take place each year. However, they can be done when necessary. The usual ingredients for the festivities are maize flour, poultry, and an old beverage called oputso. The rites guarantee a prosperous harvest and the wellbeing of the community.

Since the current residents of these two towns are not natives, they are less familiar with the history, customs, and cultural legacy of the area, particularly before the civil war, colonialism, and colonization.

Community consultation in Livevene

CULTURAL AND ARCHAEOLOGICAL HERITAGE SURVEY IN THE STUDY AREA

During the survey, the team found fourteen grave sites of modern date, one of which contained five graves (CH-11), one had three graves (CH-01), and the remaining twelve contained just one grave. All of the graves are evidence of cultural heritage. All graves were demarcated, to varying degrees, with stone boulders gathered from the local landscape, some were difficult to identify and within dense vegetation. The graves are between 60 and 70 centimeters broad and 1 to 1.5 meters long, according to the stones that mark them. The graves are located in typical regional rocky areas with nest grass and a few small trees.

Graves in Livevene (CH-01)

A grave site with three graves

A Grave in Livevene (CH-02)

A grave

A Grave in Livevene (CH-03)

A grave

The grave is located inside a propriety, but the grave is not well marked.

A Grave in Livevene (CH-04)

A grave

A Grave in Livevene (CH-05)

A grave

A Grave in Livevene (CH-06)

A grave

A Grave in Livevene (CH-07)

A grave

The grave is outside the local study area, around 67 meters from the local study area.

A Grave in Livevene (CH-08)

A grave

A Grave and Ceramic in Livevene (CH-09)

A grave

There is modern-dated decorative pottery (incision lines) near the grave that was likely used to store water. The purpose of providing a pot of water is to indicate that the locals think the deceased needs to drink water.

Decorated ceramic near a grave

A Grave in Livevene (CH-10)

Graves in Livevene (CH-11)

Three graves in a grave site with five graves in Livevene

There are five graves in this location, three of which are extremely close together, and the other two are around 20 meters apart. They are on a property with houses and cattle.

A Grave in Mugudo (CH-12)

A grave

A Grave in Mugudo (CH-13)

A grave

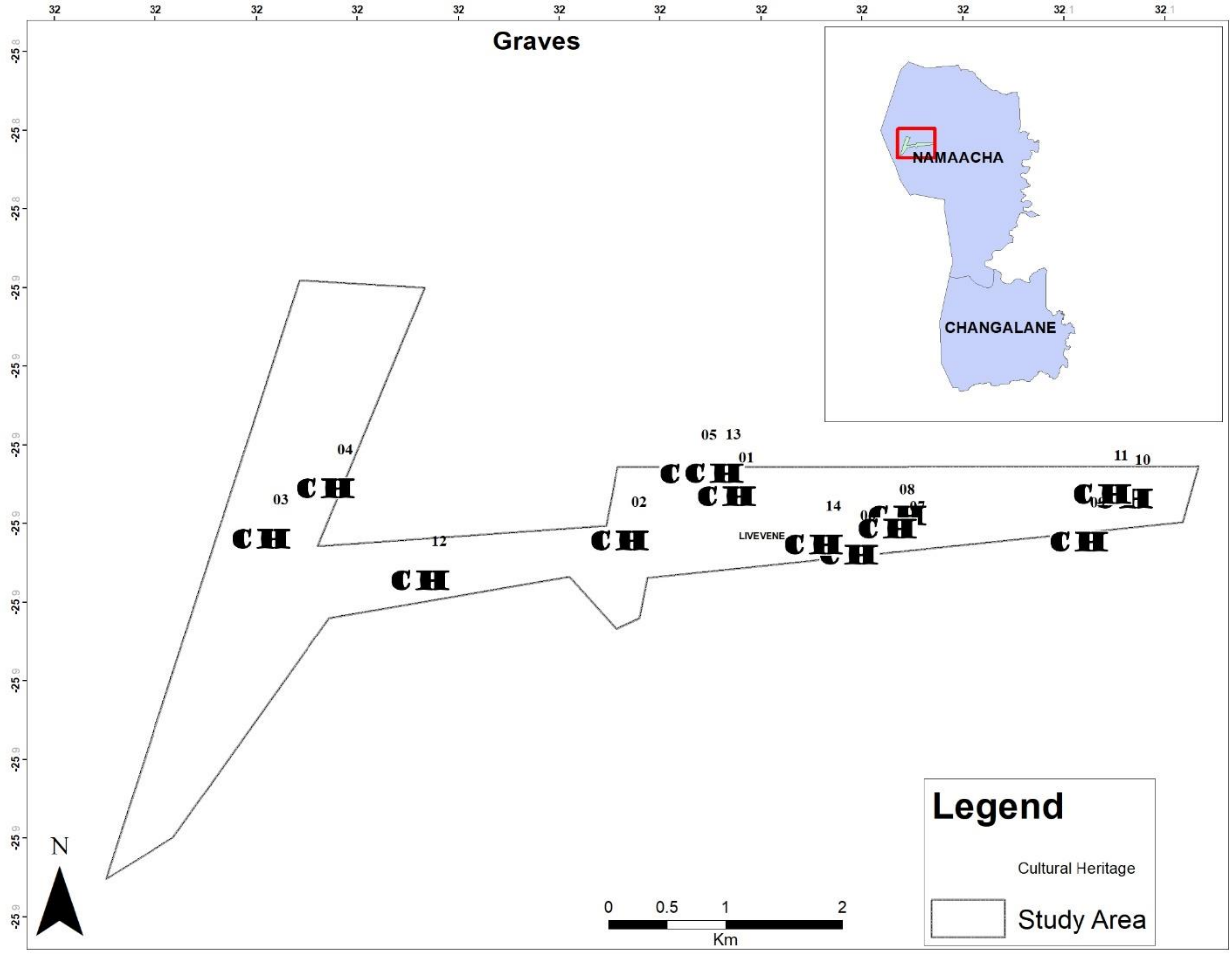
A Grave in Mugudo (CH-14)

Table A-2 - List of Identified Cultural Heritage Sites

Site ID	Type	Sub-type	Period	Location/ Village	Description	UTM North	UTM South	Valuation (L/M/H/VH)
CH-1	Cultural	Three graves	Modern	Livevene	Graves belonging to three different families, namely: Bila, Chitlango, and Chissingue. These graves are close to a dwelling.	7138151	402356	High
CH-2	Cultural	One grave	Modern	Livevene	This grave belongs to the Simbinhane family; it is not close to any house.	7138345	402255	High
CH-3	Cultural	One grave	Modern	Livevene	This grave is located inside a propriety, but the grave is not well marked.	7137743	403031	High
CH-4	Cultural	One grave	Modern	Livevene	Which family owns the grave is unknown.	7137661	403299	High
CH-5	Cultural	One grave	Modern	Livevene	The identity of the family whose burial it is remains unknown.	7137996	403632	High
CH-06	Cultural	One grave	Modern	Livevene	Which family owns the grave is unknown.	7137887	403597	High
CH-7	Cultural	One grave	Modern	Livevene	The identity of the family whose grave it	7137785	405073	High

Site ID	Type	Sub-type	Period	Location/ Village	Description	UTM North	UTM South	Valuation (L/M/H/VH)
					is remains unknown. The grave is visible and far from any homes. The grave is outside the local study area, around 67 meters from the local study area.			
CH-8	Cultural	One grave	Modern	Livevene	The identity of the family whose burial it is remains unknown.	7138153	405415	High
CH-9	Cultural	One grave	Modern	Livevene	There used to be a home in the vicinity of this grave. Due to the nature of the evidence, there is decorative pottery (incision lines) near the burial that was likely used to store water. The purpose of providing a pot of water is to indicate that the locals think the deceased needs to drink water.	7138189	405249	High
CH-10	Cultural	One grave	Modern	Livevene	The grave belongs to the Mbanze family.	7137766	401532	High
CH-11	Cultural	Five graves	Modern	Livevene	There are five graves in this location, three of which are extremely close together, and the other two are around 20 meters apart. They are on a property.	7137418	399994	High
CH-12	Cultural	One grave	Modern	Mugudo	This grave is close to a house.	7137764	398768	High
CH-13	Cultural	One grave	Modern	Mugudo	This grave is close to a house.	7138193	399260	Medium
CH-14	Cultural	One grave	Modern	Mugudo	This grave is far from the housing area.	7138342	402065	High

Map 4.1: Cultural Heritage Sites



HIGH-SENSITIVITY SITES

The field survey identified thirteen medium-sensitivity cultural heritage sites within the local study area and one outside the study area. Among the thirteen grave sites within the local study area, one site has five graves, another has three graves, and one has one grave with decorated ceramic remains.

A grave in a site with three graves in Livevene (CH-01)

Decorated ceramic remains near a grave (CH-09)

Two graves in a grave site with five graves in Livevene (CH-11)

CONCLUSION AND RECOMMENDATIONS

CULTURAL AND SACRED RESOURCES

The survey found fourteen **cultural heritage sites** within the local study area, of which one (CH-11) had five graves, one (CH-01) had three, and the other eleven each had just one grave. There is decorated ceramic remain near one of the graves (CH-09). All identified grave sites are medium-sensitivity sites. The study also identified one grave outside the local study area.

As part of their **intangible cultural heritage**, communities in the local study carry out ceremonies and rituals are carried out there, such as requests for good harvests and well-being for community's members.

There is a likelihood of finding some lithic material and pottery in the project area as there were settlements before the colonial period. Given the proximity of the District of Namaacha to Eswatini (formerly Swaziland), it is also likely that elements of cultural heritage originating from or influenced by Eswatini will be found.

During the operation phase, it is anticipated that all construction activities involving clearing, excavation, leveling, and heavy vehicle circulation will have been completed. The operational phase may have an impact on cultural heritage in the following situations:

- Maintenance and repair: it is important to bear in mind that the operation phase also involves maintenance and repair and, therefore, possible circulation of heavy vehicles, excavation, and levelling. All these specific activities could have an impact on cultural heritage.
- Possible need for infrastructure expansion: any need for infrastructure expansion will involve construction activities and, therefore, excavation, drilling, circulation of heavy vehicles, and handling of heavy loads. Thus, these activities can have an impact on cultural heritage.
- Accessibility: in the operation phase, access to the project area and factory for cultural heritage works will be limited to members of communities close to the project area.

.The entire proposed footprint in which the grave sites are located is considered, from the point of view of the archaeological heritage, to be subject to an impact of a negative and direct nature. The survey identified thirteen medium-sensitivity sites. Therefore, cultural heritage management must ensure avoidance and mitigation measures. The recommendation is avoidance through redesign and long-term management planning with the participation of community leaders, the communities, and the district government (this must keep the provincial government informed).

BIBLIOGRAFIA

Adamowicz, L. (2001). Sasol Natural Gas Project, Mozambique to South Africa: Environmental Impact Study. Specialist Study 8: Impacts on Archaeology, South Africa.

Barradas, L. (1972), "Os Construtores dos Zimbábués," in Monumenta 8, pp. 41–53.

Barradas, L. (1968), Povos da Proto-História de Moçambique: os Uaque-Uaque. In: Monumenta 4, pp. 31–44.

Decreto no 27/97, de 20 de Julho, que Aprova o Regulamento de Protecção do Património Arqueológico e a Composição do Conselho Nacional do Património Cultural, Boletim da Republica no 29.

Duarte, T.R. (1988). Arqueologia da Idade do Ferro em Moçambique (1974–1988): Retrospectiva do trabalho realizado. In: Trabalhos de Arqueologia e Antropologia n°5, pp. 57–72.

Ekblom, A. (2004). Changing Landscapes: An Environmental History of Chibuene, Southern Mozambique Studies in Global Archaeology 5 Uppsala: Department of Archaeology and Ancient History.

Garlake, P.S. (1976). An investigation of Manekweni, Mozambique. Azania, pp. 25–47.

Golden Associates (2016), Integrated Environmental and Social Baseline Report (IESBR) Report No. 1659075-306943, September Maputo, Mozambique.

Golden Associates (2014) EIA for the PSA Development and LPG Project EIA. Cultural Heritage Specialist Report.

ICF (2012) Performance Standards on Environmental and Social Sustainability https://www.ifc.org/wps/wcm/connect/c02c2e86-e6cd-4b55-95a2-b3395d204279/IFC_Performance_Standards.pdf?MOD=AJPERES&CVID=kTjHBzk

Instituto Nacional de Estatísticas (2012), Estatísticas do Distrito de Monapo.

Lei no 10/88, de 22 de Dezembro, que determina a protecção legal dos bens materiais e imateriais do património cultural moçambicano. Boletim da República no 51 (I).

Macamo, S. (2009). Manual de Pré-História (trabalho não publicado). Maputo: UEM, Departamento de História.

Ministério da Administração Estatal (MAE) (2005) Perfil do Distrito de Monapo, – Província de Nampula, Governo de Moçambique.

Direcção Nacional do Património Cultural (2012) Manual de Conservação do Património Imóvel em Moçambique. República de Moçambique. Ministério da Cultura. Maputo.

Pikirayi, I (2012), Peter Garlake (1934–2011), Great Zimbabwe and the Politics of the Past in Zimbabwe, Azania: Archaeological Research in Africa, 47:2, 223-225, DOI:10.1080/0067270X.2012.682779.

Resolução no 11/2010 de 2 de Junho, aprova a Politica de Museus.

Resolução no 12/97 de 10 de Junho, aprova a Política Cultural de Moçambique e Estratégia de sua Implementação. Boletim da República no 19 (I) Série

Resolução no12/2010, de 2 de Junho, aprova a Política de Monumentos. Boletim da República no 20 (I) Série.

Sinclair, P. J. J. (1987). Space, Time, and Social Formation: A Territorial Approach to the Archaeology and Anthropology of Zimbabwe and Mozambique, c. 0-1700 ad., Societas Archaeologica Upsaliensis, Uppsala, Sweden.

UNESCO. (1972). Convenção para a Protecção do Património Mundial, Cultural e Natural, Paris: WHC: https://whc.unesco.org/en/convention/.

UNESCO. (2001). Convenção para a Protecção do Património Cultural Subaquático. Paris: WHC, https://en.unesco.org/underwater-heritage/2001.UNESCO. (2003). Convenção para a Salvaguarda do Património Cultural Imaterial. Paris: WHC: https://unesdoc.unesco.org/ark:/48223/pf0000132540.

UNESCO. (2005). Convenção para a Protecção e Promoção do da Diversidade das Expressões Culturais. Paris: WHC: https://unesdoc.unesco.org/ark:/48223/pf0000246264?2=null&queryId=66b269fa-de62-410d b606-7872ce8de904.

Vogel, J. (1978) The Gokomere Tradition. The African Archaeology Bulletin (33): 12–17

WSP (2023) Proposed 63MW Namaacha Wind Farm Project in Namaacha, Mozambique, Cultural Heritage Work Plan, client document.

ANEXO 1: PARTICIPANTS IN COMMUNITY CONSULTATIONS

Name	Contact
Simão Mabote	869777483/865158225- Head of lands
Mauro Raúl	844807024
Lucia João	840512695
Gildo Luís	
Marta Ernesto	
Rachida Malate	
Carlota Mutuque	
Marcelina Bila	
Judite João	850809203
Rabeca José	
Mertina Damião	846630614
Lizete Albino Sitoe	
Teresa Francisco	
Nomsa Francisco	860035173
Isabel Munice	
Isaura Manhice	
Minora Nhachale	
Angélica Malalene	840371730
Consolada	869262662
Januário Saquene	
Tomás Wanela	860035173
Silvestre Zacarias	869993415
Domingos Vilanculos	871571694
Xavier	846590237
Nelson	848219878

Jeremias	
Manuel	
Paulino Alfredo	
Francisco Paulo	
Manuel	
Sousa Jossefo	848431719
Bento Elias	84264262
Carmónio	86333384
José Gustavo	850601203
José Gabriel	
Nelton Chivambo	848628381
Carmindo Simão	
Pascoal	843044055
Orlando Manhiça	842124436
Alexandre Saimo	867680614

Appendix B

CULTURAL HERITAGE GAZETTEER

Table B-1 - Cultural Heritage Gazetteer

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
CH-1	2023	Cultural	High	Three modern graves associated with three different families: Bila, Chitlango, and Chissingue. These graves are close to a dwelling	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	402356	7138151
CH-2	2023	Cultural	High	Modern grave associated with the Simbinhane family; it is not close to a house	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	402255	7138345
CH-3	2023	Cultural	High	Modern grave located within the boundary of a	Direct physical impacts from ground clearance and construction.	Avoidance – Cultural Heritage Management Plan, 20m buffers	403031	7137743

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
				property. The grave is not clearly marked	Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism		
CH-4	2023	Cultural	High	Modern grave associated unknown family	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	403299	7137661
CH-5	2023	Cultural	High	Modern grave associated unknown family	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase.	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	403632	7137996

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
					Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors			
CH-6	2023	Cultural	High	Modern grave associated unknown family	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	403597	7137887
CH-7	2023	Cultural	High	Modern grave associated unknown family. The grave is visible and not close to any dwellings. The grave is within the AII	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	405073	7137785

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
CH-8	2023	Cultural	High	Modern grave associated unknown family.	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	405415	7138153
CH-9	2023	Cultural	High	Modern grave and fragments from a ceramic vessel. A dwelling was once in the vicinity of the grave. The vessel had incised line decoration and was potentially placed near the grave for providing water to the deceased.	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	405249	7138189
CH-10	2023	Cultural	High	Modern grave belonging to Mbanze family	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping	401532	7137766

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
					construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism		
CH-11	2023	Cultural	High	Five modern graves; three of which are very close together. The others are approximately 20m apart. The graves are within the boundary of a property	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	399994	7137418
CH-12	2023	Cultural	High	Modern grave located close to a house	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	398768	7137764

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
					disruption to spiritual connections to ancestors			
CH-13	2023	Cultural	High	Modern grave located close to a house	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	399260	7138193
CH-14	2023	Cultural	High	Modern grave far from an area of housing	Direct physical impacts from ground clearance and construction. Indirect impacts through changes to setting both at construction and operational phase. Loss of access during construction and operation which would result in disruption to spiritual connections to ancestors	Avoidance – Cultural Heritage Management Plan, 20m buffers around graves, constraints mapping Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	402065	7138342

Site ID No.	Year Recorded	Type	Valuation	Description	Potential Impacts	Summary of Preliminary Mitigation Measures	UTM East	UTM South
MFA-1	2019	Cultural	Low	Pai Nosso - Christian church within the AID. Roof made of grass	N/A – This church is no longer being used by the community	N/A – This church is no longer being used by the community	398710	7137274
MFA-2	2019	Cultural	High	Monument for Samora Machel within the AII. Located across the international border in South Africa	Indirect impacts through changes to visual setting at operational phase.	Minimisation – Ongoing engagement programme and implementation of Project Grievance Mechanism	395381	7133208
MFA-3	2019	Cultural	High	Namaacha waterfalls	N/A	N/A	403462	7128480
MFA-4	2019	Cultural	Medium	Sanctuary of Nossa Senhora de Fátima	N/A	N/A	401355	7125261
MFA-5	2019	Cultural	High	Libombos mountains	N/A	N/A	400475	7096136

Appendix C

FIGURES

Figure C-1 - Cultural Heritage Receptors: Overview

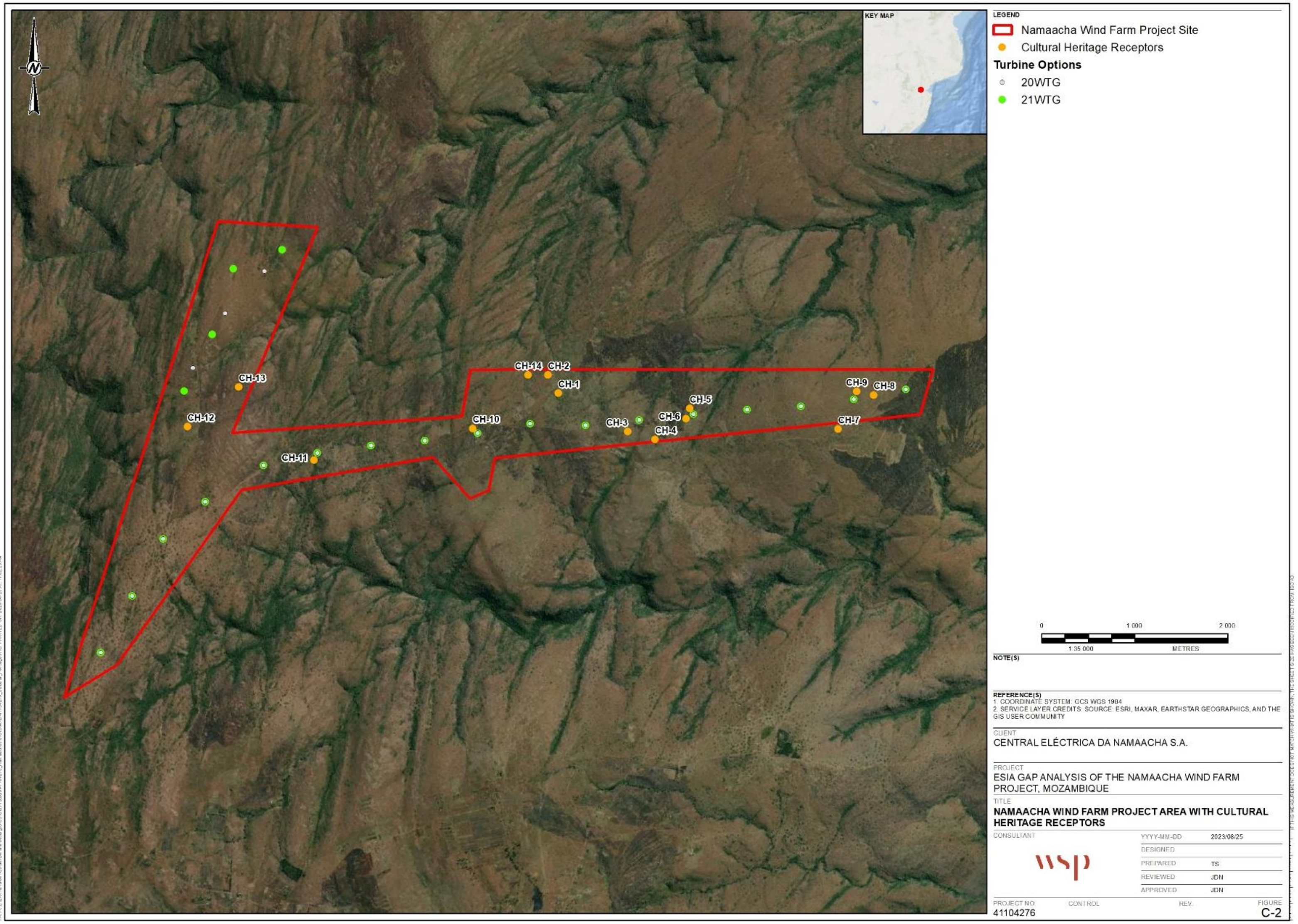
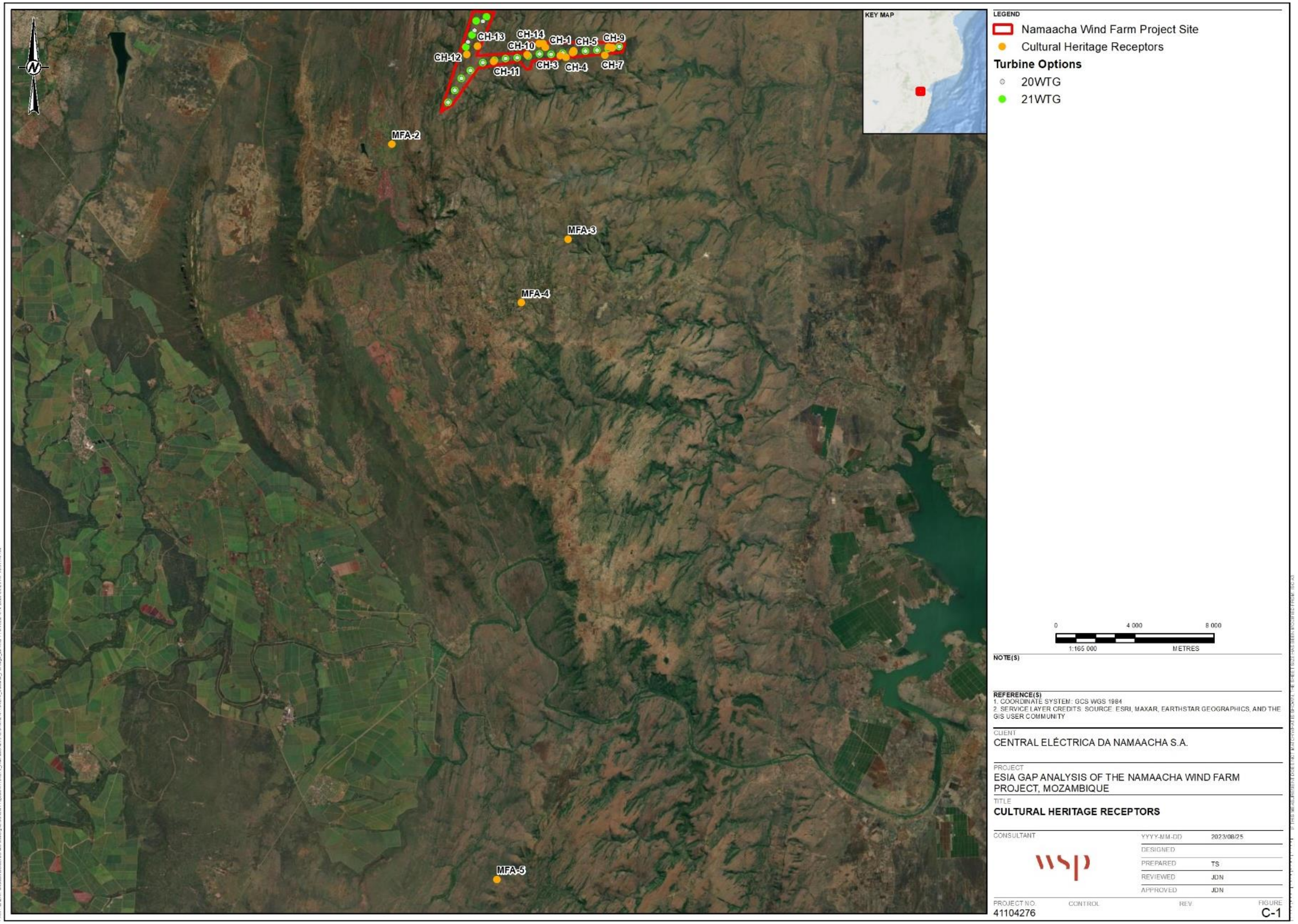


Figure C-2 - Cultural Heritage Receptors: Project Site



First Floor
3 Wellington Place
Leeds
LS1 4AP

wsp.com