ARCUS

KOMSBERG WIND ENERGY FACILITY, WESTERN CAPE AND NORTHERN CAPE

AVIFAUNAL IMPACT ASESSMENT REPORT

On behalf of

KOMSBERG WIND FARMS (PTY) LIMITED

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Prepared By:

Arcus Consultancy Services

Office 220 Cube Workspace
Icon Building
Cnr Long St & Hans Strijdom Avenue
Cape Town
8001

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

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EXECUTIVE SUMMARY

This report is the final report relating to 12 months of bird surveys, carried out between March 2015 and February 2016, and assessment for the proposed Komsberg Wind Energy Facility (WEF). The purpose of this report is to outline:

- The combined results of the four seasons of pre-construction avifaunal monitoring at the proposed WEF site;
- The baseline avifauna environment at the proposed WEF site, based on a thorough desk based review and the results of the pre-construction monitoring;
- The potential impacts of the proposed development on avifauna as well as an assessment of the potential impacts, and associated mitigation measures.

A combined total of 135 species were recorded in and around the WEF and control site during the four seasonal surveys. This included 20 priority species and 24 South African endemic or near endemic species. A total of 9 Regional Red Data species were observed across all surveys including three species listed regionally as *Endangered*, namely Black Harrier, Ludwig's Bustard and Martial Eagle.

Raptors constituted the majority of flight paths (94 %) recorded within the WEF, with Verreaux's Eagle being the most commonly recorded vantage point target species. A total of 306 flights and 363 individuals[1] of 13 species (12 of which are priority species) were recorded on the WEF site. 144 (47 %) of these flights were by Verreaux's Eagle. This species is listed as *Vulnerable,* and potentially prone to collisions with wind turbines. To date five mortalities of this species at WEFs in South Africa are known. The lower lying, flat open areas were utilised by terrestrial species such as the Red Data Karoo Korhaan and Ludwig's Bustard. The former was more abundant and the latter was scarce. No flights of Karoo Korhaan or Ludwig's Bustard were recorded over four seasons of VP monitoring on either the WEF or control site, and it is unlikely that these species would be significantly impacted upon by collisions with wind turbines.

One active Verreaux's Eagle nests, as well as an active African Harrier Hawk nest was located within the WEF site together with roost locations for Verreaux's and Martial Eagles.

Avifaunal Sensitivity Zones were identified and mapped based on landscape features as well as observed flight activity. Zones of high sensitivity were designated as 'no-go' for the placement of turbines including buffers around raptor nests, while various recommendations were made relating to the remaining sensitivity zones.

Potential impacts of the project were identified for the construction and operational phases, and these impacts were rated using set criteria for each of the four components of the Komsberg Wind Energy Facility, namely: Komsberg East WEF; Komsberg East Grid Connection; Komsberg West WEF and Komsberg West Grid Connection.

The significance rating of impacts ranged from Medium to High Negative in the absence of mitigation measures, while the significance of residual impacts (after the application of mitigation) ranged from Low to Medium Negative. The most important residual impacts which were rated as Medium Negative were found to be collisions with turbines and disruption of local bird movement patterns for both Komsberg East and Komsberg West WEFs, as well as collisions with power lines for the Komsberg East Grid Connection.

Cumulatively, the combined impacts of the four components together with those of up to 7 potential large WEFs within 50 km of the Komsberg WEF site, may present a significant medium to high negative impact to birds (especially Verreaux's Eagle and Ludwig's Bustard, particularly from collision impacts (with either powerlines or turbines). However there is

[1] Not necessarily 363 different birds as multiple observations may have been made of the same individuals at different times.

much uncertainty in this cumulative assessment which was done at a high level with low confidence.

Conducting a detailed cumulative impact assessment of all of these facilities together on a regional scale (which should include a population analysis of the regional Verreaux's Eagle population as well as some level of collision risk modelling or predictions for this population) is beyond the scope of this specialist study. The Specialist will, outside of the scope of this report, engage with the appropriate regional or national agency/ies in the context of strategic planning regarding the commissioning of such a report by these bodies.

Although the confidence in our cumulative impact assessment is low (in the absence of such a study), the specialist believes that the project may proceed (if all recommendations and mitigation measures are adequately implemented) prior to such a study being implemented. This is primarily due to the generally low numbers of priority species encountered and low levels of flight activity, when compared with other regions worked in by the specialist.

SPECIALISTS' DECLARATION OF INDEPENDENCE AND QUALIFICATIONS

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

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

Specialist:	Andrew Pearson (Pr.Sci.Nat)
Qualification:	BSc (hons) Conservation Ecology
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400423/11
Fields of Expertise:	Ecological Science
Registration:	Professional Member

Andrew Pearson (17 February 2016)

Anja Terörde is an Ecology Consultant (Avifauna) at Arcus and holds a Master of Science degree in Ornithology from the Percy FitzPatrick Institute of African Ornithology, as well as over four years of experience as an environmental management professional. The findings, results, observations, conclusions and recommendations given in this report are based on this author's best scientific and professional knowledge as well as available information. Anja conducted site visits and provided inputs to the species behaviour with regard to the analysis and interpretations of the avifauna data as an Avifauna Specialist. The Natural Scientific Professions Act of 2003 aims to "Provide for the establishment of the South African Council of Natural Scientific Professions (SACNSP) and for the registration of professional, candidate and certified natural scientists; and to provide for matters connected therewith." Anja is a professional member of the SACNSP, as detailed below:

Specialist:	Anja Terörde (Pr.Sci.Nat)
Qualification:	MSc Zoology (Ornithology)
Affiliation:	South African Council for Natural Scientific Professions
Registration number:	400037/16
Fields of Expertise:	Ecological Science
Registration:	Professional Member

Anja Terörde (17 February 2016)

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1 INTRODUCTION

Komsberg Wind Farms (Pty) Ltd proposes the development of the Komsberg Wind Energy Facility (WEF), located on the border of the Northern and Western Cape Provinces, approximately 40 km south east of Sutherland, with a small portion of the proposed site transcending into the Northern Cape Province (the 'project'). Arcus Consultancy Services Ltd ('Arcus') have been appointed to provide avifaunal specialist input in the form of a specialist Impact Assessment Report for the project. Arcus were also appointed to conduct the required 12 months of pre-construction avifaunal monitoring, the results of which have advised the impact assessment.

1.1 Purpose and Aims

The purpose and aims of this report are to provide:

- A confirmation of the terms of reference adopted for the avifaunal study;
- Description of the monitoring programme and the methods used as part of the Impact Assessment;
- Results of the 12 month monitoring programme;
- A description of the avifaunal status quo, including a description of avifaunal microhabitats available on the project site; and
- A description of potential predicted impacts to avifauna as well as a significance rating, impact assessment and mitigation measures.

1.2 The Project Site and Description

The site on which the project is proposed covers approximately 26,832 ha in total (the 'WEF site'), although the likely area within which wind turbines are to be situated will be substantially less. Two WEFs are planned within the WEF site, Komsberg East WEF and Komsberg West WEF, with a total maximum capacity of 275 megawatts (MW) each, with up to 55 wind turbines on the Komsberg West WEF and up to 55 wind turbines on the Komsberg East WEF, with between 2 and 5 MW of power generation capacity per turbine. For the purpose of the monitoring programme the two WEF's were seen as one, and are thus referred to as the WEF site. Each turbine will have a maximum hub height of 120 m, a maximum rotor diameter of 140 m and a maximum height to the tip of 190 m. Medium voltage cables will be installed between turbine strings or rows, these will be laid underground where practical but some will be over head. Medium voltage cabling will also be installed between the turbines and the onsite substation; these too will be laid underground where practical. Foundations, hardstands and internal access roads up to 8 m wide will be constructed to each turbine, the two onsite substations and to ancillary infrastructure; underground cabling will also be installed adjacent to the roads as far as possible. Two 100 x 150 m onsite substation complexes (one on Komsberg East and one on Komsberg West) will be constructed to facilitate stepping up the voltage from medium to high voltage, up to 400 kilovolts (kV), to enable the connection of the two WEFs to the Eskom grid.

Two new high voltage over-head power lines of approximately 35 km and approximately 55 km in length respectively, will be installed from the onsite switching stations (100 x 150m) to the Eskom grid at the Eskom Komsberg Main Transmission Substation. On each WEF, a 30 x 50 m operations compound will be constructed to include a services workshop area and site offices for control, maintenance and storage. Temporary infrastructure will include a site camp, laydown areas and a batching plant totalling 150 x 100 m in extent.

In summary, the proposed project consists of four components:

- Komsberg East WEF;

- Approximately 55 km Electrical Grid Connection and Associated Infrastructure for Komsberg East WEF ('Grid Connection East');
- Komsberg West WEF;
- Approximately 35 km Electrical Grid Connection and Associated Infrastructure for Komsberg West WEF ('Grid Connection West').

Each component requires an environmental impact assessment and environmental authorisation as a condition of the Environmental Impact Assessment Regulations (GN. R 543, 2010) introduced through the National Environmental management Act (NEMA) (Act No.107 of 1998). The Department of Environmental Affairs (DEA) requires that all proposed WEF's undergo a minimum of 12 months of pre-construction avifaunal monitoring in line with Best Practice Guidelines[2], and that the results are used to inform the avifaunal impact assessment.

2 TERMS OF REFERENCE

The following terms of reference were utilised for the preparation of this report:

- Description of existing avifaunal baseline conditions through field and desktop research including a description of the methodology adopted;
- Identification of information gaps and limitations;
- Identification of the sensitivity of the avifaunal baseline to the development, specifically with regard to the conservation status of species;
- Identification of the Regional Red Data and priority species present and potentially present on the project site;
- Prediction of likely potential impacts on the avifauna, including cumulative impacts, during construction and operation;
- Assessment of identified likely potential impacts (positive and negative), considering the extent, intensity, duration and probability of an impact occurring as well as cumulative impacts; and
- Identification of appropriate mitigation measures and monitoring requirements, or enhancement measures, to minimise impacts on avifauna or deliver enhancement from the proposed project.

3 POLICY AND LEGISLATIVE CONTEXT

The legislation relevant to this specialist field and the proposed project are as follows:

3.1 The Convention on Biological Diversity (CBD), 1993

A multilateral treaty for the international conservation of biodiversity, the sustainable use of its components and fair and equitable sharing of benefits arising from natural resources. Signatories have the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. The convention prescribes that signatories identify components of biological diversity important or conservation and monitor these components in light of any activities that have been identified which are likely to have adverse impacts on biodiversity. The CBD is based on the precautionary principle which states that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat and that in the absence of scientific consensus the burden of proof that the action or policy is not harmful falls on those proposing or taking the action.

[2] Applicable at the commencement of the monitoring programme, and in this case Jenkins *et al.* 2011.

3.2 The Convention on the Conservation of Migratory Species of Wild Animals (CMS or Bonn Convention), 1983

An intergovernmental treaty, concluded under the aegis of the United Nations Environment Programme, concerned with the conservation of wildlife and habitats on a global scale. The fundamental principles listed in Article II of this treaty states that signatories acknowledge the importance of migratory species being conserved and agree to take action to this end "whenever possible and appropriate", "paying special attention to migratory species the conservation status of which is unfavourable and taking individually or in cooperation appropriate and necessary steps to conserve such species and their habitat".

3.3 The Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), 1999

An intergovernmental treaty developed under the framework of the Convention on Migratory Species (CMS), concerned the coordinated conservation and management of migratory waterbirds throughout their entire migratory range.

Signatories of the Agreement they have expressed their commitment to work towards the conservation and sustainable management of migratory waterbirds, paying special attention to endangered species as well as to those with an unfavourable conservation status. The assessment of the ecology and identification of sites and habitats for migratory waterbirds is required to coordinate efforts that ensure that networks of suitable habitats is maintained and investigate problems likely posed by human activities.

3.4 National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) – Threatened or Protected Species List (TOPS)

Amendments to the TOPS Regulations and species list were published on 31 March 2015 in Government Gazette No. 38600 and Notice 256 of 2015. The amended species list excluded all species threatened by habitat destruction and which are not affected by other restricted activities, but included the following target species relevant for this study:

Endangered – Martial Eagle, Ludwig's Bustard; *Protected* – Blue Crane.

3.5 The Nature and Environmental Conservation Ordinance No 19 of 1974; Western Cape Nature Conservation Laws Amendment Act of 2000; and Northern Cape Nature Conservation Act, 2009 (Act No. 9 of 2009)

These were developed to protect both animal and plant species within the various provinces of the country which warrant protection. These may be species which are under threat or which are already considered to be endangered and species are listed in the relevant documents. The provincial environmental authorities are responsible for the issuing of permits in terms of this legislation.

3.6 The Civil Aviation Authority Regulations, 2011

These are relevant to the issue of lighting of wind energy facilities, and to painting turbine blades, both of which are relevant to bird collisions with turbine blades.

3.7 The Equator Principles (EPs) III, 2013

The principles applicable to the project are likely to include:

- Principle 2: Environmental and Social Assessment;
- Principle 3: Applicable Environmental and Social Standards;
- Principle 4: Environmental and Social Management System and Equator Principles Action Plan;

- Principle 8: Covenants.

These principles, among various requirements, include a requirement for an assessment process (e.g. EIA process), an Environmental and Social Management Plan (ESMP) to be prepared by the client to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards, and the appointment of an independent environmental expert to verify monitoring information.

4 METHODOLOGY

4.1 Study Approach

The approach to the study followed that which was required by the Best Practice Guidelines applicable at the time of the surveys (Jenkins *et al.* 2011) ('the Guidelines') and those of the NEMA EIA process.

The approach consisted of three stages:

- The avifaunal baseline at the project site was defined through a desktop study, a 12 month pre-construction monitoring programme and a nest survey;
- The results of this were used to create an Avifaunal Sensitivity Map and Avifaunal No-Go Areas Map to inform turbine placement, and to identify potential impacts;
- The potential impacts of the proposed project were assessed with and without identified mitigation measures.

The following terminology is used:

- Priority species = all species occurring on the Birdlife South Africa (BLSA) and Endangered Wildlife Trust (EWT) Avian Sensitivity Map priority species list[3]. This list consists of 107 species with a priority score of 170 or more, and most likely to be affected negatively by WEFs. The priority score was determined by BLSA and EWT after considering various factors including bird families most impacted upon by WEFs, physical size, species behaviour, endemism, range size and conservation status;
- Red Data species: Species whose regional conservation status is listed as Near-Threatened, Vulnerable, Endangered or Critically Endangered in the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor et al. 2015);
- Endemic or Near-endemic: Endemic or near endemic (i.e. ~70% or more of population in RSA) to South Africa (not southern Africa as in field guides) or endemic to South Africa, Lesotho and Swaziland. Taken from BirdLife South Africa Checklist of Birds in South Africa, 2014.
- Target species (i.e. the species to be recorded by each particular method) per survey method[4] were as follows:
  - Walked Transects: all birds;
  - Driven Transects: all raptors; all large (non-passerine) priority species;
  - Vantage Point Surveys: all raptors; all large (non-passerine) priority species;
  - Incidental Observations: all raptors; all large (non-passerine) priority species; and
  - Focal sites: all species associated, utilising or interacting at/with the focal site.

4.1.1 Defining the Baseline

The baseline avifauna environment for the WEF was defined utilising a desk based study and informed by on site seasonal monitoring (over a 12 month period), a specialist nest survey, as well as previous experience from monitoring and field work conducted by the specialists in the immediate area. The primary source of avifaunal information was the

[3] Retief, E, Anderson, M., Diamond, M., Smit, H., Jenkins, A. & Brooks, M. (2011) Avian Wind Farm Sensitivity Map for South Africa: Criteria and Procedures used. *Priority species list updated in 2014 by BLSA*.

[4] For a description of the survey methods see Section 4.5.

results of the 12 month pre-construction monitoring programme, which included four seasonal site visits and was completed in January 2016. All this information was examined to determine the potential location, abundance and behaviour of avifauna which may be sensitive to development, and to understand their conservation status and sensitivity.

4.1.1.1 Sources of information

- Bird distribution data of the Southern African Bird Atlas Project (SABAP1; Harrison et al. 1997) and Southern African Bird Atlas Project 2 (SABAP2) obtained from the Avian Demography Unit of the University of Cape Town;
- Co-ordinated Water-bird Count (CWAC) project (Taylor et al. 1999);
- The Important Bird Areas (IBA) of southern Africa project (Barnes 1998);
- Bird Impact Assessment for the proposed Sutherland Renewable Energy Facility (Jenkins 2011);
- Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment for the Three Phased Hidden Valley Wind Energy Facility (EWT 2014);
- Publically available satellite imagery;
- Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Taylor et al. 2015); and
- Results of the 12 month pre-construction avifaunal monitoring programme.

4.1.2 Identification of Potential Impacts

After collation of the baseline data from the sources of information listed above the potential impacts of the project were identified, for both the construction and operational phases. This was done by reviewing existing literature and data available (both locally and internationally) on the potential impacts of WEFs on avifauna and considering the potential avifaunal community on the project site.

4.1.3 12 Month Pre-Construction Bird Monitoring Survey Design

Arcus designed and implemented a survey strategy to provide 12 months bird survey data for the WEF site. The survey design and method was developed to be in line with the best practice guidelines applicable at the beginning of the 12 month programme ('the Guidelines'). At the time of commencement of the surveys, the whole site (including Komsberg East and Komsberg West) was referred to as the WEF site. For the purposes of this section the WEF site is therefore defined as the area enclosed by the farm portions that constitute both Komsberg East and Komsberg West WEFs. The monitoring techniques used were walked transects (WT); Driven transects (DT); bird flight activity through vantage point (VP) observations; Focal site (FS) surveys, nest surveys and incidental records. In order to provide useful comparative data in the event of the construction and operation of the project, surveys were also undertaken at a nearby control site. The control site was located approximately 7 km south of the eastern section of the WEF site, and approximately 20 km east of the south western section of the WEF site (Figure 1), and was selected primarily on the basis of its accessibility and similarity of the predominant habitats to the project site.

The WEF and control sites were visited on 18, 19 and 20 March 2015 by the avifaunal specialist in order to identify focal sites and confirm the locations and accessibility of the vantage points, driven transects, walked transects.

The primary aims of the 12 month pre-construction avifaunal monitoring survey were:

- To estimate the number/density of birds regularly present or resident within the broader impact area[5] of the project before its construction;

[5] The broader impact area was defined as the WEF site itself, and up to 1 km from the boundary of the WEF site. As the WEF site is large, yet only smaller areas within it will have turbines, this definition of the broader impact area was deemed sufficient.

- To document patterns of bird movements in the vicinity of the project before its construction;
- To estimate the collision risk to key species by analysing the frequency with which individuals or flocks fly at rotor swept height (RSH);
- To inform comment on the merits of the application in the avifaunal impact assessment report;
- To establish a pre-impact baseline of bird numbers, distributions and movements; and
- To mitigate impacts by informing the final design, construction and management strategy of the project.

4.1.3.1 Survey amendments

- A focussed Verreaux's Eagle nest search (Section 4.5.6) was added to the winter seasonal surveys.
- Five additional focal sites (FS2-FS6) were located during the winter season, and added to the survey protocols for the remaining two surveys (spring and summer).

4.2 12 Month Pre-Construction Bird Survey Methodology

Four seasonal surveys were carried out: Autumn (21-31 March 2015); winter (20-30 June 2015 and 03-06 August 2015); spring (13-22 October 2015); and summer (07-16 January 2016).

4.2.1 Walked Transects

The purpose of the walked transect surveys was to estimate bird populations and densities across the site, with a particular focus on small terrestrial species and passerines.

Seven walked transects were sampled in the WEF and two were sampled in the control site and referred to as control walked transects (CWT) (Figure 2). Each transect was 1 km in length and was conducted twice during each seasonal survey, resulting in eight replications of each transect across the monitoring programme. Transects were conducted by a pair of observers who walked from the start to the end point of the transect, whilst recording all birds seen or heard up to 150 m on either side of the transect. The perpendicular distance in meters to the transect line was noted as well as number and age of individuals, their behaviour and if they were seen or heard. Beyond 150 m, only priority species were noted and were recorded as incidental sightings.

Locations, dates and times of the WT are presented in Appendix II. Transects are named according to location and visit within the season; i.e. WT2.1 is transect location two, first visit; WT2.2 is transect location two, second visit. For site planning and logistical reasons, transects were named according to the closest vantage point (VP), and therefore do not necessarily follow a numerical order, and the seven transects are named WT2, WT3, WT6, WT8, WT9, WT10 and WT11.

To estimate density Index of Kilometric Abundance (IKA) values were calculated by taking the sum of the number of individual birds observed per 1 km transect over each season divided by the number of seasons. Standard deviation values of the whole site were calculated using the square root of the pooled variance of all transects divided by the number of transects.

4.2.2 Vantage Points

12 vantage points were surveyed in the WEF site (6 in Komsberg East and 6 in Komsberg West), and one in the control site (CVP). The location of the VPs was designed to maximise coverage of the ridges identified by the proponent for potential turbine placement, taking into account accessibility. Observer pairs monitored a viewshed of 360 degrees with a radius of 2.5 km from each VP (Figure 3). VP locations did not change between surveys. The viewsheds were the focus of observation, however if target species were noted beyond

these (or if a species being recorded flew out of the viewshed but was still visible), they would also be recorded. For each flight of a target species the flight path was recorded on a large scale map along with data on the number/species of bird(s) and type of flight.

Flight heights were recorded through five height bands: 1: 0-20 m; 2: 20-40 m; 3: 40-120 m; 4: 120-160 m and 5: >160 m. Each VP on the WEF site was surveyed for 12 hours per seasonal survey. The control site VP was surveyed for a total of 9 hours per seasonal survey. A total of 612 hours of VP observations was therefore carried out across the WEF and control sites during the 12 month programme. Survey dates and times are presented in Appendix II and co-ordinates and total hours surveyed are presented in Table 1 below.

Table 1: Vantage Point Geographic Co-ordinates and Hours Surveyed

VP	Co-ordinates		Autumn	Winter	Spring	Summer	Total time surveyed
	South	East					
1	32.7851°	20.80876°	12h25m	12h	12h	12h	*48h25m*
2	32.749°	20.82127°	12h	12h	12h	12h	*48h*
3	32.7396°	20.84521°	11h45m	12h	12h	12h	*47h45m*
4	32.754°	20.85059°	11h50m	12h	12h	12h	*47h50m*
5	32.7786°	20.865692°	12h	12h	12h	12h	*48h*
6	32.7121°	20.87541°	12h	12h	12h	12h	*48h*
7	32.7411°	21.036174°	12h	12h	12h	12h	*48h*
8	32.7062°	20.97328°	12h	12h	12h	12h	*48h*
9	32.7319°	20.99825°	12h	12h	12h	12h	*48h*
10	32.7113°	21.01895°	12h	12h	12h	12h	*48h*
11	32.7013°	21.04248°	12h	12h	12h	12h	*48h*
12	32.7086°	21.06386°	12h	12h	12h	12h	*48h*
CVP	32.8545°	21.06733°	9h	9h	9h	9h	*36h*
		Total	*153h*	*153h*	*153h*	*153h*	***612 hours***

h=hours; m=minutes

Average passage rates and standard deviations (SD) were calculated as the average number of individuals recorded flying per hour of vantage point observations.

4.2.3 Driven Transects

Large terrestrial priority species and raptors were sampled using five driven transects on the WEF site and one driven transect on the control site (Figure 2).

Each transect was conducted twice during each seasonal survey, resulting in eight replications of each transect across the monitoring programme. Transects were conducted by a pair of observers driving slowly (approximately 30 km p/h) with the vehicle windows open, and stopping regularly to scan important habitats such as ridges, cliffs and open areas. All target species were recorded, along with the geographical location of the observers for each record.

Locations, dates and times of the driven transects are presented in Appendix III: Driven Transect survey details. Transects are named according to location and visit within the season; i.e. DT1.1 is transect location one, first visit; DT1.2 is transect location one, second visit.

4.2.4 Focal Sites

Focal sites are any identifiable features within the landscape that are likely to support notable avifauna (e.g. a roost or nesting site) or have the potential to support breeding pairs or large densities of avifauna (e.g. dams, wetlands, river systems) and these sites may change as the project progresses and other focal sites become evident. A total of six focal sites (FS1 was surveyed over all four seasons. Following the winter season (survey

2), FS2-FS6 were added and surveyed during each of the two remaining seasonal surveys. No focal sites were identified in the control site. When surveyed during a particular season, focal sites were visited on two occasions during the applicable season.

Table 2; Figure 2) were surveyed for the presence of priority species. FS1 was surveyed over all four seasons. Following the winter season (survey 2), FS2-FS6 were added and surveyed during each of the two remaining seasonal surveys. No focal sites were identified in the control site. When surveyed during a particular season, focal sites were visited on two occasions during the applicable season.

Table 2: Geographic Positions and Descriptions of Focal Sites

Focal Site	Co-ordinates		Description
	South	East	
FS1	32.713240°	21.031210°	Two cliff faces (east and west) approximately 300 m apart, viewed from the same point (FS1). Each cliff face has one Verreaux's Eagle nest structure.
FS2	32.7275611°	20.9307972°	Verreaux's Eagle roost on *Eucalyptus* trees.
FS3	32.7301083°	20.9335027°	Verreaux's Eagle roost/perch on rocks.
FS4	32.7281694°	20.831105°	Martial Eagle roost on Poplar copse.
FS5	32.6927667°	21.0403°	African Harrier Hawk nest.
FS6	32.6769611°	20.77903°	Verreaux's Eagle nest.

4.2.5 Incidental Records

Relevant incidental observations of target species were recorded while commuting to or from, or on the WEF site and control site, but outside the survey protocols and times described above, e.g. when driving *en route* to survey locations.

4.2.6 Focussed Nest Search

Prior to the second (winter) seasonal survey, an initial analysis of Verreaux's Eagle flight data (i.e. the location of flight paths) collected to date, as well as an examination of publically available satellite imagery and 1:50 000 maps, was conducted to determine focus areas for this search. Fifty-one cliff faces and/or ridges with potential cliff habitat (C1-C51) were identified (Figure 4). The avifaunal specialist and an assistant visited the WEF site over four days (03 to 06 August 2015) and surveyed each of the 51 cliffs. From 08 – 09 February 2016, additional cliffs (C52-C59) were surveyed by the avifaunal specialist. The cliffs were accessed either by vehicle or foot, so that a suitable viewpoint as close to each cliff could be found. Cliffs were surveyed using a combination of 10x42 zoom binoculars as well as a tri-pod mounted 20-60 x 60 Nikon Prostaff 5 fieldscope. The aim was to locate Verreaux's Eagle nests (which are typically large), however the presence of any raptor nest (active or inactive) was noted if observed. Relevant incidental observations of priority species were also recorded by the specialist (during the August visit but not during the February visit) while commuting to and from the cliffs, and this data was added to the incidental observation results for the winter survey.

4.3 Determination of Avian Sensitivity Zones

Avifaunal Sensitivity Zones were designated based on landscape features and observed flight activity during 12 months of avifaunal monitoring on the WEF site.

Observed flight sensitivity was determined by creating a Grid Cell Sensitivity Score (GCSS), falling within either a Low, Medium, Medium-High or High classification for a 200 m x 200 m grid covering the WEF site. The GCSS was derived by analysing the following characteristics of all mapped priority species and raptors flight lines passing through each grid cell:

- Priority species score and the number of individuals associated with each flight line;
- Risk height factor, which considered if the flight was within the Rotor Swept Height;
- The duration of the flight; and
- The length of the flight.

These factors were considered in the following equation to determine a Flight Section Sensitivity Score (FSSS), for each section of flight within a grid cell. The GCSS is the sum of these flight sections within the grid cell, giving a sensitivity score specific to the cell.

FSSS = PSS x N x (X/Y x D) x (P+1)

Where:
- PSS is the Priority Species Score (Retief *et al.* 2011, updated 2014).
- N is the number of birds that are associated with the flight line.
- X is the length of the flight line section that is within a particular Grid Square.
- Y is the length of the whole flight line.
- D is the duration of the whole flight.
- P is the proportion of the flight line at Risk Height.

Grid cells within the WEF site boundary without a GCSS did not have any recorded priority species flights passing through from the monitoring survey, either because no species were recorded, or they were beyond the viewsheds covered by VP watches.

The resultant GCSS scores were categorised as follows: Low (2 – 20,000); Medium (20,000-120,000); Medium-High (120,000-300,000); and High (>300,000).

Additional Sensitivity zones were identified by buffering the following landscape features:

- Priority species and/or raptor nests
- Raptor Roost sites
- Steep slopes
- National Freshwater Ecosystem Priority Areas (NFEPA) Rivers and Wetlands
- Agricultural Lands
- Dolerite Sills (i.e. rocky outcrops)

The resultant Avifaunal Sensitivities and No-Go Areas Maps (Figure 13 and Figure 14), which identified no-go areas, were submitted to the proponent to inform turbine placement. It was recommended that where possible the hierarchy of sensitivity scores be considered, with preferential turbine placement in areas with Low or Unknown Sensitivity areas, and decreasing preference through to Medium-High Sensitivity areas. High Sensitivity Zones were designated as no-go areas.

4.4 Impact Assessment Methodology

The potential impacts of each component of the proposed development (as defined in Section 1.2) were identified and assessed individually. The potential impacts which are assessed are detailed in Section 8 for focal species identified through the baseline environment information presented in Section 5. This is not to say other bird species are or have not been considered by following this approach, but rather it is assumed that by using the focal species as surrogates, which if protected and conserved will result in the protection of the remaining species. The impact is assessed by considering the worst case scenario occurring for one or more of the focal species.

The methodology used was supplied by the Environmental Assessment Practitioner (EAP), is consistent with that used in the preliminary assessment in the scoping report, and is presented in Appendix IV. For each impact, the significance was determined in the absence of any mitigation ('without mitigation'), mitigation measures were identified and the significance was re-rated, assuming the effective implementation of the mitigation ('with mitigation').

The assessment 'without mitigation' assumes the worst case scenario in which any 55 of the turbines on Komsberg West WEF or any 58 of the turbines on Komsberg East WEF, proposed for the preferred layout and the alternative layout are constructed with no adherence to the no-go areas. The assessment 'with mitigation' assumes that all turbines are constructed outside of avifaunal no-go areas, and all additional mitigations described in the impact tables in Chapter 7 are also adequately implemented for each phase of the proposed development.

An indication of the probability of the impact occurring is also given, along with the specialists confidence in the accuracy of the rating. The degree to which the impact could be reversed is determined, and whether or not the impact would cause an irreplaceable loss of resources. An indication of if (and how) the impacts can be avoided, managed or mitigated is given. Essential mitigation measures for each of the identified impacts are also provided.

4.5 Assumptions and Limitations

- The SABAP1 data covers the period 1986-1997. Bird distribution patterns can change regularly according to availability of food and nesting substrate. (For a full discussion of potential limitations in the SABAP1 data, see Harrison et al. 1997).
- There is still limited information available on the environmental effects of wind energy facilities in South Africa. Approximately 15 commercial scale facilities are currently in operation, many of which have only recently begun operating, and monitoring reports (detailing impacts) are not readily available. Therefore, estimates of impacts are mostly based on knowledge gained internationally, which should be applied with caution to local species and conditions.
- While sampling effort was as recommended in the guidelines, to achieve statistically powerful results it would need to be increased beyond practical possibilities. The data was therefore interpreted using a precautionary approach.
- Practical constraints (e.g. limited farm roads) did not allow all available cliff habitat to be searched during the focussed Verreaux's Eagle nest search.
- At the time of the survey the maximum blade tip height of proposed turbines was assumed to be 160 m. Therefore flight heights were recorded in the following height bands: 1: 0-20 m; 2: 20-40 m; 3: 40-120 m; 4: 120-160 m and 5: >160 m. Using these bands, the flight height analysis that was done assumed that flights within bands 2, 3 and 4 were within Rotor Swept Height (RSH) and the avifaunal sensitivity map was based on this definition of the RSH. It is proposed to utilise turbines with a maximum blade tip height of up to 190 m. Since height is difficult to judge in the field it can be assumed that most flights recorded as above 160 m were in fact very high flights and probably above 190 m. However, some flights that were recorded as above could have actually been within rotor swept height. This was considered in the impact assessment and a precautionary approach was adopted.

5 BASELINE ENVIRONMENT

5.1 Vegetation and Land Use

Four different vegetation types occur within the WEF site with the majority of the site falling into Central Mountain Shale Renosterveld vegetation type (Figure 5). Central Mountain Shale Renosterveld is associated with clayey soils and occurs on the southern and south-eastern slopes of the Kleine Roggeveldberge and Komsberg. It is classified as *Least Threatened* but has a very limited extent without any formal conservation. Levels of transformation are considered low and while no endemic plant species are known to occur in it, it has been poorly sampled. It is relatively sensitive with a relatively high abundance of plant species of conservation concern.

A smaller portion of the WEF site falls within the Koedoesberge-Moordenaars Karoo and Gamka Karoo vegetation types. The Koedoesberge-Moordenaars Karoo is associated with a slightly undulating to hilly landscape covered by low succulent shrubs with scattered tall shrubs. It is classified as *Least Threatened* and has not been significantly impacted by transformation but only a very small proportion is conserved and it is poorly researched. At least 14 species are endemic to this vegetation type. The Gamka Karoo vegetation type is also classified as *Least Threatened* and less than 1 % of it has been transformed. However it is poorly protected. It is characterised by undulating plains covered with dwarf spiny shrubland and occasional low trees. Sandy bottoms are covered in dense stands of perennial bunchgrasses

Land use on the WEF site and surrounding areas is predominantly low density agriculture (i.e. small livestock grazing and wool production).

5.2 Bird Micro-habitats

In order to determine which bird species are more likely to occur on the proposed project site, it is important to understand the habitats available to birds at a smaller spatial scale, i.e. micro habitats. Micro- habitats are important in determining avifaunal abundances, density and likelihood of occurrences. Micro habitats are shaped by factors other than vegetation, such as topography, land use, food sources and man-made factors.

The proposed project site is relatively topographically diverse and consists of large relatively flat plains, undulating hills and steep slopes, with the high Roggeveld Mountains and Great Escarpment to the north. Aerial photographs, satellite imagery, and most importantly field work has been used to identify the following micro habitats on the project site:

5.2.1 Karoo Plains and Scrub

Large areas of the project site consist of relatively flat or undulating areas of Karoo scrub vegetation, occasionally interspersed with grasses. These open areas, are primarily at lower altitudes between the ridges and are likely to be utilised by terrestrial birds such as bustards, korhaans, francolins and storks. A variety of raptors may also forage over these open scrub areas, such as Southern Pale Chanting Goshawk, Jackal Buzzard, Martial Eagle and possibly Black Harrier. The scrubland habitat is also suitable for many small passerine birds such as larks, eremomelas and prinias, many of which are endemic or near-endemic species.

5.2.2 Cultivated Lands and Pastures

Limited areas of irrigated agricultural land and pastures occur around farmhouses or near associated with watercourses and rivers. These areas may provide a feeding ground for many species of birds, as land preparation makes insects, seeds, bulbs and other food sources readily available. This habitat type may be used by ibises, herons, storks, egrets, geese, francolins and a variety of passerine species.

5.2.3 Rivers and Drainage Lines

While the rivers, streams and drainage lines may not always carry water, these features are dominated by denser and taller riparian scrub (such as *Acacia Karoo*) and generally have a higher abundance of bird life than the surrounding vegetation.

Drainage lines, streams and rivers may form flyways for amongst others, ibises, ducks, cormorants, geese and storks, while riparian scrub will host a number of smaller passerine species. Rivers responsible for eroding cliff faces into the landscape may also therefore indirectly provide roosting and nesting habitat for geese, ibises, herons, storks, Hamerkop and raptor species such as Rock Kestrel, Verreaux's Eagle, African Harrier Hawk and Jackal Buzzard.

5.2.4 Farm Dams

Dams are important attractions for various bird species in the South African landscape, and in the Karoo are often the only source of water during the dry season. Dams, although limited on the project site, may (when they contain water) attract various waterfowl, such as Spur-winged Goose, South African Shelduck, and Egyptian Goose. Storks, African Spoonbill, herons and egrets may also frequent these water bodies, as well as fish-eating raptors such as African Fish Eagle. Blue Cranes are known to use farm dams as roost sites.

5.2.5 Ridges and/or Cliffs

The high Roggeveld Mountains and Great Escarpment characterise the north of the project site. Numerous long ridges run north to south from the escarpment, particularly in the eastern and western farm portions of the project site. The central area of the site has less hills and ridges, and is more open and flat.

The hills and ridges are important for various raptors, e.g. Rock Kestrel, African Harrier Hawk, Jackal Buzzard and Verreaux's Eagle, that may use the slopes for soaring and to gain lift. Rocky outcrops and cliffs may be important nesting habitat for various raptors, most importantly Verreaux's Eagle, which is likely to spend time hunting along rocky outcrops and ridges. Black Stork may also nest on suitable cliffs. Rocky ridges are also home to Rock Hyrax ('Dassie') an important prey species of Verreaux's Eagle, which will hunt regularly in these areas. African Rock Pipit is also found on rocky slopes.

5.2.6 Farmsteads and Feeding Kraals

Farmsteads are disturbed areas surrounding farm houses or areas of human activity, while feeding kraals are areas where livestock gather for food, shelter and water provided by the farmers. These habitats are frequented by small passerine birds such as sparrows, starlings, weavers and larks but also by egrets, ibis and guineafowl. Farmsteads are utilised by a variety of raptors such as Black-shouldered Kite and Barn Owl, which prey on various rodent species that occur in these areas.

5.2.7 Stands of Alien Trees

Stands of alien trees such as poplars and blue gums occur scattered around the site, mainly near farmsteads, rivers and drainage lines. These are frequently utilised as roosts by raptors such as Verreaux's Eagle and Martial Eagle, and also frequented by a variety of passerines such as doves, starlings and weavers.

5.3 Results of the Avifaunal Community Desktop Study

5.3.1 Southern African Bird Atlas Project 1

The SABAP1 data (Harrison *et al.*, 1997) was collected between 1986 and 1997 and is one of the best long term data sets on bird distribution and abundance available in South Africa at present. This data was collected in quarter degree squares, with the WEF site covering the following squares: 3220DB, 3220DD, 3221CA and 3221CC (Figure 5).
Table 3 indicates the reporting rate for all raptors and priority species recorded by the SABAP1 data within these squares, as well as giving a total number of species recorded in each square which varied from 62 to 106, with the latter being recorded in square 3221CA,

which also has the most records of priority species (11 out of 16). The SABAP1 project recorded a total of 147 species (Appendix I) for the pentads considered.

Table 3: Raptors and Priority Species (Retief et al. 2011, updated 2014) Recorded by SABAP1 in the Quarter Degree Squares Covering the Project Site (Harrison et al., 1997).

Species	Priority Species Score	Regional Red Data Status (Taylor *et al.* 2015)	Report rate (%) **			
			3220DB	3220DD	3221CA	3221CC
Total species			*98*	*100*	*106*	*62*
Number of cards submitted			*8*	*12*	*5*	*5*
African Rock Pipit	200	NT	-	-	20	-
Barn Owl	-	-	-	-	20	-
Black-chested Snake-Eagle	230	-	-	17	-	-
Black Harrier	345	EN	13	-	-	-
Black Korhaan (pre-split)	180/270*	-	13	-	-	-
Black-shouldered Kite*	174	-	-	-	20	-
Black Stork	330	V	-	-	20	-
Gabar Goshawk	-	-	-	-	-	20
Greater Kestrel	174	-	-	-	20	-
Grey-winged Francolin	190	-	13	8	80	40
Jackal Buzzard	250	-	38	-	20	-
Karoo Korhaan	240	NT	13	17	60	40
Little Sparrowhawk	-	-	-	-	20	-
Ludwig's Bustard	320	EN	13	17	-	-
Martial Eagle	350	EN	13	8	-	-
Rock Kestrel	-	-	63	42	40	20
Pale Chanting Goshawk	200	-	-	25	20	20
Spotted Eagle-owl	170	-	-	-	40	-
Steppe Buzzard	210	-	-	-	20	-
Verreaux's Eagle	360	V	50	17	60	20

** Northern Black Korhaan has a score of 180, while Southern Black Korhaan has a score of 270.*
*EN = Endangered; V = Vulnerable; NT = Near-threatened. **Report rates are percentages of the number of times a species was recorded in the square, divided by the number of times that square was counted. It is important to note that these species were recorded in the entire quarter degree square in each case and may not actually have been recorded on the proposed WEF site.*

5.3.2 Southern African Bird Atlas Project 2

This project is part of an ongoing study by the Animal Demography Unit (ADU), a research unit based at the University of Cape Town (UCT). SABAP2 data was examined for the pentads (which are roughly 8 km x 8 km squares, and are smaller than the squares used in SABAP1) which had been counted and as there is only data for three pentads covered by the project site (3240_2050, 3240_2045, 3235_2055 and 3240_2100) data from the following surrounding pentads have also been examined as, due to the inherent mobility of birds, species recorded in these pentads may be present on the project site: 3235_2045, 3235_2050, 3230_2055, and 3235_2100 (Figure 5). These additional pentads cover a large area and thus data from these pentads is used with caution.

While SABAP2 coverage in the project site and immediate area is relatively poor with most pentads having 5 or less cards submitted[6] and some having not been counted at all, a total of 113 species including thirteen priority species have been recorded by the SABAP2 data considered (Appendix I). Table 4 shows the reporting rates for Priority Species and Raptors recorded in the Pentads considered. Pentads shown in bold in this table are those covered by the WEF site farm boundaries. Seven regional Red Data Priority Species or raptors were recorded, including three classified as *Endangered*: Ludwig's Bustard, Martial Eagle and Black Harrier. Priority species or raptors with relatively high reporting rates and recorded across a number of pentads are: Martial Eagle, Verreaux's Eagle, Jackal Buzzard, Grey-winged Francolin, Pale Chanting Goshawk, Rock Kestrel and Karoo Korhaan.

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

Table 4: Raptors and Priority Species (Retief et al. 2011, updated 2014) Recorded in the SABAP2 Pentad Squares Covering the Project Site and the Immediate Surrounding Area.

Species	**Priority Species Score**	**Regional Red Data Status (Taylor *et al.* 2015)**	**Report rate (%) ****							
			3240_2050	**3240_2045**	**3235_2055**	**3240_2100**	3235_2045	3235_2050	3230_2055	3235_2100
Total species			*50*	*77*	*28*	*30*	*58*	*58*	*24*	*57*
Number of cards submitted			*3*	*12*	*3*	*1*	*4*	*8*	*2*	*5*
African Rock Pipit	200	NT	-	-	-	-	-	-	-	60
Black Harrier	345	EN	-	-	-	-	-	12.5	-	-
Booted Eagle	230	-	-	-	-	-	-	25	100	40
Grey-winged Francolin	190	-	-	83.33	33.33	-	-	25	-	20
Jackal Buzzard	250	-	100	58.33	-	-	25	37.5	100	60
Karoo Korhaan	240	NT	33.33	33.33	33.33	-	-	62.5	-	40
Ludwig's Bustard	320	EN		16.67	-	-	50	-	-	-
Martial Eagle	350	EN	-	25	-	-	50	25	100	20
Rock Kestrel	-	-	66.67	58.33	-	-	75	62.5	-	80
Southern Black Korhaan	270	V	-	33.33	-	-	-	-	-	-
Spotted Eagle-owl	170	-	-	-	-	-	50	-	-	-
Steppe Buzzard	210	-	-	16.67	-	-	-	-	-	-
Pale Chanting Goshawk	200	-	*Ad Hoc*	41.67	66.67	-	50	25	-	20
Verreaux's Eagle	360	V	66.67	8.33	-	100	-	12.5	-	40

*EN = Endangered; V = Vulnerable; NT = Near-threatened. **Report rates are essentially percentages of the number of times a species was recorded in the pentad, divided by the number of times that pentad was counted. It is important to note that these species were recorded in the entire pentad in each case and may not actually have been recorded on the proposed WEF site.*

5.3.3 Coordinated Waterbird Count (CWAC) Data

There are no CWAC sites within 50 km of the proposed project site.

5.3.4 Important Bird Area (IBA) Project

The proposed development is not situated within an IBA and there are no IBA's within 50 km of the proposed project site.

5.3.5 Bird Impact Assessment for the proposed Sutherland Renewable Energy Facility (SREF)

This study, conducted by *AVISENSE* Consulting cc (Jenkins 2011), was authored by Dr. Andrew Jenkins. The study covered an area to the immediate north and west of the proposed project site. The study included a desktop component, two short site visits (4 to 8 April and 21 October 2010) and an impact assessment.

The desktop study identified that approximately 210 bird species may potential occur on the proposed SREF site, including 14 Regional Red Data species, 69 endemics or near-endemics, and four Regional Red Data endemics (Ludwig's Bustard, Blue Crane, Black Harrier and Sclater's Lark). The study noted that some species were included despite the fact that they were not recorded in SABAP1 or SABAP2 data for the area as the habitat on the site was deemed suitable by Dr. Jenkins to potentially support such species. Seventeen priority species that had not been recorded by SABAP1 or SABAP2 for the Komsberg WEF site (see 3.1.1 and 3.1.2 above) were listed as potentially present by Jenkins (2011), namely African Fish Eagle, African Marsh Harrier (*Endangered*), Black Kite, Black Sparrowhawk, Blue Crane (*Near-threatened*), Burchell's Courser (*Vulnerable*), Cape Eagle-owl, Greater Flamingo (*Near-threatened*), Kori Bustard (*Near-threatened*), Lanner Falcon (*Vulnerable*), Lesser Flamingo (*Near-threatened*), Lesser Kestrel, Peregrine Falcon, Rufous-breasted Sparrowhawk, Sclater's Lark (*Near-threatened*), Secretarybird (*Vulnerable*) and White Stork.

During Dr Jenkins' two site visits in 2010 a total of 73 species were recorded on the SREF site and included eight priority species, namely Jackal Buzzard, Booted Eagle, Martial Eagle (*Endangered*), Verreaux's Eagle (*Vulnerable*), Southern Pale Chanting Goshawk, Karoo Korhaan (*Near-threatened*), African Rock Pipit (*Near-threatened*) and Rufous-breasted Sparrowhawk. The site visits recorded a priority species (Rufous-breasted Sparrowhawk) that had not been recorded in SABAP data for the Komsberg WEF site (see 3.1.1 and 3.1.2 above). Other points of interest included an immature Martial Eagle and a pair of Secretarybirds (*Vulnerable*) observed by Dr. Jenkins in the *'broader impact area'* as well as a suspected Verreaux's Eagle nest on the Komsberg pass. The report also noted *"Three pairs of Martial Eagle nest on pylons on the Droeriver-Muldersvlei 400 kV line about 14-20 km to the south (DRO-MVL towers 447, 506 & 513 and 542)"* as well as an additional "*three Verreaux's Eagle nests in the greater area*".

5.3.6 Pre-construction Bird Monitoring Report and Updated Avifaunal Assessment for the Three Phased Hidden Valley Wind Energy Facility.

This study was conducted by the Endangered Wildlife Trust (EWT 2014), and included four seasonal surveys across a 12 month period recording 153 species, including 21 priority species and 8 Regional Red Data species (Taylor *et al.* 2015). This study recorded species that were not recorded by the SABAP1 or SABAP2 data for the Komsberg WEF site (see 3.1.1 and 3.1.2 above), including five priority species: Black Sparrowhawk, Blue Crane (*Near-threatened*) during the spring survey, Cape Eagle-Owl during the winter and spring surveys, Lanner Falcon (*Vulnerable*) during the summer survey and Rufous-breasted Sparrowhawk during the winter and spring surveys.

5.4 Komsberg WEF 12 Month Pre-construction Monitoring Results

5.4.1 Walked Transects

In the WEF site bird numbers were highly variable across the seven transects, ranging from 0 to 90 birds per kilometre transect, with an overall average of 29.21 (SD±22.98) (Table 5). The number of species per transect ranged from 1 to 28 with an average of 11.36 (SD±7.51) species per transect in the WEF.

Table 5: Summary of 1 km walked transect results across all seasons - WEF

Transect Ref	IKA* (all birds)	IKA (target species)	Species richness
	Mean ± SD	Mean ± SD	Mean ± SD
WT2	26.5 (±13.31)	0.25 (±0.46)	11.25 (±5.87)
WT3	4.38 (±3.29)	0.13 (±0.35)	2.75 (±2.12)
WT6	41.63 (±22.81)	0.00 (±0.00)	16.63 (±8.40)
WT8	47.50 (±21.48)	0.63 (±1.77)	18.25 (±5.90)
WT9	18.25 (±12.71)	0.00 (±0.00)	8.25 (±4.98)
WT10	41.00 (±17.99)	0.00 (±0.00)	15.88 (±4.52)
WT11	25.25 (±30.11)	0.00 (±0.00)	6.50 (±4.63)
Total	29.21 (±22.98)	0.14 (±0.70)	11.36 (±7.51)

**IKA: Index of Kilometric Abundance = Birds/km; SD = Standard Deviation*

Priority species were also recorded in the WEF transect surveys and included Jackal Buzzard (WT2), Martial Eagle (WT2), Karoo Korhaan (WT6) and Verreaux's Eagle (WT6).

A total of 82 species including three Red Data species (Karoo Korhaan, Martial Eagle and Verreaux's Eagle), four priority species and 19 endemic or near-endemic species were found during walked transect surveys on the WEF site. The highest number of birds (380 individuals) was recorded on WT8 and the highest number of species was recorded on WT6 (60). Both of these transects were located at lower altitudes, in close proximity to drainage lines. The lowest number of birds (35) and species (14) was recorded on WT3, which is situated on Komsberg West WEF on top of a ridge.

Table 6: Small Terrestrial Species Transect Results - WEF

Transect (Figure 2)	Number of Individual Birds	Total Species Recorded	Priority Species (P) and Red Data Species (Status)*	Non-Priority, Frequently Recorded and/or Abundant.
WT2	212	45	Jackal Buzzard (250), Martial Eagle (350, EN)	Cape Bunting, Karoo Chat, Karoo Prinia, Barn Swallow
WT3	35	14	-	Grey-backed Cisticola
WT6	333	60	Karoo Korhaan (240, NT), Verreaux's Eagle (360, VU)	Cape Bunting, Grey-backed Cisticola, Karoo Chat, Karoo Long-billed Lark, Karoo Scrub Robin, Three-banded Plover
WT8	380	56	-	Acacia Pied Barbet, Bokmakierie, Cape Bunting, Karoo Chat, Karoo Long-billed Lark, Karoo Prinia, Red-faced Mousebird
WT9	146	35	-	Acacia Pied Barbet, Cape Bunting, Karoo Chat, Layard's Tit-babbler, Red-faced Mousebird
WT10	328	54	-	Acacia Pied Barbet, Cape Bunting, Layard's Tit-babbler,

Transect (Figure 2)	Number of Individual Birds	Total Species Recorded	Priority Species (P) and Red Data Species (Status)*	Non-Priority, Frequently Recorded and/or Abundant.
				Mountain Wheatear, White-throated Canary, Yellow Canary
WT11	202	28	-	Black-headed Canary, Cape Bunting, Mountain Wheatear
CWT1	115	24	Karoo Korhaan (240, NT); Pale Chanting Goshawk (200)	Karoo Long-billed Lark, Karoo Chat, Cape Bunting, Mountain Wheatear
CWT2	593	66	Karoo Korhaan (240, NT); Spotted Eagle Owl (170); Verreaux's Eagle (360, VU)	Cape Robin Chat, Acacia Pied Barbet, Southern Double-collared Sunbird, Cape Turtle Dove, Cape White-eye, Chestnut-vented Tit-babbler, Karoo Prinia

**Red Data Status (*Taylor *et al.* 2015*) status: NT=Regionally Near-Threatened; VU= Regionally Vulnerable*

The number of birds recorded on the two control site walked transects ranged from 5 to 109 birds per kilometre transect (Table 7), with an overall average of 44.25 (SD±39.24). The two control transects varied greatly in habitat, with the transect running along a riverbed (CWT2) showing consistently high numbers of birds, while abundance was generally low on CWT1 which ran across open scrub.

Four priority species were recorded during walked transect surveys on the control site (Table 6). These were Verreaux's Eagle (CWT2), Karoo Korhaan (CWT1, CWT2), Spotted Eagle Owl (CWT2) and Pale Chanting Goshawk (CWT1, CWT2).

Table 7: Summary of Four Seasonal Surveys 1 km Walked Transect Results - Control Site

Walked Transect Reference (Figure 2)	IKA	IKA	Species richness
	(all birds)	(target species)	
	Mean ± SD	Mean ± SD	Mean ± SD
CWT1	14.38 (±11.45)	2.50 (±2.62)	6.13 (±3.04)
CWT2	65.13 (±38.88)	1.13 (±1.25)	25.88 (±9.28)
Total	44.25 (±39.24)	1.81 (±2.10)	16.00 (±12.19)

5.4.2 Vantage Points

Average ± SD passage rates of target species per vantage point over the four surveys ranged from 0.27 to 1.54 target birds per hour in the WEF.

The overall average ± SD passage rate for the WEF was 0.63 ± 1.17 target birds per hour of observation (Table 8). The average passage rate of target species per hour from 4 seasonal surveys in the control site was 0.50 (±0.88).

The standard deviations were high mostly because the incidences of target birds were not normally distributed throughout the day.

Table 8: Seasonal Average Passage Rate of Target Species per hour from 4 Seasonal Surveys

Vantage Point	Passage Rate (individuals per hour) Mean (±SD)				
	S1	S2	S3	S4	Average
1	0.25 (±0.45)	0.33 (±0.65)	0.00 (±0.00)	0.50 (±0.80)	**0.27 (±0.57)**
2	0.83 (±1.19)	0.33 (±0.78)	0.75 (±0.87)	1.25 (±1.91)	**0.79 (±1.27)**
3	0.25 (±0.45)	0.17 (±0.39)	0.67 (±0.65)	0.92 (±1.16)	**0.50 (±0.77)**

Vantage Point	Passage Rate (individuals per hour) Mean (±SD)				
	S1	S2	S3	S4	Average
4	0.42 (±0.90)	0.17 (±0.39)	1.25 (±1.86)	1.00 (±1.60)	**0.71 (±1.35)**
5	0.58 (±0.90)	0.17 (±0.58)	0.75 (±1.36)	0.33 (±0.78)	**0.46 (±0.94)**
6	0.08 (±0.29)	0.25 (±0.45)	0.75 (±1.36)	0.25 (±0.62)	**0.33 (±0.81)**
7	0.42 (±1.00)	1.00 (±1.65)	0.67 (±0.89)	0.83 (±1.19)	**0.73 (±1.20)**
8	0.62 (±1.66)	0.08 (±0.29)	0.33 (±0.49)	0.25 (±0.45)	**0.33 (±0.92)**
9	1.50 (±1.62)	0.25 (±0.62)	0.17 (±0.39)	1.00 (±1.21)	**0.73 (±1.18)**
10	1.58 (±2.50)	1.58 (±1.68)	1.08 (±1.51)	1.92 (±1.88)	**1.54 (±1.89)**
11	1.08 (±1.83)	0.42 (±0.79)	0.58 (±0.90)	1.25 (±1.48)	**0.83 (±1.33)**
12	0.42 (±0.90)	0.00 (±0.00)	0.17 (±0.39)	0.67 (±0.78)	**0.31 (±0.66)**
Average	**0.67 (±1.34)**	**0.40 (±0.92)**	**0.60 (±1.05)**	**0.85 (±1.29)**	**0.63 (±1.17)**
Control	0.44 (±1.01)	0.89 (±1.17)	0.56 (±0.73)	0.11 (±0.33)	**0.50 (±0.88)**

The flight paths of a total of 13 positively identified target species were recorded from vantage points, including 12 priority species and 11 raptors (10 of which are priority species).

The total number of flight paths recorded in the WEF over four seasons was 306 (Figure 8 and Figure 9) with a total of 363 individuals observed (although it must be noted that the same individual birds may have been seen multiple times over the period of the survey). Raptors accounted for at least 290 flight paths (95 %).

The most frequently recorded species was Verreaux's Eagle which, with 144 flight paths (Figure 7), accounted for 47 % of flight paths, while Rock Kestrel was the second most frequently recorded species and accounted for 21 % of flight paths, followed by Jackal Buzzard with 16 % of flights. Together, these three species therefore constituted 255 flight paths, or 83 % of all recorded flights.

While target species utilised each of the height categories, 82 % of flights included at least some time at RSH (height bands two (20-40 m), three (40-120 m) and four (120-160 m) while 187 flights, or 61 % of flights included 50 % or more of their duration at RSH (i.e. between 20 m and 160 m). A summary of flight paths by target species is presented in Table 9. A high proportion of Verreaux's Eagle flights (81%) included some time at RSH.

Table 9: Flight Path Target Species – WEF Site

Species	**Species Priority Score***	**Red Data Status (Taylor *et al.* 2015)**	**Total no. of Flight paths**	**Total no. of birds recorded****	**Estimated minimum number of separate individuals**	**No. of flights with a portion at RSH (% of flights with a portion at RSH)**
African Harrier-Hawk	190	-	7	7	3	6 (85.7 %)
Black Stork	330	VU	6	8	3	6 (100 %)
Booted Eagle	230	-	2	2	1	1 (50.0 %)
Greater Kestrel	174	-	3	4	2	2 (66.7 %)
Jackal Buzzard	250	-	48	49	5	39 (81.3 %)
Karoo Korhaan	240	NT	1	2	2	0 (0 %)
Lanner Falcon	300	VU	1	1	1	1 (100 %)
Martial Eagle	350	EN	6	6	2	5 (83.3 %)
Pale Chanting Goshawk	200	-	5	5	2	3 (60.0 %)
Peregrine Falcon	240	-	1	1	1	1 (100 %)

Species	Species Priority Score*	Red Data Status (Taylor *et al.* 2015)	Total no. of Flight paths	Total no. of birds recorded**	Estimated minimum number of separate individuals	No. of flights with a portion at RSH (% of flights with a portion at RSH)
Rock Kestrel	-	-	63	69	6	56 (88.9 %)
Steppe Buzzard	210	-	3	3	2	3 (100 %)
Verreaux's Eagle	360	VU	144	189	8	117 (81.3 %)
Unidentified Species	-	-	9	9	-	7 (77.8 %)
Unidentified Raptor	-	-	7	8	-	3 (43 %)
Totals			**306**	**363**	**NA**	**250 (81.7 %)**

**Priority species (Retief et al. 2011, updated 2014). EN = Endangered NT = Near-threatened, VU= Vulnerable. ** Multiple observations may have been made of the same individuals at different times.*

While the total number of flight paths recorded for all target species was highest in summer (103 flights), followed by autumn (81 flights), spring (75) and winter (47), the number of Verreaux's Eagle flight paths recorded was highest in autumn (58 flights), fairly equal in winter (33) and summer (34), and lowest during spring (19). This may be due to increased activity around the nest site in autumn in preparation for breeding in winter, followed by the provisioning of food to the nest site during winter as chicks would be unable to forage for themselves.

The estimated minimum number of Verreaux's Eagles, flights on or around the WEF site, was 8, consisting of three territorial adult pairs, and two separate juveniles. The possible presence of 'floaters' (i.e. non-territorial adults) and additional juveniles, dispersing from other territories, is noted, and therefore this number of individuals is a minimum estimate. Juvenile eagles may be at more risk from collision (as they are still perfecting their flying skills, learning to hunt, exploring new terrain), including when dispersing from the home territories into unfamiliar areas. Of the 144 Verreaux's Eagle flights recorded, 15 (10 %) included flights of juveniles or immature birds.

The total number of flight paths recorded at the control site VP over four seasons was 13 with a total of 18 individuals observed (although it must be noted that the same individual birds may have been seen multiple times over the period of the survey) (Table 10). Three target species were recorded at the control site VP, of which two were priority species. Verreaux's Eagle and Pale Chanting Goshawk each accounted for 38.5% of flight paths with Rock Kestrel making up the balance. Target species utilised all height bands, however Verreaux's Eagle was only recorded above rotor swept height.

Table 10: Flight Path Target Species - Control Site

Species	Species Priority Score* (Retief *et al.*, 2011)	Red List Status (Taylor *et al.* 2015)	Total no. of Flight paths	Total no. of birds recorded**	No. of flights with a portion at RSH (% of flights with a portion at RSH)
Pale Chanting Goshawk*	200	-	5	7	3 (60 %)
Rock Kestrel	-	-	3	3	3 (100 %)
Verreaux's Eagle*	360	VU	5	8	0 (0 %)
Totals			**13**	**18**	**6 (46 %)**

**Priority species (Retief et al. 2011, updated 2014). VU=Vulnerable. ** Multiple observations may have been made of the same individuals at different times.*

5.4.3 Driven Transects

The driven transects conducted over the 12 month period recorded few target species. In 413.6 km of driven transects conducted, 33 records were made of target species comprising 43 individual birds from 7 identified species on the WEF and control site (Table 11). This equates to an average of 0.104 target birds per kilometre. On the WEF site where 368 km of transects were conducted the average number of target birds per kilometre was 0.092, while on the control site where 45.6 km of transects were conducted, there were 0.197 target birds per kilometre (somewhat inflated by the single record of a group of 5 Grey-winged Francolins). DT2 and DT5 recorded the most target species records (11 and 7 respectively) in the WEF site, while DT2 had the least records (2), although it was the longest transect (a total of 96 Km). On the WEF site, Verreaux's Eagle was only recorded on DT4, and on a number of occasions (4 records), and it is likely that these were all records of the same pair that was recorded around FS2.

Table 11: Summary of Driven Transect Results

Species	Total Birds Recorded **	Max. Flock Count	Number of Records per Driven Transect					
			DT1 (76km)$	DT2 (96km) $	DT3 (61.6) $	DT4 (64.8) $	DT5 (69.6) $	CDT (45.6) $
Grey-winged Francolin*	5	5	-	-	-	-	-	1
Jackal Buzzard*	8	8	2	3	-	-	3	-
Karoo Korhaan*	8	2	-	1	1	2	1	-
Pale Chanting Goshawk*	7	2	1	3	-	-	1	1
Rock Kestrel	6	1	-	4	1	-	1	-
Steppe Buzzard*	1	1	-	-	-	-	1	-
Unidentified Falcon	1	1	-	-	-	-	-	1
Verreaux's Eagle*	7	2	-	-	4	-	-	1
Total	**43**	**NA**	**3**	**11**	**6**	**2**	**7**	**4**

**Priority species (Retief et al., 2011) **Where more than one bird recorded, the same individual bird may have been recorded more than once. The figures in this column therefore do not necessarily indicate the number of individuals of this species present, or the population size. $ Total distance conducted per transect over four seasonal surveys.*

5.4.4 Focal Sites

Summarised results from four seasonal surveys at the six focal sites are shown in Table 12 below, with the following key findings:

- Although Verreaux's Eagles were observed interacting with both nest structures at FS1, it was confirmed that the active nest structure, within which the pair of Eagles successfully raised and fledged a chick (observed during the course of monitoring), was the nest on the south western cliff face.
- The stand of Eucalyptus trees at FS2, is an important Roost for a pair of Verreaux's Eagles (Note: This is a different pair to the pair breeding at FS1). It is likely that this pair may attempt to nest in the vicinity (or possibly in the trees), although no nest site could be located.
- The stand of alien trees at FS4, is an important roost for a pair of Martial Eagles. It is possible that this pair may have a nest in the vicinity, although no nest site could be located.
- In the subsequent visits to the African Harrier Hawk Nest site (FS5) in spring and summer, the breeding pair could not be located, and it could not be confirmed whether they had bred successfully.
- In the subsequent visits to the Verreaux's Eagle nest site outside of the WEF (FS6) in spring and summer, the breeding pair could not be located, and it could not be

confirmed whether they had bred successfully. A Black Stork and a Martial Eagle were observed at this location, soaring above the cliffs during spring.

Table 12: Summary of Focal Site Results (number of individuals counted during each of the two counts, per season, is given in brackets)

Focal Site visit	Survey 1 (autumn)		Survey 2 (winter)		Survey 3 (spring)		Survey 4 (summer)	
	Priority Species (number of individuals)	**Notes**	**Priority Species (number of individuals)**	**Notes**	**Priority Species (number of individuals)**	**Notes**	**Priority Species (number of individuals)**	**Notes**
FS1.1	Verreaux's Eagle (1)	One adult Verreaux's Eagle recorded perched at the nest.	0 (0)	No birds recorded at or interacting with the focal site.	Verreaux's Eagle (1)	Juvenile on the active nest site on the south western cliff.	0 (0)	No birds recorded at or interacting with the focal site.
FS1.2	0 (0)	No birds recorded at or interacting with the focal site.	Verreaux's Eagle (2)	A pair of Verreaux's Eagles were at the active nest site on the south western cliff.	0 (0)	-	0 (0)	No birds recorded at or interacting with the focal site.
FS2.1					0 (0)	-	0 (0)	
FS2.2					0 (0)	-	Verreaux's Eagle (1)	Verreaux's Eagle was flushed from Eucalyptus tree perch.
FS3.1					0 (0)	-	0 (0)	
FS3.2					0 (0)	-	Verreaux's Eagle (2)	Verreaux's Eagle was flushed from Eucalyptus tree (FS2) and flew to Rock perch (FS3) where it was joined by a second bird.
FS4.1					Martial Eagle (2)	Pair of Martial Eagles perched on trees	0 (0)	Martial Eagle not present[7]
FS4.2					0 (0)	-	0 (0)	
FS5.1					0 (0)	-	0 (0)	
FS5.2					0 (0)	-	0 (0)	Cinnamon-breasted Warbler recorded.
FS6.1					Martial Eagle (1); Black Stork (1).	No birds on Verreaux's Eagle nest. Martial Eagle and Black Stork flying very high overhead	0 (0)	No birds on Verreaux's Eagle nest.
FS6.2					0 (0)		0 (0)	No birds on Verreaux's Eagle nest.

[7] Note: Martial Eagle was seen at this location outside of the survey times and was recorded as an incidental record.

5.4.5 Incidental Records

A total of 244 individuals (although, in some cases this could be the same bird or group of birds viewed multiple times) from 184 incidental observations of target species, with 14 positively identified species, were made. Of these 14 species, 13 were priority species with Rock Kestrel being the only non-priority species recorded (Table 13).

The species most regularly recorded incidentally was Karoo Korhaan, with 36 records (accounting for 20 % of all incidental records) totalling 75 individuals. It was often seen in small groups of 2 to 4 birds, and mostly on the lower lying flat areas. Rock Kestrel and Jackal Buzzard were also regularly recorded and each species accounted for 19 % of incidental records. Pale Chanting Goshawk was recorded incidentally on 30 occasions (16 %), while there were 22 incidental records (12 %) of Verreaux's Eagle. These five species therefore account for 85 % of all incidental records. Figure 11 shows the locations of observers when making the majority of incidental records, and although the majority of records follow the distribution of the available road network, some spatial patterns can be found. Karoo Korhaan were mostly observed in the central regions of the WEF, in the lower lying open areas. Most records of Martial Eagle were in the west, particularly near the identified roost site. One record of White Stork was made in the agricultural lands at Putterskraal. Verreaux's Eagle were recorded incidentally throughout, but more often in the central and eastern areas. Pale Chanting Goshawk, Jackal Buzzard and Rock Kestrel were often perched on electricity or telephone poles near the main dirt roads.

Table 13: Number of Incidental Records of Target Species during Four Seasonal Surveys

Species	Number of observations	Total individuals**	Maximum flock count
Black Harrier*	2	2	1
Black-chested Snake Eagle*	1	1	1
Black Stork*	1	1	1
Greater Flamingo*	1	1	1
Greater Kestrel*	2	3	2
Jackal Buzzard*	50	51	2
Karoo Korhaan*	40	84	4
Lanner Falcon*	2	2	1
Ludwig's Bustard*	2	2	1
Martial Eagle*	11	15	2
Pale Chanting Goshawk*	38	39	2
Rock Kestrel	43	47	2
Steppe Buzzard*	3	3	1
Verreaux's Eagle*	29	41	3
White Stork*	1	5	5
Unidentified Owl	1	1	1
Unidentified Raptor	4	4	1
TOTALS	**231**	**302**	**NA**

**Priority species (Retief et al. 2011, updated 2014). Italics = endemics or near-endemics. ** Multiple observations may have been made of the same individuals at different times.*

5.4.6 Focussed Nest Search

Of the 59 surveyed cliffs (Figure 4), four cliffs were found to have a total of four raptor nests. An active Verreaux's Eagle nest was located at Cliff 41 (C41), approximately 6 km west of the WEF site boundary (subsequently designated as FS6, see section 5.4.4). An inactive Verreaux's Eagle nest was located at C40 approximately 3.3 km west of the WEF site boundary, while an inactive unidentified raptor nest was located at C39 approximately

2.3 km west of the WEF site boundary. One nest of an unidentified raptor (likely either a Jackal Buzzard or an African Harrier Hawk) was located within the WEF site at C12.

The specialists confirmed the presence of two regular Verreaux's Eagle roosts (FS2 and FS3) and a Martial Eagle roost (FS4) on the WEF site. A pair of Verreaux's Eagle regularly utilised a stand of eucalyptus trees (FS2) as well as a rocky outcrop (FS3) in close proximity to the farm house at Brinksfontein as a perch and roost (Figure 2). This pair was recorded by other survey methods described above, along with a third bird (a sub adult) recorded at the same location during DT3 in winter, indicating the possibility of a nest in the area. Verreaux's Eagle do occasionally nest in trees. A thorough search of the eucalyptus trees as well as surrounding cliffs (C28, C29 and C30) did not reveal the presence of a nest. The landowner has confirmed that he has observed this pair of birds carrying sticks and branches. This indicates that the pair may have attempted to build a nest, but failed or that a nest has not been found but may exist in the broader area (the former explanation being more likely).

A pair of Martial Eagles were observed (incidentally and during walked transects) in the area surrounding a stand of alien trees (FS4) in the west of the WEF site. This stand of trees was thoroughly searched by the specialist during the nest survey, who flushed a pair of Martial Eagles. Evidence of a regular roost was found (Figure 12), as well as an inactive unidentified raptor nest, believed to be too small to be utilised by Martial Eagle.

Additional active and/or inactive nest sites located outside of the nest survey (i.e. during routine monitoring surveys) include: An active Verreaux's Eagle nest and an inactive Verreaux's Eagle nest (both located during the site set up by the specialist and designated as FS1) and an active African Harrier Hawk nest (FS5) located by observers during surveys at VP11 in winter.

The locations of all inactive and active raptor nests and roost sites located in and around the WEF to date (utilising all survey methods including the focussed Verreaux's Eagle Nest Search) are shown in Figure 12.

5.4.7 Species Summaries

5.4.7.1 Seasonal Surveys

A combined total of 135 species was recorded in and around the WEF and control site during the four seasonal surveys (Appendix I). This includes 20 priority species and 24 South African endemic or near endemic species. A total of 9 Red Data species were observed across all four surveys (Table 14), including three species listed as regionally *Endangered*, three as *Vulnerable* and three as *Near-threatened* (Taylor *et al.* 2015).

Table 14: Red Data Species Recorded During Four Seasonal Surveys on the WEF and Control Site

Species	**Red Data Status (Taylor *et al.* 2015)**
Black Harrier	*Endangered*
Ludwig's Bustard	*Endangered*
Martial Eagle	*Endangered*
Black Stork	*Vulnerable*
Lanner Falcon	*Vulnerable*
Verreauxs' Eagle	*Vulnerable*
African Rock Pipit	*Near-threatened*
Greater Flamingo	*Near-threatened*

Species	Red Data Status (Taylor *et al.* 2015)
Karoo Korhaan	*Near-threatened*

Generally the highest diversities and abundances of small passerine species were found on the lower lying walked transects, associated with drainage lines, and riparian scrub habitat. The more exposed transects, on higher ridges (where most turbines are planned) generally recorded fewer species and lower numbers of birds. Open karoo scrublands were frequented by chats, larks and korhaans, while regularly recorded species associated with drainage lines and denser thicket habitats were: Acacia Pied Barbet, Cape Robin Chat, Bokmakierie, Karoo Prinia, Grey-backed Cisticola, Cape Bunting, and Red-faced Mousebird. A red listed passerine, African Rock Pipit (Near-Threatened), was recorded within the WEF site, particularly around the top of the ridges near VP9.

Waterbirds were scarce while raptors were generally observed flying over all habitat types. Key foraging areas for raptor species such as Verreaux's Eagle, Jackal Buzzard, Greater Kestrel and Rock Kestrel were generally observed along steep slopes or ridges at higher altitude. In contrast, Pale Chanting Goshawk was mostly observed in the lower flat areas. Birds of the family Corvidae (crows and ravens) were abundant with White-necked Raven, in particular, being one of the most regularly observed larger species, including flocks of up to 30 birds.

Key findings from the four seasonal surveys can be summarised as follows:

- 135 species identified;
- 20 priority species recorded;
- 24 South African endemic or near endemic species recorded;
- 9 Red Data species recorded;
- The overall average ± SD passage rate for the WEF was 0.63 ± 1.17 target birds per hour of observation, which is relatively low compared with other WEF sites worked on by the specialists;
- A total of 306 flights and 363 individuals of 13 species (12 of which are priority species) were recorded on the WEF site. 144 (47 %) of these flights were by Verreaux's Eagle. This Red Data species is listed as Vulnerable (Taylor et al. 2015);
- Raptors constituted the majority of flight paths (94 %) recorded within the WEF, with Verreaux's Eagle being the most commonly recorded vantage point target species;
- Rock Kestrel was the second most frequently recorded species and accounted for 21 % of flight paths, followed by Jackal Buzzard with 16 % of flights.
- 82 % of flights included at least some time at RSH height bands two (20-40 m), three (40-120 m) and four (120-160 m) while 187 flights, or 61 % of flights included 50 % or more of their duration at RSH;
- A high proportion of Verreaux's Eagle flights (81%) included some time at RSH;
- Three target species were recorded in 13 flight paths at the control site. The two priority species, Verreaux's Eagle and Pale Chanting Goshawk, were recorded in five flight paths each, while three flights of Rock Kestrel were recorded;
- The lower lying, flat open areas were, were utilised by terrestrial species such as the Red Data Karoo Korhaan and Ludwig's Bustard. The former was more abundant and the latter was scarce;
- No flights of Karoo Korhaan or Ludwig's Bustard were recorded over four seasons of VP monitoring on either the WEF or control sites;
- Species such as Egyptian Goose, Spur-winged Goose, Crowned Lapwing, and Hadeda Ibis, although generally common in South Africa, were relatively scarce on the WEF site and were usually observed near to farm houses and pockets of agricultural lands;
- The species most regularly recorded incidentally was Karoo Korhaan. Rock Kestrel, Jackal Buzzard, Pale Chanting Goshawk and Verreaux's Eagle were also regularly recorded incidentally. These five species accounted for 85 % of all incidental records;

- Two active Verreaux's Eagle nests were located, of which one is situated within the WEF;
- Verreauxs' Eagle is the species of most concern to the development and was observed across the site in relatively high abundance when compared to other priority species. Verreauxs' Eagle has moderate abundance on the site when compared to other parts of the country. As such this species has been the focus of the recommended mitigation measures.
- An active African Harrier Hawk nest is located within the WEF site; and
- Important roost locations for Verreaux's and Martial Eagles were identified.

5.5 Avifaunal Community Summary

Arcus conclude that at least a total of 192 species are likely to be present in or near the proposed WEF site. These species were either recorded by the SABAP data examined (see 5.3.1 and 5.3.2 above), physically observed in the area by the authors of two avifaunal reports for neighbouring sites (Jenkins, 2011 and EWT 2014), or were recorded by Arcus during the 12 month monitoring surveys on the WEF site.

Appendix I shows 193 species (including one species, Red-winged Warbler, thought to have been a possible misidentification by EWT 2014) and includes 28 endemic or near-endemic species, 25 priority species and 11 Regional Red Data species, namely Ludwig's Bustard (*Endangered*), Black Harrier (*Endangered*), Martial Eagle (*Endangered*), Black Stork (*Vulnerable*), Lanner Falcon (*Vulnerable*), Verreaux's Eagle (*Vulnerable*), Southern Black Korhaan (*Vulnerable*), Greater Flamingo (*Near-threatened*), Karoo Korhaan (*Near-threatened*), Maccoa Duck (*Near-threatened*), Blue Crane (*Near-threatened*) and African Rock Pipit (*Near-threatened*).

5.6 Discussion

Overall the baseline environment in terms of avifauna at the proposed WEF site was found to be typical for the vegetation, habitat and micro-habitat types in the region. In general, few important avifaunal micro-habitats exist, and the most important of these were found to be ridgelines (with associated cliff's and rocky outcrops) and rivers and drainage lines (with associated riparian thickets as well as cliffs).

The combined avifaunal community which potentially exists on the WEF site comprises of up to 192 species, including 25 priority species, 28 endemic or near-endemic species and 11 Red Data species. During the 12 months of monitoring 135 of these 192 species were recorded in and around the WEF and control sites, including 20 of the 25 priority species, 24 of the 28 South African endemic or near-endemic species, and 9 of the 11 Red Data species. These three figures are all moderate, when compared with the specialists' experience on other WEF sites in South Africa. However, it is not only the presence (or potential presence) of certain species on a WEF site that is important, but also the abundance of those species as well as their behaviour. It is also possible that climatic conditions during the year of monitoring (which included periods of drought) may have reduced (or less likely, even increased) the overall number of species recorded on the WEF. Many species have highly sporadic movements in response to rainfall and other factors such as food (e.g. Ludwig's Bustard, Amur Falcon, Lesser Kestrel, White Stork) and may not have been present, or were present in lower numbers during the survey year. Examination of historical data sources (e.g. SABAP data) was therefore used to try to determine the likely abundance of these species on the WEF site outside of the monitoring year. Of the four species mentioned above, only Ludwig's Bustard was recorded in the historical SABAP data examined.

Of the 9 Red Data species recorded, two (Verreaux's Eagle and Karoo Korhaan) were found to have a moderate abundance (in comparison to other areas of South Africa worked in by the specialists) on the WEF site (while the remaining species had a low abundance). Of these only Verreaux's Eagle recorded relatively high flight activity (relative to other priority species on the WEF site). Therefore, when considering the potential impacts of the proposed development, these were two of the most important species.

Verreaux's Eagle is red listed as *Vulnerable* (Taylor *et al.* 2015), is a priority species, and is known to collide with wind turbines in South Africa (Smallie 2015). Verreaux's Eagle were generally more active in the north east of the WEF, along prominent ridgelines and near to the identified nest site. During the spring survey the chick at the active nest site on the WEF site had fledged and was observed flying. It was not observed at the nest again in summer and it is expected that this individual was chased from the territory by the breeding pair.

It is important to afford this species protection by not placing turbines in areas of high recorded flight activity, as well as avoiding prominent ridgelines where possible. Further protection will also be gained by enforcing a strict no-go buffer for turbine placement around the identified Verreaux's Eagle nests (See Section 6). These recommendations have been adequately adhered to by the proponent and are acceptable to the Specialist. Although Verreaux's Eagle had high flight activity relative to other species on the WEF site, the majority of activity was by only a few birds and it is estimated that approximately 8 individuals were responsible for all 144 flights recorded over the 12 months of monitoring. Furthermore, when compared to other areas worked on by the specialists, the levels of activity are considered moderate.

The rough density (approximately 1 pair/93 km^2)[8] of Verreaux's Eagle on the WEF site and it's surrounds is low when compared to other relatively high density populations of this species studied in other parts of the region (e.g. Nuweveld escarpment, Beaufort West: mean density 1 pair/24 km^2 (Davies 1994); Cederberg, W Cape: mean inter-pair distance 4.7 km (n = 22, range 3.4-7.2 km); Sandveld, W Cape: mean inter-pair distance 5.8 km (n = 24, range 1.6-15.2 km) – Jenkins 2014: Pers. Comm.; proposed Umsinde Emoyeni WEF, Murraysberg : approximately 1 pair/57 km^2 (Pearson 2015). Nonetheless, this population (of approximately three breeding pairs and one or two juveniles), together with the Martial Eagle pair observed in the west of the WEF site, represent an important biodiversity asset of the site, and are likely to be important components of the local ecology.

There are two confirmed active nests of a priority species or raptor on the WEF site to date: one Verreaux's Eagle nest and one African Harrier Hawk nest. Three inactive (or unused) raptor nests have also been located on the WEF site, two belonging to unidentified species and one to Verreaux's Eagle. Outside of the WEF site, within 7 km from the site boundary, two additional Verreaux's Eagle nests have been located one of which has been confirmed as active by the avifaunal specialists during the winter nest survey. One inactive unidentified raptor nest has also been located (Figure 12). Given the extent of the site, the range of habitats and (in some cases) the observation of juveniles, it is possible that the following priority species or raptors are also breeding on or in close proximity to (i.e. within approximately 5 km) the WEF site: Pale Chanting Goshawk; Booted Eagle; Jackal Buzzard; Cape Eagle-owl; Karoo Korhaan; Rock Kestrel and Martial Eagle.

The pair of Verreaux's Eagles that were utilising eucalyptus trees as a roost (FS2) during the winter survey were not observed in the trees during the spring survey but they were observed foraging further to the north. They were again observed using the roost during summer. After discussion with a farm worker it seems that these individuals may have arrived in the area relatively recently and as a result have not yet set up a breeding territory or selected a suitable nesting site.

Black Stork (*Vulnerable*) was observed in the spring survey and the summer survey, but not during autumn or winter. The summer observations included a group of three birds

[8] This figure is approximate, and should be used with caution, as it is based on 3 pairs of eagles (and two active nests) being located within an area of approximately 280 km^2, within which additional nests may be located.

observed flying from VP7. This species is thought to have complex seasonal movements and may be locally nomadic in the Karoo (Hockey *et al.* 2005). This species is a cliff-nester, and breeding mainly takes place in winter (Taylor *et al.* 2015)

A Greater Flamingo (*Near-threatened*) was observed in the spring and summer surveys but not in the previous two surveys. This species is capable of long distance movements between inundated water sources (Hockey *et al.* 2005) and may occasionally transit through the WEF site in response to rainfall events. It should be noted though that the Greater Flamingo is not common in the area, and information from SABAP 2, has no record of this species on the site. In the absence of more information it is considered unlikely for this species to occur on the WEF site, and unlikely to be at significant risk from the development.

During the winter survey an owl was recorded but the species could not be determined. During the spring survey an owl was observed and positively identified to be a Spotted Eagle-Owl. While both the Spotted and Cape Eagle-Owls are priority species only the former has been confirmed to be on the WEF site to date. A Western Barn Owl was recorded during the summer surveys.

Although not a Red Data species or a priority species, the Rock Kestrel population of the area was relatively large (compared with other raptors), and this predator may play in important role in the ecosystem. This species has been known to collide with turbines in South Africa (pers. obs.), and is therefore potentially at risk.

Small terrestrial species are potentially more vulnerable to the impacts of habitat destruction and displacement, however the species richness and abundance of passerines on the site was relatively low. The index of kilometric abundance (IKA) for small terrestrial species was extremely varied across the different walked transects and across seasons on the WEF, and therefore it was difficult to draw any firm patterns and conclusions. Numbers were highly variable across the seven transects, yet the overall IKA from all walked transects of 29.21 (SD±22.98) birds per kilometre is comparable with other WEFs worked on by the specialists. Apart from African Rock Pipit (which was not overly abundant), few Red Data passerines were recorded. A number of South African Endemic or Near-endemic passerines were recorded, with notable species being Cinnamon-breasted Warbler, Ground Woodpecker, Karoo Lark and Sickle-winged Chat. Passerines were generally more abundant along draining lines at lower altitudes.

The most important species to be considered in the impact assessment are the priority species and/or Red Data species and/or endemic/near endemic species, that were found to be relatively abundant on site relative to other species, or are potentially present due to availability of habitats, or had high levels of activity, or displayed high risk behaviour (e.g. flying at risk height). These 'focal species' were determined to be the following: **Verreaux's Eagle, Black Harrier, Martial Eagle, Black Stork, African Harrier Hawk, Jackal Buzzard, Rock Kestrel, Pale Chanting Goshawk, Spotted Eagle-owl, Ludwig's Bustard, Karoo Korhaan, African Rock Pipit, Ground Woodpecker, Cinnamon-breasted Warbler, Cape Spurfowl, Karoo Prinia, Grey-winged Francolin, Large-billed Lark, Karoo Lark, Karoo Eremomela, and Sickle-winged Chat.**

5.6.1 Nest Buffer Distances

Due to its levels of activity, conservation status, ecological role as an apex predator, priority score, and its confirmed susceptibility to collision mortality in South Africa, Verreaux's Eagle is the most important species to be considered in the impact assessment. The level of activity of this species over four seasons is regarded as moderate to high, relative to the other target species observed, the majority of which had low activity. In order to afford sufficient protection to Verreaux's Eagle (and other important species), it was necessary to establish certain buffers, some of which are regarded as 'No-go' areas. The extent, shape, and characteristics of these No-go areas were established following detailed analysis of the full 12 month data set, and considering the specialist's opinion and experience (including discussions within Birds and Renewable Energy Specialist Group (BARESG)), as well as current best practice in South Africa.

In the absence of detailed site-specific information of the core foraging ranges of the raptors observed within the WEF site (e.g. GPS tracking information) an approach to determine the size of buffer zones around nest sites using half the mean inter-nest distance of the local population is often employed (e.g. U.S. Fish & Wildlife Service 2013, Jenkins & du Plessis 2014). This measurement, however, is more appropriate in areas where a number of nest sites have been located in an area to provide a statistically sound mean. For this project, only two active Verreaux's Eagle nests were located in over 26,000 ha, and therefore another approach to buffering these nested was followed, which involved considering standard practise in South Africa as well as observed flight activity.

Standard practise for buffering eagle nests in SA varies. On the Umsinde Emoyeni WEF (Pearson 2015), nests were buffered by 3 km. Jenkins (UNDATED) buffered a single Verreaux's Eagle nest by 1.5 km at the Roggeveld WEF and a single Martial Eagle nest by 2.5 km. Smallie (2014) buffered a single Verreaux's Eagle nest on the proposed Ishwati Emoyeni WEF by 2 km, while van Rooyen and Froneman (2014) reduced a 1 km buffer of a Verreaux's Eagle nest to a 800 m buffer, based on observational data at the Longyuan Mulilo De Aar 2 North Wind Energy Facility. At the proposed Springbok Wind Energy Facility, Dr. Rob Simmons placed a 1 km No-go buffer around a Verreaux's Eagle nest (Simmons, 2010). When considering these buffers, it is important to note that the majority of these recommendations above were made prior to any confirmed Verreaux's Eagle mortalities at WEFs in South Africa. They were also made based on site-specific information and knowledge by the specialist of the site, and may not be applicable elsewhere. It has now been confirmed that Verreaux's Eagles are vulnerable to collision with turbines, as Smallie (2015) recorded three collision fatalities of this species over a period of less than two months on a wind farm in the Eastern Cape. To date in South Africa, five Verreaux's Eagle mortalities at WEFs have now been confirmed (pers. Com. Sam Ralston-Paton). What is notable also, is that Smallie (2015) found that the turbines where the fatalities occurred where at least 3.5 km from suitable Verreaux's Eagle breeding habitat, and that pre-construction bird monitoring on the site recorded relatively low Verreaux's Eagle flight activity, albeit with a slight peak in autumn. Furthermore, Birdlife SA and the Birds and Renewable Energy Specialist Group (BARESG) are currently compiling guidelines for Verreaux's Eagle which will require a minimum buffer of 3 km, while a study in the Cederberg on Verreaux's Eagles confirmed that the majority of activity of this species in that area is within 3 km of the nest site (Dr. Andrew Jenkins (supervising Morgan Pfeiffer), pers. com.). Other factors considered when determining buffers for the Verreaux's Eagle nests were that relative to other WEF sites where the specialists have experience, the level of Verreaux's Eagle activity on the WEF site is regarded as moderate and the passage rates observed were generally low (relative to other WEF sites worked on by the specialists) of all target species (including Verreaux's Eagle).

All of the above information was considered when creating an 'adjusted buffer' designated as a no-go area around the active nest on the Komsberg East WEF, by starting with a 3 km circular buffer, and then adjusting it ('shaping' it) based on areas of high flight activity (see Section 6.1 below for more details). Furthermore a 1 km circular 'No-go' buffer was added to all Verreaux's Eagle nests (active or inactive) and a 3 km circular Medium-High Sensitivity Zone was placed around the active Verreaux's Eagle nests on the WEF site.

6 AVIFAUNAL SENSITIVITY MAPPING

Avifaunal sensitivity mapping has been done to advise the WEF design and the turbine layout (Figure 13 and Figure 14). Following four seasonal surveys, flight activity of

Verreaux's Eagle, Jackal Buzzard, and Rock Kestrel as well as the location of raptor nests are the most important considerations in the turbine layout/design process.

The process of compiling an avifaunal sensitivity map for the WEF included the identification of sensitivity zones based on landscape features (e.g. nest sites and rivers) as well as the identification of sensitivity zones based on observed flight activity during 12 months of avifaunal monitoring.

We recommend turbine placement follow a hierarchy with preferential placement in No Sensitivity Zones, followed by Low, Medium and then Medium High Zones. No turbines should be placed in Avifaunal No-go Areas. Where two or more sensitivity areas overlap spatially, the layer with the higher sensitivity designation is applicable. These recommendations have been adequately adhered to by the proponent and are acceptable to the Specialist.

6.1 High Sensitivity Zones

High Sensitivity Zones are designated as No-go areas for turbine placement, and it is strongly recommended that associated infrastructure (particularly overhead power lines) be placed outside of these areas. They include the following:

- 1 km radius around a Martial Eagle Roost;
- 1 km radius around Verreaux's Eagle roosts;
- 1 km radius around Verreaux's Eagle nests;
- 500 m radius around African Harrier Hawk Nest;
- An reshaped buffer of the active Verreauxs Eagle nest on the WEF site, based on a detailed analysis of Verreaux's Eagle flight data and an associated grid cell flight sensitivity score for Verreaux's Eagles;
- 200 m buffer of agricultural fields; and
- 200 m buffer of National Freshwater Ecosystem Priority Areas (NFEPA) wetlands (including dams) and Rivers.
- 200 m X 200 m Grid Cells with a High Grid Cell Sensitivity Score (GCSS) based on observed flight activity.

6.2 Medium-High Sensitivity Zones

Turbines and infrastructure can be built in these zones although it is strongly recommended that infrastructure and turbines, where possible, be placed first in zones of lower sensitivity. Medium-High Sensitivity Zones include:

- 1 km – 2 km zone from Martial Eagle Roost;
- 1 km – 2 km zone from Verreaux's Eagle Roosts;
- 500 m – 1 km zone from African Harrier Hawk Nest; and
- 3 km radius around active Verreaux's Eagle Nests.
- 200 m X 200 m Grid Cells with a Medium-High Grid Cell Sensitivity Score (GCSS) based on observed flight activity.

6.3 Medium Sensitivity Zones

Turbines and infrastructure can be built in these zones although it is recommended that infrastructure and turbines, where possible, be placed first in zones of Low or Unknown sensitivity. Medium Sensitivity Zones include

- 1 km radius around Inactive Unidentified Raptor Nests.
- Steep slopes (i.e areas with a >25% slope) buffered by 100 m.
- 150 m buffer of Dolerite sills (i.e. rocky outcrops that provide habitat for the Verreaux's Eagle's preferred prey species, the Rock Hyrax or 'Dassie').
- 200 m X 200 m Grid Cells with a Medium Grid Cell Sensitivity Score (GCSS) based on observed flight activity.

6.4 Low Sensitivity Zones

These zones consist of 200 m X 200 m Grid Cells with a Low Grid Cell Sensitivity Score (GCSS) based on observed flight activity, that fall outside of any of the zones indicated above. For example, a Grid Cell may have a low GCSS, based on flight activity, but it falls within the steep slopes buffer, the grid cell would then be considered to be of Medium Sensitivity.

6.5 Unknown Sensitivity or No Sensitivity Zones

These are all areas outside of the zones discussed above, and or areas without a GCSS. These areas were either not covered by VP viewsheds, or if they were within a viewshed, priority species were not recorded, and there were no other obvious avifaunal features that could be designated. Areas of Unknown or No Sensitivity are preferred for turbine placement.

7 ALTERNATIVES

The impact assessment below (Section 5) assesses the worst case scenario for each WEF. In the case of the Komsberg East and West WEFs this represents a scenario where turbines are constructed without adequate adherence to no-go zones or certain sensitivities. From an avifaunal perspective, the significance of impacts would be reduced with adequate adherence to the recommendations and/or a reduction in the number of turbines, if possible.

The proponent has adjusted their layout accordingly and with more than 25 turbine positions having to be dropped or moved. As such, they have accommodated the recommendations made and the 'with mitigation' impact significance levels are those associated with the final layouts submitted and shown in this report in Figure 13 and Figure 14. Furthermore, if a reduction in turbine count is possible or required this would further reduce the impacts and significance levels.

In the case of the No-go alternative, the avifaunal status quo would remain (as described under the baseline environment (Section 3). There would be no additional impacts on avifauna.

8 AVIFAUNAL IMPACT ASSESSMENT

8.1 Background to Interactions between Wind Energy Facilities and Birds

South Africa has experienced an increase in the number of wind energy developments in the past five years, but still lacks some information about the effects that these developments have on the certain aspects of the environment. International experience has shown that birds can be impacted negatively by wind farms, and that the severity of these impacts can differ drastically from site to site (Drewitt & Langston 2006). Overall, it appears that severe impacts, such as the high mortality numbers of Golden Eagle observed at Altamont Pass in California (Orloff & Flannery 1992; Hunt 1995; Hunt *et al.* 1998) seem to be the exception rather than the rule, with the majority of facilities recording relatively low mortalities (Erickson *et al.* 2001; de Lucas *et al.* 2008; Strickland *et al.* 2011). The effects of one poorly placed facility, or some poorly sited turbines within a facility, can however affect the population of certain species at a regional, national or even global level (Bellebaum *et al.* 2013; Carrete 2009; Dahl *et al.* 2012). Hence, it is important to assess the impacts of wind energy facilities, and to base this assessment on a thorough investigation of the local avifauna prior to construction, as has been done for the proposed development.

The main impacts of wind energy facilities and their associated infrastructure have been identified as (a) displacement through disturbance and habitat destruction and (b) mortality through collisions with turbines and/or powerlines and (c) electrocution on live power infrastructure (Drewitt & Langston 2006; Percival 2005; van Rooyen 2000). In the lack of documented effects of WEFs in South Africa, these impacts are therefore considered to also be the potential impacts of the proposed development.

Also, collisions with power lines and electrocution are well known causes of mortality for certain species (van Rooyen & Smallie 2006). So while limited information on bird mortality through collisions with turbines is available from South Africa, wind energy facilities are expected to have a potential impact on avifaunal communities.

8.2 Identification of Potential Impacts

The following key potential impacts, arising from the proposed project's construction and operational phases have been identified for Komsberg East WEF and Komsberg West WEF and associated grid connections.

8.2.1 Habitat destruction

During the construction of WEF and grid connection infrastructure, some habitat destruction and alteration will take place. This happens with the construction of access roads, the clearing of servitudes and areas for tower/pylon placements, and the levelling of substation yards, development of laydown areas and turbine bases. This habitat destruction is both temporary in the case of, for example construction compounds and laydown areas, and permanent in the case of turbine foundations and substation compounds.

The scale of direct habitat loss resulting from the construction of a wind farm and associated infrastructure depends on the size of the project but, generally speaking, is likely to be small per turbine base. Typically, actual habitat loss amounts to 2–5% of the total development area (Drewitt & Langston 2006) of a WEF although it is much less in the case of Komsberg WEFs.

The removal of vegetation which provides habitat for avifauna and food sources may have an impact on birds breeding, foraging and roosting.

8.2.2 Disturbance and Displacement

Disturbances and noise from staff and construction activities can impact on certain sensitive species particularly whilst feeding and breeding, resulting in effective habitat loss through a perceived increase in predation risk (Frid & Dill 2002; Percival 2005). There are various potentially sensitive species occurring on the WEF site including African Rock Pipit, Karoo Korhaan, Verreaux's Eagle and Martial Eagle. This can cause these species to be displaced, either temporarily (i.e. for some period during the construction activity) or permanently (i.e. they do not return), into less suitable habitat which may reduce their ability to survive and reproduce.

These factors can all lead to birds avoiding the area for feeding or breeding, and effectively leading to habitat loss and a potential reduction in breeding success (Larsen & Madsen 2000; Percival 2005). Turbines can also be disruptive to bird flight paths, with some species altering their routes to avoid them (Dirksen *et al.* 1998, Tulp *et al.* 1999, Pettersson & Stalin 2003). While this reduces the chance of collisions it can also create a displacement or barrier effect, for example between roosting and feeding grounds and result in an increased energy expenditure and lower breeding success (Percival 2005).

Disturbance distances (the distance from wind farms up to which birds are absent or less abundant than expected) can vary between species and also within species with alternative habitat availability (Drewitt & Langston 2006). Some international studies of various species have recorded disturbance distances of 80 m, 100 m, 200 m and 300 m (Larsen & Madsen 2000, Shaffer & Buhl 2015) but distances of 600 m (Kruckenberg & Jaehne 2006) and up to 800 m have been recorded (Drewitt & Langston 2006).

Leddy et al (1999) found increased densities of breeding grassland passerines with increased distance from wind turbines, and higher densities in the reference area than within 80 m of the turbines, indicating that displacement did occur at least in this case. A recent comparative study of nine wind farms in Scotland (Pearce-Higgens et al, 2009) found seven of the 12 species studied exhibited significantly lower frequencies of occurrence close to the turbines, after accounting for habitat variation, with evidence of turbine avoidance in a further two. No species were more likely to occur close to the turbines. Raptors are generally fairly tolerant of wind farms, and continue to use the area for foraging (Thelander et al. 2003, Madders & Whitfield 2006, Pers. Obs.), and may not be affected by displacement, however this increases their collision risk.

It is expected that some species potentially occurring on the WEF site will be susceptible to displacement, for example smaller passerines such as larks, warblers, woodpeckers and chats, as well as large terrestrial Red Data species such as Karoo Korhaan and Ludwig's Bustard.

During operation of the grid connections, servitudes for the power lines will have to be cleared of excess vegetation at regular intervals. This is done to allow access to the power line for maintenance, to prevent vegetation from intruding into the prescribed clearance gap between the ground and the conductors, and to minimize the risk of fire under the line which can result in electrical flashovers. These and other maintenance activities can disturb sensitive species occurring on site.

During the decommissioning phase nesting birds utilising the electrical infrastructure are vulnerable to disturbance impacts, especially if nests are disturbed or removed during the removal/take down of structures (e.g. pylons). Particularly Martial Eagle (Endangered) which occurs in the area is known to utilise pylons for nesting and could be susceptible to disturbance, and experience a resulting reduced breeding success.

8.2.3 Electrocution

Electrocution of birds from electrical infrastructure including overhead lines is an important and well documented cause of bird mortality, especially raptors and storks (APLIC 1994; van Rooyen and Ledger 1999). Electrocution may also occur within newly constructed substations. Electrocution refers to the scenario where a bird is perched or attempts to perch on the electrical structure and causes an electrical short circuit by physically bridging the air gap between live components and/or live and earthed components (van Rooyen 2004).). With regard to the grid connection infrastructure, overhead power line infrastructure with a capacity of 132 kV or more do not generally pose a risk of electrocution due to the large size of the clearances between the electrical infrastructure components. Electrocutions are therefore more likely for larger species whose wingspan is able to bridge the gap such as eagles or storks. Various large raptors (such as Martial Eagle, Verreaux's Eagle and Ludwig's Bustard), susceptible to electrocution (particularly in the absence of safe and mitigated structures) occur in the area. Electrocution is possible on electrical infrastructure within the substation particularly for species such as crows and owls.

8.2.4 Power Line Collisions

Collisions with large (132kV or above) power lines are a well-documented threat to birds in southern Africa (van Rooyen 2004), while smaller lines pose a higher threat of electrocution but can still be responsible for collision. In addition to their grid connections wind energy facilities may have overhead lines between turbine strings and substations that pose a collision threat.

Collisions with overhead power lines occur when a flying bird does not see the cables, or is unable to take effective evasive action, and is killed by the impact or impact with the ground. Especially heavy-bodies birds such as bustards, cranes and waterbirds, with limited manoeuvrability are susceptible to this impact (van Rooyen 2004). Many of the collision and electrocution sensitive species are also considered threatened in southern Africa. The Red Data (Taylor *et al.* 2015) species vulnerable to power line collisions are generally long living, slow reproducing species under natural conditions. Some require very specific conditions for breeding, resulting in very few successful breeding attempts, or breeding might be restricted to very small areas. These species have not evolved to cope with high adult mortality, with the results that consistent high adult mortality over an extensive period could have a serious effect on a population's ability to sustain itself in the long or even medium term. Species that may be affected on the WEF site include Ludwig's Bustard, Karoo Korhaan and Greater Flamingo. Ludwig's Bustard is known to be particularly prone to collision (pers. Com R. Simmons, J. Smallie, M. Martins and BARESG) (Shaw *et al.* 2010).

Collisions with power lines could occur both for the grid connection infrastructure, and power lines within the WEF.

8.2.5 Wind Turbine Collisions

WEFs can have adverse impacts on avifauna through the collision of birds with moving turbine blades. A number of factors influence the number of birds impacted by collision, including:

- Number of birds in the vicinity of the WEF;
- The species of birds present and their flying patterns and behaviour;
- The design of the development including the turbine layout, height and size of the rotor swept area.

It is important to understand that not all birds that fly through the WEF at heights swept by rotors automatically collide with blades. In fact avoidance rates for certain species have proven to be extremely high. In a radar study of the movement of ducks and geese in the vicinity of an off-shore wind facility in Denmark, less than 1 % of bird flights were close enough to the turbines to be at risk, and it was clear that the birds avoided the turbines effectively (Desholm and Kahlert 2005). Whilst avoidance rates for SA species are currently unknown due to the lack of data, comparisons can be drawn between functionally similar species, for example Verreaux's Eagle with Golden Eagle, in order to inform an assessment.

The majority of studies on collisions caused by wind turbines have recorded relatively low mortality levels (Madders & Whitfield 2006). This is perhaps largely a reflection of the fact that many of the studied wind farms are located away from large concentrations of birds. It is also important to note that many records are based only on finding carcasses, with no correction for carcasses that were overlooked or removed by scavengers (Drewitt & Langston 2006). Relatively high collision mortality rates have been recorded at several large, poorly-sited wind farms in areas where large concentrations of birds are present (including IBAs), especially among migrating birds, large raptors or other large soaring species, e.g. in the Altamont Pass in California, USA (Thelander and Smallwood 2007), and in Tarifa and Navarra in Spain (Barrios and Rodrigues 2004).

Although large birds with poor manoeuvrability (such as cranes, flamingos, korhaans, and bustards) are generally at greater risk of collision with structures (Jenkins *et al*. 2011), it is noted that these classes of birds (unlike raptors) do not feature prominently in literature as wind turbine collision victims. It may be that they avoid wind farms, resulting in lower collision risks, or that they are not distracted and focussed on hunting and searching the ground while flying, as is the case for raptors.

Collisions of various species with turbine infrastructure (including the tower) have been observed recently in South Africa (pers. obs). There are documented reports of three Verreaux's Eagle mortalities from collisions with operational wind turbines in May 2015 at a WEF in the Eastern Cape (Smallie 2015). Birdlife SA also reports and additional two mortalities of this species to date (pers. Com. Sam Ralston-Paton). The fatalities were unexpected as they occurred on relatively flat topography a considerable distance (at least

3.5 km) from suitable Verreaux's Eagle breeding habitat, and pre-construction bird monitoring by Smallie (2015) on the site recorded 'low Verreaux's Eagle flight activity'. Without seeing and analysing the detailed data collected by Smallie (2015) it's difficult to quantify what is meant by 'low activity', as this may be a relative description. It is also unknown, what, if any, mitigation measures were applied at this site. However, what is relevant is that it has been confirmed that this species collides with turbines and that collisions may not necessarily occur where predicted, and that they can occur away from areas perceived to be preferred use areas. While limited in extent, this information has reduced the confidence with which we assess collision impacts based on perceived sensitivities for this species (e.g. nest sites and ridgelines in the case of Verreaux's Eagle).

8.2.6 Disruption of Local Bird Movement Patterns

Wind energy facilities may form a physical barrier to movement of birds across the landscape, this may alter migration routes and increase distances travelled and energy expenditure or block movement to important areas such as ephemeral wetlands altogether. This potential impact is not yet well understood, is likely to be more significant as a cumulative impact with surrounding developments, is difficult to measure and assess, and therefore mitigation measures are difficult to identify.

8.3 Impact Assessment of Komsberg East WEF

8.3.1 Construction Phase - Habitat Destruction

The extent of this impact is local and confined to the project site. Habitat destruction can be temporary in the case of, for example construction offices and laydown areas, or will last for the duration of the project, in the case of turbine foundations and substation compounds. The impact can be permanent (long-term) if no rehabilitation takes place, following the decommissioning of the development. The intensity of this impact is considered to be medium negative as a partial loss of habitat and resources will occur. As habitat destruction will definitely occur during construction the probability of this impact is high. The resulting significance of the impact is medium with a high confidence.

Mitigation measures as detailed in Table 15 can reduce the duration of the impact to the lifetime of the project, and decrease the intensity to low negative, which would result in a low significance rating for this impact.

Table 15: Possible Impact or Risk of Habitat Destruction for Komsberg East WEF in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	H	H
Can the impact be reversed?			YES – Areas disturbed during construction can be rehabilitated after construction and after decommissioning				
Will impact cause irreplaceable loss of resources?						NO – rehabilitation of habitat is possible	
Can impact be avoided, managed or mitigated?			YES –The total area of impact (and thus the intensity rating) can be minimised. Turbine and associated infrastructure areas can be rehabilitated after project close.				

Essential mitigation measures to reduce negative impacts or enhance opportunities: 1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction 2) High traffic areas and buildings such as offices, batching plants, storage areas etc. should where possible be situated in areas that are already disturbed; 3) Existing roads and farm tracks should be used where possible; 4) The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; 5) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas; 6) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 7) No off-road driving; 8) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced; 9) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded. 10) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist. 11) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).

8.3.2 Construction Phase - Disturbance and Displacement

Disturbances and noise from staff and construction activities can impact on certain sensitive species particularly whilst feeding and breeding. This may result in these species being displaced from the project site into other areas. The extent of this impact will be restricted to the immediate WEF site (local). It is expected that the majority of displacement will occur for the duration of the construction phase but some species may take longer to return. The impact is considered to be of high intensity and negative. The probability of some displacement occurring is considered definite with a high confidence during the busy construction period, resulting in a medium significance of this impact (Table 16

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	H	Negative	M	H	H
With Mitigation	L	L	M	Negative	L	M	H
Can the impact be reversed?		PARTIALLY – In some areas of the operational WEF, birds disturbed during construction may return to their activities after completion of construction.					
Will impact cause irreplaceable loss of resources?		POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.					
Can impact be avoided, managed or mitigated?		PARTIALLY– Some disturbance is inevitable with the activities associated with construction.					
Essential mitigation measures to reduce risk or enhance opportunities: 1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All							

contractors are to adhere to the CEMP and should apply good environmental practice during construction. 2) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced; 3) The appointed Environmental Control Officer (ECO) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed. 4) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise. 5) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas; 6) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 7) During the construction phase, an avifaunal specialist must conduct surveys/exploration of the WEF site (particularly focussing on the Martial Eagle and Verreaux's Eagle Roost sites as well as suitable cliff nesting habitat). This should be done during and after, the breeding season (i.e approximately in July and again in September) of large Eagles (e.g. Martial and Verreaux's Eagle). The aim will be to locate nest sites, so that these may continue to be monitored during the construction and operation phase, along with the monitoring of already identified nest sites (see point 8 below); and 8) Appoint a specialist to design and conduct monitoring of the breeding of raptors at the two identified nests (to date) of African Harrier Hawk and Verreaux's Eagle (Figure 12) as well as any additionally located nests (see point 7 above). This monitoring can be combined with the exploration described above, and should be conducted on two occasions (i.e approximately in July and again in September) across each calendar year, during construction. The aim will be to monitor any disturbance to or displacement of the breeding birds during construction.

6).

If all mitigation measured are adhered to the duration of the impact can be restricted to the construction phase (short-term) and the intensity of the impact can be lowered to medium, resulting in a low significance rating.

Table 16: Possible Impact or Risk of Disturbance and Displacement for Komsberg East WEF in Construction Phase.

	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	L	M	H	Negative	M	H	H
With Mitigation	L	L	M	Negative	L	M	H
Can the impact be reversed?			PARTIALLY – In some areas of the operational WEF, birds disturbed during construction may return to their activities after completion of construction.				
Will impact cause irreplaceable loss of resources?			POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.				
Can impact be avoided, managed or mitigated?			PARTIALLY– Some disturbance is inevitable with the activities associated with construction.				

Essential mitigation measures to reduce risk or enhance opportunities:

9) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.
10) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
11) The appointed Environmental Control Officer (ECO) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed.
12) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.
13) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas;
14) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible;
15) During the construction phase, an avifaunal specialist must conduct surveys/exploration of the WEF site (particularly focussing on the Martial Eagle and Verreaux's Eagle Roost sites as well as suitable cliff nesting habitat). This should be done during and after, the breeding season (i.e approximately in July and again in September) of large Eagles (e.g. Martial and Verreaux's Eagle). The aim will be to locate nest sites, so that these may continue to be monitored during the construction and operation phase, along with the monitoring of already identified nest sites (see point 8 below); and
16) Appoint a specialist to design and conduct monitoring of the breeding of raptors at the two identified nests (to date) of African Harrier Hawk and Verreaux's Eagle (Figure 12) as well as any additionally located nests (see point 7 above). This monitoring can be combined with the exploration described above, and should be conducted on two occasions (i.e approximately in July and again in September) across each calendar year, during construction. The aim will be to monitor any disturbance to or displacement of the breeding birds during construction.

8.3.3 Operational Phase – Disturbance and Displacement

It is expected that some species potentially occurring on the WEF site will be susceptible to displacement during the operational phase, for example smaller passerines such as larks, coursers and large terrestrial Red Data species such as Karoo Korhaan and Ludwig's Bustard. The extent of the impact will be restricted to the sites of disturbance within the WEF site. The duration of the impact will last for the duration of operations. The intensity is considered potentially high and probable to occur, resulting in a medium significance.

With implementation of the mitigation measures listed in **Error! Reference source not found.** the intensity can be lowered significantly to low resulting in a low significance.

Table 17: Possible Impact or Risk of Disturbance and Displacement for Komsberg East WEF in Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	H	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H

Can the impact be reversed?	POSSIBLY – After decommissioning and rehabilitation displaced species will possibly return.	
Will impact cause irreplaceable loss of resources?	POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.	
Can impact be avoided, managed or mitigated?	PARTIALLY– Some disturbance is inevitable with the operational activities	
Essential mitigation measures to reduce risk or enhance opportunities: 1) A site specific Operational Environmental Management Plan (OEMP) must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance. All contractors are to adhere to the OEMP and should apply good environmental practice during all operations. 2) The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possibly breeding by these species. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational Wind Farm, the nest/breeding site must not be disturbed and an avifaunal specialist must be contacted for further instruction. 3) Operational phase bird monitoring, in line with applicable guidelines, must be implemented and must include monitoring of all raptor nest sites for breeding success. The feasibility of fitting a GPS tracking devise to one of the Verreaux's Eagles using the active nest site should be explored further by the proponent and the specialist. This information would feed into the operational monitoring programme and would assist in determining disturbance and displacement effects. 4) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas; 5) Construction of infrastructure must consider avifaunal sensitivity zones (section 6) and avoid areas of higher sensitivities where possible;		

8.3.4 Operational Phase – Electrocution

The impact occurs locally and is restricted to powerlines within the Komsberg East WEF site. As the result of the impact is mortality it could affect the breeding success of species and their populations, therefore the intensity is considered potentially high and the duration long-term. As electrocution is known to affect many species in South Africa the impact is probable to occur. Therefore the significance of the impact would be high without mitigation.

If all powerlines are either underground or of a bird-friendly design as detailed in the table below the probability of electrocution occurring can be significantly reduced so that the intensity of the impact would be low. The duration of the impact would then be restricted to the life time of the project and reversible, resulting in an impact of low significance.

Table 18: Possible Impact or Risk of Electrocution for Komsberg East WEF in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	H	Negative	H	M	M
With Mitigation	L	M	L	Negative	L	L	M
Can the impact be reversed?			POSSIBLY – Bird fatalities caused by electrocution are irreversible. However local populations may recover if the occurrence of deaths is low.				

Will impact cause irreplaceable loss or resources?	POSSIBLY – Electrocution from overhead power lines causes bird fatalities which could significantly impact populations of certain species.	
Can impact be avoided, managed or mitigated?	YES – Reducing the total length of overhead power lines and using a safe pylon design can reduce the risk of electrocution.	
Possible mitigation measures to reduce risk or enhance opportunities: 1) Electrical infrastructure should not be constructed in 'no-go areas' and construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 2) Place power lines underground where possible; 3) Any new overhead power lines must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' monopole structures, with clearances between live components of 1.8 m or greater and which provides a safe bird perch.		

8.3.5 Operational Phase - Collisions with Power Lines

The extent of this impact is restricted to constructed powerlines within the Komsberg East WEF. If severe the effect could last beyond the duration of their existence. As the result of this impact is mortality which may affect the viability of a population the potential intensity is considered high negative. As discussed previously (Section 8.2.4) the impact is probable to occur. The resulting significance is potentially high.

If mitigation measures listed in Table 19 are adhered to the intensity of the impact can be significantly reduced to low, which would prevent the duration extending beyond the lifespan of the project (medium), resulting in a low significance rating.

Table 19: Possible Impact or Risk of Collisions with Power Lines for Komsberg East WEF in Operational Phase

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	H	Negative	H	M	L
With Mitigation	L	M	L	Negative	L	M	L
Can the impact be reversed?	POSSIBLY – Bird fatalities caused by collisions with overhead power lines are irreversible. However local populations may recover if the occurrence of deaths is low.						
Will impact cause irreplaceable loss of resources?	POSSIBLY – Collisions with overhead power lines causes bird fatalities which could significantly impact populations of certain species.						
Can impact be avoided, managed or mitigated?	YES – Reducing the total distance of overhead power lines and increasing their visibility by fitting bird flight diverters (BFD's) can reduce the number of collisions.						
Possible mitigation measures to reduce risk or enhance opportunities:							

1) Electrical infrastructure should not be constructed in 'no-go areas' and construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 2) Place new power lines underground where possible; 3) Place new overhead power lines adjacent to existing power line or linear infrastructure (e.g. roads and fence lines); 4) Attach appropriate marking devices (BFDs) on all new overhead power lines to increase visibility. Once the final power line route has been authorised and the tower/pylon positions have been pegged, an avifaunal specialist must conduct a 'walkthrough' of the authorised route prior to construction in order to identify the exact spans of line that require BFDs. 5) Develop and implement a carcass search programme for birds during the first two years of operation, in line with the South African monitoring guidelines (Jenkins *et al.* 2015). This program must include monitoring of overhead power lines.

8.3.6 Operational Phase - Collisions with Wind Turbines

The duration of the impact will be at least for the operational phase of the facility, but could impact populations permanently through local extinctions. The intensity of the impact is high (Table 20). The effect could have an impact on the regional population of certain species and the extent is therefore considered high. The resulting significance of the impact is high negative.

If mitigation measures detailed below are implemented, especially turbine placement is informed by the avifaunal sensitivity map and No-go Areas, then the extent of the impact could be reduced to local (medium), the duration to the lifespan of the facility (medium), and the intensity to medium (partial loss and slight alteration). The resulting significance with mitigation would be medium.

Table 20: Possible Impact or Risk of Collisions with Turbines for Komsberg East in Operational Phase.

	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	H	H	H	Negative	H	M	M
With Mitigation	M	M	M	Negative	M	M	M
Note: The extent of the impact will be on site at a turbine where the bird collides, but if numerous collisions of an important species occur, e.g. Verreaux's Eagle, this could have an impact on the local Roggeveld/Moordenaars Karoo population, and even an impact on a more regional scale. The loss of this keystone apex predator may have other ecological impacts beyond the site boundary.							
Can the impact be reversed?			POSSIBLY – Bird fatalities caused by collisions with turbines are irreversible. However local populations may recover if the occurrence of deaths is low.				
Will impact cause irreplaceable loss of resources?			POSSIBLY – Collisions with turbines cause bird fatalities, which could significantly impact local and/or regional populations of certain species.				
Can impact be avoided, managed or mitigated?			PARTIALLY – The intensity and probability of the impact can potentially be reduced through informed placement of turbines.				
Possible mitigation measures to reduce risk or enhance opportunities: 1) Turbines must not be constructed within any of the High Sensitivity Zones identified (Section 6).							

1) The hierarchy of sensitivity zones presented in Section 6 should be considered where possible, with preferential turbine placement in areas of Unknown, No or Low Sensitivity, and decreasing preference through to Medium-High Sensitivity Zones. Where two or more sensitivity areas overlap, the layer with the higher sensitivity designation should take preference.
2) Develop and implement a carcass search programme for birds during the first two years of operation, in line with the South African monitoring guidelines. The feasibility of fitting a GPS tracking devise to one of the Verreaux's Eagles using the active nest site should be explored further by the proponent and the specialist. This information would feed into the operational monitoring programme and would assist in determining collision effects.
3) Develop and implement a 24 month post-construction bird activity monitoring program that mirrors the pre-construction monitoring surveys completed by Arcus and is in line with the South African post-construction monitoring guidelines. This program must include thorough and ongoing nest searches and nest monitoring.
4) Frequent and regular review of operational phase monitoring data (activity and carcass) and results by an avifaunal specialist. This review should also establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development.
5) The above reviews should strive to identify sensitive locations at the development including turbines and areas of increased collisions with power lines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist and independent review), the specialist should conduct a literature review specific to the impact (e.g. collision and/or electrocution) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
    a. Assess the suitability of using deterrent devices (e.g. DT Bird and ultrasonic/radar/electromagnetic deterrents for bats) to reduce collision risk.
    b. Identify options to modify turbine operation to reduce collision risk if absolutely necessary and other methods have not had the desired results.

8.3.7 Operational Phase - Disruption of Local Bird Movement Patterns

The extent of this impact would affect bird populations travelling through the area and therefore extend beyond the boundaries of the wind farm and is thus classified as medium. The duration would be for the lifespan of the project (medium). The intensity would be moderate and the resulting significance medium.

While some mitigation is possible by avoiding turbine placement in obvious flyways, and by making turbines more visible through lighting, this will not change the significance of this impact.

Table 21: Possible Impact or Risk of Disruption of Local Bird Movements for Komsberg East in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	M	M	M	Negative	M	M	L
With Mitigation	M	M	M	Negative	M	M	L
Can the impact be reversed?			YES				
Will impact cause irreplaceable loss or resources?			POSSIBLY – Impact is not well understood.				
Can impact be avoided, managed or mitigated?			PARTIALLY- Local and regional movement of species is not well understood and so mitigation measures are difficult to identify.				
Possible mitigation measures to reduce residual risk or enhance opportunities: 1) Turbines must not be constructed within any of the High Sensitivity Zones identified (Section 6).							

2) The hierarchy of sensitivity zones presented in Section 6 should be considered where possible, with preferential turbine placement in areas of Unknown, No or Low Sensitivity, and decreasing preference through to Medium-High Sensitivity Zones. Where two or more sensitivity areas overlap, the layer with the higher sensitivity designation should take preference.
3) Lighting on turbines to be of an intermittent and coloured nature rather than constant white light to reduce the possible impact on the movement patterns of nocturnal migratory species.

8.4 Impact Assessment of Komsberg West WEF

8.4.1 Construction Phase - Habitat Destruction

The extent of this impact is local and confined to the project site. Habitat destruction can be temporary in the case of, for example construction offices and laydown areas, or will last for the duration of the project, in the case of turbine foundations and substation compounds. The impact can be permanent (long-term) if no rehabilitation takes place, following the decommissioning of the development. The intensity of this impact is considered to be medium negative as a partial loss of habitat and resources will occur. As habitat destruction will definitely occur during construction the probability of this impact is high. The resulting significance of the impact is medium with a high confidence.

Mitigation measures as detailed in Table 22 can reduce the duration of the impact to the lifetime of the project, and decrease the intensity to low negative, which would result in a low significance rating for this impact.

Table 22: Possible Impact or Risk of Habitat Destruction for Komsberg West WEF in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	H	H
Can the impact be reversed?			YES – Areas disturbed during construction can be rehabilitated after construction and after decommissioning				
Will impact cause irreplaceable loss of resources?						NO – rehabilitation of habitat is possible	
Can impact be avoided, managed or mitigated?			YES –The total area of impact (and thus the intensity rating) can be minimised. Turbine and associated infrastructure areas can be rehabilitated after project close.				

Essential mitigation measures to reduce negative impacts or enhance opportunities:
1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction 2) High traffic areas and buildings such as offices, batching plants, storage areas etc. should where possible be situated in areas that are already disturbed; 3) Existing roads and farm tracks should be used where possible; 4) The minimum footprint areas of infrastructure should be used wherever possible, including road widths and lengths; 5) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas; 6) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 7) No off-road driving; 8) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced; 9) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats within which construction activities may need to be excluded. 10) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist. 11) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).

8.4.2 Construction Phase - Disturbance and Displacement

Disturbance and displacement will occur on the immediate WEF site, therefore the extent is local. It is expected that the majority of displacement will occur for the duration of the construction phase which can be up to 24 months (medium term). The impact is considered to be of high intensity and negative. The probability of some displacement occurring is considered definite with a high confidence during the busy construction period, resulting in a medium significance of this impact (Table 23). If all mitigation measured are adhered to the duration of the impact can be restricted to the construction phase (short-term) and the intensity of the impact can be lowered to medium, resulting in a low significance rating.

Table 23: Possible Impact or Risk of Disturbance and Displacement for Komsberg West WEF in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	L	M	Negative	L	M	H
Can the impact be reversed?		PARTIALLY – In some areas of the operational WEF, birds disturbed during construction may return to their activities after completion of construction.					
Will impact cause irreplaceable loss of resources?		POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.					
Can impact be avoided, managed or mitigated?		PARTIALLY– Some disturbance is inevitable with the activities associated with construction.					
Essential mitigation measures to reduce risk or enhance opportunities:							

1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.
2) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
3) The appointed Environmental Control Officer (ECO) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possible breeding by these species. The ECO must then, during audits/site visits, make a concerted effort to look out for such breeding activities of Red Data species, and such efforts may include the training of construction staff (e.g. in Toolbox talks) to identify Red Data species, followed by regular questioning of staff as to the regular whereabouts on site of these species. If any of the Red Data species are confirmed to be breeding (e.g. if a nest site is found), construction activities within 500 m of the breeding site must cease, and an avifaunal specialist is to be contacted immediately for further assessment of the situation and instruction on how to proceed.
4) Prior to construction, an avifaunal specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final turbine positions, to identify any nests/breeding/roosting activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise.
5) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas;
6) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible;
7) An avifaunal specialist must conduct regular surveys/exploration of the WEF sites (particularly focussing on the Martial Eagle and Verreaux's Eagle Roost sites as well as suitable cliff nesting habitat). This should be done at least twice during a calendar year, optimally spaced during and after, the breeding season of large Eagles (e.g. Martial and Verreaux's Eagle). The aim will be to locate nest sites, so that these may continue to be monitored during the construction and operation phase, along with the monitoring of already identified nest sites; and
8) Appoint a specialist to design and conduct monitoring of the breeding of raptors at the two identified nests (to date) of African Harrier Hawk and Verreaux's Eagle (Figure 12) as well as any additionally located nests (see point 7 above). This monitoring can be combined with the gorge exploration described above, and should be conducted on three occasions across a calendar year, during construction.

8.4.3 Operational Phase – Disturbance and Displacement

It is expected that some species potentially occurring on the WEF site will be susceptible to displacement during the operational phase, for example smaller passerines such as larks, coursers and large terrestrial Red Data species such as Karoo Korhaan and Ludwig's Bustard.

The extent of the impact will be local and restricted to the WEF site for the duration of the disturbance (operation). The intensity is considered potentially medium and probable to occur, resulting in a medium negative significance.

With implementation of the mitigation measures listed in Table 24the intensity can be lowered to low resulting in a low negative significance.

Table 24: Possible Impact or Risk of Disturbance and Displacement for Komsberg West WEF in Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H

Can the impact be reversed?	POSSIBLY – After decommissioning and rehabilitation displaced species will possibly return.	
Will impact cause irreplaceable loss of resources?	POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.	
Can impact be avoided, managed or mitigated?	PARTIALLY– Some disturbance is inevitable with the operational activities	

Essential mitigation measures to reduce risk or enhance opportunities:

1) A site specific Operational Environmental Management Plan (OEMP) must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance. All contractors are to adhere to the OEMP and should apply good environmental practice during all operations.
2) The on-site WEF manager (or a suitably appointed Environmental Manager) must be trained by an avifaunal specialist to identify the potential priority species and Red Data species as well as the signs that indicate possibly breeding by these species. If a priority species or Red Data species is found to be breeding (e.g. a nest site is located) on the operational Wind Farm, the nest/breeding site must not be disturbed and the avifaunal specialist must be contacted for further instruction.
3) Operational phase bird monitoring, in line with applicable guidelines, must be implemented and must include monitoring of all raptor nest sites for breeding success.
4) No turbines should be constructed in no-go areas (see Section 6), while associated infrastructure should be avoided where possible in these areas; and
5) Construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible.

8.4.4 Operational Phase – Electrocution

Electrocution occurs locally and is restricted to powerlines associated within the Komsberg West WEF site. As the result of the impact is mortality it could affect the breeding success of species and their populations, the intensity is considered high and the duration potentially long-term. As electrocution is known to affect many species in South Africa the impact is probable to occur. Therefore the significance of the impact is potentially high negative.

If all powerlines are underground or of a bird-friendly design as detailed in the table below the intensity of the impact can be significantly reduced to low. The duration of the impact would then be restricted to the life time of the project and reversible, resulting in an impact of low negative significance.

Table 25: Possible Impact or Risk of Electrocution for Komsberg West WEF in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	H	Negative	H	M	M
With Mitigation	L	M	L	Negative	L	L	M

Can the impact be reversed?	POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.	
Will impact cause irreplaceable loss or resources?	POSSIBLY – Electrocution from overhead power lines causes bird fatalities which could significantly	

	impact populations of certain species.	
Can impact be avoided, managed or mitigated?	YES – Reducing the total length of overhead power lines and using a safe pylon design can reduce the risk of electrocution.	
Possible mitigation measures to reduce risk or enhance opportunities: 1) Electrical infrastructure should not be constructed in 'no-go areas' and construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 2) Place power lines underground where possible and any new overhead power lines must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' monopole structures, with clearances between live components of 1.8 m or greater and which provides a safe bird perch.		

8.4.5 Operational Phase - Collisions with Power Lines

The extent of this impact is restricted to constructed powerlines within the Komsberg West WEF and if severe the effect could last beyond the duration of their existence. As the result of this impact is mortality which may affect the viability of a population the intensity is considered potentially high. As discussed previously (Section 7.2.4) the impact is probable to occur. The resulting significance is potentially high negative.

If mitigation measures listed in the table below are adhered to the intensity of the impact can be significantly reduced to low, which would prevent the duration extending beyond the lifespan of the project (medium), resulting in a low significance rating.

Table 26: Possible Impact or Risk of Collisions with Power Lines for Komsberg West WEF in Operational Phase

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	H	Negative	H	M	L
With Mitigation	L	M	L	Negative	L	M	L
Can the impact be reversed?	POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.						
Will impact cause irreplaceable loss of resources?	POSSIBLY – Collisions with overhead power lines causes bird fatalities which could significantly impact populations of certain species.						
Can impact be avoided, managed or mitigated?	YES – Reducing the total distance of overhead power lines and increasing their visibility by fitting bird flight diverters (BFD's) can reduce the number of collisions.						
Possible mitigation measures to reduce risk or enhance opportunities: 1) Electrical infrastructure should not be constructed in 'No-go areas' and construction of infrastructure must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 2) Place new power lines underground where possible;							

3) Place new overhead power lines adjacent to existing power line or linear infrastructure (e.g. roads and fence lines); 4) Attach appropriate marking devices (BFDs) on all new overhead power lines to increase visibility. Once the final power line route has been authorised and the tower/pylon positions have been pegged, an avifaunal specialist must conduct a 'walkthrough' of the authorised route prior to construction in order to identify the exact spans of line that require BFDs; and 5) Develop and implement a carcass search programme for birds during the first two years of operation, in line with the South African monitoring guidelines (Jenkins *et al.* 2015). This program must include monitoring of overhead power lines.

8.4.6 Operational Phase - Collisions with Wind Turbines

The duration of the impact will be at least for the operational phase of the facility, but could impact populations permanently through local extinctions. The intensity of the impact is considered potentially high (Table 27). The effect could have an impact on the regional population of certain species and the extent is therefore considered high. The resulting significance of the impact is high negative.

If mitigation measures detailed below are implemented, especially turbine placement is informed by the avifaunal sensitivity map and No-Go Areas, then the extent of the impact could be reduced to local (medium), the duration to the lifespan of the facility (medium), and the intensity to medium (partial loss and slight alteration). The resulting significance with mitigation would be medium negative.

Table 27: Possible Impact or Risk of Collisions with Turbines for Komsberg West WEF in Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	H	H	M	Negative	H	M	M
With Mitigation	M	M	M	Negative	M	L	M
Note: The extent of the impact will be on site at a turbine where the bird collides, but if numerous collisions of an important species occur, e.g. Verreaux's Eagle, this could have an impact on the local Roggeveld/Moordenaars Karoo population, and even an impact on a more regional scale. The loss of this keystone apex predator may have other ecological impacts beyond the site boundary.							
Can the impact be reversed?			POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.				
Will impact cause irreplaceable loss of resources?			YES – Collisions with turbines causes bird fatalities, cumulative impacts could significantly impact local and/or regional populations of certain species.				
Can impact be avoided, managed or mitigated?			PARTIALLY – The intensity and probability of the impact can potentially be reduced through informed placement of turbines.				
Possible mitigation measures to reduce risk or enhance opportunities: 1) Turbines must not be constructed within any of the High Sensitivity Zones identified (Section 6). 2) The hierarchy of sensitivity zones presented in Section 6 should be considered, with preferential turbine placement in areas of Unknown, No or Low Sensitivity, and decreasing preference through to Medium-High Sensitivity Zones. Where two or more sensitivity areas overlap, the layer with the higher sensitivity designation should take preference. 3) Develop and implement a carcass search programme for birds during the first two years of operation, in line with the South African monitoring guidelines.							

4) Develop and implement a 24 month post-construction bird activity monitoring program that mirrors the pre-construction monitoring surveys completed by Arcus and is in line with the South African post-construction monitoring guidelines. This program must include thorough and ongoing nest searches and nest monitoring.
5) Frequent and regular review of operational phase monitoring data (activity and carcass) and results by an avifaunal specialist. This review should also establish the requirement for continued monitoring studies (activity and carcass) throughout the operational and decommissioning phases of the development.
6) The above reviews should strive to identify sensitive locations at the development including turbines and areas of increased collisions with power lines that may require additional mitigation. If unacceptable impacts are observed (in the opinion of the bird specialist), the specialist should conduct a literature review specific to the impact (e.g. collision and/or electrocution) and provide updated and relevant mitigation options to be implemented. As a starting point for the review of possible mitigations, the following may need to be considered:
    a. Assess the suitability of using deterrent devices (e.g. DT Bird and ultrasonic/radar/electromagnetic deterrents for bats) to reduce collision risk.
    b. Identify options to modify turbine operation to reduce collision risk

8.4.7 Operational Phase - Disruption of Local Bird Movement Patterns

The extent of this impact would affect bird populations travelling through the area and therefore extend beyond the boundaries of the wind farm and is thus classified as medium. The duration would be for the lifespan of the project (medium). The intensity would be moderate and the resulting significance medium negative.

While some mitigation is possible by avoiding turbine placement in obvious flyways, and by making turbines more visible through lighting, this will not change the significance of this impact.

Table 28: Possible Impact or Risk of Disruption of Local Bird Movements for Komsberg West in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	M	M	M	Negative	M	M	L
With Mitigation	M	M	M	Negative	M	M	L
Can the impact be reversed?						YES	
Will impact cause irreplaceable loss or resources?	POSSIBLY – Impact is not well understood.						
Can impact be avoided, managed or mitigated?	PARTIALLY- Local and regional movement of species is not well understood and so mitigation measures are difficult to identify.						

Possible mitigation measures to reduce residual risk or enhance opportunities:

1) Turbines must not be constructed within any of the High Sensitivity Zones identified (Section 6)
2) The hierarchy of sensitivity zones presented in Section 6 should be considered, with preferential turbine placement in areas of Unknown, No or Low Sensitivity, and decreasing preference through to Medium-High Sensitivity Zones. Where two or more sensitivity areas overlap, the layer with the higher sensitivity designation should take preference.
3) Lighting on turbines to be of an intermittent and coloured nature rather than constant white light to reduce the potential impact on the movement patterns of nocturnal migratory species.

8.5 Komsberg East Grid Connection

8.5.1 Construction Phase – Habitat Destruction

Habitat destruction will be limited to the grid connection area. Without rehabilitation the duration can be permanent. The intensity of habitat destruction is considered to be medium, resulting in an impact of potentially medium negative significance.

With appropriate mitigation measures listed in Table 29 the intensity and duration of the impact can be lowered resulting in a low negative significance.

Table 29: Possible Impact or Risk of Habitat Destruction for Komsberg East Grid Connection in Construction Phase.

<table>
<tr><th></th><th>Extent</th><th>Duration</th><th>Intensity</th><th>Status</th><th>Significance</th><th>Probability</th><th>Confidence</th></tr>
<tr><td>Without Mitigation</td><td>L</td><td>H</td><td>M</td><td>Negative</td><td>M</td><td>H</td><td>H</td></tr>
<tr><td>With Mitigation</td><td>L</td><td>M</td><td>L</td><td>Negative</td><td>L</td><td>H</td><td>H</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="3">Can the impact be reversed?</td><td colspan="3">YES – Areas disturbed during construction can be rehabilitated after construction and after decommissioning</td><td colspan="2"></td></tr>
<tr><td colspan="3">Will impact cause irreplaceable loss of resources?</td><td colspan="3"></td><td colspan="2">NO – rehabilitation of habitat is possible</td></tr>
<tr><td colspan="3">Can impact be avoided, managed or mitigated?</td><td colspan="3">YES –The total area of impact (and thus the intensity rating) can be minimised. The servitude can be rehabilitated after project close.</td><td colspan="2"></td></tr>
<tr><td colspan="8">Essential mitigation measures to reduce negative impacts or enhance opportunities:
1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction
2) High traffic areas and buildings such as offices, batching plants, storage areas etc. should where possible be situated in areas that are already disturbed;
3) Existing roads and farm tracks should be used where possible;
4) The minimum footprint areas of infrastructure should be used wherever possible, including servitude widths and lengths;
5) Where possible, grid infrastructure (within the WEF site) should not be constructed in High Sensitivity Zones (see Section 6);
6) Construction of grid infrastructure (within the WEF site) must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible;
7) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
8) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist.
9) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).
10) Beyond the WEF site, the Grid Connection route should, where possible, follow existing linear infrastructure such as roads and power lines, and should be constructed as close as practically possible to the existing infrastructure.
11) Where possible the Grid Connection route must avoid sensitive areas such as wetlands, dams, rivers and cultivated lands.</td></tr>
</table>

8.5.2 Construction Phase - Disturbance and Displacement

The duration of disturbance is expected to last for the duration of the construction phase (medium-term) and will be restricted to the grid connection area. Disturbance during the breeding season and close to nesting sites can potentially impact the breeding success of various sensitive species. Therefore this impact is considered of medium intensity resulting in a medium negative significance.

With mitigation measures detailed in Table 30 the residual impact is expected to be low negative.

Table 30: Possible Impact or Risk of Disturbance and Displacement for Komsberg East Grid Connection in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H
Can the impact be reversed?			PARTIALLY – In some areas of the operational WEF, birds disturbed during construction may return to their activities after completion of construction.				
Will impact cause irreplaceable loss of resources?			POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.				
Can impact be avoided, managed or mitigated?			PARTIALLY– Some disturbance is inevitable with the activities associated with construction.				
Essential mitigation measures to reduce risk or enhance opportunities: 1) Prior to construction, the avifaunal specialist should conduct a site walkthrough, covering the final grid connection route and pylon locations, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise. 2) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.							

8.5.3 Operational Phase – Disturbance and Displacement

The extent of this impact will be local and last for the duration of the operation of the grid connection (medium term). As disturbance is largely restricted to regular maintenance activities that do not occur on a daily basis the intensity of the impact is considered medium, resulting in a medium negative significance.

The implementation of an Operational Environmental Management Plan (OEMP) can lower the intensity of this impact to low, which would result in a low residual impact significance.

Table 31: Possible Impact or Risk of Disturbance and Displacement for Komsberg East WEF in Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H

Can the impact be reversed?	POSSIBLY – After decommissioning and rehabilitation displaced species will possibly return.	
Will impact cause irreplaceable loss of resources?	UNLIKELY – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.	
Can impact be avoided, managed or mitigated?	PARTIALLY– Some disturbance is inevitable with the operational activities, but these can be minimised.	
Essential mitigation measures to reduce risk or enhance opportunities: 1) A site specific Operational Environmental Management Plan (OEMP) must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance. All contractors are to adhere to the OEMP and should apply good environmental practice during all operations.		

8.5.4 Operational Phase – Electrocution

While the impact occurs locally and is restricted to the grid connection area, it could have an effect on regional populations. As the result of the impact is mortality it could affect the breeding success of species and their populations, the intensity is considered high and the duration potentially long-term. As electrocution is known to affect many species in South Africa the impact is probable to occur. Therefore the significance of the impact is potentially high negative.

By using bird friendly structures as detailed in Table 32 the intensity of the impact can be significantly reduced to low. A reduced mortality will prevent populations to be affected on a regional scale, so the extent would be local. The residual impact would therefore be a low negative.

Table 32: Possible Impact or Risk of Electrocution for Komsberg East Grid Connection in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	M	H	H	Negative	H	M	M
With Mitigation	L	M	L	Negative	L	L	M
Can the impact be reversed?		POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.			.		
Will impact cause irreplaceable loss or resources?		POSSIBLY – Electrocution from overhead power lines causes bird fatalities which could significantly impact populations of certain species.					
Can impact be avoided, managed or mitigated?		YES – Reducing the total length of overhead power lines and using a safe pylon design can reduce the risk of electrocution.					
Possible mitigation measures to reduce risk or enhance opportunities: 1) Any grid connection power line/s must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' monopole structures, with clearances between live components of 1.8 m or greater and which provide a safe bird perch.							

2) The operational monitoring programme for the associated WEF site must be in line with the South African monitoring guidelines (Jenkins *et al.* 2015) and must include regular monitoring of the grid connection power line and all new associated substations for electrocution (and collision) mortalities. Any mortalities should be reported to the Endangered Wildlife Trust (EWT)

8.5.5 Operational Phase - Collisions with Power Lines

As the result of this impact is mortality which may affect the viability of a population the intensity is considered high, and the extent high, as regional populations could be affected. As discussed previously the impact is probable to occur. The resulting significance is high.

If mitigation measures listed in Table 33 are adhered to the intensity of the impact can be reduced to medium, resulting in a medium significance rating.

Table 33: Possible Impact or Risk of Collisions with Power Lines for Komsberg East Grid Connection in Operational Phase

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	H	M	H	Negative	H	M	L
With Mitigation	M	M	M	Negative	M	M	L
Can the impact be reversed?			POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.				
Will impact cause irreplaceable loss of resources?			POSSIBLY – Collisions with overhead power lines causes bird fatalities which could significantly impact populations of certain species.				
Can impact be avoided, managed or mitigated?			YES – Reducing the total distance of overhead power lines and increasing their visibility by fitting bird flight diverters (BFD's) can reduce the number of collisions.				
Essential mitigation measures to reduce risk or enhance opportunities: 1) Where possible, grid infrastructure (within the WEF site) should not be constructed in High Sensitivity Zones (see Section 6) 2) Construction of grid infrastructure (within the WEF site) must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 1) Construct new power lines close to existing power lines where possible. 3) An avifaunal specialist must conduct a site walk through of final Grid Connection route and pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required. 4) Install bird flight diverters as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans. 5) The operational monitoring programme for the associated WEF site must be in line with the South African monitoring guidelines (Jenkins *et al.* 2015) and must include regular monitoring of the grid connection power line for collision (and electrocution) mortalities. Any mortalities should be reported to the Endangered Wildlife Trust (EWT).							

8.6 Komsberg West Grid Connection

8.6.1 Construction Phase – Habitat Destruction

Habitat destruction will be limited to the grid connection area. Without rehabilitation the duration can be permanent. The intensity of habitat destruction is considered to be medium negative, resulting in an impact of potentially medium negative significance.

With appropriate mitigation measures listed in the table below the intensity and duration of the impact can be lowered resulting in a low negative significance.

Table 34: Possible Impact or Risk of Habitat Destruction for Komsberg West Grid Connection in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	H	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	H	H

Can the impact be reversed?	YES – Areas disturbed during construction can be rehabilitated after construction and after decommissioning	
Will impact cause irreplaceable loss of resources?		NO – rehabilitation of habitat is possible
Can impact be avoided, managed or mitigated?	YES –The total area of impact (and thus the intensity rating) can be minimised. The servitude can be rehabilitated after project close.	

Essential mitigation measures to reduce negative impacts or enhance opportunities:

1) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction
2) High traffic areas and buildings such as offices, batching plants, storage areas etc. should where possible be situated in areas that are already disturbed;
3) Existing roads and farm tracks should be used where possible;
4) The minimum footprint areas of infrastructure should be used wherever possible, including servitude widths and lengths;
5) Where possible, grid infrastructure (within the WEF site) should not be constructed in High Sensitivity Zones (see Section 6);
6) Construction of grid infrastructure (within the WEF site) must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible;
7) Environmental Control Officers to oversee activities and ensure that the site specific construction environmental management plan (CEMP) is implemented and enforced;
8) Any clearing of stands of alien trees on site should be approved first by an avifaunal specialist.
9) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and to this end a habitat restoration plan is to be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).
10) Beyond the WEF site, the Grid Connection route should, where possible, follow existing linear infrastructure such as roads and power lines, and should be constructed as close as practically possible to the existing infrastructure.
11) Where possible the Grid Connection route must avoid sensitive areas such as wetlands, dams, rivers and cultivated lands.

8.6.2 Construction Phase - Disturbance and Displacement

The duration of disturbance is expected to last for the duration of the construction phase (medium-term). Disturbance during the breeding season and close to nesting sites can potentially impact the breeding success of birds nesting in the area and various species sensitive to disturbance and displacement may occur such as Ludwig's Bustard, Blue Crane and Verreaux's Eagle. Therefore this impact is considered of medium intensity.

With mitigation measures the residual impact is expected to be low.

Table 35: Possible Impact or Risk of Disturbance and Displacement for Komsberg West Grid Connection in Construction Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H
Can the impact be reversed?			PARTIALLY – In some areas of the operational WEF, birds disturbed during construction may return to their activities after completion of construction.				
Will impact cause irreplaceable loss of resources?			POSSIBLE – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.				
Can impact be avoided, managed or mitigated?			PARTIALLY– Some disturbance is inevitable with the activities associated with construction.				
Essential mitigation measures to reduce risk or enhance opportunities: 1) Prior to construction, the avifaunal specialist should conduct a site walkthrough, covering the final grid connection route and pylon locations, to identify any nests/breeding activity of sensitive species, as well as any additional sensitive habitats. The results of which may inform the final construction schedule in close proximity to that specific area, including abbreviating construction time, scheduling activities around avian breeding and/or movement schedules, and lowering levels of associated noise. 2) A site specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.							

8.6.3 Operational Phase – Disturbance and Displacement

The extent of this impact will be local and last for the duration of the operation of the grid connection (medium term). As disturbance is largely restricted to regular maintenance activities that do not occur on a daily basis the intensity of the impact is considered medium, resulting in a potentially medium negative significance.

The implementation of an Operational Environmental Management Plan (OEMP) can lower the intensity of this impact to low, resulting in a low residual impact significance.

Table 36: Possible Impact or Risk of Disturbance and Displacement for Komsberg West WEF in Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	L	M	M	Negative	M	H	H
With Mitigation	L	M	L	Negative	L	M	H

Can the impact be reversed?	POSSIBLY – After decommissioning and rehabilitation displaced species will possibly return.	
Will impact cause irreplaceable loss of resources?	UNLIKELY – Disturbance and potential displacement of birds may impact breeding and thus impact on the population of a species.	
Can impact be avoided, managed or mitigated?	PARTIALLY– Some disturbance is inevitable with the operational activities, but these can be minimised.	
Essential mitigation measures to reduce risk or enhance opportunities: 1) A site specific Operational Environmental Management Plan (OEMP) must be implemented, which gives appropriate and detailed description of how operational and maintenance activities must be conducted to reduce unnecessary disturbance. All contractors are to adhere to the OEMP and should apply good environmental practice during all operations.		

8.6.4 Operational Phase – Electrocution

While the impact occurs locally and is restricted to the grid connection area, it could have an effect on regional populations. As the result of the impact is mortality it could affect the breeding success of species and their populations, the intensity is considered high and the duration potentially long-term. As electrocution is known to affect many species in South Africa the impact is probable to occur. Therefore the significance of the impact is potentially high negative.

By using bird friendly structures as detailed in

Table 37 below the intensity of the impact can be reduced to medium, and the extent to local, as reduced mortality will prevent populations to be affected on a regional scale. The residual impact would therefore be potentially low negative.

Table 37: Possible Impact or Risk of Electrocution for Komsberg West Grid Connection in the Operational Phase.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	M	H	H	Negative	H	M	M
With Mitigation	L	M	L	Negative	L	L	M
Can the impact be reversed?			POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.				
Will impact cause irreplaceable loss or resources?			POSSIBLY – Electrocution from overhead power lines causes bird fatalities which could significantly impact populations of certain species.				
Can impact be avoided, managed or mitigated?			YES – Reducing the total length of overhead power lines and using a safe pylon design can reduce the risk of electrocution.				
Possible mitigation measures to reduce risk or enhance opportunities: 1) Any grid connection power line/s must be of a design that minimizes electrocution risk by using adequately insulated 'bird friendly' monopole structures, with clearances between live components of 1.8 m or greater and which provide a safe bird perch.							

2) The operational monitoring programme for the associated WEF site must be in line with the South African monitoring guidelines (Jenkins *et al.* 2015) and must include regular monitoring of the grid connection power line and all new associated substations for electrocution (and collision) mortalities. Any mortalities should be reported to the Endangered Wildlife Trust (EWT)

8.6.5 Operational Phase - Collisions with Power Lines

The intensity of this impact is correlated to the length of the proposed power lines. As the Komsberg West Grid Connection is shorter than the Komsberg East Grid Connection, the intensity of this impact is expected to be lower (medium). The extent is potentially medium, as regional populations could be affected. As discussed previously the impact is probable to occur. The resulting significance is potentially medium negative.

If mitigation measures listed below are adhered to the intensity of the impact can be reduced to low, resulting in a low negative significance rating.

Table 38: Possible Impact or Risk of Collisions with Power Lines for Komsberg West Grid Connection in Operational Phase

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	M	M	M	Negative	M	M	L
With Mitigation	M	M	L	Negative	L	M	L
Can the impact be reversed?			POSSIBLY – Bird fatalities are irreversible. However local populations may recover if the occurrence of deaths is low.				
Will impact cause irreplaceable loss of resources?			POSSIBLY – Collisions with overhead power lines causes bird fatalities which could significantly impact populations of certain species.				
Can impact be avoided, managed or mitigated?			YES – Reducing the total distance of overhead power lines and increasing their visibility by fitting bird flight diverters (BFD's) can reduce the number of collisions.				
Essential mitigation measures to reduce risk or enhance opportunities: 1) Where possible, grid infrastructure (within the WEF site) should not be constructed in High Sensitivity Zones (see Section 6) 2) Construction of grid infrastructure (within the WEF site) must consider avifaunal sensitivity zones and avoid areas of higher sensitivities where possible; 1) Construct new power lines close to existing power lines where possible. 3) An avifaunal specialist must conduct a site walk through of final Grid Connection route and pylon positions prior to construction to determine if, and where, bird flight diverters (BFDs) are required. 4) Install bird flight diverters as per the instructions of the specialist following the site walkthrough, which may include the need for modified BFDs fitted with solar powered LED lights on certain spans. 5) The operational monitoring Programme for the associated WEF site must be in line with the South African monitoring guidelines (Jenkins *et al.* 2015) and must include regular monitoring of the grid connection power line for collision (and electrocution) mortalities. Any mortalities should be reported to the Endangered Wildlife Trust (EWT).							

8.7 Cumulative Impacts

8.7.1 Komsberg East WEF and Komsberg East Grid Connection

The cumulative impacts of the Komsberg East WEF and Komsberg East Grid Connection may be slightly higher than the individual impacts for habitat destruction, disturbance and displacement, electrocution and power line collisions, but the significance is expected to remain the same for each of these impacts. The cumulative impact is therefore expected to have the significance of the component with the higher significance.

8.7.2 Komsberg West WEF and Komsberg West Grid Connection

The cumulative impacts of the Komsberg West WEF and Komsberg West Grid Connection may be slightly higher than the individual impacts for habitat destruction, disturbance and displacement, electrocution and power line collisions, but the significance is expected to remain the same for each of these impacts. The cumulative impact is therefore expected to have the significance of the component with the higher significance.

8.7.3 Komsberg East WEF, Komsberg East Grid Connection, Komsberg West WEF and Komsberg West Grid Connection

The cumulative impact of the Komsberg East and West Wind Energy Facilities and associated electrical grid connection infrastructure is expected to have an overall impact higher than the individual components, especially for the operational phase. Depending largely on turbine placement, the combined impact of up to 110 turbines has the potential to affect the viability of local populations. If all No-go and High Sensitivity zones are avoided, and if all recommended mitigations are correctly implemented, the cumulative impacts of the two WEFs may be acceptable. To reduce cumulative impacts, Arcus would recommend wherever possible utilising the minimum number of turbines to meet the required MW output.

8.7.4 Komsberg East WEF, Komsberg East Grid Connection, Komsberg West WEF, Komsberg West Grid Connection and Proposed WEF Projects within a 50 km radius.

All of the above mentioned impacts, and particularly those associated with the operational phase of the proposed project, may be intensified by each other and due to the potential cumulative impacts of a number of proposed WEFs (and associated infrastructure) within 50 km of the project site.

Approximately 7 large WEFs in various stages of the EIA application process fall within this 50 km radius of the project site. Included in these are two projects that already have preferred bidder status in the department of Energy's Renewable Energy Independent Power Producers Procurement Programme (REIPPPP), and are due for imminent construction, including Roggeveld Wind Farm (140 MW) and Karusa Wind Farm (140 MW), the latter of which was part of the originally proposed Hidden Valley WEF (another phase of which, namely the Great Karoo WEF, borders on Komsberg West.

In the scope of this impact study it is difficult to say with confidence at this stage what the cumulative impact of all the proposed developments will be on birds because there is no cumulative baseline to measure against. The extent of actual impacts on the region's avifauna will only become known once a few wind farms are developed and operational data becomes available, and regional population viability analysis have been conducted for key species. Furthermore, the developments considered may not all be constructed. However, the specialist believes that these projects may proceed (if all recommendations and mitigation measures are adequately implemented). This is primarily due to the generally low numbers of priority species encountered and low levels of flight activity, when compared with other regions worked in by the specialist.

Conducting a detailed cumulative impact assessment of all of these facilities together on a regional scale (which should include a population analysis of the regional Verreaux's Eagle population as well as some level of collision risk modelling or predictions for this population) is beyond the scope of this specialist study and although useful for the area the projects can proceed without such a study being compiled. The Specialist will, outside of the scope of this report, engage with the appropriate regional or national agency/ies in the context of strategic planning regarding the commissioning of such a report by these bodies.

At a high level and with low confidence it can be said that, if four or more of these facilities are approved and constructed they (together with Komsberg East WEF and Komsberg West WEF) may present a medium to high significant threat to birds, particularly from collision impacts (with either powerlines or turbines). Collisions with powerlines and wind turbines can potentially affect the viability of regional populations, particularly of Verreaux's Eagle, Karoo Korhaan, Martial Eagle and Ludwig's Bustard.

The significance of these cumulative impacts will depend largely on:

- The final turbine layouts of all facilities;
- If turbine placement was informed by pre-construction monitoring and nest surveys on these facilities;
- The density of the Verreaux's Eagle populations on the facilities (i.e the regional population of Verreaux's Eagle).
- The species richness, abundance and behaviour of the avifaunal community within and around the various WEFs;
- Whether or not mitigation measures were recommended and implemented and are successful.

If all proposed projects that are built implement appropriate mitigation measures as well as post-construction monitoring programmes and share the information gained from these, then the overall significance of the discussed impacts may be reduced. However, the significance of some cumulative impacts is likely to remain medium to high negative even after mitigation.

As WEF developments typically only result in approximately 0.5 – 2% of the land being disturbed/destroyed, and considering that the habitats that are likely to be destroyed occur in relative abundance elsewhere within the broader region, the cumulative impacts of habitat destruction on birds is predicted to be low to medium. The majority of priority species potentially occurring at the project site all have relatively large distribution ranges and as such, the cumulative impacts of disturbance and displacement are likely to be medium and regionally significant, rather than national. Furthermore, the majority of the species likely to be displaced have suitable habitat beyond the WEF (even if the 4 or more of the 7 projects are constructed), the cumulative impact is likely to be of medium significance. Assuming that all new power line infrastructure associated with the proposed WEFs in the 50 km radius will be constructed using a safe, 'bird friendly design' the cumulative impact of electrocution is likely to be of medium significance.

8.8 Stakeholder Consultation

Birdlife SA was consulted prior to the compilation of the final AIAR. The methodology used for the monitoring programme was explained and accepted in principal. The main avifaunal issues recorded by the monitoring and the impact study were relayed to Birdlife SA. They also gave comment and advised Arcus to consider the extensive number of WEFs proposed in the area.

9 CONCLUSION

Generally the proposed project (including all four project components) is situated in an area with a moderate species richness, and the WEF site does not appear to be overly sensitive in terms of avifauna. In the specialists opinion (based on experience in other parts of the country) the Komsberg/Sutherland area appears to be a relatively good area for the placement of a WEF, as the abundance and activity of priority species is generally low. However, some Red Data species are present, and these few species require protection.

The species of most concern were identified as Verreaux's Eagle, Martial Eagle, Ludwig's Bustard and Karroo Korhaan. Of these, Verreaux's Eagle is most likely to be impacted by the development, with the breeding pair situated on the Komsberg East WEF being at most risk. To provide protection to this pair, as well as to other priority species, detailed sensitivity mapping was conducted and 'no-go' areas were identified. It is also recommended that the viability of capturing one of these pair of eagles and fitting it with a GPS tracking device be explored, so that its movements can be monitored. This can commence with the commencement of construction and continue through the construction phase, and in to the operational phase. This information can then feed into the construction phase and operational phase monitoring, and assist in identifying impacts (e.g. collision or displacement) of this pair, as well as any other behavioural changes in response to construction activities and/or the presence of turbines. It need not have an impact on exclusion zones for turbine placement, this will remain as outlined in this report.

The proponent has taken into consideration the recommendations made regarding the sensitivity zones (Section 6) and no-go areas described in this report when designing the layout of the WEFs and grid connections. A significant number of turbines have been dropped in an iterative design process. As these design recommendations have been implemented, and assuming that all the recommendations and mitigations given for the construction and operational phases are implemented, it has been assessed that the impacts (of the four project components) are likely to be brought to a moderately significant level, and would be acceptable.

Of more concern to the specialists are the potential cumulative impacts of an additional up to 7 large WEFs proposed within 50 km of the Komsberg WEF site. It was found that cumulatively the residual impact of collision from the Komsberg East and West WEFs and Grid Connections (with turbines and/or over-head power lines) may be medium to high negative, although our confidence in this rating is low.

Conducting a detailed cumulative impact assessment of all of these facilities together on a regional scale (which should include a population analysis of the regional Verreaux's Eagle population as well as some level of collision risk modelling or predictions for this population) is beyond the scope of this specialist study and although useful for the area the projects can proceed without such a study being compiled. The Specialist will, outside of the scope of this report, engage with the appropriate regional or national agency/ies in the context of strategic planning regarding the commissioning of such a report by these bodies.

Although the confidence in our cumulative impact assessment is low (in the absence of such a study), the specialist believes that the projects may proceed (if all recommendations and mitigation measures are adequately implemented) prior to such a study being implemented. This is primarily due to the generally low numbers of priority species encountered and low levels of flight activity, when compared with other regions worked in by the specialist.

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APPENDIX I: SPECIES SUMMARY

				Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2			
Species name		AVISENSE	EWT				3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100	WEF	CONTROL
1	Apalis, Bar-throated		x	8													
2	Avocet, Pied		x			25						100					
3	Barbet, Acacia Pied	x		75	100	38				Ad hoc			80		100	x	x
4	Batis, Pririt			67	60	13							60			x	x
5	Bee-eater, European			8									40			x	
6	Bishop, Southern Red		x	25			8						20			x	
7	Bishop, Yellow		x														
8	Bokmakierie	x	x	75	100	88	100	75	100	100	33.33		60	40	100	x	x
9	Boubou, Southern															x	x
10	Bulbul, African Red-eyed		x	8	40	13							40			x	x
11	*Bulbul, Cape*		x	17												x	x
12	Bunting, Cape	x	x	67	100	75	83	25	100	100	100		80	100	100	x	x
13	Bunting, Cinnamon-breasted															x	
14	Bunting, Lark-like		x	25	20	13	50	25	88	66.67	100		60	60	100	x	x

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
15	**Bustard, Ludwig's (EN)**		x	17		13	17	50								x	
16	Buttonquail, Kurrichane		x														
17	***Buzzard, Jackal***	x	x			38	58	25	38	100		100	20	60		x	x
18	**Buzzard, Steppe**		x				17						20			x	
19	*Canary, Black-headed*	x	x	25	40	38	50	50	63	Ad hoc	33.33		80	40		x	x
20	Canary, Black-throated	x														x	
21	Canary, Cape		x										20				
22	Canary, White-throated	x	x	58	80	63	67	50	25	33.33			60			x	x
23	Canary, Yellow	x	x	33		63	33	25	88	33.33	33.33		40	60		x	x
24	Chat, Anteating	x	x		40	13										x	
25	Chat, Familiar	x	x	58	80	38	25	Ad hoc		33.33			100	20	100	x	x
26	Chat, Karoo	x	x	92	100	75	75		13	33.33	66.67		60	20		x	x
27	*Chat, Sickle-winged*	x	x			25	67	25	88	66.67	33.33			80		x	
28	Chat, Tractrac		x			25											
29	Cisticola, Grey-backed	x	x	67	40	38	100	Ad hoc	88	100	100		40	60		x	x
30	Cisticola, Levaillant's		x							Ad hoc							

	Species name	AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2			
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100	WEF	CONTROL
31	Cisticola, Zitting		x														
32	Coot, Red-knobbed	x	x			38		25					20				
33	Cormorant, Reed		x	8													
34	Cormorant, White-breasted	x	x					50					40				
35	**Crane, Blue (NT)**		x														
36	Crombec, Long-billed		x	17	40	50	25			33.33			60	20		x	x
37	Crow, Cape		x													x	
38	Crow, Pied	x	x	25	20		42	25	25	Ad hoc	33.33		20	40		x	x
39	Cuckoo, Diderick			25									40				x
40	Darter, African		x														
41	Dove, Laughing			50	20	25		Ad hoc		Ad hoc			100		100	x	x
42	Dove, Namaqua			17		25	17				33.33		60	20		x	x
43	Dove, Red-eyed			25		25	50								100	x	x
44	Dove, Rock		x													x	
45	Drongo, Fork-tailed		x														
46	Duck, African Black	x	x	42								100	40				
47	Duck, Maccoa		x														

	Species name	AVISENSE	EWT	**Rep Rate (%)**												**ARCUS SURVEY**	
				3220 DD	**3221 CC**	**3220DB**							**3221CA**				
				SABAP 1	**SABAP 1**	**SABAP 1**	**SABAP2**						**SABAP 1**	**SABAP2**			
	Species name	**AVISENSE**	**EWT**				**3240_ 2045**	**3235_ 2045**	**3235_ 2050**	**3240_ 2050**	**3235_ 2055**	**3230_ 2055**		**3235_ 2100**	**3240_ 2100**	**WEF**	**CONTROL**
48	Duck, Yellow-billed	x	x	8		38	8	50				50	40			x	
49	**Eagle, Booted**	x	x						25			100		40		x	
50	**Eagle, Martial (EN)**	x	x	8		13	25	50	25			100		20		x	
51	**Eagle, Verreaux's (VU)**	x	x	17	20	50	8		13	66.67			60	40	100	x	x
52	**Eagle-owl, Cape**		x														
53	**Eagle-owl, Spotted**		x					50					40			x	x
54	*Eremomela, Karoo*	x		17	20	25	42		38	Ad hoc	66.67					x	x
55	Eremomela, Yellow-bellied		x	17	20	13	33						20			x	x
56	**Falcon, Lanner (VU)**		x													x	
57	Fiscal, Common (Southern)	x	x	75	60	50	58	25		33.33			40	20	100	x	x
58	**Flamingo, Greater (NT)**															x	
59	Flycatcher, African Dusky																x
60	*Flycatcher, Fairy*	x	x	25				Ad hoc		33.33			60			x	x
61	*Flycatcher, Fiscal*	x		33	40	13							40			x	x

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
62	Flycatcher, Spotted			8													
63	***Francolin, Grey-winged***		x	8	40	13	83		25		33.33		80	20		x	
64	Goose, Egyptian	x	x	42		63	8	25	38			100	80			x	
65	Goose, Spur-winged		x					Ad hoc								x	
66	Goshawk, Gabar		x		20												
67	**Goshawk Pale Chanting**	x	x	42	20		42	50	25	Ad hoc	66.67		20	20		x	x
68	Grebe, Black-necked		x														
69	Grebe, Little		x			25	8					100					
70	Greenbul, Sombre		x														
71	Greenshank, Common		x			13	8	25				50	20				
72	Guineafowl, Helmeted		x	8												x	
73	Hamerkop	x	x	17									60			x	x
74	***Harrier, Black (EN)***		x			13			13			Ad hoc				x	
75	**Harrier-hawk, African**		x													x	
76	Heron, Black-headed	x	x				8	25		Ad hoc						x	
77	Heron, Grey			25	20	13		25					60	20		x	

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2			
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100	WEF	CONTROL
78	Hoopoe, African			8	20								20			x	x
79	House-martin, Common		x						13				20				
80	Ibis, African Sacred	x	x	8				25				50			100	x	
81	Ibis, Hadeda	x	x	17		13	58	100	25				20		100	x	x
82	**Kestrel, Greater**												20			x	
83	Kestrel, Rock	x	x	42	20	63	58	75	63	66.67			40	80		x	x
84	Kingfisher, Malachite			8													
85	Kingfisher, Pied															x	
86	**Kite, Black-shouldered**		x										20				
87	**Korhaan, Karoo (NT)**	x		17	40	13	33		63	33.33	33.33		60	40		x	x
88	***Korhaan, Southern Black (VU)***		x			13	33										
89	Lapwing, Blacksmith	x	x	58	20	88		100	13			100	80		100	x	
90	Lapwing, Crowned	x	x				17	25	13				20	60		x	
91	*Lark, Cape Clapper*	x	x				42	25	75		33.33		20	60			
92	*Lark, Karoo*		x	8	20	13	8		25		33.33		20	40	100	x	x

				Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2			
Species name		AVISENSE	EWT				3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100	WEF	CONTROL
93	Lark, Karoo Long-billed	x		50	20	63	92	Ad hoc	63	33.33			40	60		x	x
94	*Lark, Large-billed*	x	x	8	20	75	67	25	100	Ad hoc	100			40		x	
95	Lark, Red-capped	x	x		20	25	42		38		33.33		20	40		x	
96	Lark, Spike-heeled		x			25		Ad hoc	25	Ad hoc	33.33		20	20		x	
97	Martin, Brown-throated		x	58	20	13						50	40			x	
98	Martin, Rock	x	x	75	60	38	75	25	38	66.67		50	80	60	100	x	x
99	Masked-weaver, Southern		x	58	40	63	33		38	33.33			80	20		x	x
100	Mousebird, Red-faced		x	25	80	13	33						40		100	x	x
101	Mousebird, Speckled		x														
102	Mousebird, White-backed	x	x	42	100	38	17						40			x	x
103	Neddicky		x													x	
104	Night-heron, Black-crowned			17													
105	Nightjar, Fiery-necked															x	x
106	Nightjar, Rufous-cheeked		x										20	20		x	
107	Owl, Barn		x										20			x	

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
108	Penduline-tit, Cape	x	x				33		13		100		40	20			
109	Pigeon, Speckled	x	x	25	20	50	42	75	25				100	60	100	x	x
110	Pipit, African		x	17		25	25		38					20		x	
111	***Pipit, African Rock (NT)***	x	x										20	60		x	
112	Pipit, Long-billed		x			13							20				
113	Pipit, Plain-backed		x														
114	Plover, Kittlitz's		x			13						100					
115	Plover, Three-banded	x	x	33		50	58	Ad hoc	13			100	100		100	x	x
116	Pochard, Southern		x														
117	*Prinia, Karoo*	x	x	92	60	50	100	25	50	Ad hoc				40		x	x
118	Quail, Common		x			13											
119	Raven, White-necked	x	x	33	40	25	92	Ad hoc	88	66.67	66.67		100	80	100	x	x
120	Reed-warbler, African			8									20			x	x
121	Robin-chat, Cape	x	x	42	40	13	25			33.33			60		100	x	x
122	Roller, European							25									
123	Ruff		x			13											

				Rep Rate (%)													
				3220 DD	3221 CC	3220DB							3221CA			ARCUS SURVEY	
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2			
	Species name	AVISENSE	EWT				3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100	WEF	CONTROL
124	Sandgrouse, Namaqua	x	x	25		38	50		88	Ad hoc	33.33	50	40	60		x	x
125	Sandpiper, Common		x														
126	Sandpiper, Curlew					13											
127	Sandpiper, Marsh		x														
128	Sandpiper, Wood		x														
129	Scrub-robin, Karoo	x	x	75	100	38	83	25	25	66.67	33.33		100	60	100	x	x
130	Seedeater, Streaky-headed																x
131	Shelduck, South African	x	x	42		100	33	50				100	40		100	x	x
132	Shoveler, Cape	x	x			38		75				100					
133	**Snake-eagle, Black-chested**			17												x	
134	Sparrow, Cape	x	x	83	100	88	50	Ad hoc		33.33			100	40	100	x	x
135	Sparrow, House			25	20	38	8						60			x	x
136	Sparrow, Southern Grey-headed		x	8									20				
137	**Sparrowhawk, Black**		x														

				Rep Rate (%)													
				3220 DD	**3221 CC**	**3220DB**							**3221CA**			**ARCUS SURVEY**	
				SABAP 1	**SABAP 1**	**SABAP 1**	**SABAP2**						**SABAP 1**	**SABAP2**			
Species name		**AVISENSE**	**EWT**				**3240_ 2045**	**3235_ 2045**	**3235_ 2050**	**3240_ 2050**	**3235_ 2055**	**3230_ 2055**		**3235_ 2100**	**3240_ 2100**	**WEF**	**CONTROL**
138	Sparrowhawk, Little												20				
139	**Sparrowhawk, Rufous-breasted**	x	x														
140	*Sparrowlark, Black-eared*			8					25		33.33		20	20			
141	Sparrowlark, Grey-backed		x		20	13							20			x	
142	Spoonbill, African	x	x	8					13				40				
143	*Spurfowl, Cape*		x	58		25	42			33.33			20	20		x	x
144	Starling, Common	x	x	25		25	8			Ad hoc			20			x	x
145	Starling, Pale-winged	x	x	75	80	38	33	Ad hoc	13	66.67			80	20	100	x	x
146	*Starling, Pied*	x	x	67	20	50	50	50	50				80	20		x	x
147	Starling, Red-winged	x	x										40		100	x	
148	Starling, Wattled			8													
149	Stilt, Black-winged		x			13		25				100				x	
150	Stint, Little		x			13											
151	Stonechat, African		x													x	
152	**Stork, Black (VU)**		x										20			x	

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
153	**Stork, White**															x	
154	Sunbird, Dusky		x	50	40		8				33.33		40		100	x	x
155	*Sunbird, Greater Double-collared*		x														
156	Sunbird, Malachite		x	42	60	38	25			33.33			60	20		x	x
157	*Sunbird, Southern Double-collared*	x	x	42	60	38	33			33.33					100	x	x
158	Swallow, Barn			17		25	67	25	88	66.67	66.67		20	Ad hoc		x	x
159	Swallow, Greater Striped	x	x	25		13	50	50	63	66.67		50	60	40	100	x	x
160	Swallow, Lesser Striped		x														
161	Swallow, Pearl-breasted		x													x	
162	Swallow, White-throated		x			13		25						20		x	
163	Swamp-warbler, Lesser			17													
164	Swift, African Black		x			13							20			x	x
165	Swift, Alpine		x								33.33		60	40		x	x
166	Swift, Common		x						13								
167	Swift, Horus								13								

	Species name	AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
168	Swift, Little		x	25		13	33		38	66.67			80			x	x
169	Swift, White-rumped		x			25	33	Ad hoc	25	66.67			40	40		x	x
170	Teal, Cape		x			25						100					
171	Teal, Red-billed		x			13		25				100					
172	Tern, White-winged		x			13											
173	Thick-knee, Spotted		x		20								40	20		x	x
174	Thick-knee, Water															x	
175	*Thrush, Karoo*		x	8	40								20			x	x
176	*Tit, Grey*	x	x	33	40	25	25		25	Ad hoc			60			x	x
177	Tit-babbler, Chestnut-vented			75	100	25							20		100	x	x
178	*Tit-babbler, Layard's*	x	x	52	20		25		13	Ad hoc			20			x	x
179	Turtle-dove, Cape	x	x	75	60	50	42	Ad hoc	50	Ad hoc			100	40	100	x	x
180	Wagtail, Cape	x	x	92	40	88	50	50	75	33.33			100	20		x	x
181	*Warbler, Cinnamon-breasted*															x	
182	*Warbler, Namaqua*	x	x	75	80	25	17						20			x	x
183	Warbler, Red-winged*		x														

Species name		AVISENSE	EWT	Rep Rate (%)												ARCUS SURVEY	
				3220 DD	3221 CC	3220DB							3221CA				
				SABAP 1	SABAP 1	SABAP 1	SABAP2						SABAP 1	SABAP2		WEF	CONTROL
							3240_ 2045	3235_ 2045	3235_ 2050	3240_ 2050	3235_ 2055	3230_ 2055		3235_ 2100	3240_ 2100		
184	Warbler, Rufous-eared	x	x	8		38	58	Ad hoc	50	Ad hoc	33.33		20	60		x	x
185	Warbler, Willow			8													
186	Waxbill, Common	x	x	25		50	42						40			x	x
187	*Weaver, Cape*	x	x	8		13	33					50				x	x
188	Wheatear, Capped	x	x			25							20				
189	Wheatear, Mountain	x	x	42	20	63	67	75	75	Ad hoc			100	40		x	x
190	*White-eye, Cape*	x	x	58	60	13							20	20		x	x
191	Whydah, Pin-tailed			8	20												
192	Woodpecker, Cardinal			17									20		100	x	x
193	*Woodpecker, Ground*	x		17	20	13	17	Ad hoc	50				20			x	

EN=Endangered; VU=Vulnerable; NT= Near-threatened.

APPENDIX II: WALKED TRANSECT SURVEY DETAILS

Ref	Transect Co-ordinates (Start)		Transect Co-ordinates (Finish)		Autumn Survey Details			Winter Survey Details			Spring Survey Details			Summer Survey Details		
	South	East	South	East	Date	Date	Date	Date	Start Time	End Time	Date	Start Time	End Time	Date	Start Time	End Time
WT2.1	32.74691°	20.83604°	32.74708°	20.82535°	26/03/15	08:10	08:50	26/06/15	08:37	09:07	16/10/15	07:29	08:30	09/01/16	06:13	06:51
WT2.2	32.74691°	20.83604°	32.74708°	20.82535°	28/03/15	07:47	08:35	28/06/15	08:22	08:50	17/10/15	07:46	08:17	10/01/16	06:27	07:03
WT3.1	32.73959°	20.84521°	32.74836°	20.84749°	21/03/15	07:37	08:18	20/06/15	08:48	09:09	13/10/15	08:19	09:00	07/01/16	06:35	07:07
WT3.2	32.73959°	20.84521°	32.74836°	20.84749°	22/03/15	07:50	08:32	21/06/15	08:37	09:02	14/10/15	08:15	08:37	08/01/16	06:40	07:15
WT6.1	32.71222°	20.87977°	32.70479°	20.87350°	23/03/15	09:00	09:44	24/06/15	09:27	09:54	16/10/15	08:10	08:55	09/01/16	06:55	07:30
WT6.2	32.71222°	20.87977°	32.70479°	20.87350°	25/03/15	07:25	08:05	26/06/15	08:55	09:45	17/10/15	07:10	08:10	10/01/16	05:43	06:37
WT8.1	32.69340°	20.91801°	32.68574°	20.91701°	23/03/15	11:20	12:20	29/06/15	12:18	13:02	15/10/15	09:28	10:24	12/01/16	06:23	07:08
WT8.2	32.69340°	20.91801°	32.68574°	20.91701°	25/03/15	08:46	09:17	30/06/15	09:57	10:49	22/10/15	07:40	08:15	14/01/16	06:38	07:25
WT9.1	32.72986°	20.99271°	32.72121°	20.99560°	29/03/15	07:52	08:26	24/06/15	10:57	11:22	15/10/15	13:04	13:38	13/01/16	06:55	07:37
WT9.2	32.72986°	20.99271°	32.72121°	20.99560°	31/03/15	08:13	08:48	26/06/15	15:45	16:08	21/10/15	14:42	15:03	15/01/16	13:45	14:05
WT10.1	32.70802°	21.02490°	32.71628°	21.02863°	26/03/15	09:16	09:47	25/06/15	10:14	10:45	15/10/15	12:51	13:22	13/01/16	07:12	07:45
WT10.2	32.70802°	21.02490°	32.71628°	21.02863°	28/03/15	08:40	09:20	27/06/15	09:10	09:42	22/10/15	08:20	09:00	14/01/16	07:36	08:16
WT11.1	32.70127°	21.04252°	32.69229°	21.04230°	29/03/15	09:25	09:50	22/06/15	09:30	10:00	18/10/15	09:00	09:37	11/01/16	07:25	07:56
WT11.2	32.70127°	21.04252°	32.69229°	21.04230°	30/03/15	08:51	09:24	23/06/15	09:20	09:44	20/10/15	08:48	09:30	12/01/16	07:31	08:19
CWT1.1	32.86258°	21.08876°	32.86223°	21.07803°	24/03/15	09:07	09:40	29/06/15	09:10	09:52	15/10/15	09:36	10:16	11/01/16	08:46	09:21
CWT1.2	32.86258°	21.08876°	32.86223°	21.07803°	25/03/15	10:00	10:30	30/06/15	12:15	12:41	19/10/15	12:30	12:50	15/01/16	06:50	07:47
CWT2.1	32.85935°	21.09106°	32.85157°	21.09642°	23/03/15	12:20	13:13	24/06/15	10:25	10:55	15/10/15	09:35	10:38	11/01/16	07:00	08:11
CWT2.2	32.85935°	21.09106°	32.85157°	21.09642°	25/03/15	08:15	09:15	29/06/15	09:15	09:50	18/10/15	08:10	09:53	15/01/16	08:27	09:02

APPENDIX III: DRIVEN TRANSECT SURVEY DETAILS

Ref	Length (km)	Transect Co-ordinates (Start)		Transect Co-ordinates (Finish)		Autumn Survey			Winter Survey			Spring Survey			Summer Survey		
		South	East	South	East	Date	Start Time	End Time	Date	Start Time	End Time	Date	Start Time	End Time	Date	Start Time	End Time
DT1.1	9.5	32.848361°	20.795722°	32.793321°	20.804327°	21/03/15	07:36	08:26	20/06/15	08:23	09:28	13/10/15	07:50	08:40	07/01/16	13:42	14:27
DT1.2	9.5	32.848361°	20.795722°	32.793321°	20.804327°	22/03/15	09:50	10:35	21/06/15	08:15	08:55	14/10/15	07:44	08:30	08/01/16	13:42	14:23
DT2.1	12.0	32.746472°	20.837849°	32.710998°	20.877593°	22/03/15	13:00	14:02	21/06/15	16:05	16:49	16/10/15	07:20	08:05	09/01/16	06:10	06:49
DT2.2	12.0	32.746472°	20.837849°	32.710998°	20.877593°	28/03/15	17:00	17:42	24/06/15	13:05	13:42	17/10/15	06:57	07:35	10/01/16	14:18	14:56
DT3.1	7.7	32.731080°	20.903810°	32.691125°	20.919356°	23/03/15	10:10	10:52	24/06/15	12:34	12:59	15/10/15	08:27	09:20	12/01/16	14:53	15:42
DT3.2	7.7	32.731080°	20.903810°	32.691125°	20.919356°	25/03/15	07:53	08:27	29/06/15	10:37	11:42	22/10/15	07:10	07:39	14/01/16	05:47	06:30
DT4.1	8.1	32.753390°	20.933320°	32.730552°	20.992577°	23/03/15	13:10	13:42	24/06/15	10:15	10:51	15/10/15	12:02	12:53	13/01/16	14:40	15:14
DT4.2	8.1	32.753390°	20.933320°	32.730552°	20.992577°	29/03/15	07:13	07:48	29/06/15	14:15	14:43	21/10/15	15:48	16:12	15/01/16	14:30	15:15
DT5.1	8.7	32.736630°	21.045130°	32.778980°	21.014710°	23/03/15	09:40	10:30	24/06/15	12:17	12:37	15/10/15	11:51	12:12	13/01/16	14:55	15:22
DT5.2	8.7	32.736630°	21.045130°	32.778980°	21.014710°	27/03/15	17:09	17:45	29/06/15	11:36	12:00	21/20/15	16:35	17:18	14/01/16	16:12	16:41
CDT.1	5.7	32.852680°	21.036090°	32.859780°	21.088630°	23/03/15	11:24	11:58	24/06/15	09:46	10:14	15/10/25	09:00	09:28	11/01/16	15:05	15:24
CDT.2	5.7	32.852680°	21.036090°	32.859780°	21.088630°	24/03/15	08:24	08:42	29/06/15	10:28	11:02	18/10/15	15:50	16:17	15/01/16	06:24	06:44

APPENDIX IV: EVALUATION METHODS FOR ENVIRONMENTAL IMPACTS

The evaluation method for determining significance of impacts is shown below.[9]

Note that an adjustment was made, which involved changing the consequence column to the significance column, due to the fact that probability should not necessarily determine significance, as, for example, catastrophic events would be highly significant, even though the probability of such an event occurring is low.

Definitions of or criteria for environmental impact parameters

The significance of environmental impacts is a function of the environmental aspects that are present and to be impacted on, the probability of an impact occurring and the consequence of such an impact occurring before and after implementation of proposed mitigation measures.

Extent (spatial scale):

Ranking criteria

L	M	H
Impact is localized within site boundary	Widespread impact beyond site boundary; Local	Impact widespread far beyond site boundary; Regional/national

Take into consideration:

- Access to resources; amenity
- Threats to lifestyles, traditions and values
- Cumulative impacts, including possible changes to land uses at and around the site.

Duration:

Ranking criteria

L	M	H
Quickly reversible, less than project life, short term (0-5 years)	Reversible over time; medium term to life of project (5-15 years)	Long term; beyond closure; permanent; irreplaceable or irretrievable commitment of resources

Take into consideration:

Cost – benefit economically and socially (e.g. long or short term costs/benefits)

[9] (Adapted from T Hacking, AATS – Envirolink, 1998: An innovative approach to structuring environmental impact assessment reports. In: IAIA SA 1998 Conference Papers and Notes

Intensity (severity):

Type of Criteria	Negative			Positive		
	H-	**M-**	**L-**	**L+**	**M+**	**H+**
Qualitative	Substantial deterioration, death, illness or injury, loss of habitat/ diversity or resource, severe alteration or disturbance of important processes.	Moderate deterioration, discomfort, Partial loss of habitat/ biodiversity/ resource or slight or alteration	Minor deterioration, nuisance or irritation, minor change in species/ habitat/ diversity or resource, no or very little quality deterioration.	Minor improvement, restoration, improved management	Moderate improvement, restoration, improved management, substitution	Substantial improvement , substitution
Quantitative	Measurable deterioration Recommended level will often be violated (e.g. pollution)	Measurable deterioration Recommended level will occasionally be violated	No measurable change; Recommended level will never be violated	No measurable change; Within or better than recommended level.	Measurable improvement	Measurable improvement
Community response	Vigorous	Widespread complaints	Sporadic complaints	No observed reaction	Some support	Favourable publicity

Take into consideration:

- Cost – benefit economically and socially (e.g. high nett cost = substantial deterioration)
- Impacts on human-induced climate change
- Impacts on future management (e.g. easy/practical to manage with change or recommendation)

Probability of occurrence:

Ranking criteria

L	M	H
Unlikely; low likelihood; Seldom No known risk or vulnerability to natural or induced hazards.	Possible, distinct possibility, frequent Low to medium risk or vulnerability to natural or induced hazards.	Definite (regardless of prevention measures), highly likely, continuous High risk or vulnerability to natural or induced hazards.

The specialist study must attempt to quantify the magnitude of impacts and outline the rationale used. Where appropriate, international standards are to be used as a measure of the level of impact.

Status of the impact:

Describe whether the impact is positive, negative or neutral for each parameter. The ranking criteria are described in negative terms. Where positive impacts are identified, use the opposite, positive descriptions for criteria.

Based on a synthesis of the information contained in (a) to (e) above, the specialist will be required to assess the significance of potential impacts in terms of the following criteria:

Significance: (Duration X Extent X Intensity)

Intensity = L				
Duration	**H**			
	M			Medium
	L	Low		
Intensity = M				
Duration	**H**			High
	M		Medium	
	L	Low		
Intensity = H				
Duration	**H**			
	M			High
	L	Medium		
		L	**M**	**H**
		Extent		

Positive impacts would be ranked in the same way as negative impacts, but result in high, medium or low positive consequence.

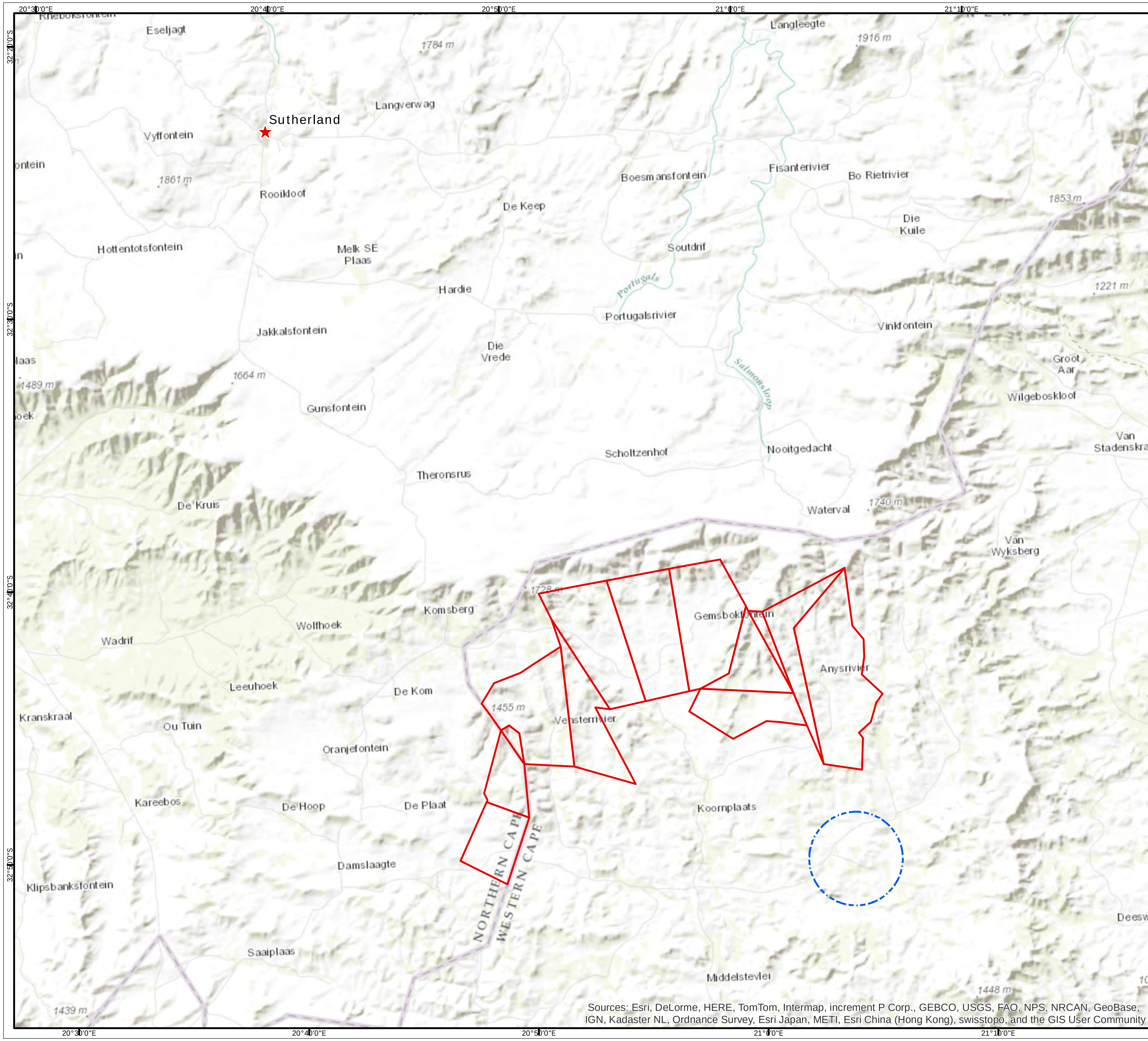
Degree of confidence in predictions:

State the degree of confidence in the predictions, based on the availability of information and specialist knowledge.

Significance Table Format:

Example of how significance tables should be formatted.

	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation							
With Mitigation							



ARCUS

WEF Site

Control Site

1:250,000 Scale @ A3

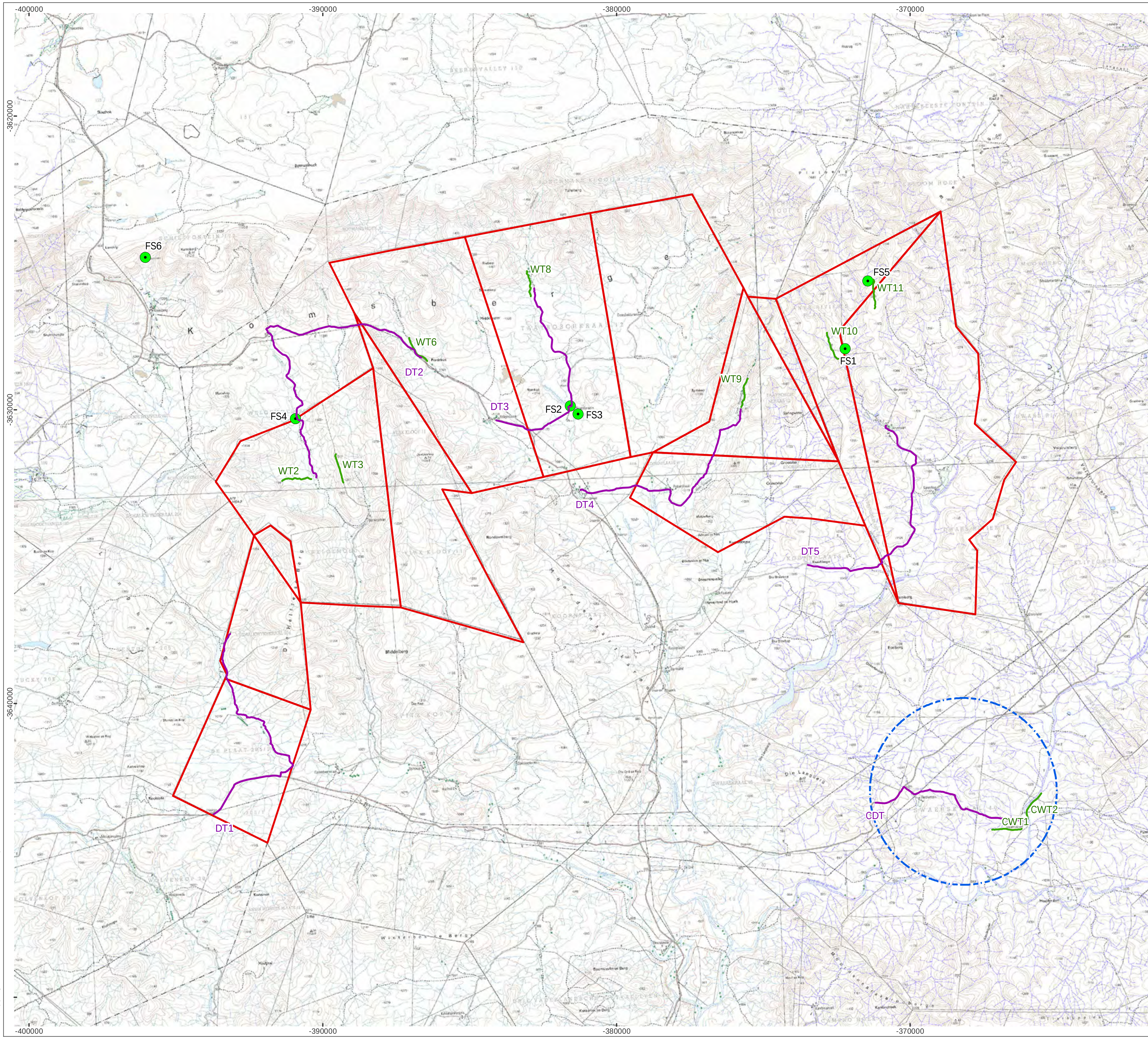
0 5 10 km

N

Produced: AT Reviewed: SC Approved: AB	Ref: 1961/REP/037 Date: 15/02/2016

WEF Site and Control Site
Figure 1

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

WEF Site
Control Site
Driven Transect
Walked Transect
Focal Site

1:125,000 Scale @ A3

0 2.5 5 km

N

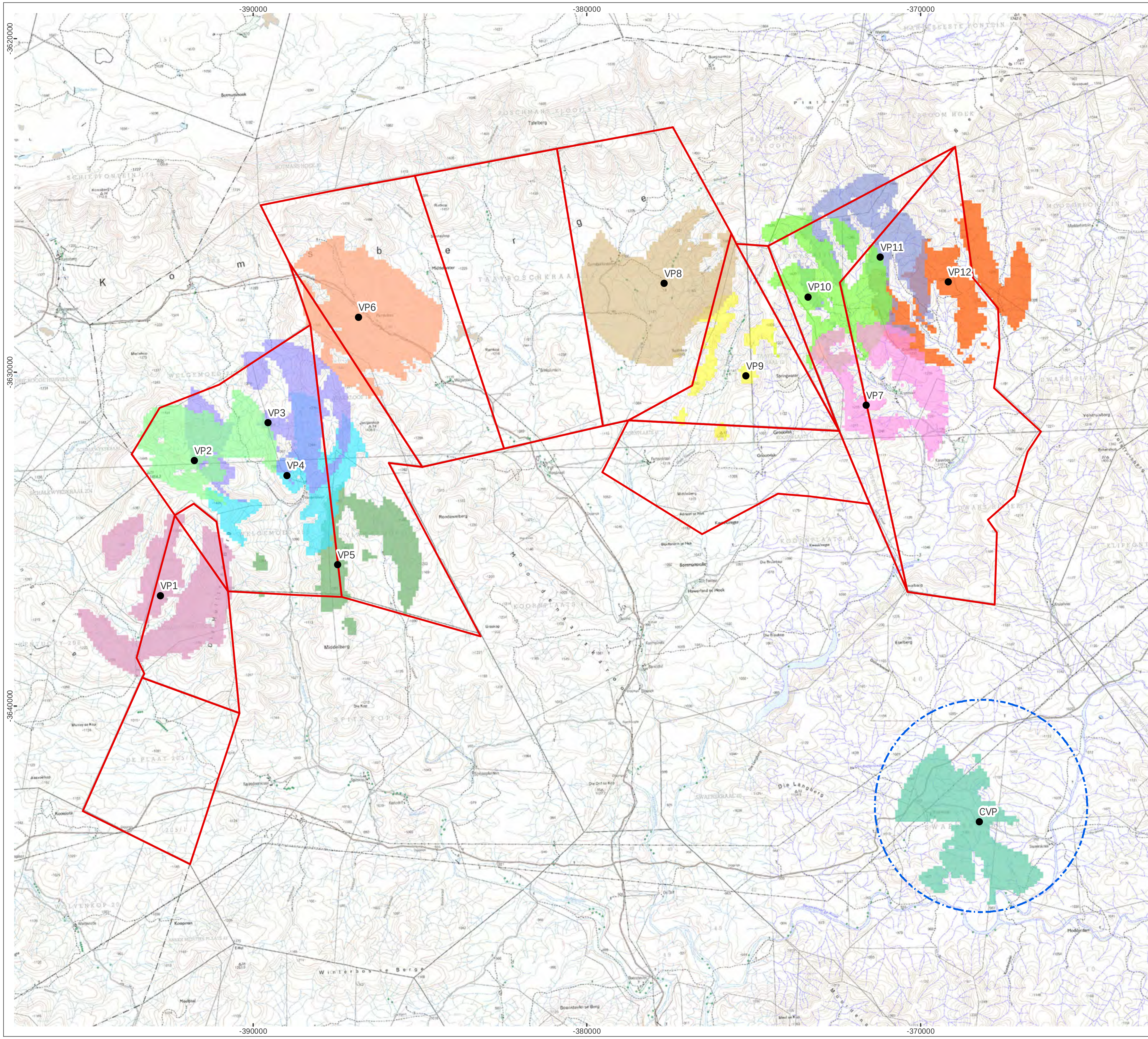
Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/038

Date: 27/01/2016

Focal Site, Driven and Walked Transect Locations
Figure 2

Komsberg Wind Energy Facility Avifaunal Impact Assessment Report



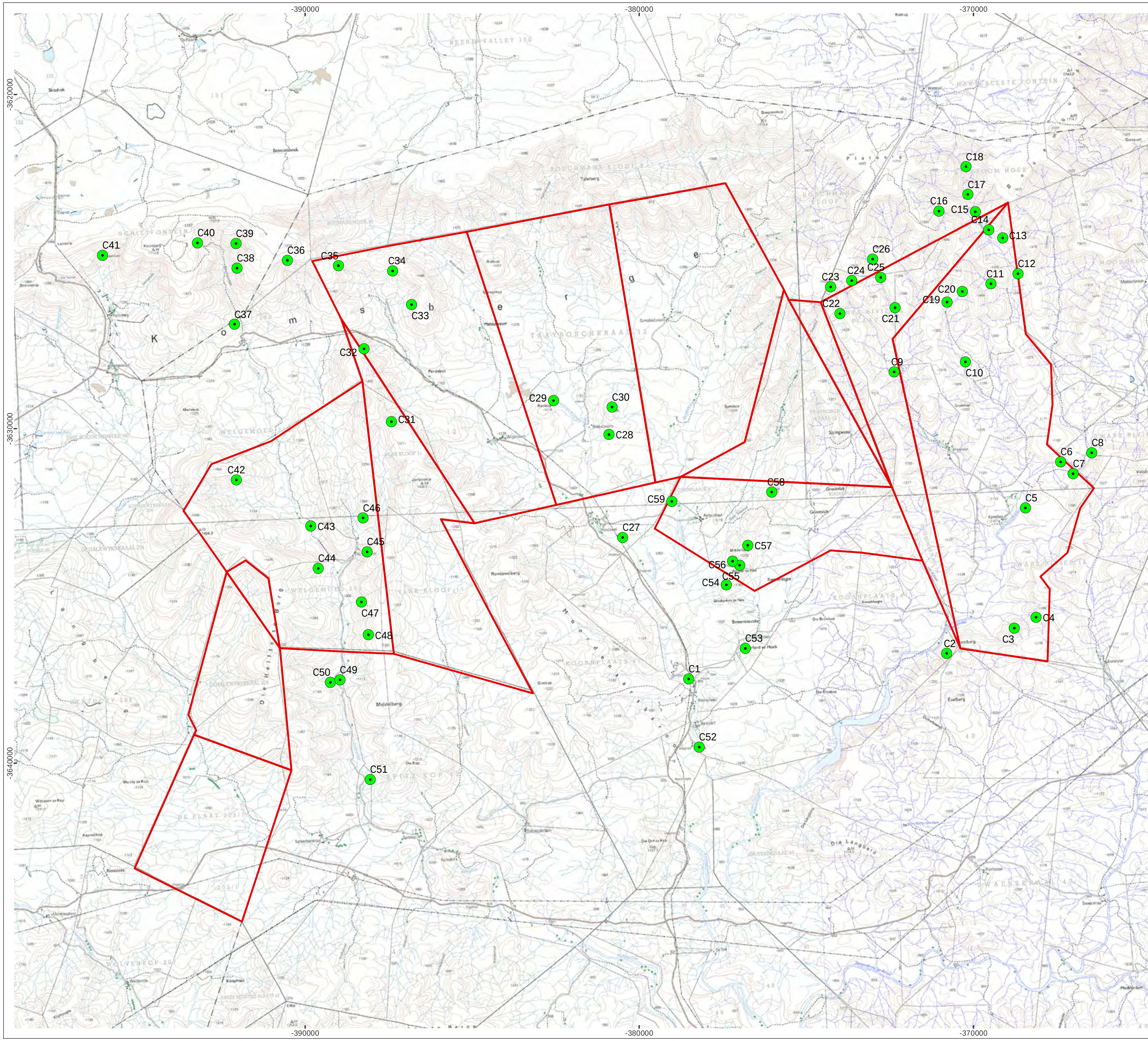
ARCUS

Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/039
Date: 27/01/2016

Vantage Points and Viewsheds
Figure 3

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



Mapping from Chief Directorate: National Geo-Spatial Information

\\192.168.16.229\sharedspace\GIS\Projects\1961 Komsberg\Document Files\Reports\Avifaunal Impact Assessment Report\1961 Fig04 Location of Surveyed Cliffs.mxd

ARCUS

WEF Site

Surveyed Cliff

1:110,000 Scale @ A3

0 2 4 km

N

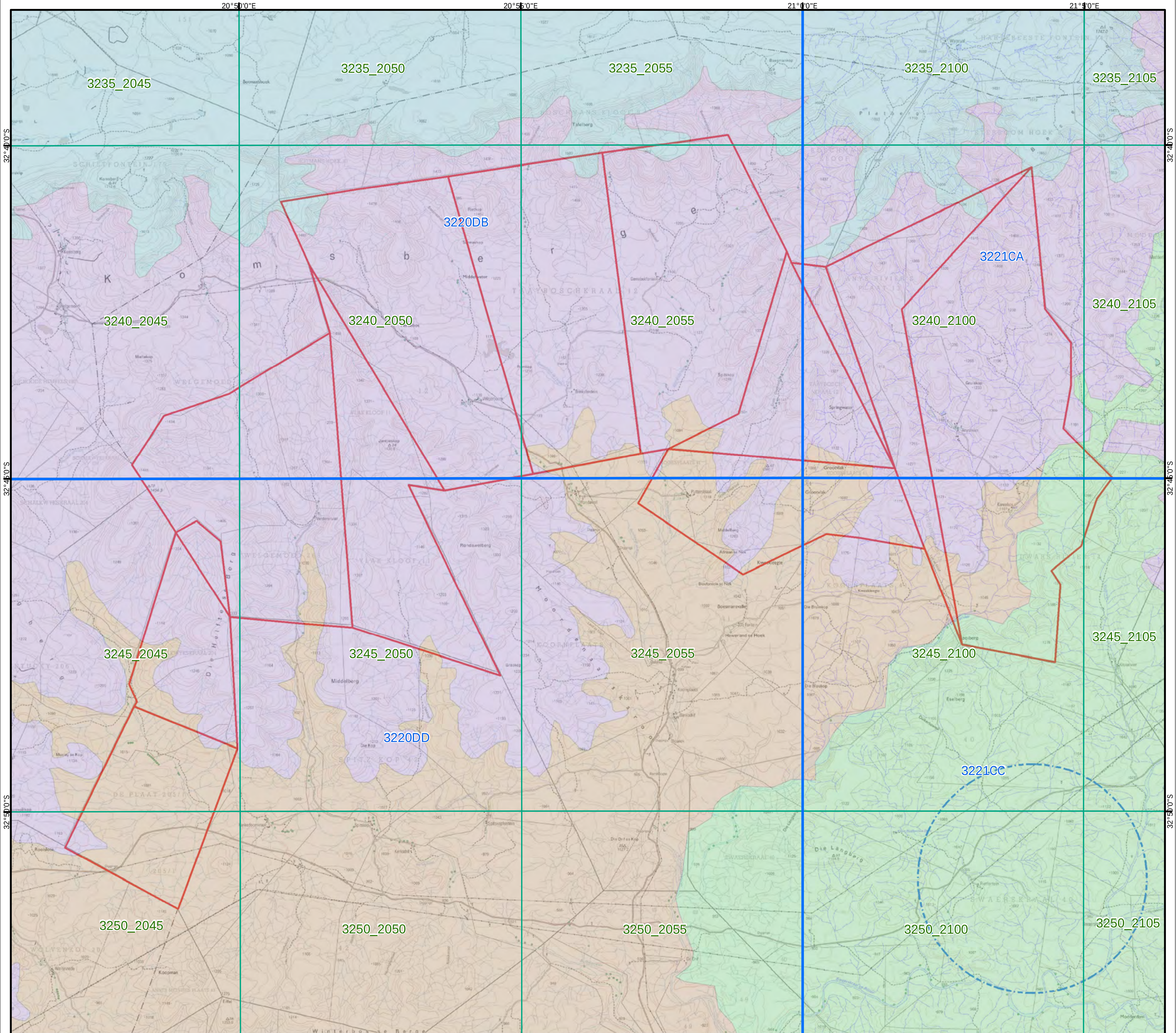
Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/0040

Date: 15/02/2016

Location of Surveyed Cliffs in Verreaux's Eagle Nest Search
Figure 4

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

WEF Site
Control Site
SABAP1 Quarter Degree Square
SABAP2 Pentad
Central Mountain Shale Renosterveld
Gamka Karoo
Koedoesberge-Moordenaars Karoo
Roggeveld Shale Renosterveld

1:102,978 Scale @ A3

0 2 4 km

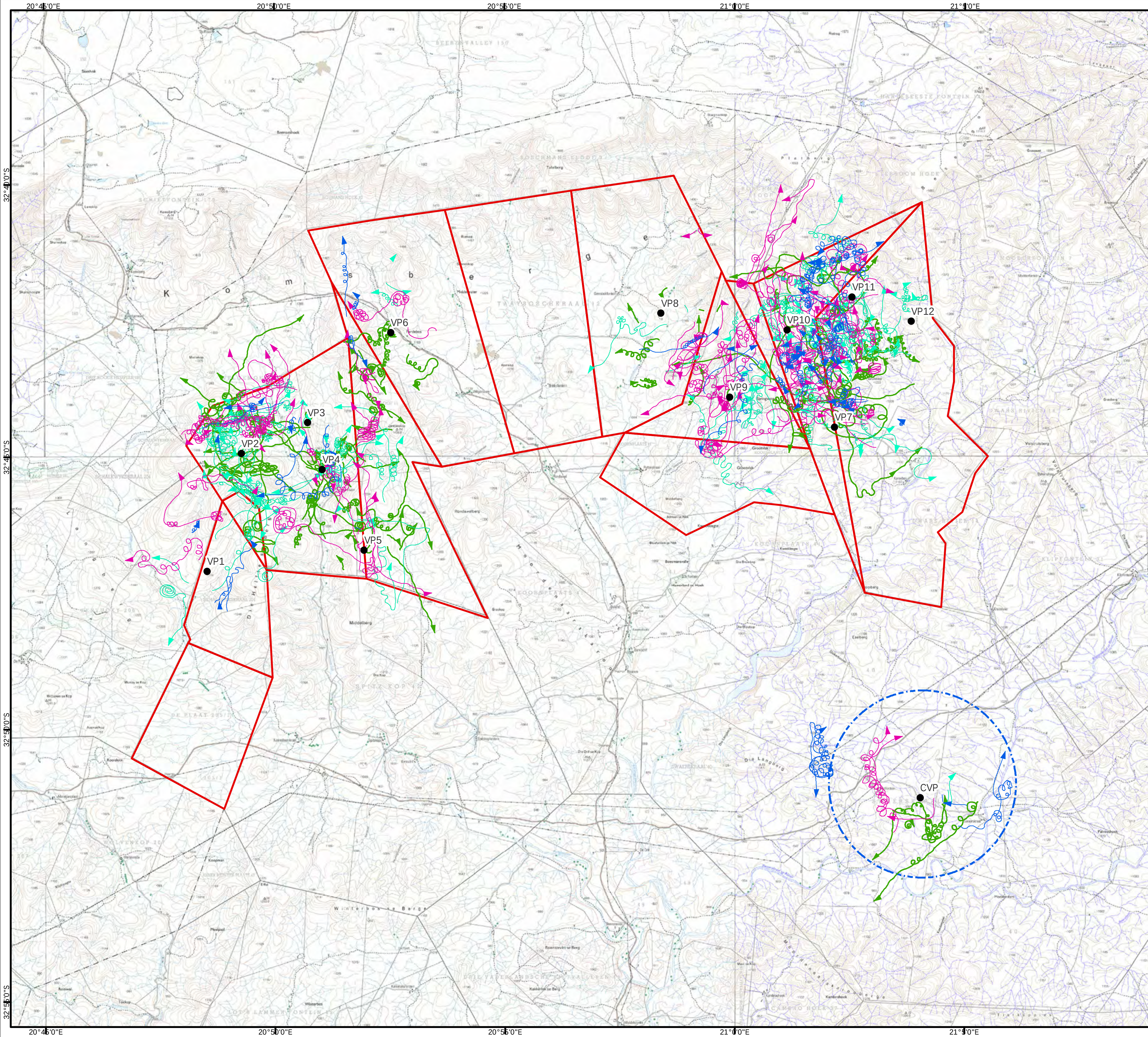
N

Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/0041
Date: 16/02/2016

Vegetation Map and SABAP Grid Squares
Figure 5

Komsberg Wind Energy Facility Avifaunal Impact Assessment Report



basemapping from Chief Directorate: National Geo-Spatial Information of South Africa

ARCUS

- WEF Site
- Control Site
- Vantage Point
- Autumn Flight
- Winter Flight
- Spring Flight
- Summer Flight

1:125,000 Scale @ A3

0 2.5 5 km

N

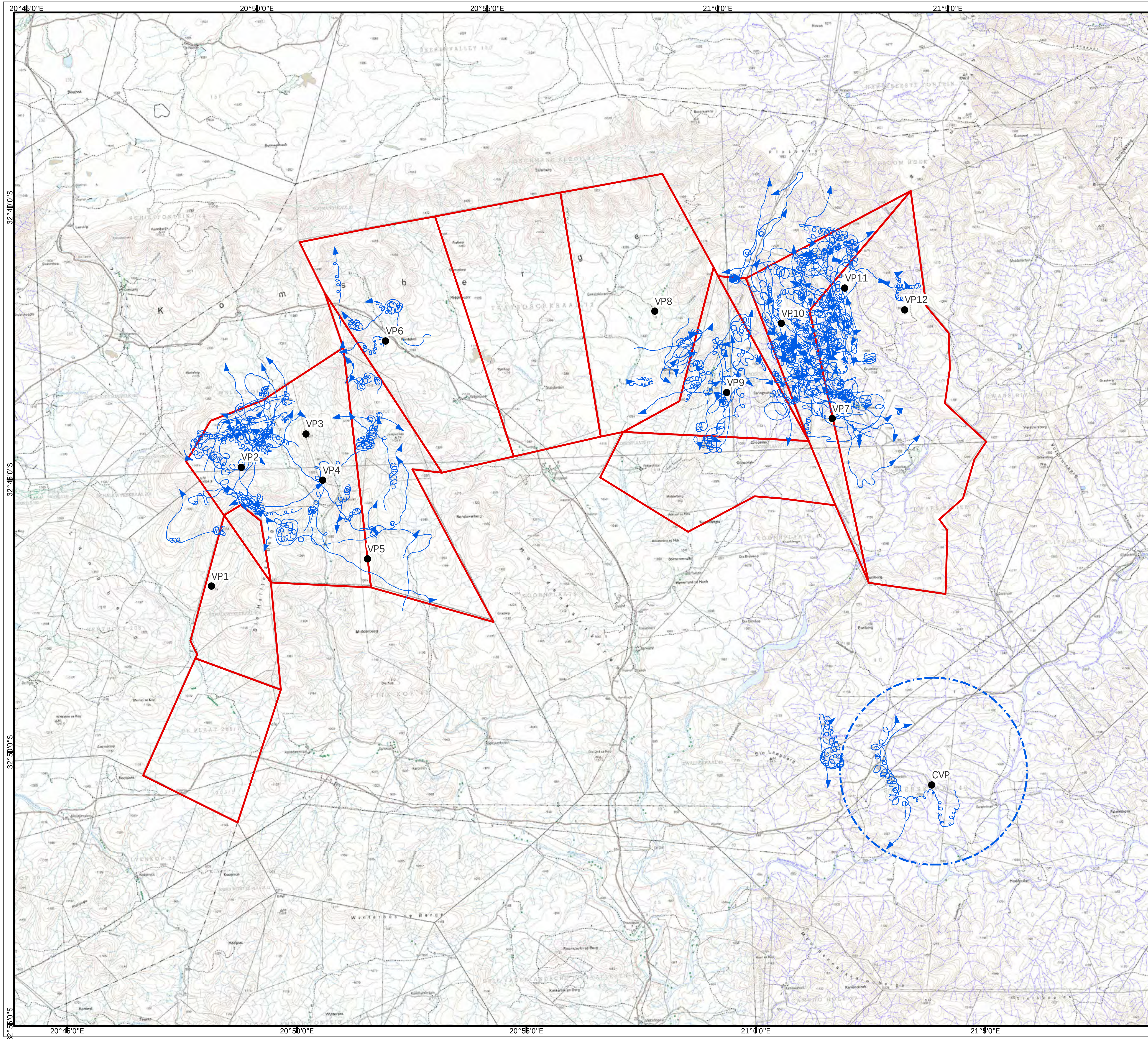
Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/046

Date: 16/02/2016

All Target Species Flights
Figure 6

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



Basemapping from Chief Directorate: National Geo-Spatial Information of South Africa

ARCUS

- WEF Site
- Control Site
- Vantage Point
- Verreaux's Eagle Flight

1:125,000 Scale @ A3

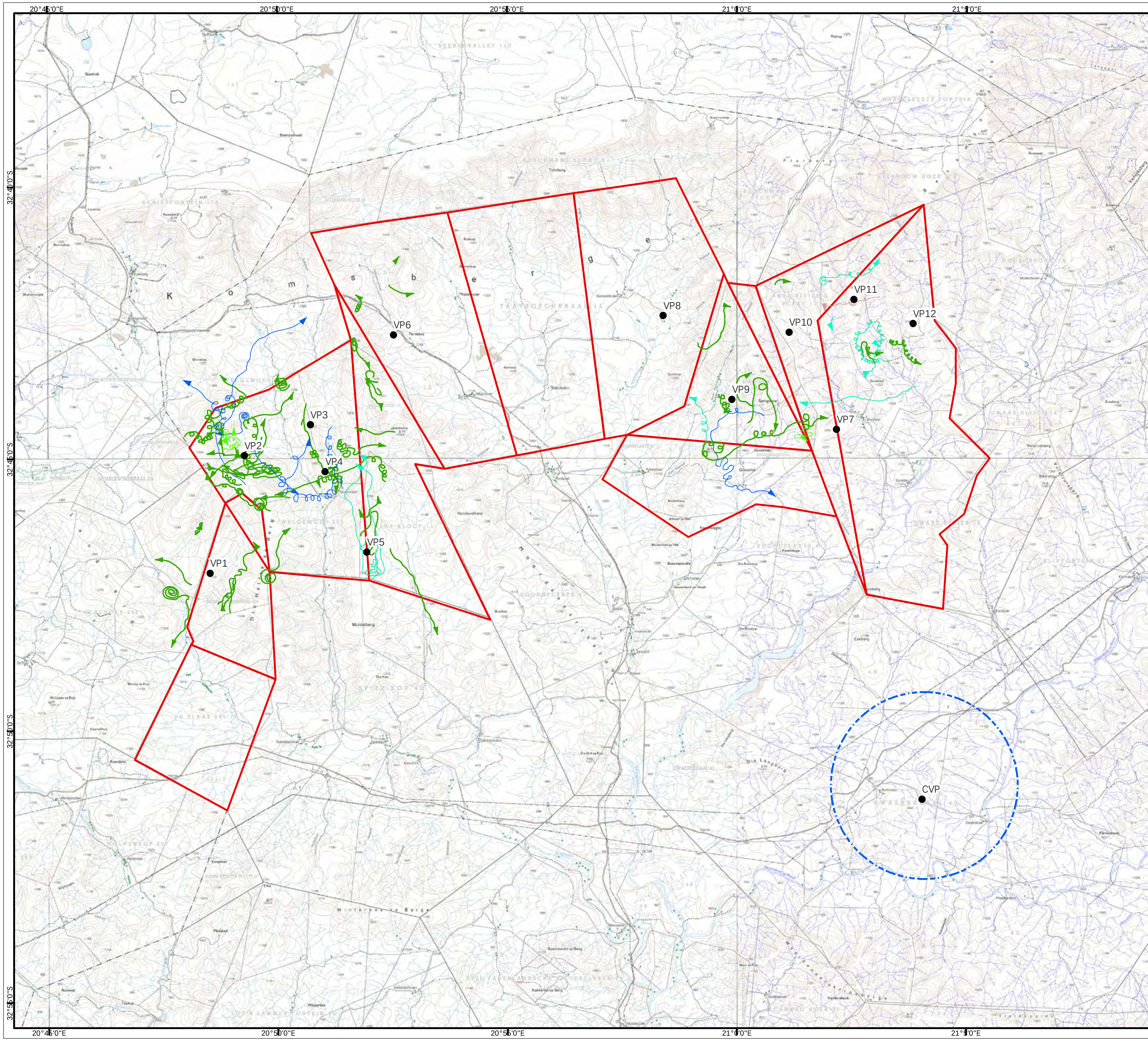
0 2.5 5 km

N

Produced: AT Reviewed: SC Approved: AB	Ref: 1961/REP/047 Date: 12/02/2016

Verreaux's Eagle Flights
Figure 7

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

- WEF Site
- Control Site
- Vantage Point
- African Harrier-hawk Flight
- Booted Eagle Flight
- Jackal Buzzard Flight
- Martial Eagle Flight
- Steppe Buzzard Flight

1:125,000 Scale @ A3

0 2.5 5 km

N

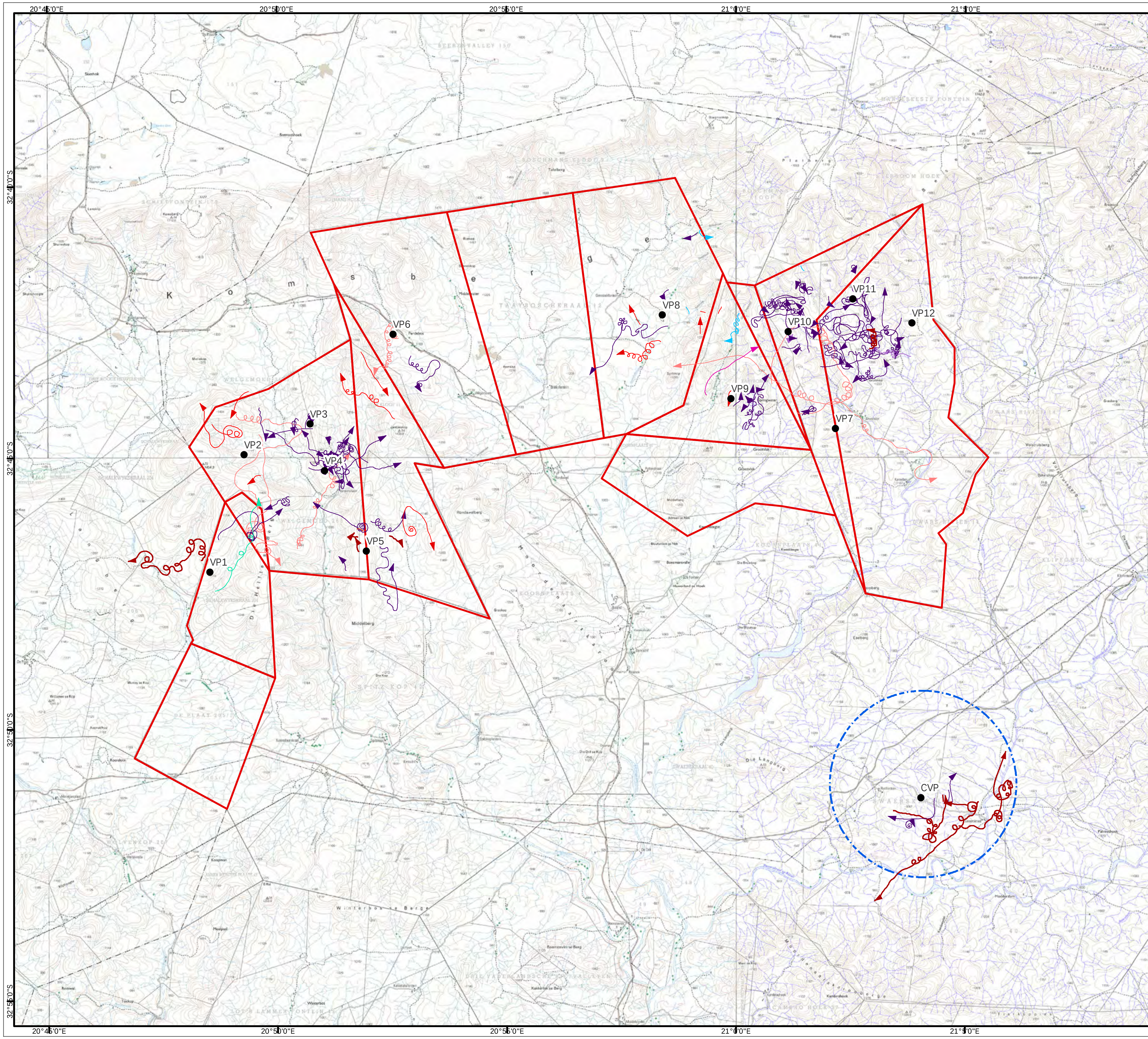
Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/048

Date: 16/02/2016

Selected Target Species Flights
Figure 8

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

- WEF Site
- Control Site
- Vantage Point
- Black Stork Flight
- Greater Kestrel Flight
- Karoo Korhaan Flight
- Lanner Falcon Flight
- Pale Chanting Goshawk Flight
- Peregrine Falcon Flight
- Rock Kestrel Flight
- Unidentified Species Flight
- Unidentified Raptor Flight

1:125,000 Scale @ A3

0 2.5 5 km

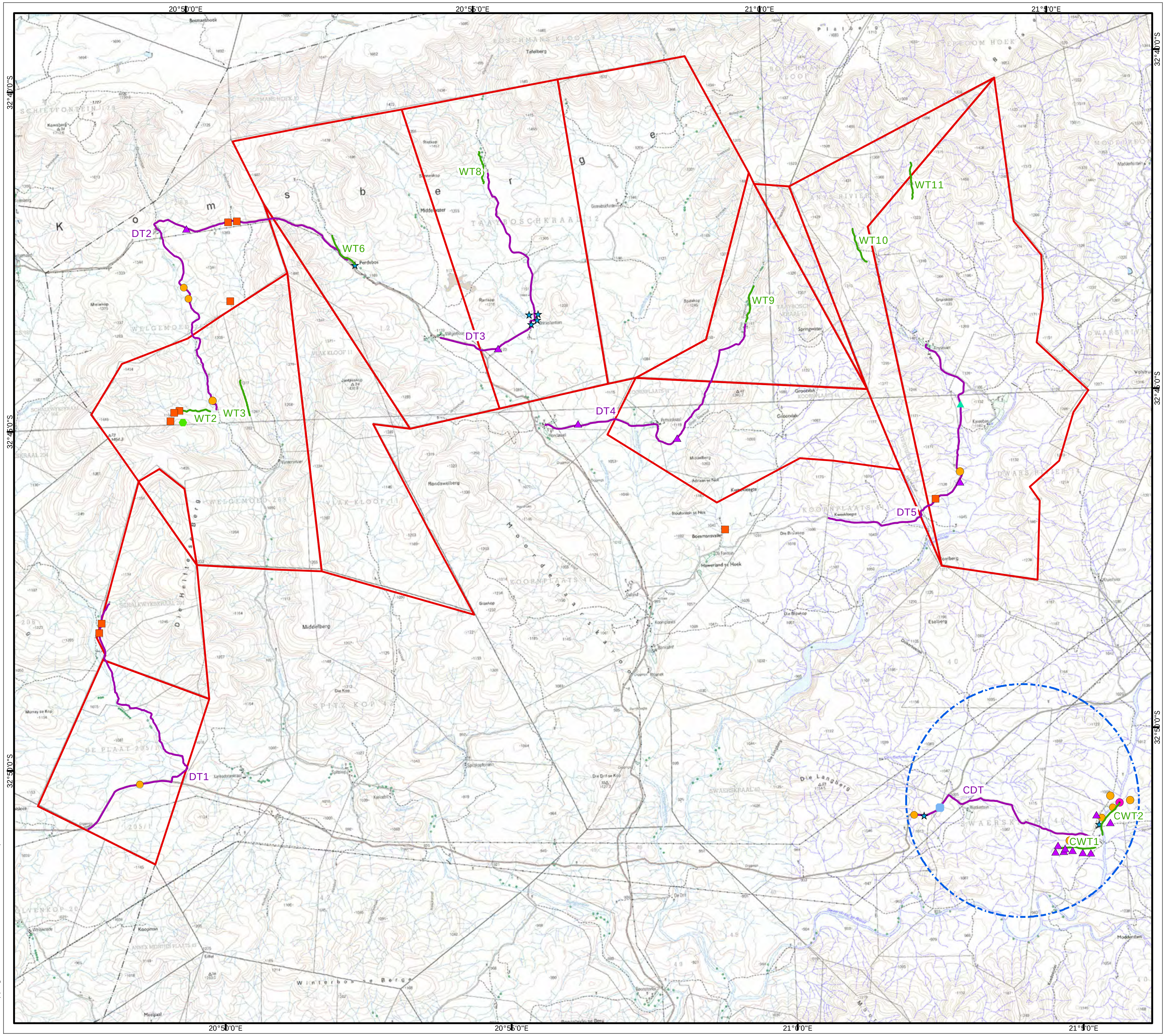
N

Produced: AT
Reviewed: SC
Approved: AB

Ref: 1961/REP/049
Date: 16/02/2016

Selected Target Species Flights II
Figure 9

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

- WEF Site
- Control Site
- Walked Transect
- Driven Transect
- Jackal Buzzard
- Karoo Korhaan
- Martial Eagle
- Pale Chanting Goshawk
- Steppe Buzzard
- Verreaux's Eagle

1:100,000 Scale @ A3

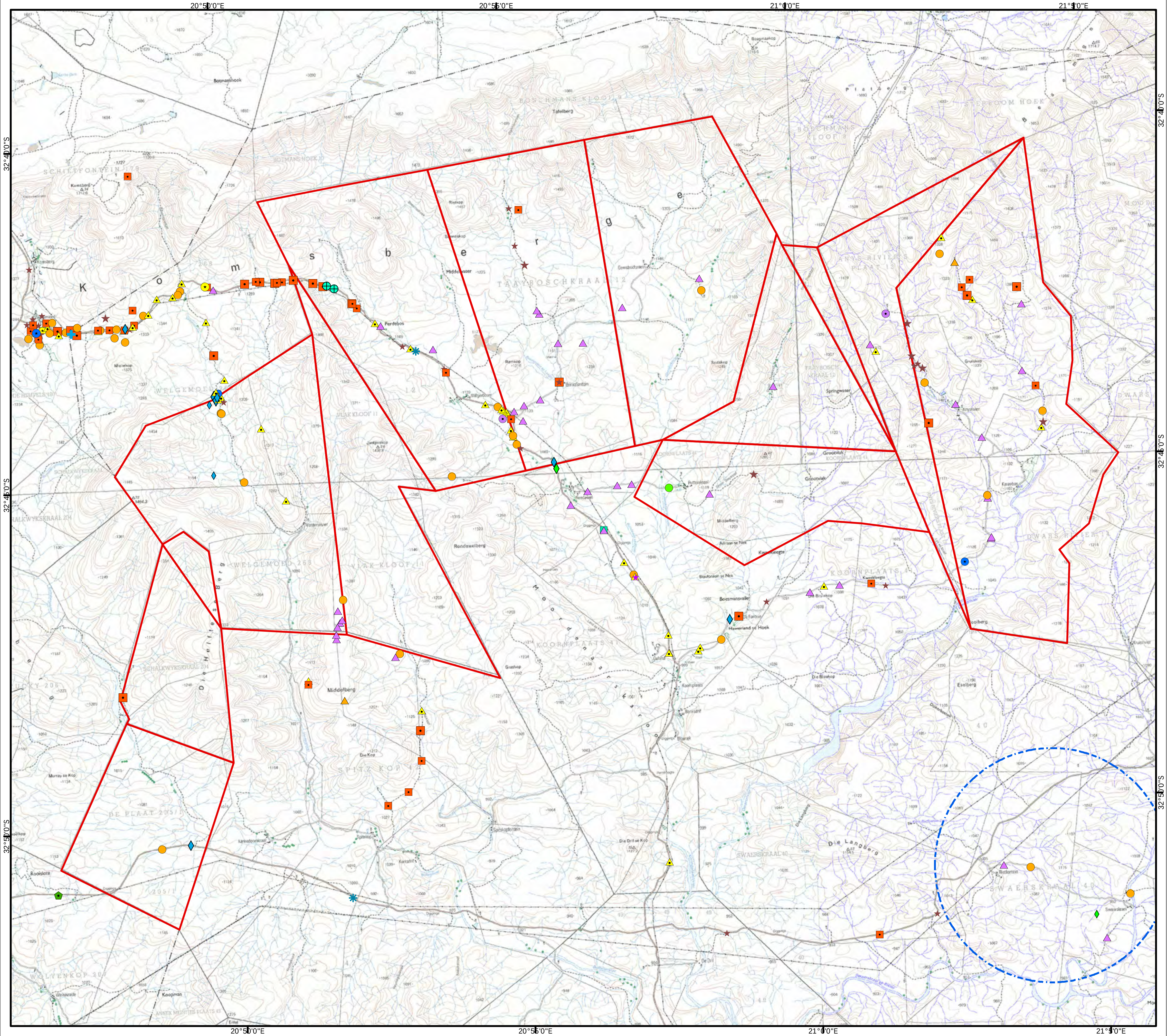
0 2 4 km

N

Produced: AT Reviewed: SC Approved: AB	Ref: 1961/REP/050 Date: 16/02/2016

Walked and Driven Transects
Priority Species Records
Figure 10

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



Basemapping from Chief Directorate: National Geo-Spatial Information of South Africa

ARCUS

- WEF Site
- Control Site
- Black-chested Snake-eagle
- Black Harrier
- Black Stork
- Greater Flamingo
- Greater Kestrel
- Jackal Buzzard
- Karoo Korhaan
- Lanner Falcon
- Ludwig's Bustard
- Martial Eagle
- Pale Chanting Goshawk
- Rock Kestrel
- Steppe Buzzard
- Verreaux's Eagle
- White Stork
- Unidentified Owl
- Unidentifid Raptor
- Unidentified Species

1:100,000 Scale @ A3

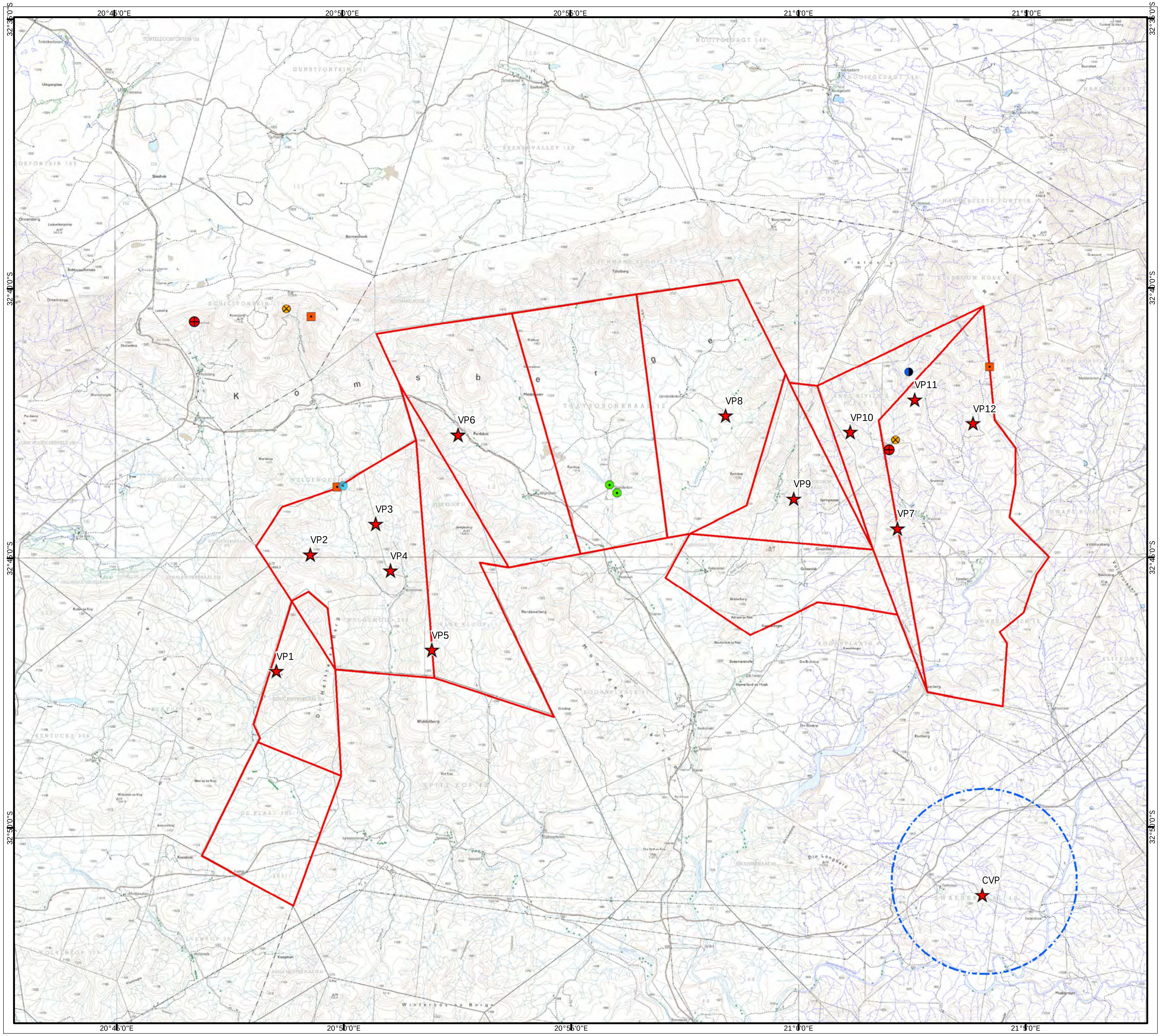
0 2 4 km

N

Produced: AT Reviewed: SC Approved: AB	Ref: 1961/REP/0051 Date: 16/02/2016

Incidental Target Species Records
Figure 11

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment report



Birdmapping from Chief Directorate: National Geo-Spatial Information of South Africa

ARCUS

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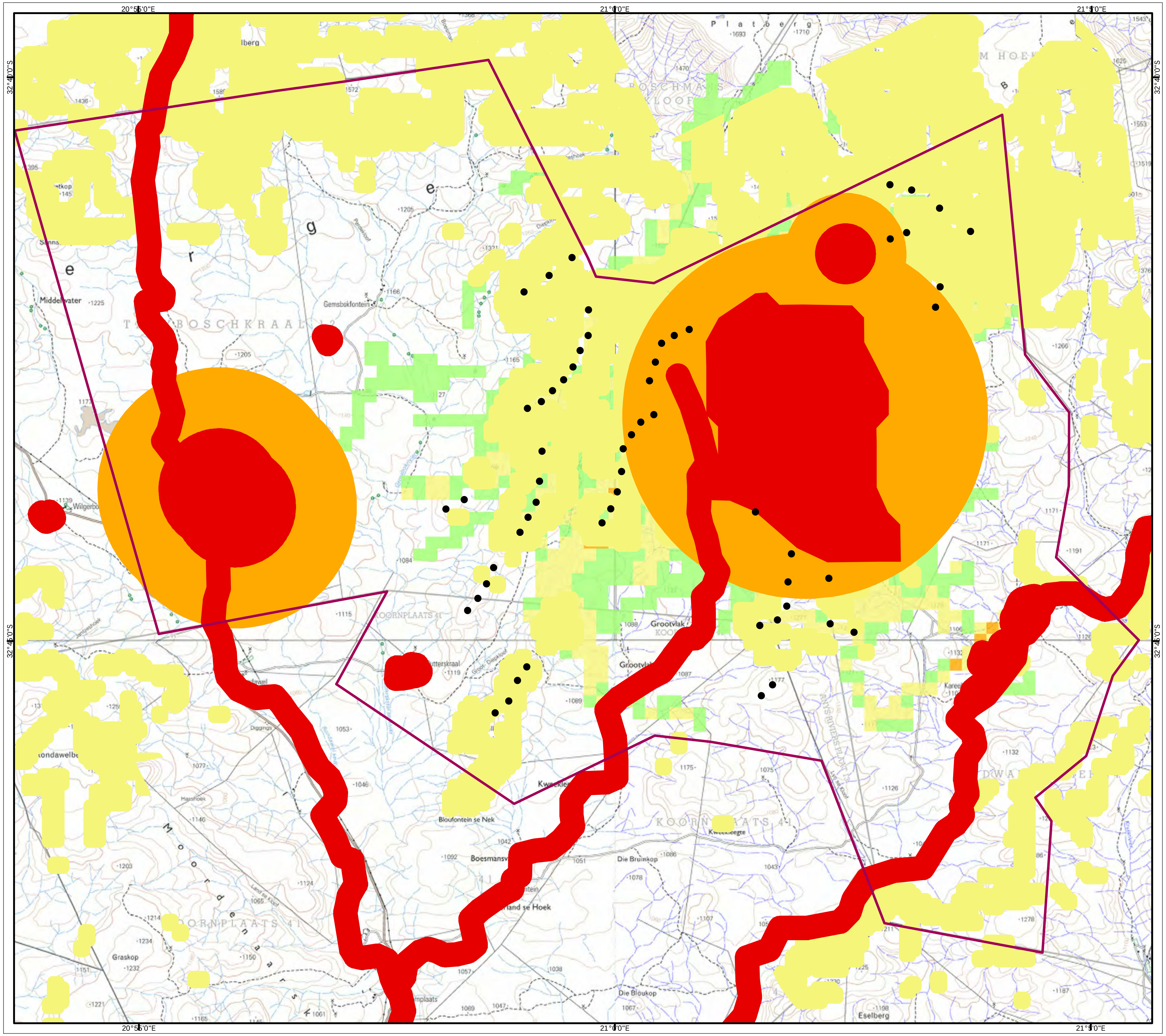
Ref: 1961/REP/052
Date: 16/02/2016

Raptor Nest and Roost Buffers
Figure 12

Komsberg Wind Energy Facility
Avifaunal Impact
Assessment Report



Birdmapping from Chief Directorate: National Geo-Spatial Information of South Africa

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Site Boundary

Final Turbine Layout

Avifaunal Sensitivity

Low

Medium

Medium/High

High (No-Go Area)

1:60,000 Scale @ A3

0 1 2 km

N

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Approved: AB

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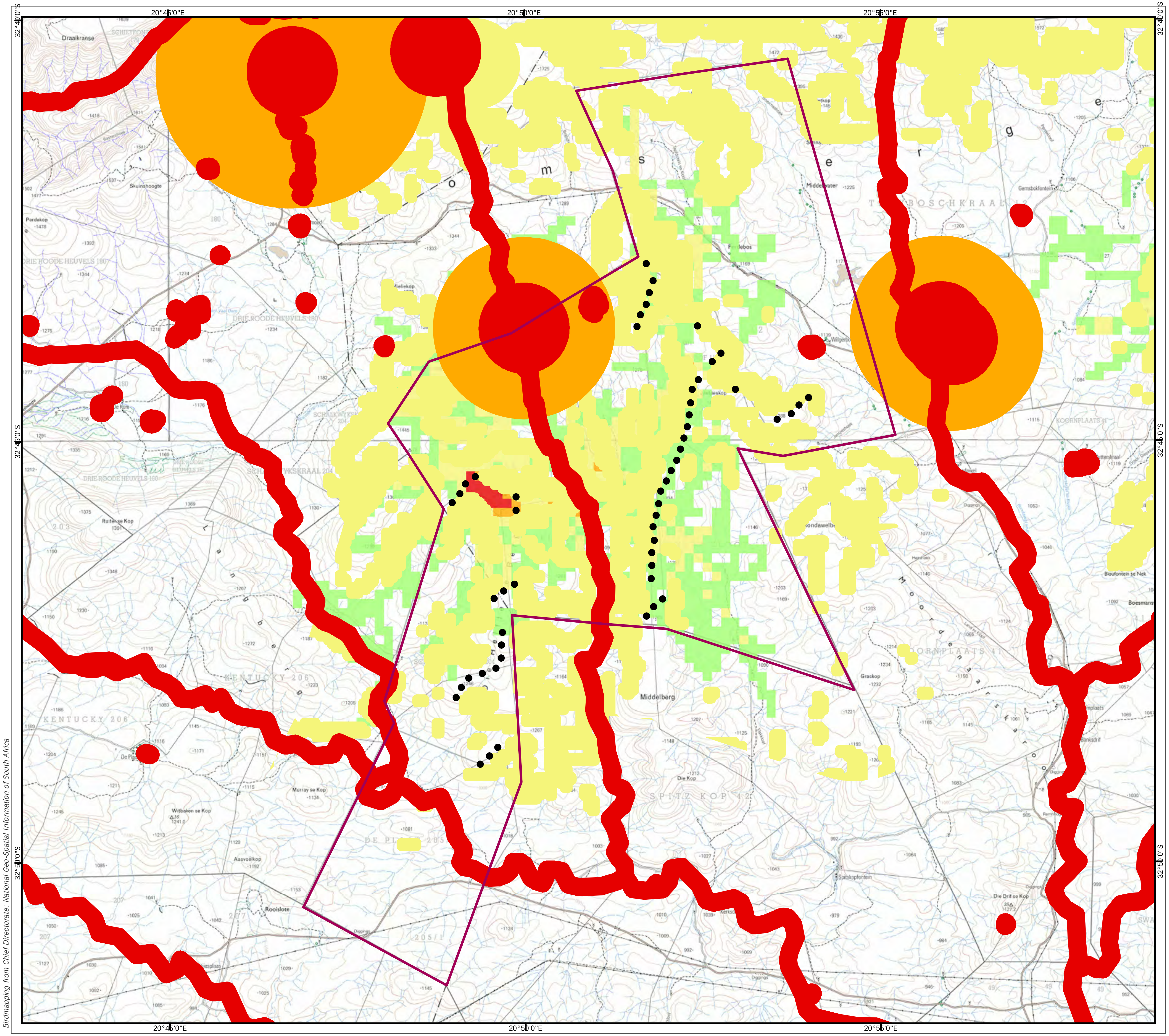
Date: 18/03/2016

Avifaunal Sensitivities and No-go Areas Map
Figure 13

Komsberg East Wind Energy Facility
Avifaunal Impact
Assessment Report



ARCUS

Site Boundary

Final Turbine Layout

Avifaunal Sensitivity

Low

Medium

Medium/High

High (No-Go Area)

1:80,000 Scale @ A3

0 1.5 3 km

N

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Date: 18/03/2016

Avifaunal Sensitivities and No-go Areas Map
Figure 14

Komsberg West Wind Energy Facility Avifaunal Impact Assessment Report

Ms Emily Herschell
Arcus
Office 211 Cube Workspace
Cnr Long Street and Hans Strijdom Road
Cape Town
8001

8 April 2016

RE: AVIFAUNAL PEER REVIEW OF THE AVIFAUNAL IMPACT ASSESSMENT REPORT FOR THE KOMSBERG WIND ENERGY FACILITY

Dear Ms Herschell,

WildSkies Ecological Services (Pty) Ltd was appointed by Arcus to conduct a peer review of the study entitled: "Komsberg Wind Energy Facility, Western Cape and Northern Cape – Avifaunal Impact Assessment Report, March 2016."

The terms of reference for this review are below. We have studied the report and engaged verbally with the author Andrew Pearson on any minor points of clarification. Our findings are as follows, reported on relative to each of the terms of reference.

1. Is the report in line with the applicable guidelines.

The applicable guidelines are the "BirdLife South Africa/Endangered Wildlife Trust Birds and Wind-Energy Best-Practice Guidelines – Best practice guidelines for assessing and monitoring the impact of wind-energy facilities on birds in southern Africa, Third Edition, 2015" by Jenkins, van Rooyen, Smallie, Harrison, Diamond, Smit-Robinson and Ralston.

The study is in line with these guidelines. It is noted that the study was designed and conducted largely during the period in which the third edition of the guidelines was under development.

C: 082 444 8919 | F: 086 6155654 | Email: jon@wildskies.co.za | W: www.wildskies.co.za
36 Utrecht Avenue, Bonnie Doon, East London, 5241
WildSkies Ecological Services (Pty) Ltd | Reg: 2011/131435/07 | VAT: 4340260779

2. Is the survey scope appropriate and in line with the applicable guidelines.

Overall, the survey scope is in line with the guidelines. More specific feedback is provided relative to each of the main forms of data collection prescribed by Jenkins *et al* (2015):

- Vantage Points. The coverage of the developable area is very good. The increase in survey radius from the 2km recommended by Jenkins *et al* (2015) to the 2.5km at Komsberg is not necessarily a problem, but the reason for this change should be explained in the text.
- Walked transects. The number of walked transects conducted on site is relatively low in our view for a site of this size, although Jenkins *et al* (2015) do not provide guidance as to how many walked transects should be done. Repeating transects twice in each season has increased the amount and robustness of data, but the geographic coverage is still relatively low. Given the overall findings of this study, whereby small passerine bird species are not a particular concern, this is not a significant shortcoming.
- Drive transects. The number and length of transects are acceptable, particularly given the terrain. The repetition of each transect twice in each season is excellent.
- Incidental observations. It is not possible to evaluate this in terms of effort as it is site specific.
- Focal sites. This is determined by need so not possible to evaluate this. On this site most focal sites were covered under nest sites below.
- Nest surveys. The study has conducted a very thorough survey of available nesting substrate on site, and provides high confidence in the status quo with respect to sensitive species breeding.
- Control site. The vantage point survey effort on the control site was relatively low. Various acceptable reasons for this are possible but are not explained in the text.

3. Are the methods and presentation of findings acceptable.

Overall the methods and presentation of findings are acceptable. The report could in our opinion benefit from figures being placed adjacent to relevant text, as in its current form it is difficult for the reader to refer to figures at the appropriate time. Figures could also benefit from more consolidation of information onto the same figures. One example is that turbine positions do not appear on the same maps as other information. The reader is forced to refer to multiple figures and try to compare. There are also no figures illustrating the grid connection routes.

4. Are the proposed recommendations and mitigations acceptable.

Overall, the proposed recommendations and mitigations are acceptable in our view. We have the following minor suggestions:

- That the recommendation that the internal on site power lines be placed under ground be strengthened to read that the specialist should be given opportunity to 'sign off' on any necessary above ground sections where it is not possible to place them underground.

5. Any additional suggestions.

The study could benefit from the following additions or changes:

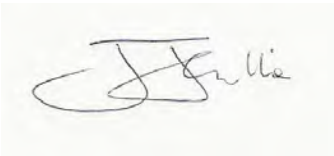
- The cumulative impact is identified as high significance, but then it is concluded that the project can proceed before a thorough cumulative assessment is done. Whilst we agree with this finding, we would suggest rewriting the text of this section to make this reasoning clearer.
- Consult and reference the more up to date version of the Important Bird Areas project – Marnewick *et al* 2015, even though IBA's have no particular relevance to this study.
- Section 4.2.6. – We suggest including an explanation of the basis on which the additional 7 cliffs were identified and surveyed late in the programme.
- Section 4.5, 4th bullet – seems to be in conflict with Section 4.2.6 which states clearly that the cliffs were searched. We suggest including some measure of the proportion of cliffs searched effectively, or confidence in the coverage.
- The level of field assessment of the grid connection power lines has not been explained in the report. The routes for the power lines are not presented in figures in this report.

6. Was the work conducted fairly and independently.

We conclude that this study was conducted both fairly and independently.

Thank-you for the opportunity to review this work. Please don't hesitate to contact us if you have any further questions.

Kind regards



Jon Smallie

C: 082 444 8919 | F: 086 6155654 | Email: jon@wildskies.co.za | W: www.wildskies.co.za
36 Utrecht Avenue, Bonnie Doon, East London, 5241
WildSkies Ecological Services (Pty) Ltd | Reg: 2011/131435/07 | VAT: 4340260779

ARCUS

KOMSBERG WIND ENERGY FACILITIES, NORTHERN AND WESTERN CAPE

PRE-CONSTRUCTION BAT MONITORING

Final Environmental Impact Assessment Report

On behalf of

KOMSBERG WIND FARMS (PTY) LIMITED

March 2016

Prepared By:

Arcus Consultancy Services

Office 220 Cube Workspace
Icon Building
Cnr Long Street & Hans Strijdom Avenue
Cape Town
8001

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

Registered in South Africa No. 2012/215000/10

Written By	Jonathan Aronson	17/03/2016
Checked By	Ashlin Bodasing	17/03/2016
Approved By	Ashlin Bodasing	17/03/2016

SPECIALISTS' DECLARATION OF INDEPENDENCE AND QUALIFICATIONS

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

Jonathan Aronson is a Bat Specialist working for Arcus. Jonathan is a key member of the South African Bat Assessment Association (SABAA) and has been at the forefront of bats and wind energy research in South Africa having contributed to the Good Practice Guidelines for Surveying Bats at Wind Energy Facilities in South Africa. Jonathan is the lead author on the guidelines for monitoring bats at operational Wind Energy Facilities (WEFs) which are currently available. Jonathan has eight years of experience in conducting studies for academic and consultancy purposes. He is registered as a Professional Natural Scientist with the South Africa Council for Natural Scientific Professions (SACNASP). The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge and available information.

Jonathan Aronson

March 2016

TABLE OF CONTENTS

1 INTRODUCTION

Komsberg Wind Farms (Pty) Ltd are considering the development of a wind energy facility ('WEF') at a site located on the border of the Northern and Western Cape provinces, 40 km south east of Sutherland ('the project'). Arcus Consultancy Services Ltd ('Arcus') were appointed to conduct the required 12 months of pre-construction bat monitoring at the site to identify any potential risks to bats posed by the project, and hence the potential risks to development consent posed by bats. Arcus have also been appointed to provide bat specialist input in the form of a specialist Impact Assessment Report for this project.

Developments such as the Komsberg WEFs have the potential to impact bats directly through collisions with 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). Impacts will vary among different WEFs depending on their location and design, and on the assemblage of bats and their behaviour. Monitoring bat activity at a proposed WEF is therefore needed to assess its potential impacts on bats and to help inform sensitive design and WEF operation.

1.1 Project Description

The site on which the project is proposed covers approximately 26,832 ha in total. The WEF will be developed in two phases (east and west) with a total maximum capacity of 275 megawatts (MW) each. Each turbine will have a maximum hub height of 120 m, a maximum rotor diameter of 140 m and a maximum height to the tip of 190 m. Overhead medium voltage cables will be installed between turbine strings or rows where necessary. Medium voltage cabling will also be installed between the turbines and the onsite substation; these will be laid underground where practical. Foundations, hardstands and internal access roads up to 8 m wide will be constructed to each turbine, the onsite substation and to ancillary infrastructure; underground cabling will also be installed adjacent to the roads. A 100 m x 150 m onsite substation complex will be constructed to facilitate stepping up the voltage from medium to high voltage, up to 400 kilovolts (kV), to enable the connection of the WEF to the Eskom grid.

Two new high voltage powerlines of 35 km and 55 km in length respectively, will be installed from the onsite switching substations (100x150m) to the Eskom grid at the Eskom Komsberg Main Transmission Substation.

A 30 m x 50 m operations compound will be constructed to include a services workshop area and site offices for control, maintenance and storage. Temporary infrastructure will include a site camp, laydown areas and a batching plant totalling 100 m x 150 m in extent.

2 SCOPE OF STUDY

2.1 Terms of Reference

This impact assessment report was compiled with consideration of the following terms of reference and includes:

- Details of the specialist who prepared the report and their expertise to compile a specialist report including a curriculum vitae and declaration of independence;
- An indication of the scope of, and purpose for which, the report was prepared;
- The date and season of the site investigation(s) and the relevance of the season to the outcome of the assessment;
- A description of any assumptions made and any uncertainties or gaps in knowledge;
- A description of the policy and legislative context;
- A description of the methodology adopted in preparing the report or carrying out the specialised process;

- A baseline description of the site and environmental attributes/conservation significance in terms of bats;
- The sensitivity of the site and its associated infrastructure to bats;
- An assessment of impacts and risks of the project to bats; and
- A discussion of anticipated cumulative impacts.

2.2 Purpose and Aims

This is the final report of the 12 month monitoring programme and has been preceded by three monitoring progress reports. The purpose of this report is to present results of the full 12 month pre-construction bat monitoring undertaken and an impact assessment to inform Komsberg Wind Farms of the key risks of developing the WEFs with regard to bats.

2.3 Assumptions and Limitations

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

- The knowledge of certain aspects of 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 may be impacted by wind energy development is very limited for many species.
- Relative to the size of the proposed project, limited amounts of data were collected at height (from two met masts). This limits the confidence in the assessment of potential impacts in the rotor-swept zone[1] based on the bat activity levels recorded but is in line with guidelines and industry standard practice, in South Africa.
- 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 be cautious when extrapolating data from echolocation surveys over large areas because 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 also very dependent on the quality of the calls used for identification. Bat echolocation, while useful to distinguish between and identify species and to sample bat activity, is not as reliable for identification purposes compared to catching bats. Species call parameters can often overlap, making species identification difficult.
- 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 past 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 presented as relative abundance.
- There is no standard scale to rate bat activity as low, medium or high. A qualitative assessment is given based on the specialists experience and on data collected from other locations. Data from this study were compared to data from other similar locations to rate the levels of bat activity recorded.
- The potential impacts of wind energy facilities on bats presented in the impact assessment represent the current knowledge in this field. New evidence from research and consultancy projects may become available in future, meaning that impacts and mitigation presented, discussed and evaluated in this final report may be adjusted in the environmental management programme. This will not influence the layout of the WEF but it may be useful in determining the mitigation measures to be implemented in future.

[1] The airspace through which the rotor blades spin.

2.4 Legislative Context

The following legalisation, policies, regulations and guidelines are all relevant to the project and the potential impact it may have on bats and habitats that support bats:

- Convention on the Conservation of Migratory Species of Wild Animals (1983)
- Convention on Biological Diversity (1993)
- Constitution of the Republic of South Africa (Act 108 of 1996)
- National Environmental Management Act (Act 107 of 1998)
- National Environmental Management: Biodiversity Act (Act 10 of 2004)
- Northern Cape Nature Conservation Act (Act 9 of 2009)
- The Equator Principles (2013)
- IUCN Red List of Threatened Species (2013)
- South Africa National Red Data List (2004)
- National Biodiversity Strategy and Action Plan (2005)
- South African Good Practise Guidelines for Surveying Bats in Wind Energy Facility Developments – Pre-Construction (2014)
- South African Good Practise Guidelines for Operational Monitoring for Bats at Wind Energy Facilities (2014)

3 SURVEY METHODOLOGY

The baseline environment for bats was investigated by conducting a desktop review of relevant literature and databases which was supplemented with data collected from field surveys at the proposed WEFs. These field surveys were part of the twelve months of bat monitoring undertaken in accordance with the South African Good Practice Guidelines for Surveying Bats in Wind Energy Facility Developments – Pre-construction[2] ('the guidelines). The aim of the monitoring programme was to determine the potential impacts on bats due to the project and if necessary to make mitigation recommendations to avoid or reduce potential impacts. The onsite monitoring for the project commenced in February 2015 and was completed in January 2016. The monitoring data collected during this period have been used to inform this final impact assessment report. These data spanned all four seasons in the region and are therefore suitable to provide an indication of potential levels of bat activity at the proposed project site.

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 at the proposed project. This included:

- Academic sources such as research papers and published texts;
- Published information on other nearby renewable energy developments;
- 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 Field Surveys

3.2.1 Acoustic Monitoring

Bat monitoring was performed in accordance with best practice guidelines. The survey approach focused on the use of passive acoustic monitoring to record bats across the project site. A desk based mapping exercise initially recommended the installation of bat detectors (SM2Bat+, Wildlife Acoustics) at nine locations. Three additional locations were added in July and August 2015 yielding 12 locations in total (Figure 1). Topography,

[2] Sowler, S. and Stoffberg, S. 2014. South African Good Practice Guidelines for Surveying Bats at Wind Energy Facility Developments – Pre-construction, 3rd Edition.

vegetation types, land use, landscape features important for bats (e.g. linear features, potential roosts and water), road access, the size of the site and the proposed turbine locations were used to determine the number and locations of bat detectors.

At 10 of the monitoring locations the detectors were installed on temporary aluminium masts with ultrasonic microphones mounted at 12 m. At two locations bat detector microphones were mounted at 12 m and 80 m above ground level on two lattice meteorological masts ('met masts'). Arcus installed the detectors on the 12 m masts from 10 – 17 February 2015 and 12 – 16 August 2015. The met mast detectors were installed by FASS Towers on 23 February 2015 (MET1) and Obelisk Energy on 26 July 2015 (MET2). All detectors were configured to record every night from 30 minutes before sunset until 30 minutes after sunrise. Data were manually retrieved from each detector between the following dates:

- 22 – 28 March 2015
- 15 – 17 April 2015
- 21 – 29 June 2015
- 11 – 13 August 2015
- 13 – 22 October 2015
- 30 November 2015 – 2 December 2015
- 22 – 24 January 2016

Driven transects were not undertaken because the nature of the site made their use unsuitable. Road access was very limited or non-existent in areas relevant to proposed turbine locations on the higher lying ridges. Where road access was possible on ridges, static detectors were used. Existing roads were confined to lower lying areas where turbines are not planned. In these areas, the distribution of static detectors sampled habitats representative of the site including drainage areas, riparian zones and foothill areas. As such, driven transects would not provide sufficient additional data to warrant their use.

3.2.2 Roost Surveys

Potential structures that bats could use as roosts were investigated during the day for the presence or evidence (e.g. guano and culled insect remains, etc.) of roosting bats whenever the specialist was on site. These included buildings, rocky outcrops and trees. Landowners were also asked if they were aware of any (active or abandoned) bat roosts or the presence of caves within the project or local region.

3.3 Data Analysis

3.3.1 Bat Echolocation Call 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 calls is called a bat pass and quantifying the number of bat passes recorded can be used to quantify the relative abundance of bat species. However, bat passes recorded from bat detectors cannot be used to directly estimate population sizes because it cannot distinguish between a single bat flying past a detector multiple times or multiple bats of the same species passing a detector once each (Kunz et al. 2007a).

Acoustic data from each bat detector were converted to zero-crossing format using Kaleidoscope (Version 3.1.3, Wildlife Acoustics) and analysed using AnalookW (Version4.1t, www.hoarybat.com). Bat species were identified from their echolocation calls using species-specific filters based on various call parameters. To aid in species identification, full-spectrum bats calls were also used to examine call sequences using Kaleidoscope.

Data from each detector were automatically processed using the scan function in AnalookW which counted the number of files that passed each species' filter. The number of AnalookW files was then used as a proxy for the number of bat passes. A bat pass was defined as a sequence of two or more echolocation calls separated from other calls by more than 500 milliseconds (Hayes 1997; Thomas 1988).

3.3.2 Meteorological Data Analysis

Meteorological data from the 80 m lattice mast MET2 were obtained and analysed in relation to bat activity. Data spanned the period from 27 July 2015 through 22 January 2016 and included wind speed (ms^{-1}), temperature (˚C) and barometric pressure (mbar). No wind speed data were available at 12 m so wind shear calculations, a standard method to extrapolate wind speeds at heights beyond the range from which wind speeds were recorded, were used to estimate wind speed at 12 m thereby making full use of the bat activity data recorded nearer ground level. All weather data were logged every 10 minutes (between 17:00 and 07:00) and the number of bat passes was summed for each of these intervals from the output of the AnalookW analysis such that they corresponded to the prevailing weather when they were recorded. Meteorological data were also obtained from the MET1 from April 2015 to January 2016. However, these were not analysed in relation to bat activity because the limited amounts of bat activity at this location resulted in the analysis lacking sufficient power to provide meaningful results.

3.3.2.1 Activity Accumulation Curves

Activity accumulation curves demonstrate how bat activity accumulates against an increasing measured variable (e.g. increasing wind speed) thus providing an estimate of the bat activity at (or below, or above) a given state of the measured variable (e.g. at a given wind speed). These curves were generated by adding the number of bat passes from a higher wind speed to the total number of bat passes recorded from all lower wind speeds, thus giving a running (and increasing) total of the number of bat passes. From these values, the accumulated proportion of total activity was calculated for each wind speed by dividing the accumulated total by the total number of bat passes recorded. The curves do not imply a causal relationship between bat activity and wind speed, but instead provide a useful tool to examine the likely amount of bat activity at a given wind speed which may be useful to understand during turbines operation. Accumulation curves were generated for wind speed at 12 m and 80 m.

3.3.2.2 Generalised Linear Modelling

Generalised Linear Models (GLMs) were used to investigate the relationship between the number of bat passes and wind speed, temperature and barometric pressure. The entire dataset was divided into several smaller datasets for analysis and the first division only included data between 20:00 and 05:00 (the peak time of bat activity at MET2). This dataset was then divided into presence-absence (i.e. ≥0 passes) and presence-only data (i.e. ≥1 passes). Each of these datasets were also separated by season. Analyses were also repeated on a new dataset which grouped all data into 30 minute time periods which was divided into smaller datasets as before. Data from 12 m and 80 m were analysed separately. The number of bat passes is a count variable and was therefore modelled under the assumptions of a Negative Binomial distribution (Arnett et al. 2010; Winkelmann and Zimmermann 1995).

4 SURVEY RESULTS

4.1 Baseline Environment

4.1.1 Habitats

The project is located in the vicinity of the Komsberge which forms part of the south-western edge of the Great Escarpment. It occurs in a botanically rich region (Clark et al.

2011) which transitions from Succulent Karoo to Nama-Karoo Biomes with the Fynbos Biome also represented across most of the project site. The project site is relatively topologically diverse and consists of large flat plains, undulating hills and steep slopes, with the high Roggeveld Mountains and Great Escarpment to the north. The slopes and broad ridges are mostly covered by shale Renosterveld with scattered Renosterbos shrubland and non-succulent Karoo shrubs. The undulating hilly landscapes to the south are covered mostly by low succulent scrub and scattered shrubs, with patches of grass on the flatter plains. The eastern areas are dominated by Karoo dwarf spiny shrubs and drought resistant grasses, such as *Aristida* and *Stipagrostis* species in the flatter plains. Land use on site is primarily grazing. Other habitats within the project relevant to bats include rocky outcrops, cliffs, farm dams, seasonal pans, ephemeral rivers and drainage lines dominated by relatively denser and taller riparian trees and scrub vegetation. Taller trees are also associated with farmsteads within the proposed WEFs site.

Habitat and topographical features at the proposed project site that are favourable for bats include the linear edges created by the drainage lines and riparian vegetation which are used as cues by bats for flight paths while foraging and to navigate while commuting (Verboom and Huitema 1997). The water sources described above, and the few farm dams at the project site (Figure 2 and Figure 3), will attract bats to drink and to forage (Barclay 1991; Todd and Waters 2007). In South African agricultural landscapes, wetland areas and surrounding habitats are recognised as important foraging areas for bats (Sirami et al. 2013) but there is limited water available for the majority of the year. The large trees (Lumsden and Bennett 2005), artificial lighting in the vicinity of the farm buildings (Rydell 1992), and nearby facilities used for animal husbandry (Downs and Sanderson 2010) should also attract bats by providing both roosting and foraging opportunities.

Potential roosting sites for bats within the project area are provided by rocky crevices, buildings and trees. Shallow caves are present in some areas of the site (landowner H. Miller, *pers. comm.*). Dolerite sills, a prominent feature of the landscape, may provide roosting opportunities for bats and several of the larger sills have been mapped (Figure 2 and Figure 3). No confirmed bat roosts have been located thus far but a potential roost was located in a large rocky crevice on the farm Anysrivier which had small deposits of bat guano (Figure 2). A roost has been confirmed outside the WEF site (approximately 4 km) on the farm Welgemoed (Figure 3) where, on numerous occasions, approximately 50 bats were observed emerging from a building. Bats were observed emerging in April 2015, October 2015, November 2015 and January 2016 but were not observed emerging in June 2015 and August 2015.

4.1.2 Bat Species

A review of published information (African Chiroptera Report 2013; Monadjem et al. 2010) found that the project falls within the actual or predicted distribution range of approximately 13 species of bat. However, the distributions of some bat species in South Africa, particularly rarer species, are poorly known so it is possible that more (or fewer) species may be present. Analysis of acoustic monitoring data from the field surveys suggests that at least five species of bat are present (Table 1). There was some evidence that an additional species, Lesueur's wing-gland bat, was recorded but very infrequently. This is a rare bat, endemic to southern Africa (Monadjem et al. 2010) and classified as near threatened in South Africa (Friedman and Daly 2004). Limited reference echolocation data for this species are available making it difficult to confirm if the calls recorded and analysed in this study were from this species. Therefore, only data for the five confirmed species are presented in this report. The sensitivity of each of these five species to the project is a function of their conservation status and the likelihood of risk to these species from WEF development. The likelihood of risk was determined from the guidelines and is based on the foraging and flight ecology of bats and migratory behaviour.

Table 1: Bat Species Recorded at the Project and their Sensitivity to WEFs

Species	Likelihood of Risk[3]	Species Code	# of Bat Passes[4]	Conservation Status	
				National[5]	International[6]
Long-tailed serotine *Eptesicus hottentotus*	Medium	LTS	2,640	Least Concern	Least Concern
Cape serotine *Neoromicia capensis*	Medium-High	CS	14,459	Least Concern	Least Concern
Natal long-fingered bat *Miniopterus natalensis*	High	NLB	811	Near Threatened	Least Concern
Roberts's flat-headed bat[7] *Sauromys petrophilus*	High	RFB	7,691	Least Concern	Least Concern
Egyptian free-tailed bat *Tadarida aegyptiaca*	High	EFB	35,929	Least Concern	Least Concern

4.2 Acoustic Monitoring Results

4.2.1 Overall Activity Patterns

A total of 61,530 bat passes were recorded from 347 sample nights from five species (Table 1) across all bat detectors. Overall, the levels of bat activity were moderate to high with a strong seasonal and species-specific effect based on the experience of the specialist and compared to other sites. Across all detectors, bats were recorded on 95 % of the sample nights. Even though this value dropped for individual monitoring locations, the number of nights with bat activity was high at a number of locations (Table 2). The Egyptian free-tailed bat and the Cape serotine were the most frequently recorded species accounting for approximately 82% of total bat activity (Table 1).

Table 2: Acoustic Monitoring Summary

Monitoring Location (Figure 1)	Altitude (masl)	Habitat	# of Sample Nights[8]	% of Sample Nights with Bat Activity	Total number of Bat Passes
KOM1	1,023	Riparian	347	65.1	5,990
KOM2	1,093	Riparian	347	85.9	8,315
KOM3	1,218	Drainage Area	340	70.9	4,197
KOM4	1,220	Riparian	340	80.3	8,618
KOM5	1,164	Drainage Area	339	78.8	7,613
KOM6	1,140	Ridge	297	57.2	2,049
KOM7	1,181	Foothill	345	60.6	3,400
KOM8	1,090	Foothill	345	73.6	3,239
KOM9	1,273	Foothill	164	82.9	2,640
KOM10	1,343	Ridge	160	81.3	1,888
MET1 (Low)	1,276	Ridge	220	44.5	1,064
MET1 (High)	1,276 (+80 m)		334	0.09	137
MET2 (Low)	1311	Ridge	181	80.0	12,139
MET2 (High)	1311 (+80 m)		181	20.0	241

The variation in the total number of bat passes per night across all monitoring locations was high over the course of the monitoring, ranging from 0 to 2,058 bat passes a night

3 Based on the guidelines.

4 A sequence of two or more echolocation calls separated from other calls by more than 500 milliseconds.

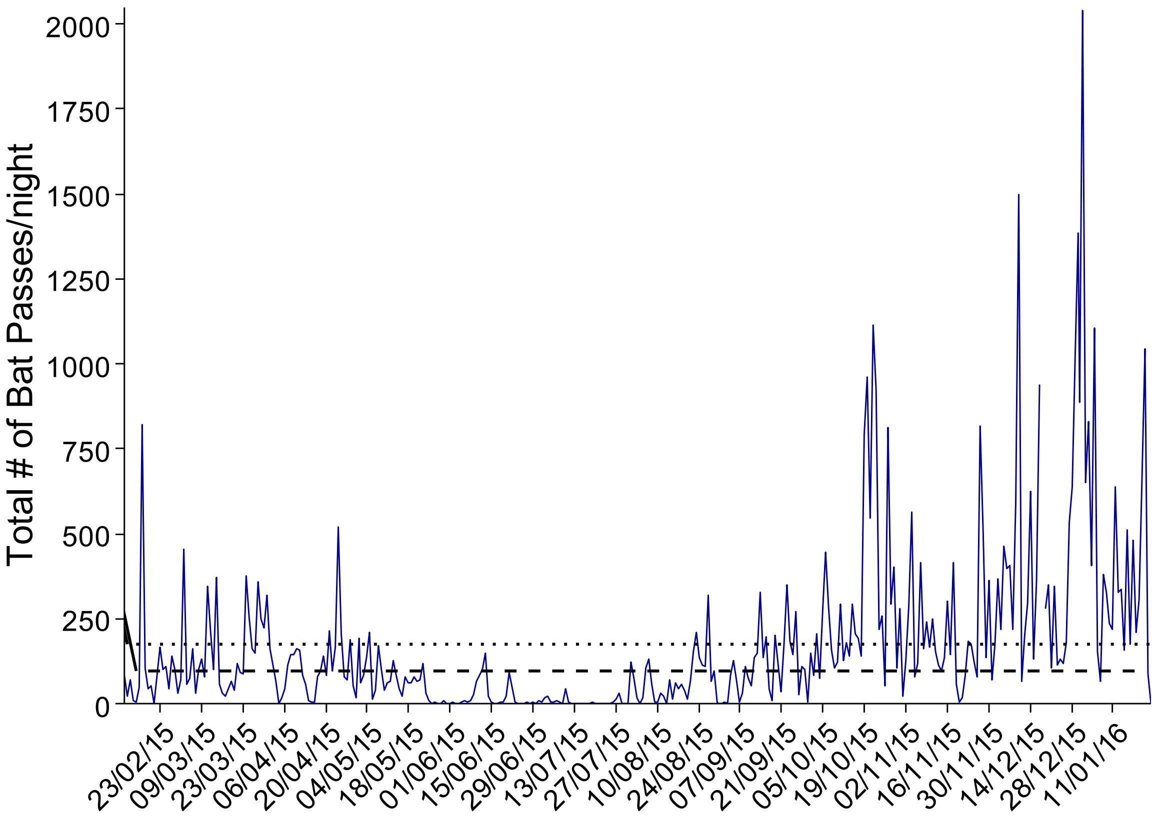
5 Red Data Book of the Mammals of South Africa: A Conservation Assessment Friedman, Y., Daly, B. eds., 2004. Red Data Book of the Mammals of South Africa: A Conservation Assessment. CBSG Southern Africa, Conservation Breeding Specialist Group (SSC/IUCN), Endangered Wildlife Trust, South Africa.

6 International Union for the Conservation of Nature (IUCN) Red List version 3.1 IUCN, 2013. IUCN Red List of Threatened Species. Version 2013.2. www.iucnredlist.org. Downloaded on 20 February 2014.

7 This species is endemic to South Africa (Monadjem et al. 2010).

8 Differences in the number of sample nights are because detectors were installed on different dates and because of technical faults with the acoustic equipment.

with a median of 94 and a mean of 177 (Graph 1). On several nights, bat activity was very high which suggests that activity is episodic and may respond quickly to changes in environmental conditions (e.g. temperature, rainfall or wind speed) and the availability of insect prey. For example, on 18/12/2016 a total of 2,058 bat passes were recorded across the project but on the following night 281 bat passes were recorded. This nightly variation in bat activity is typical in the specialist's experience.

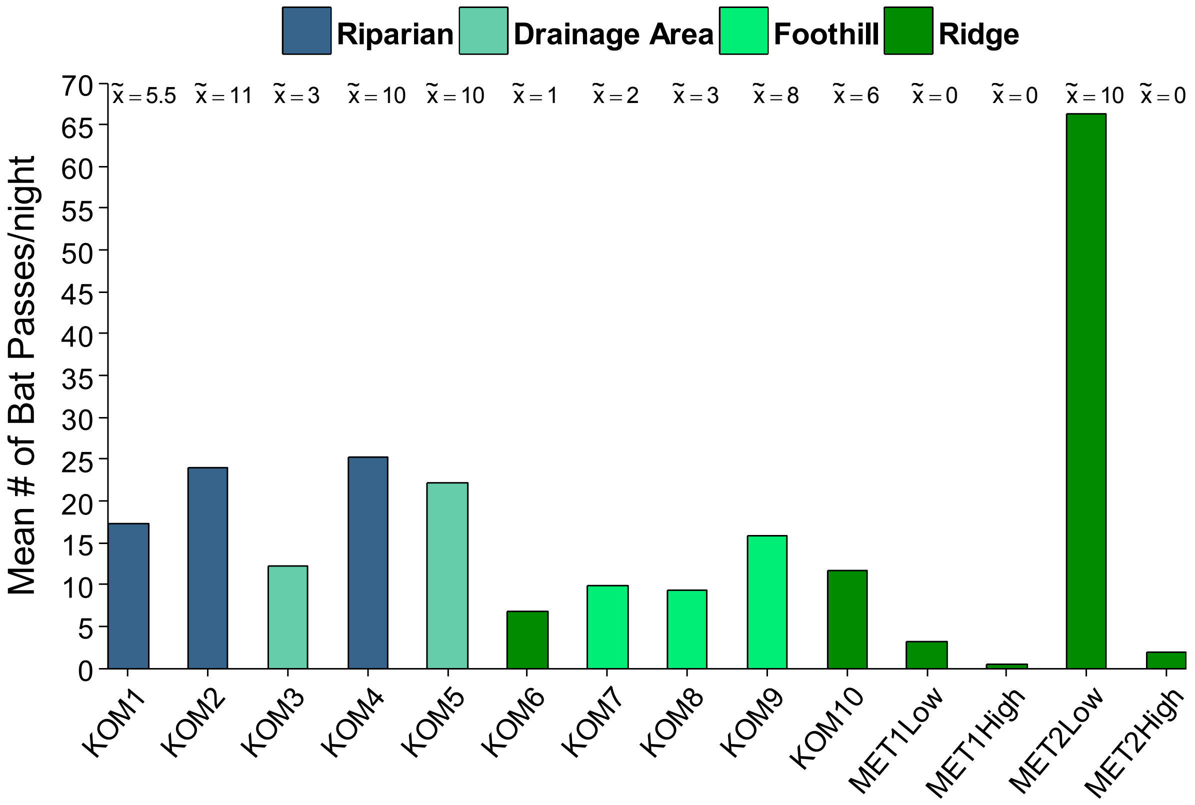


Graph 1: The total number of bat passes/night across all detectors during the sampling period. The dotted and dashed lines show the mean (177) and median (94) number of bat passes per night respectively.

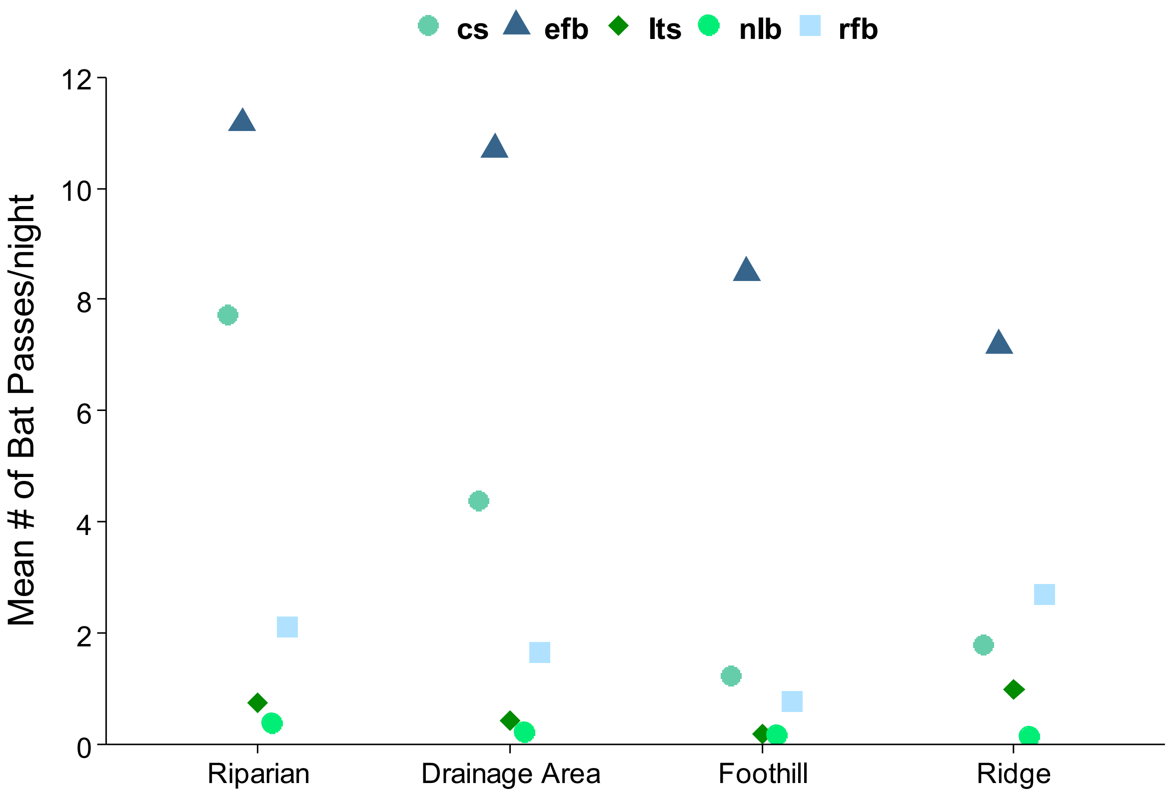
4.2.2 Spatial Activity Patterns

Bat activity was highest at MET2Low, KOM2, KOM4 and KOM5 (Table 2; Graph 2). At these locations mean bat activity ranged from 66.3 bat passes/night to 22.3 bat passes/night. Large variation in the number of bat passes per night was also evident at these locations compared to other locations. The median number of bat passes was highest at MET2Low, KOM2, KOM4 and KOM5 (Graph 2). The lowest mean activity was at MET1High and MET2High where 0.41 bat passes/night and 1.3 bat passes/night were recorded respectively.

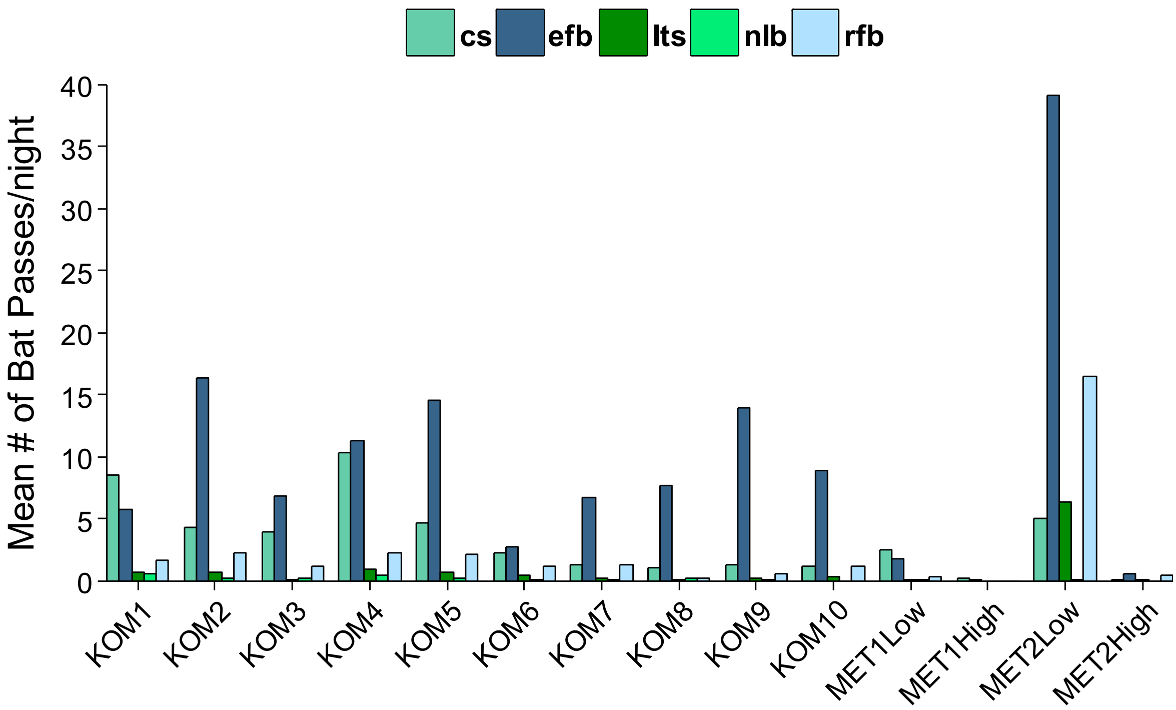
There was a negative relationship between altitude and bat activity. Average and median bat activity was higher in riparian zones and in drainage areas compared to ridges and foothill areas (Graph 2). However, total bat activity was higher on ridges compared to drainage areas but this was mostly due to activity at MET2Low (see discussion in section 4.3). The distribution of activity levels for some species reflected this negative relationship but did not for others (Graph 3). The Egyptian free-tailed bat, the Cape serotine and the Natal long-fingered bat had higher activity in riparian and drainage areas compared to foothills and ridges. Roberts's flat-headed bat and the Long-tailed serotine had slightly higher activity on the ridges than the riparian and drainage areas. Each of the five species was recorded at each monitoring location (Graph 4).



Graph 2: The mean number of bat passes/night in different habitats over the study period at each monitoring location. The median number ($\tilde{x}$) of bat passes per night for each monitoring location is shown above the plot.



Graph 3: The mean number of bat passes/night in the different habitats for each species across all monitoring locations.

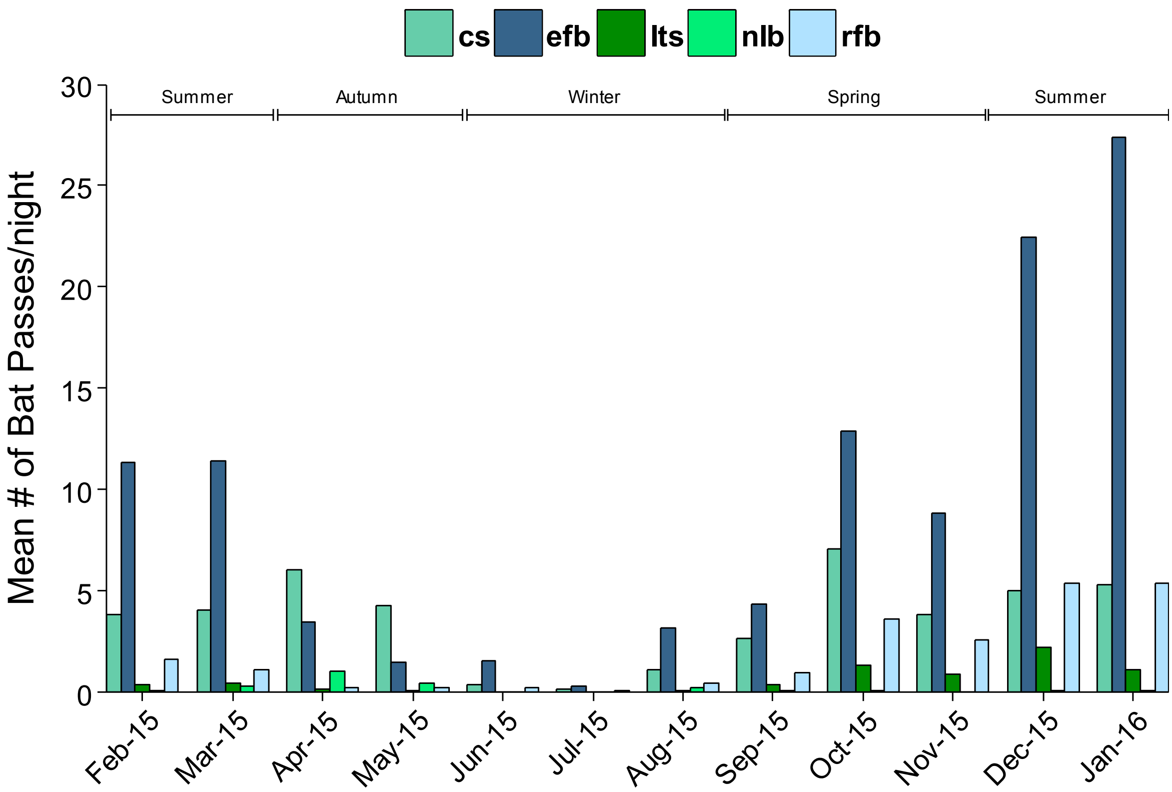


Graph 4: The mean number of bat passes/night for five species at each monitoring location.

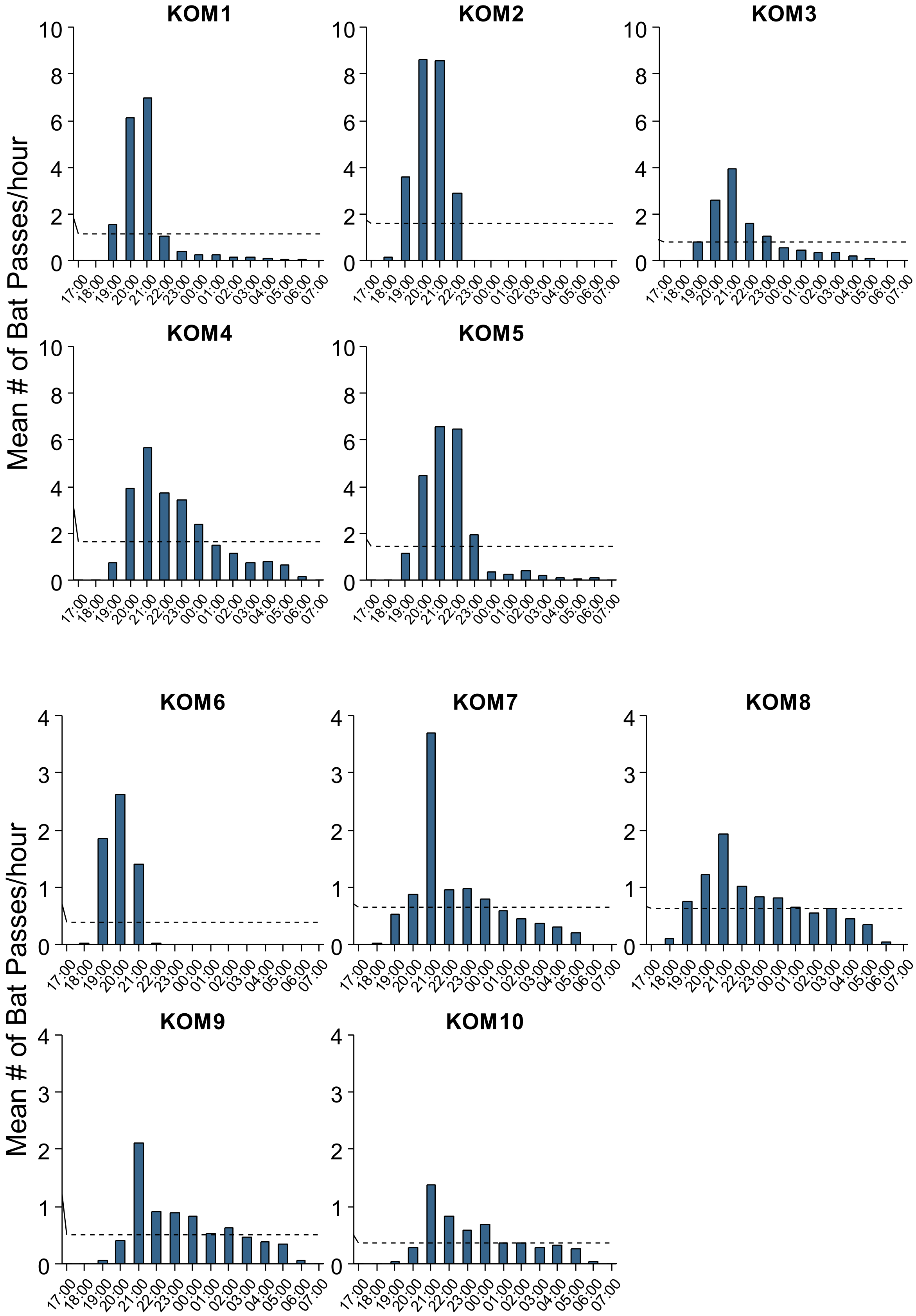
The frequency with which each species was recorded varied among locations but the Egyptian free-tailed bat and the Cape serotine were the most frequently recorded species at most locations (Graph 4). Mean activity for these two species peaked at MET2Low with 39.1 bat passes/night and KOM4 with 10.4 bat passes/night respectively (Graph 4). The Natal long-fingered bat and the Long-tailed serotine had very low activity across most monitoring locations peaking at KOM1 with a mean of 0.5 bat passes/night and MET2Low with a mean of 6.3 bat passes/night (although this was an outlier driven by summer activity patterns – see Graph 4 and Graph 5). Roberts's flat-headed bat also had its highest mean activity at MET2Low with 16.5 bat passes/night (Graph 4) but if this location is excluded, its mean activity for the site as a whole was very low at 1.2 bat passes/night.

4.2.3 Temporal Activity Patterns

Bats were recorded on all the sample nights in summer, all but one night in autumn (at the end of autumn on 31/05/2015), on 79 % of sample nights in winter and all but one night at the start of spring (01/09/2015). Bat activity peaked in summer (mean: 324.2, median: 180; bat passes/night), decreased through autumn (mean: 87.5, median: 72; bat passes/night) into winter (mean: 32.0, median: 6; bat passes/night) before increasing again in spring (mean: 217.6, median: 146; bat passes/night). The highest levels of activity were recorded in December 2015 (mean: 489.9, median: 351; bat passes/night) and the lowest levels of activity were recorded in July 2015 (mean: 6.2, median: 2; bat passes/night). Most species followed this trend except for the Cape serotine and Natal long-fingered bat which had slightly higher activity in spring and autumn respectively compared to summer (Graph 5). In winter, there were periods in early June and late August when more than 100 bat passes were recorded per night (Graph 1).

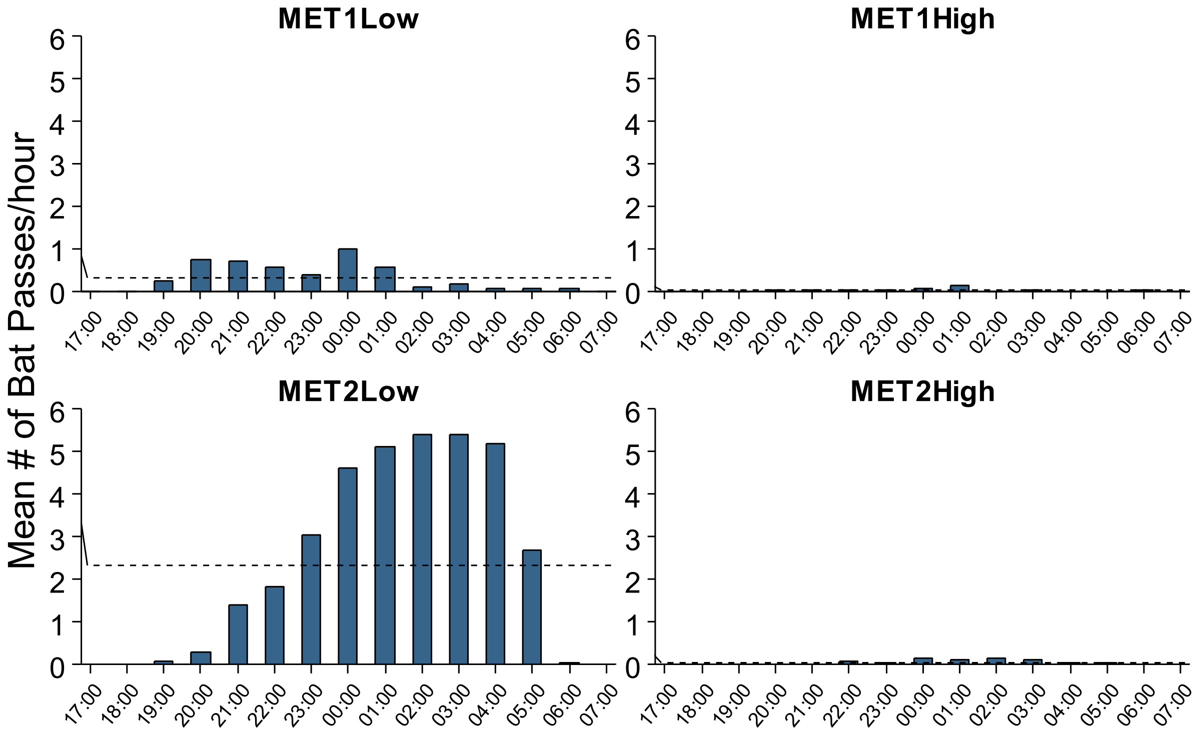


Graph 5: The mean number of bat passes/night for five species across the twelve months sampled.



Graph 6: The mean number of bat passes/hour (of all species) in each time period[9] for each monitoring location. The dashed line shows the mean number of bat passes/hour per night.

[9] Tick marks on the x-axes refer to hourly ranges i.e. 17h00 represents the period 17h01 – 18h00 etc.

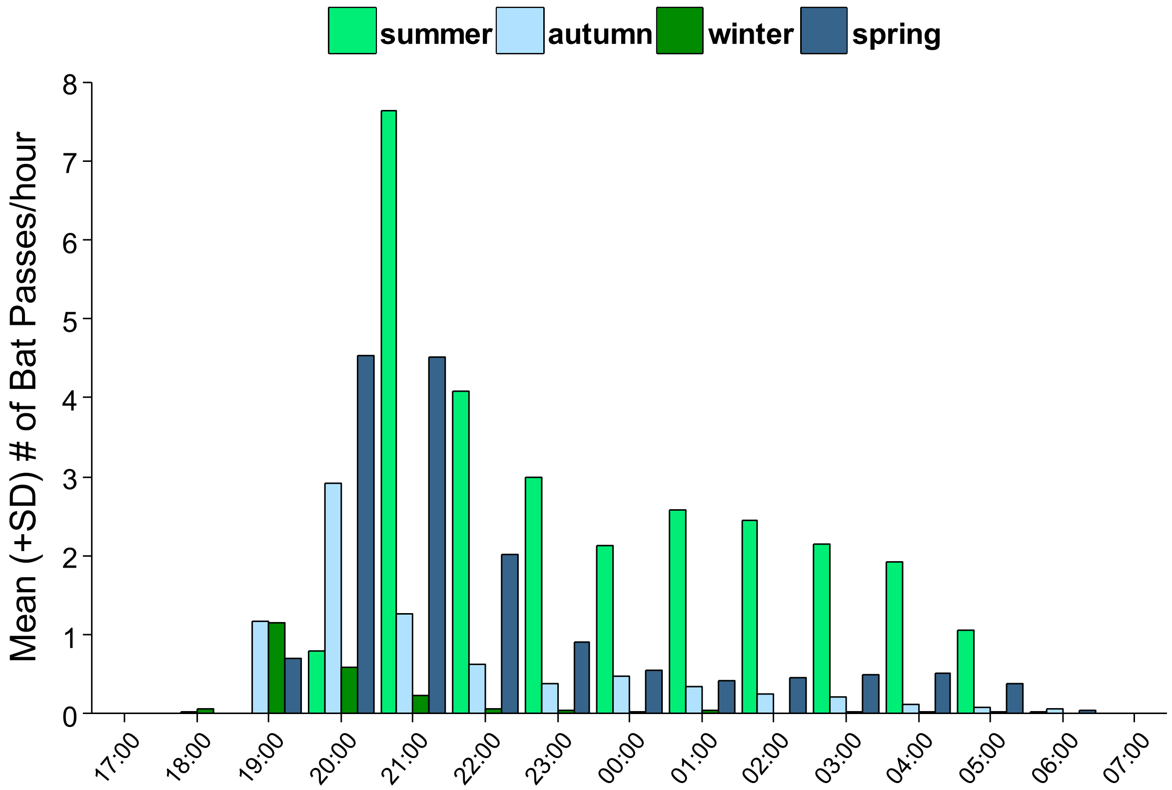


Graph 6cont: The mean number of bat passes/hour (of all species) in each time period[10] for each monitoring location. The dashed line shows the mean number of bat passes/hour per night.

The mean number of bat passes per hour peaked at different times at each monitoring location but was generally highest between 19:00 and 21:00 (Graph 6). The two met masts were the only locations where activity peaked in the early morning (Graph 6). The mean number of bat passes per hour was highest at KOM2 between 20:00 and 21:00 with 8.6 bat passes. At some monitoring locations (e.g. KOM2 and KOM6) bats were only recorded during the first few hours of the night whereas at others bats were recorded throughout most of the night.

In winter and autumn bat activity started the earliest compared to other seasons (between 18:00 and 20:00). In winter activity peaked between 19:00 and 20:00 and declined for the rest of the night with only a slight increase again between 04:00 and 06:00 (Graph 7). Activity in autumn peaked an hour later compared to winter (between 20:00 and 21:00) and did not increase after this. In spring bat activity also peaked between 20:00 and 21:00 and peaked again slightly later in the evenings between 03:00 and 05:00 (Graph 7). In summer bat activity started the latest, at 20:00, peaking between 21:00 and 22:00.

[10] Tick marks on the x-axes refer to hourly ranges i.e. 17h00 represents the period 17h01 – 18h00 etc.

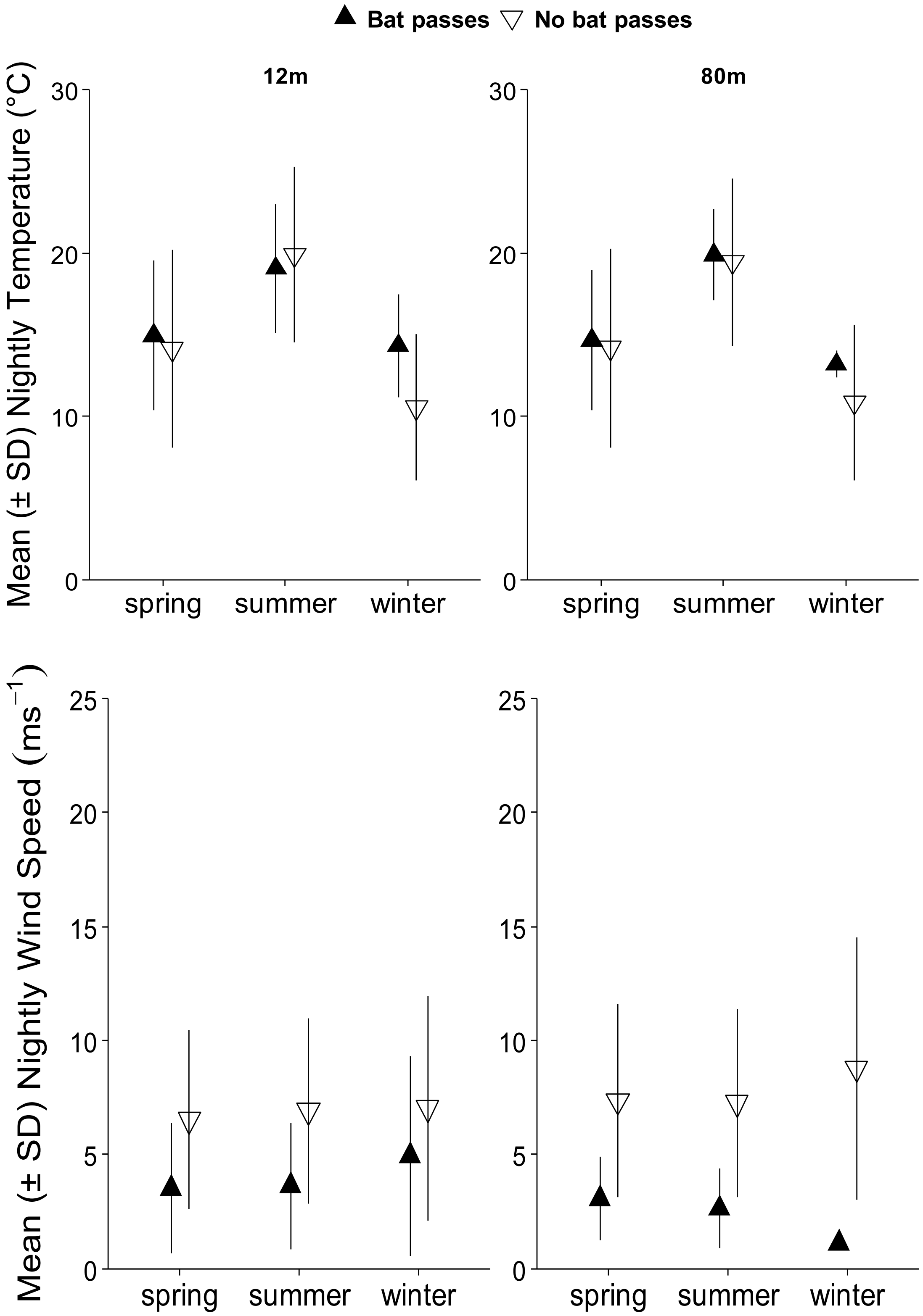


Graph 7: The mean number of bat passes (of all species and across all monitoring locations) per hour in each time period per season.

4.2.4 Meteorological Analysis

Bat activity showed general positive and negative correlations with temperature and wind speed respectively. In spring at 12 m at MET2, the mean nightly temperature that bats were active in (i.e. when bat passes *were* recorded) was 14.9 °C compared to a mean of 14.1 °C for nights that bats were not active (Graph 8). There was a similar pattern in winter but the difference in temperature when bats were and were not recorded was greater (Graph 8). Summer had an opposite effect at 12 m as bats were active in lower temperatures that they were not active. At 80 m, bats were active in higher temperatures across all seasons compared to temperatures they were not active in and again, this difference was greatest in winter (Graph 8).

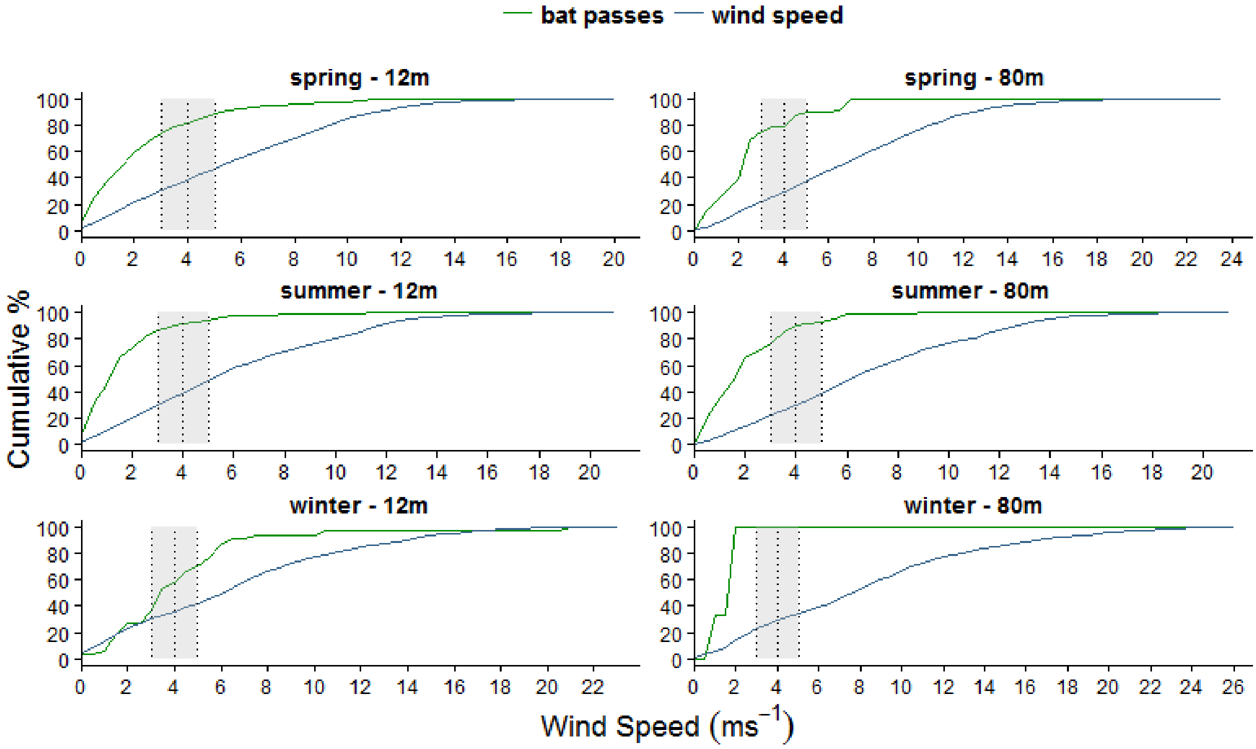
Bats tended to be more active at lower wind speeds. For example, in spring the mean nightly wind speed that bats were active in at 12m was 3.5 ms^{-1} compared to 6.5 ms^{-1} for nights that bats were not active (Graph 8). Summer and winter showed the same pattern. At 80 m in spring and summer this difference was greater as bats were active at lower mean nightly wind speeds. At 80 m in winter the mean nightly wind speed when bats were recorded at 80 m was 1.1 ms^{-1}.



Graph 8: The influence of mean nightly temperature and mean nightly wind speed on bat activity in spring, summer and winter at MET2.

The profile of cumulative bat activity is very different from the profile of cumulative wind speed for all six combinations of season and height (Graph 9). They accumulate at different rates indicating that bat activity is influenced by wind speed. The accumulation curves showed that bats can be active at high wind speeds (for example up to 16.5 ms^{-1} in spring at 12 m) and that accumulated bat activity levels varied seasonally (Graph 9). In spring at 12 m, 73 % of the accumulated bat activity levels occurred below 3 ms^{-1}, a typical cut-in speed for many wind turbines, compared to 87 % in summer and 37 % in winter. Accumulated activity also varied with height; 87 % versus 77 % at 3 ms^{-1} at 12 m and 80 m respectively in summer for example (Graph 9).

If changing the cut-in speed of high risk wind turbines were required (for example, based on operational phase data), this may have a noticeable impact on the proportion of bats that could be potentially at risk of spinning blades. For example, data from 80 m in spring showed that 75 % of bat activity occurred below 3 ms^{-1} and that this increased to 79 % of bat activity as wind speed increased to 4 ms^{-1} and 90 % for a wind speed of 5 ms^{-1} (Graph 9). In summer at 80 m, 77 % of bat activity occurred below 3 ms^{-1}, 90 % below 4 ms^{-1} and 93% below 5 ms^{-1}.



Graph 9: Accumulation curves of bat activity across all species with increasing wind speed at MET2 in spring, summer and winter. The grey band highlights the range of typical wind turbine cut-in speeds from 3 ms^{-1} to 5 ms^{-1}.

The analysis of the relationship between bat activity and wind speed, temperature and barometric pressure showed mixed results across all models (results not shown). Only wind speed and temperature emerged as significant predictors of bat activity in most models. However, despite the model results suggesting significant relationships between bat activity and these two predictor variables, the magnitude was small across all models. In addition, post-hoc tests showed that the data did not fit any of the models well suggesting that the models have low predictive use.

4.3 Discussion

The general trends evident in the bat activity data are a dominance of recorded activity levels by two species, a decrease in bat activity with altitude and greater activity in lower lying areas, higher bat activity for three hours in the early evening, a seasonal pattern with lower activity in autumn and winter and higher activity in spring and summer, a positive but weak relationship between bat activity and temperature and a negative but weak relationship between bat activity and wind speed.

Most bat activity involved the Egyptian free-tailed bat and the Cape serotine which together accounted for approximately 83 % of total bat activity. Both species are of Least Concern nationally and internationally and according to the guidelines, they have a high and medium-high likelihood of risk from WEFs respectively (Table 1). The Cape serotine displays foraging behaviour that may bring this species within the rotor-swept zone of wind turbine blades; it forages at a range of heights including near to the ground, on the edge of vegetation and in open air relatively high above the ground (e.g. at least 40 m, J. Aronson, *pers. obs.*). This may bring these bats into the range of the lower sweep of turbine blades. The Egyptian free-tailed bat is a high-flying species whose morphology and echolocation enable fast flight in open areas and these bats are therefore at risk of encountering wind turbine blades across most of the rotor-swept zone. Monitoring of operational WEFs in South Africa has confirmed that Cape serotine and Egyptian free-tailed bats have suffered mortality by wind turbines (Aronson et al. 2013; Doty and Martin 2012). The species recorded least often was the Natal long-fingered bat which has the highest national conservation status of the five species recorded being listed as Near Threatened. This is a migratory species (Monadjem et al. 2010) and is protected under an international agreement in the Convention on the Conservation of Migratory Species of Wild Animals (1979). The majority of bat mortalities at wind energy facilities in North America and Europe are migratory species (Baerwald and Barclay 2011; Cryan 2011; Kunz et al. 2007b) therefore it may be assumed that the Natal long-fingered bat is at risk from wind turbines in South Africa. This species migrates during autumn (April and May) and spring (September and October) between summer maternity roosts and winter hibernating sites generally located at higher latitudes, and is reported to migrate distances from approximately 150 km to 560 km (Miller-Butterworth et al. 2003; Monadjem et al. 2010). This species did have higher activity in autumn and it is unclear if this is related to any migration events but it is likely that there is a local population of the Natal long-fingered bat at the project and surrounding region.

Bat activity was higher in riparian zones and in drainage areas compared to ridges and foothill areas. This could be because the more complex habitat in these areas and access to water is more favourable for bats. Linear edges created by the drainage lines and riparian vegetation are used as cues by bats for flight paths while foraging and to navigate while commuting (Verboom and Huitema 1997). No turbines are planned for riparian or drainage areas but these must still be buffered with a 200 m no-go buffer zone (Figure 2 and Figure 3). No infrastructure (excluding roads), including the turbine blade tip, should be within this buffer zone. Despite the higher activity in general in lower lying areas, some species did show increased activity on ridges.

On average across the 12 monitoring locations the activity of Roberts's flat-headed bat was greater in riparian and drainage areas but its presence was notable at MET2Low (see Figure 1 for MET2 location) with an average of 16.5 bat passes/night on this ridge (Graph 4). An important finding is that 90 % of the activity of this species at MET2 occurred during two brief periods during the year across December and January (i.e. summer); one lasting 16 days and the other 11 days (Graph 5). Roberts's flat-headed bat is also a free-tailed bat with similar flight behaviour to Egyptian free-tailed bats and is also at high risk from WEFs (Table 1) and endemic to southern Africa (Monadjem et al. 2010). The higher activity at MET2 could be due to the nearby presence of rocky habitat (Figure 2) providing roosting opportunities under slabs of exfoliated rock or narrow crevices and cracks which this species appears to be adapted to use (Jacobs and Fenton 2001). The Long-tailed serotine and the Egyptian free-tailed bat are also known to roost in rock crevices (Monadjem et al. 2010). Compared to the other monitoring locations, both species had their highest mean activity per night at MET2; 6.3 bat passes/night and 39.1 bat passes/night respectively (Graph 4). As with Roberts's flat-headed bat, the vast majority of this activity came in brief periods in December and January. For example, for the Long-tailed serotine, 75 % of activity at MET2Low occurred during a nine day period in December and a 5 day period in January. For the Egyptian free-tailed bat 80 % of activity occurred during a 17 day period in December and a 12 day period in January. Prominent geological features of the landscape at Komsberg are dolerite sills running along ridgelines and in higher lying areas, including near MET2. These features present roosting opportunities for these three, and possibly other, species of bat in the form of rocky habitat. The turbines of the WEF are proposed to be placed in areas on ridges near some of the dolerite sills and as such a 200 m no-go buffer zone has been placed around several of the more prominent dolerite sills to reduce the risk to bats (Figure 2 and Figure 3). No infrastructure, including the turbine blade tip, should be within this buffer zone.

Other features of the site that are also buffered due to their importance for bats include farm buildings (200 m), agricultural fields (200 m), NFEPA wetlands and farm dams (200 m), major drainage areas (200 m) and NFEPA rivers (200 m). A 50 m buffer was also placed around the location MET2 which recorded high numbers of bats in summer. This distance was chosen because it is potentially the maximum distance that some bats could be recorded by an ultrasonic microphone in ideal conditions. All of these buffers, mapped in Figure 2 and Figure 3 are no-go zones, therefore no infrastructure (excluding roads as discussed above), including the turbine blade tip, should be within them.

Bat activity peaked at different times at each monitoring location but was generally highest in the early evening (between 19:00 and 21:00) which is typical for many insectivorous bats (Hayes 1997; Kunz 1973; Taylor et al. 2013). A second peak later in the night before sunrise is sometimes also possible but this was mostly not observed except at the met masts where bat activity appeared to peak later in the night. There was also a clear seasonal effect in peak activity times with activity starting and peaking earlier in winter and latest in summer (Graph 7). In spring there appeared to be a small second peak in activity in the early hours of the morning. Emergence times of bats from their daytime roosts is influenced by a range of factors including sunset times (Thomas and Jacobs 2013) and the later sunset times in spring and summer result in the later peaks in bat activity. The impact of seasons on bat activity is also expressed at a nightly and monthly scale and is a consistent pattern (Hayes 1997) also observed in this study (Graph 1).

These patterns may be mediated through environmental conditions such as wind speed, temperature, rainfall, humidity and barometric pressure which themselves vary seasonally have been shown to influence bat activity in numerous studies (Arnett et al. 2007; Baerwald and Barclay 2011; Cryan and Brown 2007; Hayes 1997; Paige 1995). However, in this study the GLM models had very low predictive power and only showed very small effects of environmental variables on bat activity. While the specialist is satisfied with the conclusiveness of this report and the assessment findings, the addition of other predicator variables (e.g. moon phase, humidity or rainfall) could improve the model fitting or alternatively different statistical methodologies could be attempted.

Based on the pre-construction monitoring data there are several species of bat that may be at risk from the project. These include the Cape serotine, Natal long-fingered bat, Roberts's flat-headed bat and Egyptian free-tailed bat. However, compared to activity levels at other sites at which the specialist has been involved, the activity levels are moderate on average despite several nights with very high activity, especially in December and January. Bat activity is also concentrated during specific time periods and appears lower in some parts of the site. The design of the facility to adhere to the no-go buffer zones (Figure 2 and Figure 3) is the primary mitigation step to reduce possible impacts to bats. Additional steps during operation could include using the temporal activity data (i.e. months and times during the night) and meteorological data to determine periods when bats are likely to be at greatest risk of mortality from operational wind turbines. This would be based initially on pre-construction activity data coupled with activity and fatality data collected during operation of the WEFs. In this way, if necessary based on concerning fatality data, peak periods in activity may be identified and related to weather conditions and, with spatial fatality data, specific turbines that cause unacceptable impacts could be targeted for mitigation of residual impacts that may not have been captured by turbine siting.

5 EVALUATION OF SITE RISK

5.1 Risk to Bats

WEFs have the potential to impact bats directly through collisions and barotrauma resulting in mortality (Horn et al. 2008; Rollins et al. 2012), and indirectly through the modification of habitats (Kunz et al. 2007b). Direct impacts pose the greatest risk to bats and, in the context of the project, habitat loss and displacement should not pose a significant risk (unless a large roost in discovered on site and bats are reluctant to leave this roost if disturbed) because the project footprint (i.e. turbines, roads) is small compared to the size of the project at 0.37 %.

Direct impacts to bats will be limited to species that make use of the airspace in the rotor-swept zone of the wind turbines. Of the five species of bat that were recorded on site, at least four exhibit behaviour that may bring them into contact with wind turbine blades and they are potentially at risk of negative impacts if not properly mitigated, although the magnitude of these impacts are unknown at this stage.

5.2 Impact Assessment

The potential direct and indirect impacts of the proposed project are presented for both the construction and operational phases based on a methodology adapted from Hacking (1998). Impacts for both the wind energy facilities and their associated 132 kV grid connections (Figure 5) are presented.

5.2.1 Direct Impacts – Wind Energy Facilities

5.2.1.1 Construction Phase

Impact Phase: Construction							
<u>Possible</u> Impact or Risk: Roost disturbance							
WEFs have the potential to impact bats directly through the disturbance of roosts during construction. 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 may roost in trees are likely to be impacted more (e.g. Cape serotine and Egyptian free-tailed bats; Monadjem et al. 2010) because 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.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	Medium	Low	Negative	Low	Low	Low
With Mitigation	Low	Medium	Low	Negative	Very Low	Low	Low
Can the impact be reversed?				UNKNOWN			
Will impact cause irreplaceable loss of resources?				NO			
Can impact be avoided, managed or mitigated?				YES			

Mitigation measures to reduce residual risk or enhance opportunities:

1) It may be possible to limit roost abandonment by avoiding construction activities near roosts.
2) No confirmed roosts have been found at the project but there are potential roosts that bats may be using including trees, rocky crevices and buildings.
3) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within including the tips of turbine blades, must be applied around potential roosts identified in Figure 2 and Figure 3. The only exception is the construction of roads which can enter the 200 m buffer but cannot pass through any rocky crevices mapped in Figure 2 and Figure 3.

4) It is recommended that a bat specialist survey the confirmed turbine locations and all other proposed site infrastructure for the presence of roosts within the 200 m buffer before any construction activities commence and once the preliminary design and layout of the site is complete.

Will this impact contribute to any cumulative impacts?	The cumulative impact of bats abandoning their roosts is dependent on the number of roosts affected, the species involved and extent of the impact across the assessed region. With effective management of the construction process across the cumulative developments and limiting roost disturbance, the cumulative impacts can be reduced.

Impact Phase: Construction

<u>Possible</u> Impact or Risk: Roost destruction

WEFs have the potential to impact bats directly through the physical destruction of roosts during construction. 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. Potential roosts that may be impacted by construction activities include trees, rocky crevices and buildings.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Low	High	Low	Negative	Medium	Medium	Low
With Mitigation	Low	Low	Low	Negative	Low	Low	Low

Can the impact be reversed?	NO
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) The WEF can be designed and constructed in such a way as to avoid the destruction of potential roosts, particularly trees, rocky crevices (if blasting is required) and buildings.
2) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within including the tips of turbine blades, must be applied around potential roosts identified in Figure 2 and Figure 3. The only exception is the construction of roads which can enter the 200 m buffer but cannot pass through any rocky crevices mapped in Figure 2 and Figure 3.
3) No construction activities with the potential to physically affect any bat roosts will be permitted without the express permission of a suitably qualified bat specialist following appropriate investigation and mitigation.
4) It is recommended that a bat specialist survey the confirmed turbine locations and all other site infrastructure for the presence of roosts within the 200 m buffer before any construction activities commence and once the preliminary design and layout of the site is complete.
5) A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.
6) During construction, laydown areas and temporary access roads should be kept to a minimum in order to limit direct vegetation loss and habitat fragmentation, while designated no-go areas must be enforced i.e. no off-road driving.
7) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and a habitat restoration plan must be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).

Will this impact contribute to any cumulative impacts?	The cumulative impact of destroying multiple roosts across a region will be negative. With mitigation, effective design of WEFs and preventing roost destruction, the cumulative impacts can be reduced.

5.2.1.2 Operational Phase

<table>
<tr><td colspan="8">Impact Phase: Operational</td></tr>
<tr><td colspan="8"><u>Possible</u> Impact or Risk: Bat mortality during commuting and/or foraging</td></tr>
<tr><td colspan="8">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 in the rotor-swept zone of the wind turbines. At least four species of bat that were recorded at the project thus far exhibit behaviour that may bring them into contact with wind turbine blades and so they are potentially at risk of negative impacts.</td></tr>
<tr><td></td><td>Extent</td><td>Duration</td><td>Intensity</td><td>Status</td><td>Significance</td><td>Probability</td><td>Confidence</td></tr>
<tr><td>Without Mitigation</td><td>High</td><td>Medium</td><td>High</td><td>Negative</td><td>High</td><td>Medium</td><td>Low</td></tr>
<tr><td>With Mitigation</td><td>Medium</td><td>Medium</td><td>High</td><td>Negative</td><td>Medium</td><td>Low</td><td>Medium</td></tr>
<tr><td colspan="4">Can the impact be reversed?</td><td colspan="4">NO</td></tr>
<tr><td colspan="4">Will impact cause irreplaceable loss of resources?</td><td colspan="4">YES</td></tr>
<tr><td colspan="4">Can impact be avoided, managed or mitigated?</td><td colspan="4">YES</td></tr>
<tr><td colspan="8">Mitigation measures to reduce residual risk or enhance opportunities:
1) There are several mitigation options available to reduce the potential for bat mortality to occur or to reduce bat mortality. Designing the layout of the project to avoid areas that are more frequently used by bats may reduce the likelihood of mortality and should be the primary mitigation measure. This has already been undertaken.
2) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within including the tips of turbine blades, must be applied around landscape features important for bats which have been identified in Figure 2 and Figure 3. The only exception is the construction of roads which can enter the 200 m buffer.
3) Operational acoustic monitoring and carcass searches for bats must be performed to monitor mortality levels for a minimum of two years and according to current (or updated) best practise guidelines (Aronson et al. 2014). Acoustic monitoring should include monitoring at height and at ground level at more than one location. Records of bat fatality must be shared with the relevant bodies, specifically the South African Bat Assessment Association.
4) If mortality does occur, the level of mortality should be considered by a bat specialist/s to determine if this is at a level where further mitigation needs to be considered. Mitigation options may include using ultrasonic deterrents, raising the cut-in speeds of turbines, turbine blade feathering and using targeted curtailment during specific seasons and time periods for specific turbines.
5) It is advised that both pre-construction and operational monitoring data are used to confirm the need for above mentioned mitigation measures such as curtailment and to determine when during WEF operation such mitigation needs to be implemented, if at all.</td></tr>
<tr><td colspan="4">Will this impact contribute to any cumulative impacts?</td><td colspan="4">The cumulative impacts will depend on the number of WEFs in the region, the species involved and the levels of bat mortality. Bats reproduce slowly (Barclay and Harder 2003) and their populations can take long periods of time to recover from disturbances so the cumulative impacts can be high if appropriate management and mitigation is not implemented.</td></tr>
</table>

<table>
<tr><td>Impact Phase: Operational</td></tr>
<tr><td><u>Possible</u> Impact or Risk: Bat mortality during migration</td></tr>
<tr><td>It has been suggested that some bats may not echolocate when they migrate (Baerwald and Barclay 2009) which could explain the higher numbers of migratory species suffering mortality in WEF studies in North America and Europe. Therefore, the risks to bats may be higher when they migrate compared to when they are commuting or foraging. This has therefore been considered as a separate impact on the Natal long-fingered bat, which is the only current species of the five species recorded during pre-construction monitoring thus far known to exhibit migratory behaviour.</td></tr>
</table>

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	High	Medium	High	Negative	High	Low	Low
With Mitigation	Medium	Medium	High	Negative	Medium	Low	Medium

Can the impact be reversed?	NO
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) There are several mitigation options available to reduce the potential for bat mortality to occur or to reduce bat mortality. Designing the layout of the project to avoid areas that are more frequently used by bats may reduce the likelihood of mortality and should be the primary mitigation measure. This has already been undertaken.
2) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within including the tips of turbine blades, must be applied around landscape features important for bats which have been identified in Figure 2 and Figure 3. The only exception is the construction of roads which can enter the 200 m buffer.
3) Operational acoustic monitoring and carcass searches for bats must be performed to monitor mortality levels for a minimum of two years and according to current (or updated) best practise guidelines (Aronson et al. 2014). Acoustic monitoring should include monitoring at height and at ground level at more than one location. Records of bat fatality must be shared with the relevant bodies, specifically the South African Bat Assessment Association.
4) If mortality does occur, the level of mortality should be considered by a bat specialist/s to determine if this is at a level where further mitigation needs to be considered. Mitigation options include using ultrasonic deterrents, raising the cut-in speeds of turbines, turbine blade feathering and using targeted curtailment during specific seasons and time periods for specific turbines.
5) It is advised that both pre-construction and operational monitoring data are used to confirm the need for above mentioned mitigation measures such as curtailment and to determine when during WEF operation such mitigation needs to be implemented, if at all.

Will this impact contribute to any cumulative impacts?	The cumulative impacts will depend on the number of WEFs in the region, the species involved and the levels of bat mortality. Bats reproduce slowly (Barclay & Harder 2003) and their populations can take long periods of time to recover from disturbances so the cumulative impacts can be high if appropriate management and mitigation is not implemented. Impacts may also affect populations over a large geographic area (Lehnert et al. 2014; Voigt et al. 2012) if gene flow is prevented in migratory species.

5.2.2 Direct Impacts – Grid Connections

5.2.2.1 Construction Phase

Impact Phase: Construction

Possible Impact or Risk: Roost disturbance

The grid connection infrastructure may impact bats directly through the disturbance of roosts during construction. 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 may roost in trees are likely to be impacted more (e.g. Cape serotine and Egyptian free-tailed bats; Monadjem et al. 2010) because 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.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence

Without Mitigation	Low	Medium	Medium	Negative	Medium	Medium	Low
With Mitigation	Low	Medium	Low	Negative	Low	Low	Low

Can the impact be reversed?	UNKNOWN
Will impact cause irreplaceable loss of resources?	NO
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) It may be possible to limit roost disturbance and abandonment by avoiding construction activities near roosts. These include trees, caves, rocky crevices and buildings along the grid connection route.
2) It is recommended that a bat specialist survey the confirmed switching station and grid connection route during the design phase for the presence of roosts before any construction activities commence.
3) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within must be applied around any roosts or potential roosts identified (limited to rocky crevices and buildings).
4) A no-go buffer zone of 500 m, in which no construction activities may take place or no infrastructure is to come within must be applied around any roosts or potential roosts identified (limited to specific tree species and caves) to specifically protect Fruit bats. The following trees species should be buffered: species of fig, Cape ash, saffronwood, yellowwood, Diospyros L., and Syzygium R.Br. ex Gaertn, if found within the grid connection route.

Will this impact contribute to any cumulative impacts?	The cumulative impact of bats abandoning their roosts is dependent on the number of roosts affected, the species involved and extent of the impact across the assessed region. With effective management of the construction process across the cumulative developments and limiting roost disturbance, the cumulative impacts can be reduced to low.

Impact Phase: Construction

<u>Possible</u> Impact or Risk: Roost destruction

The grid connection infrastructure may impact bats directly through the physical destruction of roosts during construction. 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. Potential roosts that may be impacted by construction activities include trees, rocky crevices and buildings.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Low	High	Low	Negative	Medium	Medium	Low
With Mitigation	Low	Low	Low	Negative	Very Low	Low	Low

Can the impact be reversed?	NO
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) The switching station and grid connection route can be designed and constructed in such a way as to avoid the destruction of potential roosts, particularly trees, caves, rocky crevices (if blasting is required) and buildings.
2) No construction activities with the potential to physically affect any bat roosts will be permitted without the express permission of a suitably qualified bat specialist following appropriate investigation and mitigation.
3) It is recommended that a bat specialist survey the confirmed grid connection route during the detailed design phase for the presence of roosts before any construction activities commence.
4) A no-go buffer zone of 200 m, in which no construction activities may take place or no infrastructure is to come within must be applied around any roosts or potential roosts identified (limited to rocky crevices and buildings).

5) A no-go buffer zone of 500 m, in which no construction activities may take place or no infrastructure is to come within must be applied around any roosts or potential roosts identified (limited to specific tree species and caves) to specifically protect Fruit bats. The following trees species should be buffered: species of fig, Cape ash, saffronwood, yellowwood, Diospyros L., and Syzygium R.Br. ex Gaertn, if found within the grid connection route.
6) A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction.
7) During construction, laydown areas and temporary access roads should be kept to a minimum in order to limit direct vegetation loss and habitat fragmentation, while designated no-go areas must be enforced i.e. no off-road driving.
8) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and a habitat restoration plan must be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).

Will this impact contribute to any cumulative impacts?	The cumulative impact of destroying multiple roosts across a region will be negative. With mitigation, effective design of WEFs and preventing roost destruction, the cumulative impacts can be reduced to low.

5.2.2.2 Operational Phase

Impact Phase: Operational

<u>Possible</u> Impact or Risk: Bat mortality through collision with transmission lines

Insectivorous bats are unlikely to collide with transmission lines due to their ability to echolocate. They are therefore able to detect and avoid obstacles in their path, such as electrical cabling. Fruit bats do not echolocate in the same manner and can collide and become electrocuted by transmission lines. There is no published evidence of this in South Africa but these events to occur globally.

The geographic distribution of at least one species of fruit bat, the Egyptian rousette, may overlap with the proposed grid connection route. The existence of suitable caves for roosting and fruit trees along or across this route may increase the likelihood that this species is present.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Low	Medium	Low	Negative	Low	Low	Low
With Mitigation	Low	Medium	Low	Negative	Very Low	Low	Low

Can the impact be reversed?	NO
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) It is recommended that a bat specialist survey the confirmed switching station and grid connection route during the design phase for the presence of cave roosts, orchards and fruit trees before any construction activities commence. The Egyptian rousette utilises the fruit of the following trees species: various species of fig, Cape ash, saffronwood, yellowwood, Diospyros L., and Syzygium R.Br. ex Gaertn. The grid connection must be surveyed for the presence of these species.
2) A no-go buffer zone of 500 m, in which no construction activities may take place or no infrastructure is to come within (including overhead power cables) must be applied around any cave roosts, orchards or fruit trees identified to protect fruit bats.

Will this impact contribute to any cumulative impacts?	The cumulative impacts will depend on the number of WEFs in the region, the species involved and the levels of bat mortality. Bats reproduce slowly (Barclay and Harder 2003) and their populations can take long periods of time to recover from disturbances so the cumulative impacts can be high

	if appropriate management and mitigation is not implemented.

5.2.3 Indirect Impacts – Wind Energy Facilities

5.2.3.1 Construction Phase

Impact Phase: Construction							
Possible Impact or Risk: Habitat modification							
Bats can be impacted indirectly through the modification or removal of habitats (Kunz et al. 2007b). The removal of vegetation during the construction phase will impact bats by removing cover and linear features that some bats use for foraging and commuting (Verboom and Huitema 1997). The footprint of the facility is small relative to the remaining habitat available in the surrounding area and as such the removal of vegetation is not likely to result in a significant impact. This impact can be reduced even further by limiting the removal of vegetation as far as possible.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	Medium	Medium	Negative	Medium	High	High
With Mitigation	Low	Medium	Low	Negative	Low	High	High
Can the impact be reversed?	YES						
Will impact cause irreplaceable loss of resources?	YES						
Can impact be avoided, managed or mitigated?	YES						
Mitigation measures to reduce residual risk or enhance opportunities: 1) This impact must be reduced by limiting the removal of vegetation as far as possible. A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction. 2) During the design phase, the bat specialist should conduct a site walkthrough, covering the final road and power line routes as well as the final substation and switching station location and turbine positions, to identify any roosts/activity of sensitive species, as well as any additional sensitive habitats. 3) During construction laydown areas and temporary access roads should be kept to a minimum in order to limit direct vegetation loss and habitat fragmentation, while designated no-go areas must be enforced i.e. no off-road driving. 4) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and a habitat restoration plan must be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).							
Will this impact contribute to any cumulative impacts?	Cumulative impacts should be low because of the limited amount of vegetation that would be removed at operating WEFs relative to the large area in the region that would not be developed. However, this will depend on the types of vegetation that are removed because the cumulative impact of removing endangered habitat will be greater than removing habitat that is not threatened.						

Impact Phase: Construction
Possible Impact or Risk: Light pollution
Currently the local region experiences very little light pollution from anthropogenic sources and the construction of a WEF will marginally increase light pollution. It is assumed that regular night-time lighting will be used only for a short period if construction activities take place at night. This artificial lighting can indirectly impact bats through its effect on insect prey (Stone 2012). Lighting attracts (Blake et al. 1994; Rydell 1992; Stone 2012) and can cause direct mortality of insects. These local reductions in insect prey may reduce foraging opportunities for bats, particularly for species that avoid illuminated areas. This impact is likely to be low because, relative to the large area in the region that would not be developed that likely supports large numbers of insects, the prey resource for

bats is likely to be sufficient. However, light pollution must be carefully considered and lighting at the project should be kept to a minimum and appropriate types of lighting should be used.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Low	Medium	Low	Negative	Low	Medium	Medium
With Mitigation	Low	Medium	Low	Negative	Low	Low	High

Can the impact be reversed?	YES
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) This impact can be mitigated by using as little lighting as possible. Where lights need to be used such as at the substation and switching station and elsewhere, these should have low attractiveness for insects such as low pressure sodium and warm white LED lights (Rydell 1992; Stone 2012). High pressure sodium and white mercury lighting is attractive to insects (Blake et al. 1994; Rydell 1992; Svensson and Rydell 1998) and should not be used as far as possible.

Will this impact contribute to any cumulative impacts?	Relative to the large area in the region that would not be developed that likely supports large numbers of insects, the prey resource for bats is likely to be sufficient for cumulative impacts to be low.

5.2.3.2 Operational Phase

Impact Phase: Operational

<u>Possible</u> Impact or Risk: Habitat creation in high risk locations

The construction of a WEF and associated building infrastructure may inadvertently provide new roosts for bats. It has been suggested that some bats may investigate wind turbines for their potential roosting spaces (Cryan et al. 2014; Horn et al. 2008; Kunz et al. 2007b) and bats could therefore be attracted to WEFs, increasing the chance of wind turbine-induced mortality. Bats may also be attracted to roosting opportunities in new buildings and road culverts at WEFs (J. Aronson, *pers. obs.*). The likelihood of large numbers of bats roosting in infrastructure at the project is low. Nonetheless, bats should be prevented from entering artificial roost structures (e.g. roofs of buildings, road culverts and wind turbines) by ensuring that they are sealed in such a way as to prevent bats from entering.

	Extent	Duration	Intensity	Status	Significance	Probability	Confidence
Without Mitigation	Low	Medium	Low	Negative	Low	Low	Medium
With Mitigation	Low	Medium	Low	Negative	Low	Low	High

Can the impact be reversed?	YES
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) Bats should be prevented from entering any possible artificial roost structures (e.g. roofs of buildings, road culverts and wind turbines) by ensuring that they are sealed in such a way as to prevent bats from entering. If bats colonise WEF infrastructure, a suitably qualified bat specialist should be consulted before any work is undertaken on that infrastructure or attempting to remove bats. Ongoing maintenance and inspections of buildings must be carried out to ensure no access to bats or actively roosting bats.

Will this impact contribute to any cumulative impacts?	If there are no roosting opportunities for bats at the project or other developments, the cumulative impacts will be low.

Impact Phase: Operational

<u>Possible</u> Impact or Risk: Light pollution

The indirect impact of light pollution created during the construction phase would persist if lighting is also used during the WEFs operational activities. 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). During the operation of the WEF, it is assumed that the only light sources would be motion sensor security lighting for short periods, turbine lighting at ground level and lighting associated with the substation and switching station. This artificial lighting would impact bats indirectly via the mortality of their insect prey thereby reducing foraging opportunities for certain bat species. However, other 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 may bring these species into the vicinity of the project and indirectly increase the risk of collision/barotrauma particularly for species that are known to forage around lights. These include the Cape serotine and the Egyptian free-tailed bat (Fenton et al. 2004; J. Aronson, p*ers. obs*.). This impact is likely to be low with mitigation but must be carefully considered. Lighting at the project should be kept to a minimum and appropriate types of lighting should be used to avoid attracting insects, and hence, bats.

	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	Medium	Low	Negative	Low	Low	Medium
With Mitigation	Low	Medium	Low	Negative	Low	Low	High

Can the impact be reversed?	YES
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) This impact can be mitigated by using as little lighting as possible. Where lights need to be used such as at the substation and switching station and elsewhere, these should have low attractiveness for insects such as low pressure sodium and warm white LED lights (Rydell 1992; Stone 2012). High pressure sodium and white mercury lighting is attractive to insects (Blake et al. 1994; Rydell 1992; Svensson & Rydell 1998) and should not be used as far as possible. Additional considerations and mitigation options are provided in Stone (2012).

Will this impact contribute to any cumulative impacts?	Cumulative impacts should be low if mitigation is applied because fewer insects would be attracted to lighting, and hence fewer bats would be attracted to feed on them. This would reduce the likelihood of bats encountering wind turbines.

Impact Phase: Operational

<u>Possible</u> Impact or Risk: Loss of ecosystem services

Bats play a critical role in many ecosystems by providing valuable ecosystem services such as pest control by insectivorous bats in agricultural systems (Kunz et al. 2011), including in South Africa (Noer et al. 2012; Taylor et al. 2011). The value of bats to this industry can be substantial (Boyles et al. 2011). Bats also prey on other insects pests like mosquitoes (Gonsalves et al. 2013; Reiskind and Wund 2009) which are vectors for diseases like Rift Valley Fever which can impact livestock. The loss of bats via mortality at WEFs can therefore indirectly have unanticipated social, economic and ecological impacts by reducing ecosystem service provision beyond the lifespan of the project. The degree of the impact will be influenced by the levels of bat mortality experienced.

	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Medium	High	Medium	Negative	Medium	Medium	Low
With Mitigation	Low	Medium	Low	Negative	Low	Low	Low

Can the impact be reversed?	POSSIBLY
Will impact cause irreplaceable loss of resources?	YES
Can impact be avoided, managed or mitigated?	YES

Mitigation measures to reduce residual risk or enhance opportunities:

1) Mitigation measures targeted towards reducing bat mortality should be applied.
2) Designing the layout of the project to avoid areas that are more frequently used by bats may reduce the likelihood of mortality and should be the primary mitigation measure. This has already been undertaken.
3) Operational acoustic monitoring and carcass searches for bats should be performed to monitor mortality levels. Acoustic monitoring should include monitoring at height and at ground level.

4) If mortality does occur, the level of mortality should be considered by a bat specialist/s to determine if this is at a level where further mitigation needs to be considered. Mitigation options include using ultrasonic deterrents, raising the cut-in speeds of turbines, turbine blade feathering and using targeted curtailment during specific seasons and time periods for specific turbines. 5) It is advised that both pre-construction and operational monitoring data are used to confirm the need for mitigation measures such as curtailment and to determine WEF operation and if such mitigation needs to be implemented.	
Will this impact contribute to any cumulative impacts?	Because insectivorous bats are apex predators, good bioindicators of ecosystem health (Jones et al. 2009), consume large amounts of insects and provide important pest control services, the cumulative impact of excessive bat mortality over a large region could be high, however there is considerable uncertainty in the ecosystem level impacts of bat mortality at WEFs.

5.2.4 Indirect Impacts – Grid Connections

5.2.4.1 Construction Phase

Impact Phase: Construction							
Possible Impact or Risk: Habitat modification							
Bats can be impacted indirectly through the modification or removal of habitats (Kunz et al. 2007b). The removal of vegetation during the construction phase will impact bats by removing cover and linear features that some bats use for foraging and commuting (Verboom and Huitema 1997). The footprint of the switching station and grid connection route is small relative to the remaining habitat available in the surrounding area and as such the removal of vegetation is not likely to result in a significant impact. This impact can be reduced even further by limiting the removal of vegetation as far as possible.							
	Extent	**Duration**	**Intensity**	**Status**	**Significance**	**Probability**	**Confidence**
Without Mitigation	Low	Medium	Low	Negative	Low	Medium	High
With Mitigation	Low	Medium	Low	Negative	Very Low	Medium	High
Can the impact be reversed?	YES						
Will impact cause irreplaceable loss of resources?	YES						
Can impact be avoided, managed or mitigated?	YES						
Mitigation measures to reduce residual risk or enhance opportunities: 1) This impact must be reduced by limiting the removal of vegetation as far as possible. A site-specific Construction Environmental Management Plan (CEMP) must be implemented, which gives appropriate and detailed description of how construction activities must be conducted to reduce unnecessary destruction of habitat. All contractors are to adhere to the CEMP and should apply good environmental practice during construction. 2) During the design phase, the bat specialist should conduct a site walkthrough, covering the final road and power line routes and the switching station and substation areas, to identify any roosts/activity of sensitive species, as well as any additional sensitive habitats. 3) During construction laydown areas and temporary access roads should be kept to a minimum in order to limit direct vegetation loss and habitat fragmentation, while designated no-go areas must be enforced i.e. no off-road driving. 4) Following construction, rehabilitation of all areas disturbed (e.g. temporary access tracks and laydown areas) must be undertaken and a habitat restoration plan must be developed by a specialist and included within the Construction Environmental Management Plan (CEMP).							
Will this impact contribute to any cumulative impacts?	Cumulative impacts should be low because of the limited amount of vegetation that would be removed relative to the large area in the region that would not be developed. However, this will depend on the types of vegetation that are removed because the						

	cumulative impact of removing endangered habitat will be greater than removing habitat that is not threatened.

5.3 Cumulative Impacts

The cumulative impact on bats was considered by searching for current and potential future development of wind energy within a 560 km radius of the project. At least 177 onshore wind facilities and onshore wind/solar PV combined facilities are being considered by the Department of Environmental Affairs in this cumulative 560 km region (Figure 4), however it is not likely that all of these facilities will reach commercial operation. This scale was chosen because it represents the maximum reported distance the Natal long-fingered bat is estimated to migrate in South Africa (Miller-Butterworth et al. 2003). This species is known to migrate over hundreds of kilometres (i.e. 560 km is not an isolated data point) between winter and summer roosts (Miller-Butterworth et al. 2003). It is important to consider cumulative impacts across the entire scale potentially affected animals are likely to move, especially mobile animals like bats. Impacts at a local scale could have negative consequences at larger scales if the movement between distant populations is impacted (Lehnert et al. 2014; Voigt et al. 2012). For example, Lehnert et al. (2014) demonstrated that among Noctule bats collected beneath wind turbines in eastern Germany, 28 % originated from distant populations in the Northern and North-eastern parts of Europe. The cumulative impacts could be lower for species that do not migrate over such large distances or resident species that are not known to migrate. The sphere of the cumulative impact would then likely be restricted to the home ranges and foraging distances of different species, which can range from 1 km to at least 15 km for some insectivorous bats (Jacobs and Barclay 2009; Serra-Cobo and Sanz-Trullen 1998) and up to at least 24 km for some fruit bats (Jacobsen et al. 1986). Impacts to the bats of the Komsberg East and West Wind Energy Facilities will be medium for non-migratory species before mitigation but could reduce to low with appropriate turbine siting and operational mitigation if determined as being necessary based on operational monitoring. Impacts on migratory species (i.e. the Natal long-fingered bat) will be high before mitigation but could reduce to low with appropriate turbine siting and operational mitigation if determined as being necessary based on operational monitoring.

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

6 CONCLUSION

Based on 12 months of pre-construction monitoring, overall bat activity is moderate on average relative to other sites based on the experience of the Specialist. Activity is high in some parts of the project site and during specific short term periods. Up to six bat species may be present at the project site and the vast majority of activity was from two species both of which are "Least Concern". However, both of these species, the Egyptian free-tailed bat and the Cape serotine, are at risk of wind turbine induced mortality despite their conservation status.

Bat activity data suggest a decrease in bat activity with altitude (including lower activity at 80 m compared to 12 m) and greater activity in lower lying areas, where turbines are not planned. However, roosting opportunities in higher lying areas provided by dolerite sills may put some bats at risk of encountering wind turbines in these areas. A 200 m no-go buffer zone on specific dolerite sills that have been mapped must be adhered to. This has informed where turbines are best placed resulting in several turbines which needed to be relocated and this has been carried out. Activity data also revealed that on a nightly time scale, bats were most active for three hours in the early evening across all seasons. However, bats were more active in summer and spring at the project and this is therefore likely to be the period when bats would be at most risk from wind turbines during operation of the WEF.

Despite not being able to use meteorological data to predict bat activity with statistical significance, wind speed and temperature did influence the behaviour of bats. If deemed necessary based on operational bat fatality data and supported by Specialist opinion and best practise guidelines, adjusting turbine operation based on wind speed, times and seasonality may be a further mitigation response to reduce residual impacts, if required.

The impact assessment concludes that, with the application of mitigation and best practice measures, the predicted levels of impact for most potential effects to bats was low. The exception is a potential medium impact after mitigation during the operational phase, associated with foraging, commuting or migrating bats colliding with the turbines. However, there is uncertainty in the level of this predicted impact because of the limited evidence-base regarding the impacts of operational WEFs on bats in South Africa. As such, the recommendation with regard to this potential impact is to conduct operational phase monitoring of bats for a minimum of two years. The results of this monitoring will be assessed by a bat specialist to determine if further mitigation and monitoring is required and, if necessary, to develop the mitigation so that it is site-specific and likely to address potential impacts to bats.

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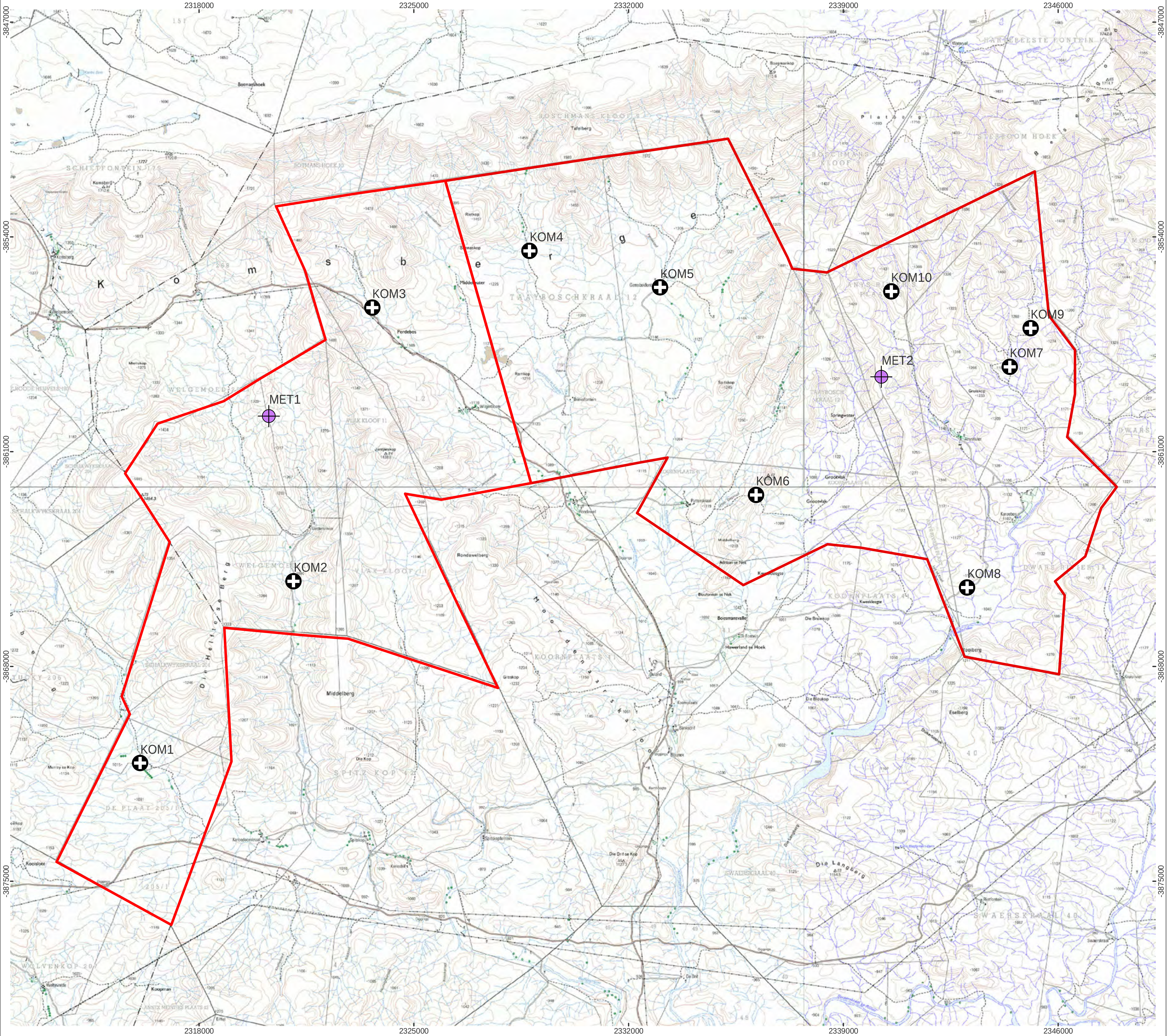
Figures



Basemapping from the Chief Directorate National Geo-Spatial Information of South Africa

ARCUS

Site Boundary

80 m Meteorological Mast

Bat Detector Location

1:120,000 Scale @ A3

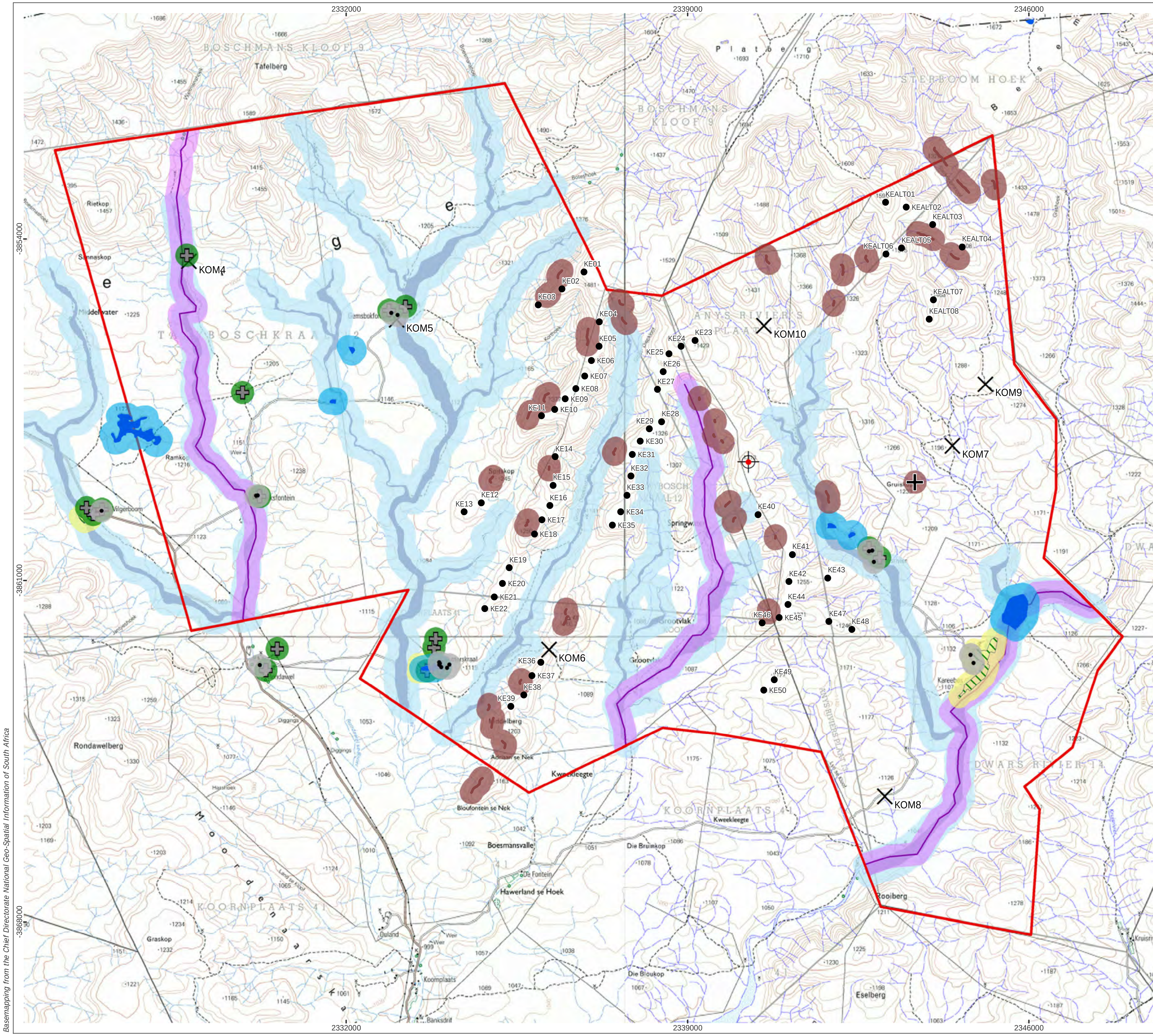
0 2 4 km

N

Produced: JA Reviewed: SC Approved: AB	Ref: 1961/REP/042 Date: 10/02/2016

Komsberg Bat Detector Locations
Figure 1

Komsberg Wind Energy Facilities
Pre-construction Bat Monitoring
Final EIA Report



ARCUS

- Site Boundary
- Final Turbine Layout
- 80 m Meteorological Mast
- Bat Detector Location
- Farm Dam
- Potential Bat Roost (Rocky Crevice)
- Farm Building
- Prominent Dolerite Sill
- NFEPA River
- Bat Monitoring Location 50 m buffer
- Farm Building 200 m buffer
- Potential Bat Roost (Rocky Crevice) 200 m buffer
- Agricultural Field
- Agricultural Field 200 m buffer
- NFEPA Wetland
- NFEPA Wetland 200 m buffer
- Farm Dam 200 m buffer
- Major Drainage Area
- Major Drainage Ares 200 m buffer
- NFEPA River 200 m buffer

1:75,000 Scale @ A3

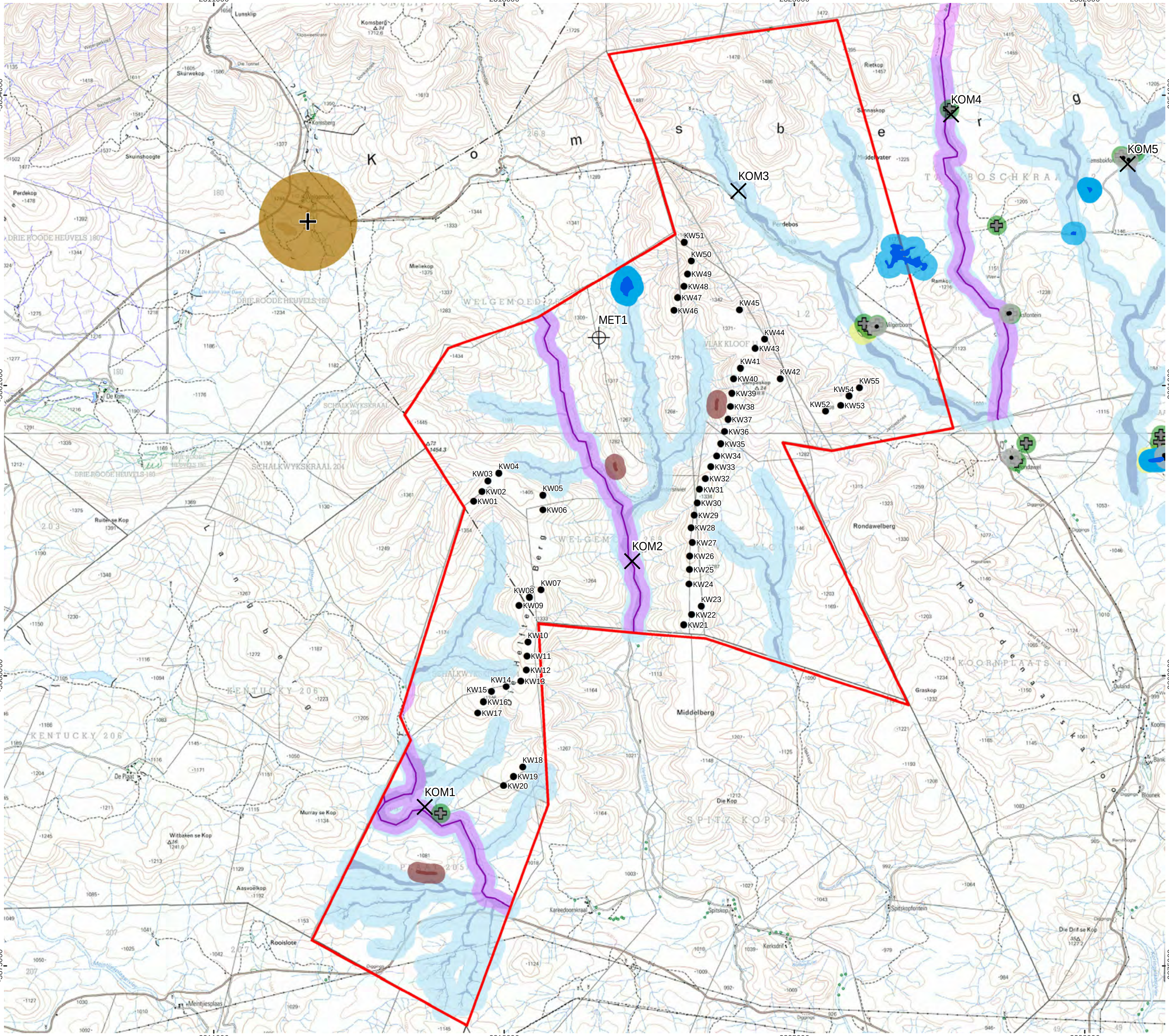
0 1.5 3 km

N

Produced: JA Reviewed: SC Approved: AB	Ref: 1961/REP/043 Date: 18/03/2016

Komsberg East Bat Constraints
Figure 2

Komsberg Wind Energy Facilities
Pre-construction Bat Monitoring
Final EIA Report



Basemapping from the Chief Directorate National Geo-Spatial Information of South Africa

ARCUS

- Site Boundary
- Final Turbine Layout
- 80 m Meteorological Mast
- Bat Detector Location
- Farm Dam
- Confirmed Bat Roost (Building)
- Farm Building
- Prominent Dolerite Sill
- NFEPA River
- Farm Building 200 m buffer
- Potential Bat Roost (Rocky Crevice) 200 m buffer
- Confirmed Bat Roost (Building) 1 km buffer
- Agricultural Field
- Agricultural Field 200 m buffer
- NFEPA Wetland
- NFEPA Wetland 200 m buffer
- Farm Dam 200 m buffer
- Major Drainage Area
- Major Drainage Ares 200 m buffer
- NFEPA River 200 m buffer

1:90,000 Scale @ A3

0 1.5 3 km

N

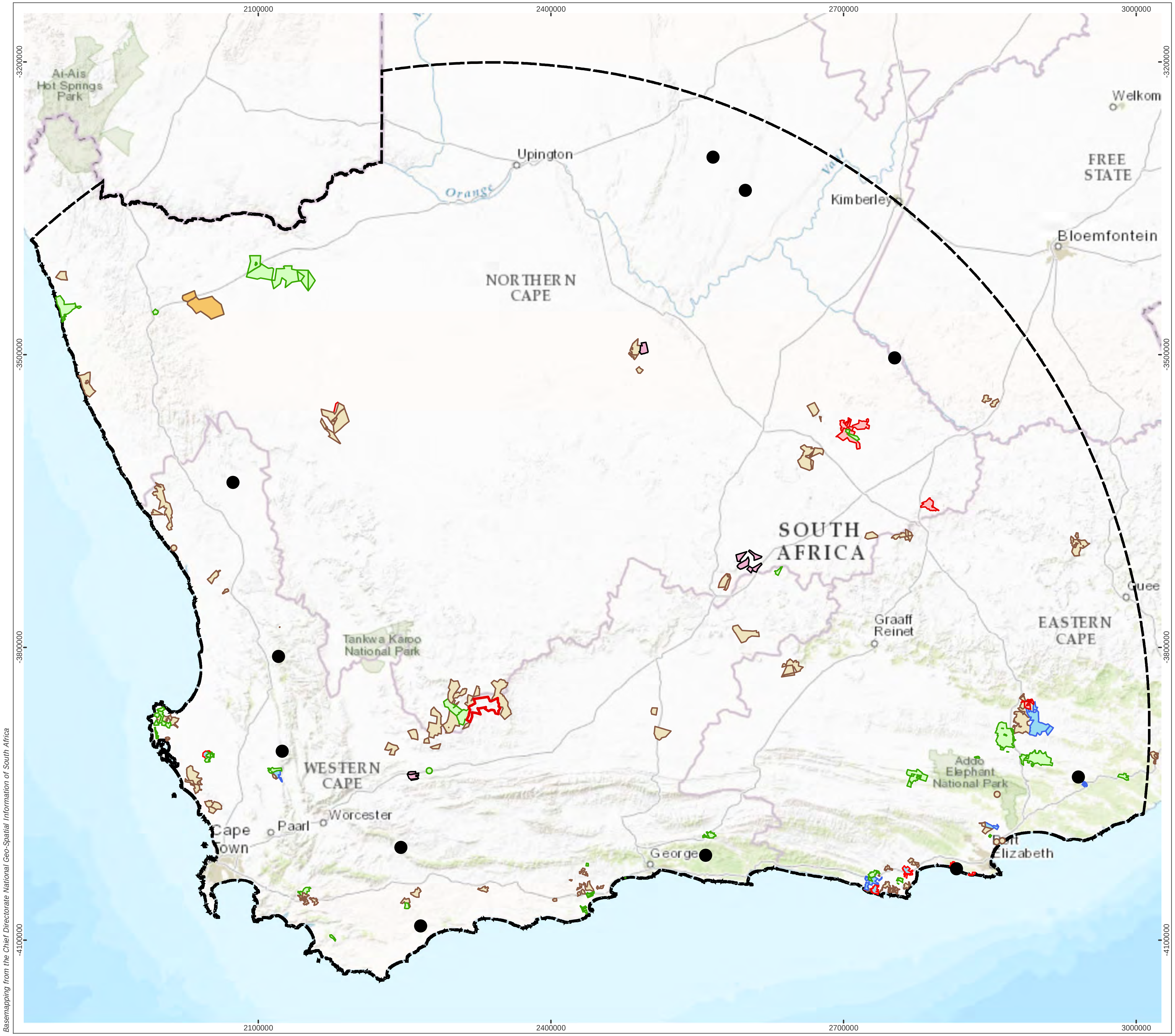
Produced: JA
Reviewed: SC
Approved: AB

Ref: 1961/REP/044

Date: 18/03/2016

Komsberg West Bat Constraints
Figure 3

Komsberg Wind Energy Facilities
Pre-construction Bat Monitoring
Final EIA Report



ARCUS

Site Boundary
Major Natal long-fingered bat roost
Cumulative Impact Region
Onshore Wind and Solar PV, Approved
Onshore Wind and Solar PV, In Process
Onshore Wind, Approved
Onshore Wind, In Process
Onshore Wind, Preferred Bidder Round 1
Onshore Wind, Preferred Bidder Round 2
Onshore Wind, Preferred Bidder Round 3

1:3,750,000 Scale @ A3

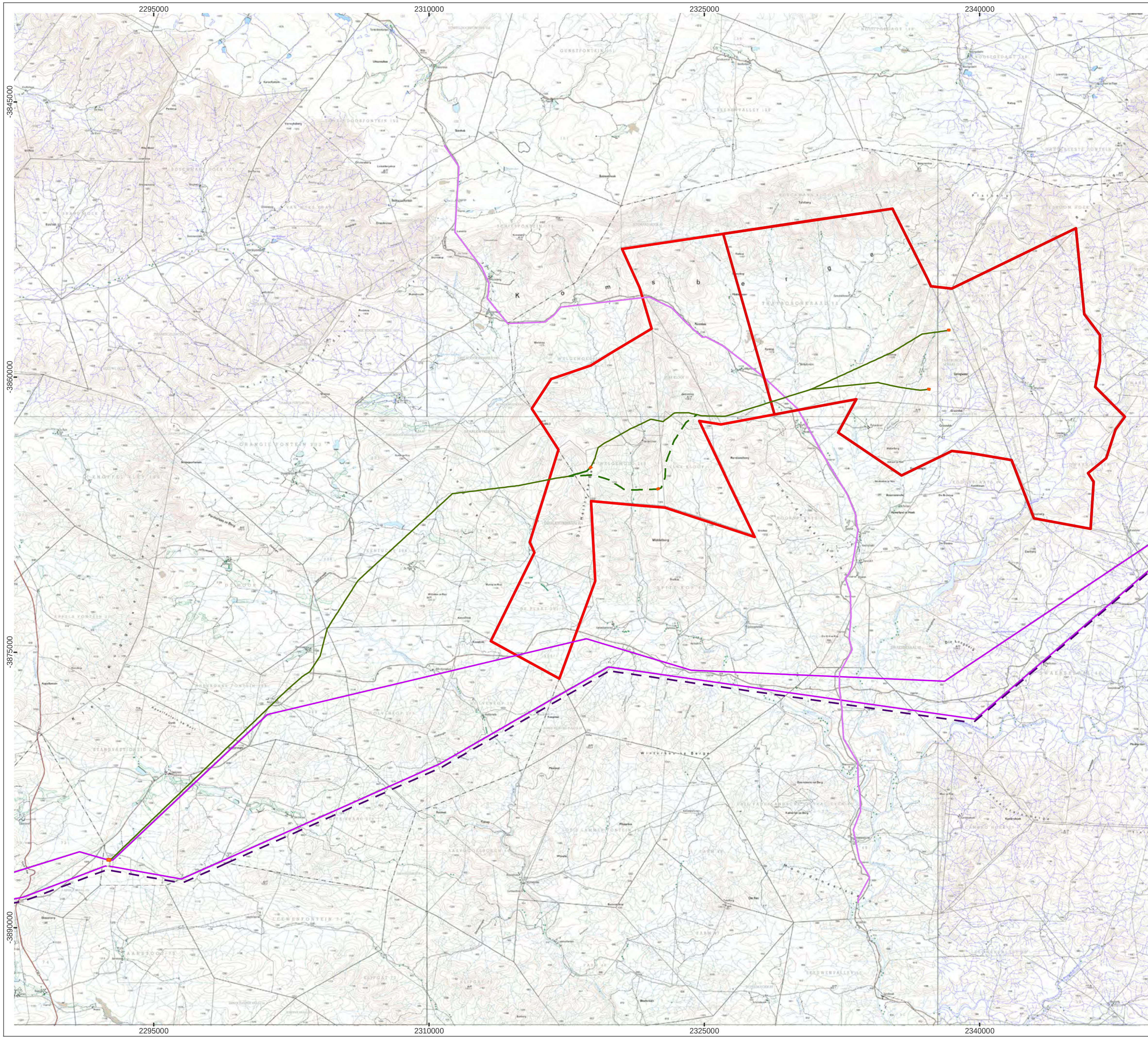
0 50 100 km

N

Produced: JA Reviewed: SC Approved: AB	Ref: 1961/REP/045 Date: 18/03/2016

Onshore Wind Energy Applications within Cumulative Impact Region
Figure 4

Komsberg Wind Energy Facilities
Pre-Construction Bat Monitoring
Final EIA Report



Basemapping from the Chief Directorate National Geo-Spatial Information of South Africa

ARCUS

- Site Boundary
- Substation
- 765 kV Transmission Line
- 400 kV Transmission line
- 66 kV Transmission Line
- 132 kV Transmission Line
- HV Connection (Subject to Eskom Interaction)

1:200,000 Scale @ A3

0 4 8 km

N

Produced: JA
Reviewed: SC
Approved: AB

Ref: 1961/REP/054
Date: 18/03/2016

Komsberg WEFs Grid Connections
Figure 5

Komsberg Wind Energy Facilities
Pre-construction Bat Monitoring
Final EIA Report

Review of the Arcus Consultancy Services bat pre-construction and final EIA report

- For the proposed Komsberg Wind Energy Facilities, Northern and Western Cape

Compiled by: Werner Marais

11 April 2016

PREPARED FOR:

Arcus Consultancy Services
Office 220 Cube Workspace
Icon Building
Cnr Long Street & Hans Strijdom Avenue
Cape Town
8001

By

ANiMALiA
zoological & ecological consultation

Godetia street
Heldervue
Somerset West
7130
☎+27 78 190 3316

✉werner@animalia-consult.co.za

www.animalia-consult.co.za

Ref: R-1604-28

Appointment of Specialist

Specialist Company:	Animalia Zoological & Ecological Consultation CC
Fieldwork conducted by:	N/A
Report done by:	Werner Marais
Overseen/reviewed by:	N/A
Appointed by:	Arcus Consultancy Services
For:	Review of the bat pre-construction and final EIA report for the Komsberg WEF's, Northern and Western Cape. As per specific terms of reference provided by Arcus.

Independence:

Animalia Zoological & Ecological Consultation CC has no connection with the developer. Animalia Zoological & Ecological Consultation CC is not a legal or financial subsidiary of the developer; remuneration for services by the developer in relation to this proposal is not linked to approval by decision-making authorities responsible for permitting this proposal and the consultancy has no interest in secondary or downstream developments as a result of the authorization of this project.

Applicable Legislation:

Legislation dealing with biodiversity applies to bats and includes the following:

NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 2004 (ACT 10 OF 2004; Especially sections 2, 56 & 97)

The act calls for the management and conservation of all biological diversity within South Africa. Bats constitute an important component of South African biodiversity and therefore all species receive additional attention to those listed as Threatened or Protected.

TABLE OF CONTENTS

1 OBJECTIVES AND TERMS OF REFERENCE FOR THE REVIEW

- If the report is in line with the applicable guidelines;
- If the survey scope is appropriate and in line with the applicable guidelines;
- Agreement with methodology and presentation of findings;
- Agreement with the proposed recommendations and mitigations;
- Additional suggestions (if any); and
- Agreement that the work was conducted fairly and independently.

Animalia has conducted this review to our best knowledge based solely on the report provided by Arcus, no analysis of any data or ground truthing of field work techniques were carried out. It was therefore assumed that all information and statements in the Arcus report is true and that no significant results, events or any other factors were omitted from the Arcus report.

2 APPLICABLE GUIDELINES

Fieldwork of the original preconstruction bat monitoring study was conducted from February 2015 until January 2016, indicating that the study design and planning had to take place in late 2014 or very early 2015. Therefore the Best Practice Guidelines applicable and available prior to the time of study initiation was the "*Sowler, S. and Stoffberg, S. 2014. South African Good Practice Guidelines for Surveying Bats at Wind Energy Facilities*" (referred to hereafter as the Guidelines).

The report and survey scope is in line with this version of the Guidelines.

3 REVIEW OF THE REPORT, METHODOLOGY AND STUDY

3.1 Does the study meet the requirements of the 2014 Guidelines in terms of sampling effort and study design?

3.1.1 Static (passive) detector survey and data analysis

Considering all systems across the entire site, the data coverage is in line with the 2014 Guidelines.

Passive data was collected at a total of 12 locations at 12m each, with 2 of these having additional microphones at 80m as well. The overall study site is approximately 26 832ha in size. The static bat detector system on meteorological mast 1 (MET1) was installed on 23 February 2015 and the other on MET2 installed on 16 July 2015, yielding passive data at height of approximately 11 months and 6 months, respectively. However, the 12m microphones have gathered approximately 11.5 months of passive data. The Guidelines state that 12 months of passive data at height and ground level (12m in this case) should be collected but allow for permissible and limited data gaps. The majority of passive systems did record very close to a 12-month cycle and therefore provided sufficient data for the specialist to analyse and make informed decisions and/or predictions on levels of impacts.. However, the operational monitoring study design should consider the uncertainties associated with the limited data gaps.

Data analysis were carried out on all passive data, according to the best knowledge of Animalia. And passive data were gathered by the systems continuously each night for sufficient nights of the year, according to the best knowledge of Animalia as no clear presentation of system down times/failures are given in the Arcus report, if any.

3.1.2 Manual detector (transects) surveys and data analysis

Transects were not carried out during the assessment. Although it is best practice and more thorough to carry out transects according to the Guidelines where possible, the specialist stated in the report that it was not practical to carry out transects and that the passive systems provided sufficient coverage of the different habitat/terrain types. Deviations from the Guidelines are acceptable if a specialist can provide sufficient motivation for the deviation. Transect data is not quantitive and merely increases the insight into a study site, the Arcus specialist is of the opinion that the passive systems provided enough insight into different habitat and terrain features. The passive systems were distributed over a variety of terrain and habitat types which supports this approach.

3.1.3 Roost surveys

All practical requirements in this regard have been met, considering that potential roosting habitat on site consists in part mostly of numerous cracks and crevices in rocks which are not possible to discover and survey comprehensively.

3.1.4 Data used

The relationships of wind, temperature and barometric pressure data with bat activity has been presented and analysed, including temporal bat activity patterns as well as species diversity and abundances of species has been determined. The requirements in this regard have been met.

3.2 Are the findings of the report supported by the data collected?

When considering the impact assessment indicating pre- and post-mitigation significance of various impacts, the ratings are supported by the data collected. The Bat Constraints maps (bat sensitivity maps) considers applicable terrain features with applicable buffers, but true risks for bats with regards to associated terrain features will have to be ascertained during the operational phase, as it is not possible the determine in full during a preconstruction study.

3.3 Are the proposed mitigation measures appropriate?

Proposed mitigations are appropriate to all the potential impacts identified for the different phases of the WEF's. However, proposed active mitigations for impacts on foraging/commuting bats during the operational phase is to some degree open ended and relies heavily on the results of the operational monitoring study. The operational monitoring study design must strongly consider this and must therefore include a clear action plan stating: the specifics of active mitigations to be followed (e.g. wind speed to use for cut-in speed, different levels of active mitigation, etc.), what constitutes a trigger for such active mitigations, the times and dates that such active mitigations are most likely to be required or tested. The data gap in part of the month of February in passive data at height must also be considered in this operational action plan. Therefore, the preconstruction EIA report must clearly request that, as a condition of authorisation, such an action plan form part of the

Komsberg WEF's operational study design, and that the WEF operator must commit to following the action plan as per the discretion of the applicable specialist and a peer review.

To decrease uncertainty for the developer in this regard, a draft version of this action plan specifying exact thresholds and values as detailed as currently possible, may already be provided to the developer together with the final bat EIA report.

4 CONCLUSION

Animalia is content that, according to our best knowledge and the information provided to us by Arcus, the reviewed bat preconstruction study was conducted fairly and independently and is sufficient to inform potential impacts on bats and decision making in the EIA process.

DISCLAIMER

The services carried out and reported in this document have been done as accurately and scientifically as allowed by the resources and knowledge available to Animalia Zoological & Ecological Consultation CC at the time on which the requested services were provided to the client. Animalia Zoological & Ecological Consultation CC reserves the right to modify aspects of the document including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although great care and pride have been taken to carry out the requested services accurately and professionally, and to represent the relevant data in a clear and concise manner; no responsibility or liability will be accepted by Animalia Zoological & Ecological Consultation CC. And the client, by receiving this document, indemnifies Animalia Zoological & Ecological Consultation CC and its staff against all claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Animalia Zoological & Ecological Consultation CC; and by the use of the information contained in this document. The primary goal of Animalia's services is to provide professionalism that is to the benefit of the environment as well as the community.

Komsberg Windfarms (Pty) Ltd

ENVIRONMENTAL NOISE IMPACT ASSESSMENT

For the

Proposed Komsberg wind energy facility between Laingsburg and Sutherland, Northern and Western Cape

Study done for:

ARCUS

Prepared by:

EAR
Enviro Acoustic Research

P.O. Box 2047, Garsfontein East, 0060
Tel: 012 – 004 0362, Fax: 086 – 621 0292, E-mail: info@eares.co.za

EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research CC was contracted by ARCUS Consulting (the EAP) to conduct an Environmental Noise Impact Assessment (ENIA) to determine the potential noise impact on the surrounding environment. This is due to the development of the Komsberg Wind Farm and associated infrastructure on various farms just between Laingsburg and Sutherland in the Western and Northern Cape.

This report briefly describes ambient sound levels in the area, potential worst-case noise rating levels and the potential noise impacts that the facility may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report did not investigate vibrations and only briefly considers blasting.

This study considered local regulations and both local and international guidelines, using the terms of reference as proposed by SANS 10328:2008 to allow for a comprehensive ENIA.

PROJECT DESCRIPTION

The windfarm will be divided into two projects. Overall, there are four components to the proposed development, comprising two WEF's and their associated grid connections. For each WEF there is a Preferred and Alternative layout. These are:

- Komsberg East Wind Energy Facility and substation(s), Western Cape Province;
- Komsberg West Wind Energy Facility and substation(s), Western and Northern Cape Provinces;
- Komsberg East Grid Connection and switching station(s), Western and Northern Cape Provinces; and
- Komsberg West Grid Connection and switching station(s), Western and Northern Cape Provinces.

It is proposed that Komsberg West and East WEF's will each have a potential maximum installed capacity of 275MW, this being based on the use of 55 Wind Turbine Generators (WTG) with WTG's having a potential maximum rated power of 5MW each.

The developer is investigating a number of different wind turbine models; not excluding the possibility of larger models that are not yet available in the commercial market.

Therefore, for the purpose of this noise assessment the sound power emission levels of the Vestas V117 3.3 MW turbine will be used.

The developer is also considering the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3000. While the sound power emission levels of the Vestas V126 3.45/3.6 are similar to the Vestas V117 3.3 MW, the sound power emission levels of the Acciona AW125/3000 is approximately 2 dB higher than either the Vestas WTGs.

This report mainly investigates the noise from the construction and operation of the WTG's, as the construction of the Grid Connection will not have a noise impact of any significance (due to the distance of construction activities to the closest receptors in the area).

BASELINE ASSESSMENT

Ambient sound levels were measured at two locations for two night-time periods during October 2015 using two class-1 Sound Level Meters as well as a portable weather station. The sound level meters would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement until the instrument was stopped.

While the area has a rural character in terms of appearance and development, daytime sound levels highlighted ambient sound levels higher than expected. The sounds were mainly due to activities associated with household and farming noises. Night-time sound levels were typical of a quiet rural district.

As most of the area were considered naturally quiet, it was selected to assign an acceptable noise rating level of a rural noise district (as per SANS 10103:2008).

NOISE IMPACT DETERMINATION AND FINDINGS

The potential noise impact was evaluated using a sound propagation model. Conceptual scenarios were developed for a construction and operational phase, considering both East and West WEF's (as well as the alternative and preferred layouts for each WEF). The output of the modelling exercise indicated that there is low risk of a noise impact (low significance during all phases of the development).

NEED AND DESIRABILITY OF PROJECT

The proposed project will raise the noise levels at a number of potential noise-sensitive developments, however these noise levels are considered to be of insignificant magnitude and unlikely to be audible when considering the likely ambient sound levels during the operational phase.

The project will greatly assist in the provision of energy, which will allow further economic growth and development in South Africa. The project will generate short and long-term employment and other business opportunities and promote renewable energy in South Africa. People in the area that are not directly affected by increased noises will have a positive perception of the project and will see the need and desirability of the project.

MANAGEMENT AND MITIGATION OF NOISE IMPACT

Due to the low significance of a noise impact, no mitigation measures will be required (including routine noise measurements), although generic measures are recommended for the developer to ensure that any potential noise impacts are minimised. Measurement locations, frequencies and procedures are provided as a guideline for the developer to consider should there be any noise complaints.

RECOMMENDATIONS

It is important that the potential noise impact be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD. While this project will have a noise impact of a number of the closest noise-sensitive receptors (layouts as reviewed), these impacts is of low significance and can be considered insignificant.

It is the opinion of the Author that the increases in noise levels are of minor significance. It is recommended that the project should be authorised (from a noise impact perspective).

CONTENTS OF THE SPECIALIST REPORT – CHECKLISTS

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6	Cross-reference in this report
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	**Section 13**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Section 14** *(also separate document to this report)*
(c) an indication of the scope of, and the purpose for which, the report was prepared;	**Section 1.1**
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	**Section 3.1**
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	**Section 1.6**
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	**Sections 3.1** and **Section 3.2**
(g) an identification of any areas to be avoided, including buffers;	Not relevant and required.
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Buffers not required.
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	**Section 6**
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	**Sections 7** and **Sections 8**
(k) any mitigation measures for inclusion in the EMPr;	**Sections 9.3.1**
(l) any conditions for inclusion in the environmental authorisation;	**Sections 9.3.2**
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	**Section 11.1**
(n) a reasoned opinion— i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	i. **Section 12** ii. **Sections 9.3.1** and **Sections 9.3.2**
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	No comments received (**Section 1.6**)
(p) any other information requested by the competent authority	Nothing requested

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 3 - Environmental Impact Assessment Process	**Cross-reference in this report**
Describe any policies or legislation relevant to your field that the applicant will need to comply with.	**Sections 2.2**
Comment on need/desirability of the proposal in terms your field and in terms of the proposal's location.	**Section 8.6**
Determine the-- (i) nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and (ii) degree to which these impacts- (aa) can be reversed; (bb) may cause irreplaceable loss of resources, and (cc) can be avoided, managed or mitigated;	**Sections 8.2**, **8.3.1**, **8.3.2**, **8.3.3** and **8.3.4**
Determine what the most ideal location within the site for the activity is in terms of your field.	**Section 8.6**
Identify suitable measures to avoid, manage or mitigate identified impacts.	(i) **planning, design and pre-construction**; Section 8.1 (iii) **construction**; Section 8.2 (iv) **operation;** Section 8.3 (v) **decommissioning, closure & rehabilitation**. Section 8.5
Identify residual risks that need to be managed and monitored.	There will be no residual risks after closure.
Include a concluding statement indicating a preferred alternative in terms of your field.	In terms of acoustics there is no preference for either the Alternative or Preferred layout. The change in sound levels is slightly less with the Preferred layout for both the East and West WEF.

This report should be sited as:

De Jager, M. (2015): "*Environmental Noise Impact Assessment for the proposed Komsberg wind energy facility between Laingsburg and Sutherland, Northern and Western Cape*". Enviro-Acoustic Research CC, Pretoria

Client:

Arcus Consulting
for
Komsberg Windfarms (Pty) Ltd

Office 211 Cube Workspace
Cnr Long Street and Hans Strijdom Road
Cape Town
8001

Report no:

AC-KWF/ENIA/201510-Rev 0

Author:

M. de Jager *(B. Ing (Chem))*

Review:

Shaun Weinberg *(B.Sc. Applied Mathematics in Physics Stream – in process)*

Date:

October 2015

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GLOSSARY OF ABBREVIATIONS

DoE	Department of Energy
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act (Act 78 of 1989)
EMP	Environmental Management Plan
FEL	Front End Loader
i.e.	that is
IFC	International Finance Corporation
km	kilometres (measurement of distance)
LHD	Load haul dumper
m	meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
m/s	meters per second
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
SABS	South African Bureau of Standards
SANS	South African National Standards
TLB	Tip Load Bucket
ToR	Terms of Reference
UTM	Universal Transverse Mercator
WHO	World Health Organisation
WEF	Wind Energy Facility
WTG	Wind Turbine Generators

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was contracted by Arcus Consulting (the consultant or EAP) to determine the potential noise impact on the surrounding environment due to the proposed development of the Komsberg Windfarm. This facility will be located on various farms between Laingsburg and Sutherland in the Western and Northern Cape (see **Figure 1-1**).

This report briefly describes ambient sound levels in the area, potential worst case noise rating levels and the potential noise impact that the facility may have on the surrounding sound environment, highlighting the methods used, potential issues identified, findings and recommendations. This report did not investigate vibrations and only briefly considers blasting.

This study considered local regulations and both local and international guidelines, using the terms of reference (ToR) as proposed by SANS 10328:2008 to allow for a comprehensive Environmental Noise Impact Assessment (ENIA).

1.2 BRIEF PROJECT DESCRIPTION

Komsberg Windfarms (Pty) Ltd (the developer) proposes the establishment of a commercial Wind Energy Facility (WEF) and associated infrastructure on various farms just between Laingsburg and Sutherland in the Western and Northern Cape.

The windfarm will be divided into two projects. Overall, there are four components to the proposed development, comprising two WEFs and their associated grid connections. For each WEF there is a Preferred and Alternative layout. These are:

- Komsberg East Wind Energy Facility, Western Cape Province;
- Komsberg West Wind Energy Facility, Western and Northern Cape Provinces;
- Komsberg East Grid Connection, Western and Northern Cape Provinces; and
- Komsberg West Grid Connection, Western and Northern Cape Provinces.

It is proposed that Komsberg West and East WEF's will each have a potential maximum installed capacity of 275MW[1], this being based on the use of 55 Wind Turbine Generators (WTG) with WTG's having a potential maximum rated power of 5MW each[2].

1.3 WEF COMPONENTS

The WEF's will comprise of the infrastructural components described below. It should be noted as the design of the proposed development is not yet finalised, all dimensions described are maximums. The final design may include infrastructure which is of equal or less dimension than the dimensions described below.

1.3.1 Turbines

Each WEF will comprise of up to 55 turbines. At this stage, it is envisaged that the turbines will each have a capacity to generate between 2 and 5 MW of power and each turbine will have a maximum height to blade tip of 190m. The turbines will be three-bladed horizontal-axis design with a hub height of up to 120 m and a rotor diameter of up to 140 m. The exact turbine model has not yet been selected and will be subject to competitive tendering after further wind analysis has been completed. The turbine model will depend upon the technical, commercial and site specific requirements.

The turbine rotor speed will vary according to the energy available in the wind, the wind speed. The turbines will generate power in wind speeds between approximately 3 metres per second (m/s) and 28 m/s (depending on the model of turbine) with maximum power output usually achieved at wind speeds of around 10 - 12 m/s. On average, wind speeds greater than approximately 28 m/s the turbines will automatically turn the angle of the blade to reduce energy capture (this is known as 'pitching') and stop turning to prevent damage.

Each turbine will require a transformer and, depending on the selected model of turbine, this will be either located within the turbine tower or adjacent to the turbine on a concrete plinth, each foundation area occupying an area of up to 30 by 30 m in total (which includes the maximum total area that may need to be disturbed during construction of the

[1] The maximum capacity applied for in this application is greater than the current Department of Energy (DoE) limit of 140MW installed capacity. The reason for applying for a greater capacity at this point in time is due to the long lead times involved in wind farm developments (2 – 5 years) from conception to construction. Hence, the applicant is applying for 275MW in order to cater for a potential change in policy in future Government procurement processes where the limit may be increased.

[2] The level of installed capacity applied for (275MW) also relies on the proposed use of a 5MW wind turbine. The developer will only select a wind turbine at a later stage when more meteorological data is available and technical or commercial viability can be confirmed.

foundation). The foundation areas are typically up to 5 m deep and may include concrete and steel plinths depending upon local ground conditions.

1.3.2 Hardstanding Areas

A hardstanding area of up to 50 m by 30 m will be established adjacent to each turbine location. This will be used to provide a platform for cranes to operate during construction (and unscheduled maintenance), as well as a clear area to lay out turbine components prior to erection.

1.3.3 Laydown Areas

For each WEF, additional temporary laydown areas of up to 150 m by 100 m in size will be required for equipment and component storage during construction. This may be split into three areas. These areas will be levelled and compacted and used for component storage. Temporary infrastructure would include a site camp, laydown areas and a batching plant.

1.3.4 Electrical Cabling and Onsite Substation

The electricity from the turbines will be transferred via a medium voltage (typically 33 kV but this can vary) electrical network to an onsite substation (typically 33/ 132 kV but this can vary). Where possible, cables will be placed underground and the feasibility of this will be confirmed as design progresses. The onsite substation will house electrical infrastructure such as transformers and switch gear to enable the energy to be transferred into the existing national grid. It will be up to 100 m by 150 m in extent.

1.3.5 Access

The turbine locations will be accessed through a network of unsealed tracks which will be established across the WEF sites. These access tracks will be up to 20 m wide during construction (including road reserve) depending on local topography, and will be reduced to between 6 and 8 m during operation and reserves rehabilitated. Such roads are required to facilitate access for the cranes and abnormal load deliveries of turbine components.

Existing farm access tracks will be upgraded and utilised where possible, as will existing watercourse crossings. Some of the aggregate required for the construction of the onsite tracks may be sourced from borrow pits within the proposed development site with additional material imported.

1.3.6 Compound

There will also be a 30 by 50 m operations and services workshop area/office building for control, maintenance and storage.

1.3.7 Ancillary Equipment

In addition to the key components outlined above, the WEFs will also require:

- Meteorological masts;
- Security fencing; and
- CCTV monitoring towers.

1.4 STUDY AREA

The study area concerns a number of dwellings or potential noise-sensitive receptors in the vicinity of the proposed development. The study area is further described in terms of environmental components that may contribute or change the sound character in the area.

1.4.1 Topography

ENPAT[3] (1998) describes the topography as *"Low Mountains"*. The turbines will be located on the ridges at approximately 1,080 – 1,600 meters above sea level (mamsl). There are little natural features that could act as noise barriers considering practical distances at which sound propagates as well as the location and height of the wind turbines.

1.4.2 Surrounding Land Use

The area in the vicinity of the proposed development is classified as predominantly agricultural and limited wilderness (wildlife and ecotourism). Surrounding land use will not significantly influence the night-time ambient sound levels (the time period of importance investigated in this report).

[3] Van Riet, W. Claassen, P. van Rensburg, J. van Viegen & L. du Plessis, *"Environmental Potential Atlas for South Africa"*, Pretoria, 1998.

Figure 1-1: Locality map indicating farm properties involved in the Komsberg Project

1.4.3 Roads and rail roads

There are no major roads or rail roads in the vicinity of the proposed WEF, with the local community using gravel roads to access their properties. Traffic volumes would be low and it is not expected that traffic noises would be of any significance in this area.

1.4.4 Residential areas

Excluding potentially noise-sensitive developments identified in **Section 1.5**, there are no formal residential areas, communities or towns close to the facility.

1.4.5 Other industrial and commercial processes

There are no other noise sources of significant importance in the area.

1.4.6 Ground conditions and vegetation

Most of the area falls within the Fynbos biome (shrub-land and low fynbos) with the vegetation typical of Escarpment Mountain Renosterveld. Vegetation in the southern sections is more typical of the Nama Karoo, with more dwarf succulents shrubs prominent. Considering a worse-case scenario, 75% hard ground conditions were used for modelling purposes. It should be noted that this factor is only relevant for air-borne waves being reflected from the ground surface, with certain frequencies slightly absorbed by the vegetation.

1.4.7 Existing Ambient Sound Levels

The area has a rural developmental character, with night-time sound levels typical of a rural area. Onsite measurements and the existing soundscape are discussed in more detail in **Section 3**.

1.5 Potential Noise-sensitive Receptors (Developments) and no-go areas

Potentially sensitive receptors, also known as noise-sensitive developments (NSDs), located within or close to the WEF's were identified using Google Earth® during the Scoping Phase (see **Figure 1-2**). This was supported by a site visit to confirm the status of the identified dwellings.

The same potential NSDs (as well as one additional NSD) were used for this study considering the draft layouts (also see **Figure 1-3**).

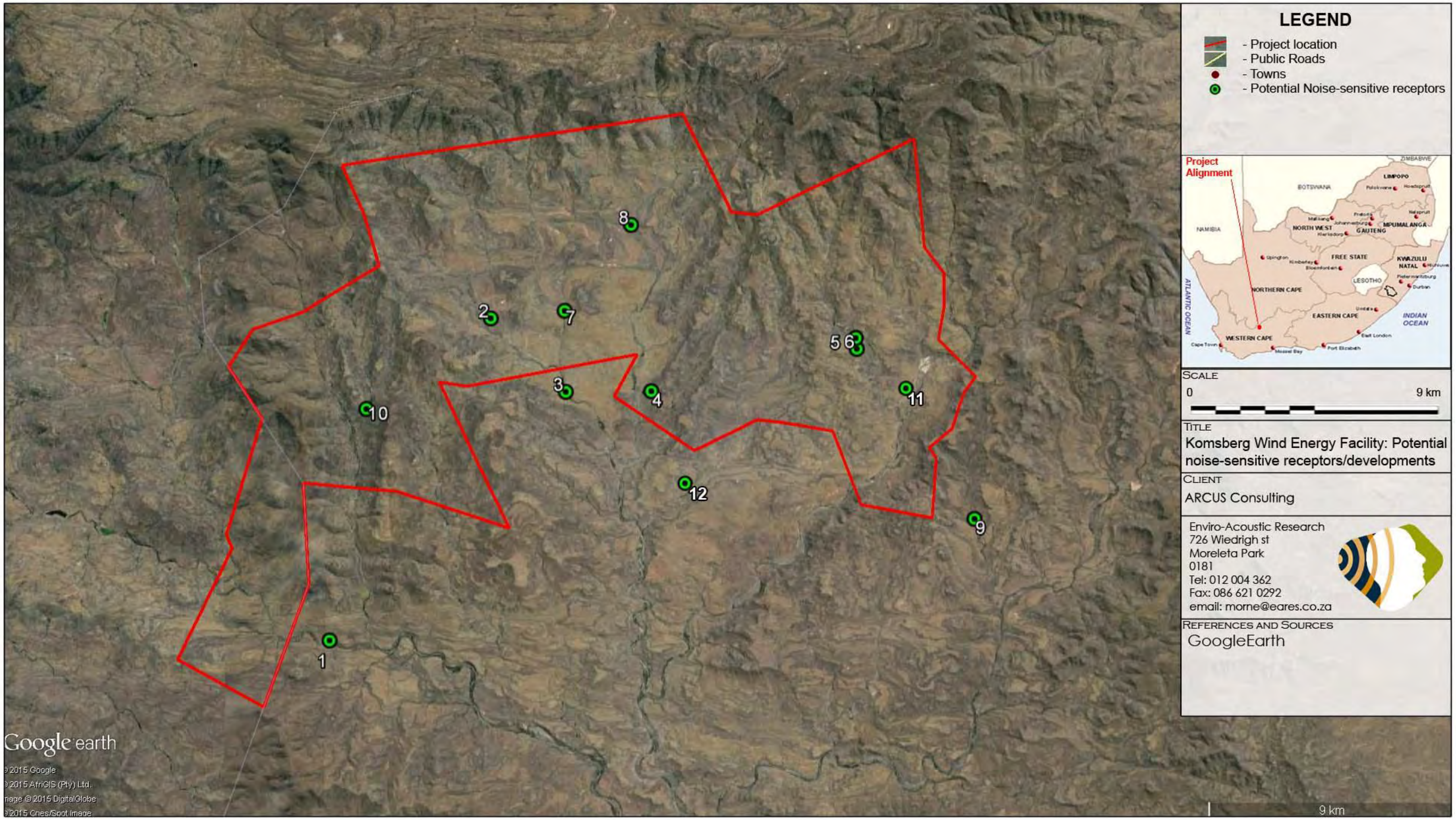

Figure 1-2: Aerial image indicating potentially noise-sensitive receptors identified during the Scoping Noise Assessment[4]

[4] Reported by developer that NSD10 is Abandoned / old homestead

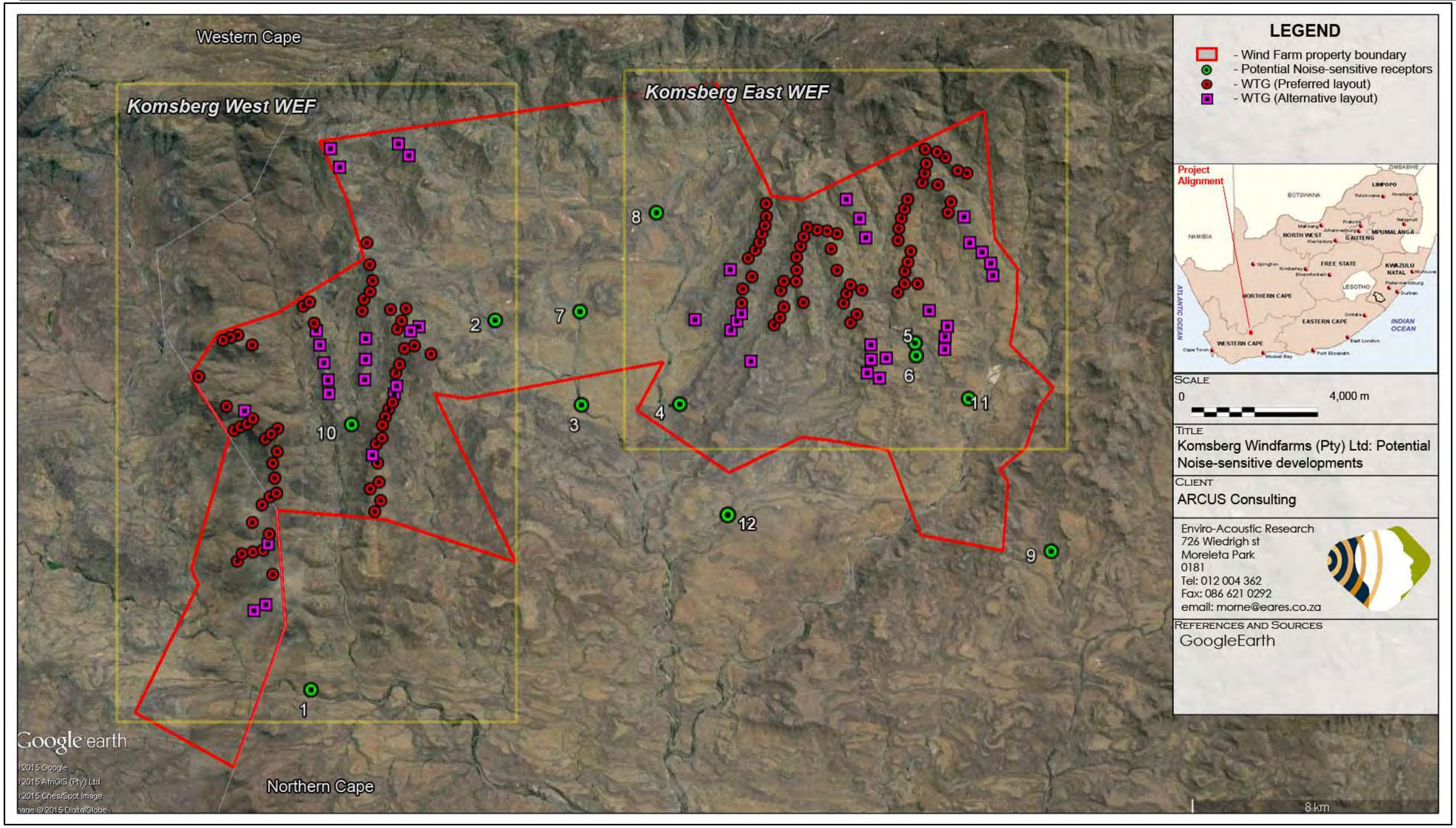

Figure 1-3: Aerial image indicating potentially noise-sensitive receptors in relation to proposed WTG's

1.6 COMMENTS REGARDS TO NOISE RECEIVED DURING THIS PROJECT

Only one comment was received from Falcon Oil and Gas. They raised a concern about the potential impact of noise and vibrations (from the wind turbines) on future seismic exploration surveys for shale gas resources.

It is the opinion of the author that this is a matter that needs to be dealt with on a corporate level, and, should there be a real need for an investigation this should be done by a specialist in this particular field.

1.7 TERMS OF REFERENCE (TOR)

A noise impact assessment must be completed for the following reasons:

- If there are potential noise-sensitive receptors staying within 1,000 m from industrial activities (SANS 10328:2008);
- It is a controlled activity in terms of the NEMA regulations and a ENIA is required, because:
    - It may cause a disturbing noise that is prohibited in terms of section 18(1) of the Government Notice 579 of 2010; and
- It is generally required by the local or district authority as part of the environmental authorization or planning approval in terms of Regulation 2(d) of GN R154 of 1992 (Regulation 4(1) in terms of PN.200 of 2013 – Western Cape).

In addition, Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282), issued in terms of the National Environmental Management Act, No. 107 of 1998 also defines minimum information requirements for specialist reports.

In South Africa the document that addresses the issues specifically concerning environmental noise is SANS 10103:2008. It has recently been thoroughly revised and brought in line with the guidelines of the World Health Organisation (WHO). It provides the maximum average ambient noise levels during the day and night to which different types of developments indoors may be exposed.

In addition, the SANS 10328:2008 standard specifies the methodology to assess the potential noise impacts on the environment due to a proposed activity that might impact on the environment. This standard also stipulates the minimum requirements to be investigated for Scoping purposes. These minimum requirements are:

1. The purpose of the investigation;
2. A brief description of the planned development or the changes that are being considered;
3. A brief description of the existing environment;
4. The identification of the noise sources that may affect the particular development, together with their respective estimated sound pressure levels or sound power levels (or both);
5. The identified noise sources that were not taken into account and the reasons why they were not investigated;
6. The identified noise-sensitive developments and the estimated impact on them;
7. Any assumptions made with regard to the estimated values used;
8. An explanation, either by a brief description or by reference, of the methods that were used to estimate the existing and predicted rating levels;
9. The location of the measurement or calculation points, i.e. a description, sketch or map;
10. Estimation of the environmental noise impact;
11. Alternatives that were considered and the results of those that were investigated;
12. A list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;
13. A detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;
14. Conclusions that were reached;
15. Recommendations, i.e. if there could be a significant impact, or if more information is needed, a recommendation that an environmental noise impact assessment be conducted; and
16. If remedial measures will provide an acceptable solution, which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after a certain time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority.

2 LEGAL CONTEXT, POLICIES AND GUIDELINES

2.1 THE REPUBLIC OF SOUTH AFRICA CONSTITUTION ACT ("THE CONSTITUTION")

The environmental rights contained in section 24 of the Constitution provide that everyone is entitled to an environment that is not harmful to his or her well-being. In the context of noise, this requires a determination of what level of noise is harmful to well-being. The general approach of the common law is to define an acceptable level of noise as that which the reasonable person can be expected to tolerate under the particular circumstances. The subjectivity of this approach can be problematic, which has led to the development of noise standards (see **Section 2.5**).

"Noise pollution" is specifically included in Part B of Schedule 5 of the Constitution, which means that noise pollution control is a local authority competence, provided that the local authority concerned has the capacity to carry out this function.

2.2 THE ENVIRONMENT CONSERVATION ACT (ACT 73 OF 1989)

The Environment Conservation Act ("ECA") allows the Minister of Environmental Affairs and Tourism ("now the Ministry of Water and Environmental Affairs") to make regulations regarding noise, among other concerns. See also **section 2.2.1**.

2.2.1 Noise Control Regulations (GN R154 of 1992)

In terms of section 25 of the ECA, the national Noise Control Regulations (GN R154 in *Government Gazette* No. 13717 dated 10 January 1992) were promulgated. The NCRs were revised under Government Notice Number R. 55 of 14 January 1994 to make it obligatory for all authorities to apply the regulations.

Subsequently, in terms of Schedule 5 of the Constitution of South Africa of 1996 legislative responsibility for administering the noise control regulations was devolved to provincial and local authorities. The National Regulations will be in effect in the Northern Cape Province with the Provincial regulations (**section 2.2.2**) relevant for the Western Cape Province.

The National Noise Control Regulations (GN R154 1992) defines:
"**Controlled area**" as:
A piece of land designated by a local authority where, in the case of--
c) Industrial noise in the vicinity of an industry-

i. the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or
ii. the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 meters, but not more than 1,4 meters, above the ground for a period of 24 hours, exceeds 61 dBA;

"**disturbing noise**" as:
Noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dBA or more.

"**zone sound level**" as:
A derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. *This is the same as the Rating Level as defined in SANS 10103:2008.*

In addition:
In terms of Regulation 2 -
"A local authority may –
(c): if a noise emanating from a building, premises, vehicle, recreational vehicle or street is a disturbing noise or noise nuisance, or may in the opinion of the local authority concerned be a disturbing noise or noise nuisance, instruct in writing the person causing such noise or who is responsible therefor, or the owner or occupant of such building or premises from which or from where such noise emanates or may emanate, or all such persons, to discontinue or cause to be discontinued such noise, or to take steps to lower the lever of the noise to a level conforming to the requirements of these Regulations within the period stipulated in the instruction: Provided that the provisions of this paragraph shall not apply in respect of a disturbing noise or noise nuisance caused by rail vehicles or aircraft which are not used as recreational vehicles;
(d): before changes are made to existing facilities or existing uses of land or buildings, or before new buildings are erected, in writing require that noise impact assessments or tests are conducted to the satisfaction of that local authority by the owner, developer, tenant or occupant of the facilities, land or buildings or that, for the purposes of regulation 3(b) or (c), reports or certificates in relation to the noise impact to the satisfaction of that local authority are submitted by the owner, developer, tenant or occupant to the local authority on written demand";

In terms of Regulation 4 of the Noise Control Regulations:

"No person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof".

2.2.2 Western Cape Provincial Noise Control Regulations: PN 200 of 2013

The control of noise in the Western Cape is legislated in the form of the Noise Control Regulations in terms of Section 25 the Environment Conservation Act No. 73 of 1989, applicable to the Province of the Western Cape as Provincial Notice 200 of 20 June 2013.

The regulations define:
"**ambient noise**" means the all-encompassing sound in a given situation at a given time, measured as the reading on an integrated impulse sound level meter for a total period of at least 10 minutes".

"**disturbing noise**" means a noise, excluding the unamplified human voice, which—
(a) exceeds the rating level by 7 dBA;
(b) exceeds the residual noise level where the residual noise level is higher than the rating level;
(c) exceeds the residual noise level by 3 dBA where the residual noise level is lower than the rating level; or
(d) in the case of a low-frequency noise, exceeds the level specified in Annex B of SANS 10103;

''noise sensitive activity'' means any activity that could be negatively impacted by noise, including residential, healthcare, educational or religious activities;

''low-frequency noise'' means sound which contains sound energy at frequencies predominantly below 100 Hz;

''rating level'' means the applicable outdoor equivalent continuous rating level indicated in Table 2 of SANS 10103;

''residual noise'' means the all-encompassing sound in a given situation at a given time, measured as the reading on an integrated impulse sound level meter for a total period of at least 10 minutes, excluding noise alleged to be causing a noise nuisance or disturbing noise;

"sound level" means the equivalent continuous rating level as defined in SANS 10103, taking into account impulse, tone and night-time corrections;

These Regulations prohibits anyone for causing a disturbing noise (Clause 2) and uses the $L_{Aeq,impulse}$ descriptor to define ambient sound and noise levels.

Also, in terms of regulation 4:

(1) The local authority, or any other authority responsible for considering an application for a building plan approval, business licence approval, planning approval or environmental authorisation, may instruct the applicant to conduct and submit, as part of the application—

(a) a noise impact assessment in accordance with SANS 10328 to establish whether the noise impact rating of the proposed land use or activity exceeds the appropriate rating level for a particular district as indicated in SANS 10103; or

(b) where the noise level measurements cannot be determined, an assessment, to the satisfaction of the local authority, of the noise level of the proposed land use or activity.

(2) *(a)* A person may not construct, erect, upgrade, change the use of or expand any building that will house a noise-sensitive activity in a predominantly commercial or industrial area, unless he or she insulates the building sufficiently against external noise so that the sound levels inside the building will not exceed the appropriate maximum rating levels for indoor ambient noise specified in SANS 10103.

(b) The owner of a building referred to in paragraph *(a)* must inform prospective tenants or buyers in writing of the extent to which the insulation measures contemplated in that paragraph will mitigate noise impact during the normal use of the building.

(c) Paragraph *(a)* does not apply when the use of the building is not changed.

(3) Where the results of an assessment undertaken in terms of subregulation (1) indicate that the applicable noise rating levels referred to in that subregulation will likely be exceeded, or will not be exceeded but will likely exceed the existing residual noise levels by 5 dBA or more—

(a) the applicant must provide a noise management plan, clearly specifying appropriate mitigation measures to the satisfaction of the local authority, before the application is decided; and

(b) implementation of those mitigation measures may be imposed as a condition of approval of the application.

(4) Where an applicant has not implemented the noise management plan as contemplated in subregulation (3), the local authority may instruct the applicant in writing to—

(a) cease any activity that does not comply with that plan; or

(b) reduce the noise levels to an acceptable level to the satisfaction of the local authority.

2.3 THE NATIONAL ENVIRONMENTAL MANAGEMENT ACT (ACT 107 OF 1998)

The National Environmental Management Act ("NEMA") defines "pollution" to include any change in the environment, including noise. A duty therefore arises under section 28 of NEMA to take reasonable measures while establishing and operating any facility to prevent noise pollution occurring. NEMA sets out measures which may be regarded as reasonable. They include the following measures:

1. to investigate, assess and evaluate the impact on the environment;
2. to inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;
3. to cease, modify or control any act, activity or process causing the pollution or degradation;
4. to contain or prevent the movement of the pollution or degradation;
5. to eliminate any source of the pollution or degradation; and
6. to remedy the effects of the pollution or degradation.

In addition, Appendix 6 of GN 982 of December 2014 (Gov. Gaz. 38282), issued in terms of this Act, have general requirements for EAPs and specialists. It also defines minimum information requirements for specialist reports.

2.4 NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT (ACT 39 OF 2004)

Section 34 of the National Environmental Management: Air Quality Act (Act 39 of2004) makes provision for:

(1) the Minister to prescribe essential national noise standards -

(a) for the control of noise, either in general or by specified machinery or activities or in specified places or areas; or

(b) for determining –

(i) a definition of noise

(ii) the maximum levels of noise

(2) When controlling noise the provincial and local spheres of government are bound by any prescribed national standards.

This section of the Act has been promulgated, but no such standards have yet been issued. Draft regulations have however, been promulgated for adoption by Local Authorities.

An atmospheric emission licence issued in terms of Section 22 may contain conditions in terms of noise. This, however, is not relevant to the project as no atmospheric emissions will take place.

2.4.1 Model Air Quality Management By-law for adoption and adaptation by Municipalities (GN 579 of 2010)

Model Air Quality Management By-Laws for adoption and adaptation by municipalities was published by the Department of Water and Environmental Affairs in the Government Gazette of 2 July 2010 as Government Notice 579 of 2010.

The main aim of the model air quality management by-law is to assist municipalities in the development of their air quality management by-law within their jurisdictions. It is also the aim of the model by-law to ensure uniformity across the country when dealing with air quality management challenges. Therefore, the model by-law is developed to be generic in order to deal with most of the air quality management challenges. With Noise Control being covered under the Air Quality Act (Act 39 of 2004), noise is also managed in a separate section under this Government Notice.

- **IT IS NOT** the aim of the model by-law to have legal force and effect on municipalities when published in the Gazette; and
- **IT IS NOT** the aim of the model by-law to impose the by-law on municipalities.

Therefore, a municipality will have to follow the legal process as set out in the Local Government: Municipal Systems Act, 2000 (Act No. 32 of 2000) when adopting and adapting the model by-law to its local jurisdictions.

2.5 NOISE STANDARDS

There are a few South African scientific standards (SABS) relevant to noise from mines, industry and roads. They are:

- SANS 10103:2008. 'The measurement and rating of environmental noise with respect to annoyance and to speech communication';
- SANS 10210:2004. 'Calculating and predicting road traffic noise';

- SANS 10328:2008. 'Methods for environmental noise impact assessments'.
- SANS 10357:2004. 'The calculation of sound propagation by the Concave method';
- SANS 10181:2003. 'The Measurement of Noise Emitted by Road Vehicles when Stationary'; and
- SANS 10205:2003. 'The Measurement of Noise Emitted by Motor Vehicles in Motion'.

The relevant standards use the equivalent continuous rating level as a basis for determining what is acceptable. The levels may take single event noise into account, but single event noise by itself does not determine whether noise levels are acceptable for land use purposes. With regards to SANS 10103:2008, the recommendations are likely to inform decisions by authorities, but non-compliance with the standard will not necessarily render an activity unlawful *per se.*

2.6 INTERNATIONAL GUIDELINES

While a number of international guidelines and standards exist, those selected below are used by numerous countries for environmental noise management.

2.6.1 Guidelines for Community Noise (WHO, 1999)

The World Health Organization's (WHO) document on the *Guidelines for Community Noise* is the outcome of the WHO- expert task force meeting held in London, United Kingdom, in April 1999. It is based on the document entitled "Community Noise" that was prepared for the World Health Organization and published in 1995 by the Stockholm University and Karolinska Institute.

The scope of WHO's effort to derive guidelines for community noise is to consolidate actual scientific knowledge on the health impacts of community noise and to provide guidance to environmental health authorities and professionals trying to protect people from the harmful effects of noise in non-industrial environments.

Guidance on the health effects of noise exposure of the population has already been given in an early publication of the series of Environmental Health Criteria. The health risk to humans from exposure to environmental noise was evaluated and guidelines values derived. The issue of noise control and health protection was briefly addressed.

The document uses the L_{Aeq} and L_{AMax} noise descriptors to define noise levels. It should be noted that a follow-up document focusing on Night-time Noise Guidelines for Europe (WHO, 2009).

2.6.2 Night Noise Guidelines for Europe (WHO, 2009)

Refining previous Community Noise Guidelines issued in 1999, and incorporating more recent research, the World Health Organization has released a comprehensive report on the health effects of night time noise, along with new (non-mandatory) guidelines for use in Europe. Rather than a maximum of 30 dB inside at night (which equals 45-50 dB max outside), the WHO now recommends a maximum year-round outside night-time noise average of 40 db to avoid sleep disturbance and its related health effects. The report notes that only below 30 dB (outside annual average) are "*no significant biological effects observed*," and that between 30 and 40 dB, several effects are observed, with the chronically ill and children being more susceptible; however, "*even in the worst cases the effects seem modest*." Elsewhere, the report states more definitively, "*There is no sufficient evidence that the biological effects observed at the level below 40 dB (night, outside) are harmful to health*." At levels over 40 dB, "*Adverse health effects are observed*" and "*many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected*."

The 184-page report offers a comprehensive overview of research into the various effects of noise on sleep quality and health (including the health effects of non-waking sleep arousal), and is recommended reading for anyone working with noise issues. The use of an outdoor noise standard is in part designed to acknowledge that people do prefer to leave windows open when sleeping, though the year-long average may be difficult to obtain (it would require longer-term sound monitoring than is usually budgeted for by either industry or neighbourhood groups).

While recommending the use of the average level, the report notes that some instantaneous effects occur in relation to specific maximum noise levels, but that the health effects of these "cannot be easily established."

2.6.3 The Assessment and Rating of Noise from Wind Farms (ETSU, 1997)

This report describes the findings of a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. It was developed as an Energy

Technology Support Unit[5] (ETSU) project. The aim of the project was to provide information and advice to developers and planners on noise from wind turbines. The report represents the consensus view of a number of experts (experienced in assessing and controlling the environmental impact of noise from wind farms). Their findings can be summarised as follows:

1. Absolute noise limits applied at all wind speeds are not suited to wind farms; limits set relative to the background noise (including wind as seen in **Figure 5-2**) are more appropriate
2. $L_{A90,10mins}$ is a much more accurate descriptor when monitoring ambient and turbine noise levels
3. The effects of other wind turbines in a given area should be added to the effect of any proposed wind energy facility, to calculate the cumulative effect
4. Noise from a wind energy facility should be restricted to no more than 5 dBA above the current ambient noise level at a NSD. Ambient noise levels is measured onsite in terms of the $L_{A90,10min}$ descriptor for a period sufficiently long enough for a set period
5. Wind farms should be limited to within the range of 35 dBA to 40 dBA (day-time) in a low noise environment. A fixed limit of 43 dBA should be implemented during all night time noise environments. This should increase to 45 dBA (day and night) if the NSD has financial investments in the wind energy facility
6. A penalty system should be implemented for wind turbine/s that operates with a tonal characteristic

This is likely the guideline used in the most international countries to estimate the potential noise impact stemming from the operation of a Wind Energy Facility. It also recommends an improved methodology (compared to a fixed upper noise level) on determining ambient sound levels in periods of higher wind speeds, critical for the development of a wind energy facility. Because of its international importance, the methodologies used in the ETSU R97 document will be recommended in this Scoping Report for implementation during the Environmental Noise Impact Assessment phase should projected noise levels (from the proposed WEF at PSRs) exceed the zone sound levels as recommended by SANS 10103:2008.

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[5] ETSU was set up in 1974 as an agency by the United Kingdom Atomic Energy Authority to manage research programmes on renewable energy and energy conservation. The majority of projects managed by ETSU were carried out by external organizations in academia and industry. In 1996, ETSU became part of AEA Technology plc which was separated from the UKAEA by privatisation.

The document uses the $L_{Aeq,f}$ and L_{A90} descriptors to define noise levels using the "Fast"-time weighting.

2.6.4 Noise Guidelines for Wind Farms (MoE, 2008)

This document establishes the sound level limits for land-based wind power generating facilities and describes the information required for noise assessments and submissions under the Environmental Assessment Act and the Environmental Protection Act, Canada.

The document defines:

- Sound Level Limits for different areas (similar to rural and urban areas), defining limits for different wind speeds at 10 m height, refer also **Table 2-1**[6]
- The Noise Assessment Report, including;
  - Information that must be part of the report
  - Full description of noise sources
  - Adjustments, such as due to the wind speed profile (wind shear)
  - The identification and defining of potential sensitive receptors
  - Prediction methods to be used (ISO 9613-2)
  - Cumulative impact assessment requirements
  - It also defines specific model input parameters
  - Methods on how the results must be presented
  - Assessment of Compliance (defining magnitude of noise levels)

Table 2-1: Summary of Sound Level Limits for Wind Farms (MoE)

Wind speed (m/s) at 10 m height	4	5	6	7	8	9	10
Wind Turbine Sound Level Limits, Class 3 Area, dBA	40	40	40	43	45	49	51
Wind Turbine Sound Level Limits, Class 1 & 2 Areas, dBA	45	45	45	45	45	49	51

[6] The measurement of wind induced background sound level is not required to establish the applicable limit. The wind induced background sound level reference curve was determined by correlating the A-weighted ninetieth percentile sound level (L90) with the average wind speed measured at a particularly quiet site. The applicable Leq sound level limits at higher wind speeds are given by adding 7 dB to the wind induced background L90 sound level reference values

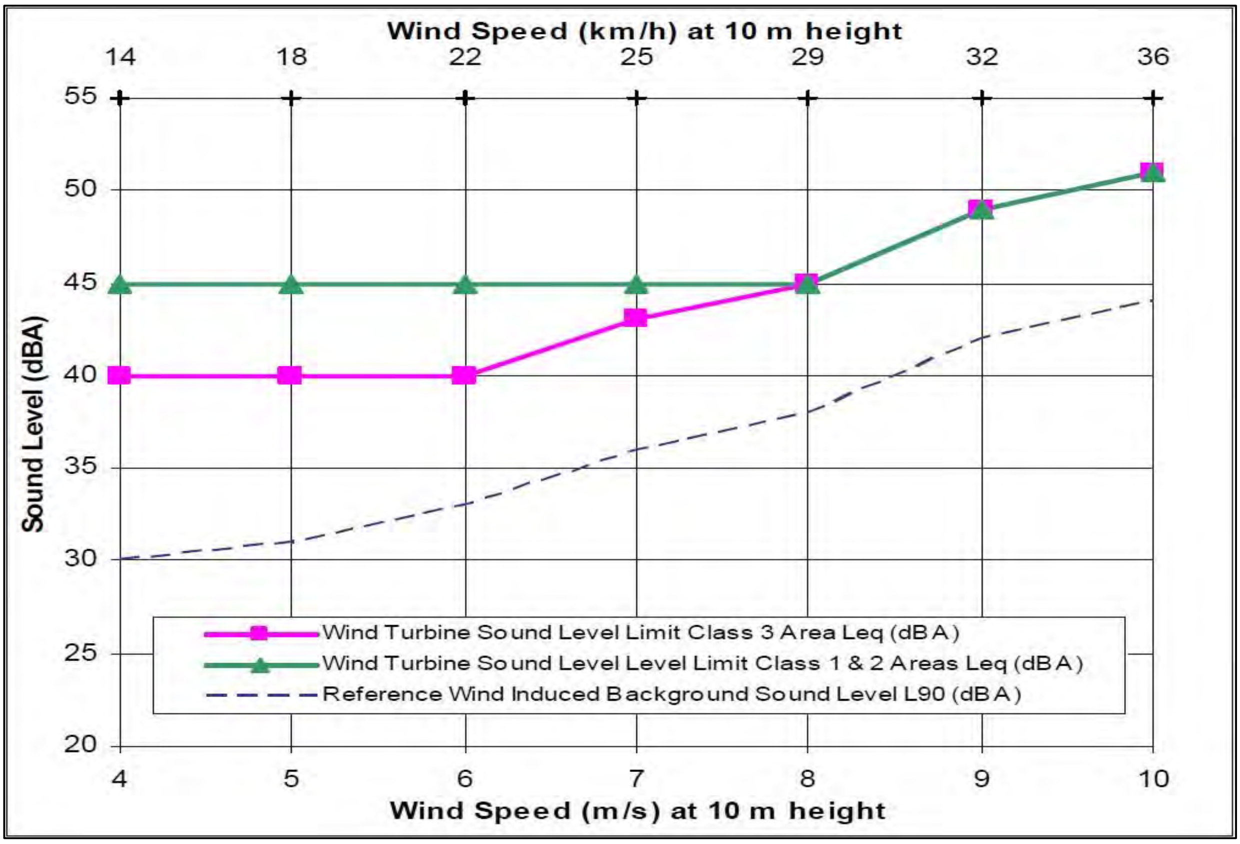

Figure 2.1: Summary of Sound Level Limits for Wind Turbines (MoE Canada)

The document used the $L_{Aeq,1hr}$ noise descriptor to define noise levels. It is not clear whether the instrument must be set to the "Fast" or "Impulse" time weighing setting, but, as the "Fast" setting is used in most international countries it is assumed that the instrument will be set to the "Fast" setting.

It should be noted that these Sound Level Limits are included for the reader to illustrate the criteria used internationally. Due to the lack of local regulations specifically relevant to wind energy facilities this criteria will also be considered during the determination of the significance of the noise impact.

2.6.5 Equator Principles

The **Equator Principles** (EPs) are a voluntary set of standards for determining, assessing and managing social and environmental risk in project financing. Equator Principles Financial Institutions (EPFIs) commit to not providing loans to projects where the borrower will not or is unable to comply with their respective social and environmental policies and procedures that implement the EPs.

The Equator Principles were developed by private sector banks and were launched in June 2003. The banks chose to model the Equator Principles on the environmental standards of the World Bank and the social policies of the International Finance Corporation (IFC). 67 financial institutions (October 2009) have adopted the Equator Principles, which have become the de facto standard for banks and investors on how to assess major development projects around the world. The environmental standards of the World Bank have been integrated into the social policies of the IFC since April 2007 as the International Finance Corporation Environmental, Health and Safety (EHS) Guidelines.

2.6.6 IFC: General EHS Guidelines – Environmental Noise Management

These guidelines are applicable to noise created beyond the property boundaries of a development that conforms to the Equator Principle.

It states that noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception. The preferred method for controlling noise from stationary sources is to implement noise control measures at source.

It goes as far as to proposed methods for the prevention and control of noise emissions, including:

- Selecting equipment with lower sound power levels;
- Installing silencers for fans;
- Installing suitable mufflers on engine exhausts and compressor components;
- Installing acoustic enclosures for equipment casing radiating noise;
- Improving the acoustic performance of constructed buildings, apply sound insulation;
- Installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m^2 in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- Installing vibration isolation for mechanical equipment;
- Limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas ;
- Re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- Placement of permanent facilities away from community areas if possible;
- Taking advantage of the natural topography as a noise buffer during facility design;

- Reducing project traffic routing through community areas wherever possible;
- Planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas; and
- Developing a mechanism to record and respond to complaints.

It sets noise level guidelines (see **Table 2-2**) as well as highlighting the certain monitoring requirements pre- and post-development. It adds another criterion in that the existing background ambient noise level should not rise by more than 3 dBA. This criterion will effectively sterilize large areas of any development. It is, therefore, the considered opinion that this criterion was introduced to address cases where the existing ambient noise level is already at, or in excess of the recommended limits.

Table 2-2: IFC Table .7.1-Noise Level Guidelines

Receptor type	One hour L_{Aeq} (dBA)	
	Daytime 07:00 - 22:00	Night-time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

The document uses the $L_{Aeq,1\ hr}$ noise descriptors to define noise levels. It does not determine the detection period, but refers to the IEC standards, which requires the fast detector setting on the Sound Level Meter during measurements for Europe.

2.6.7 National and International Guidelines - Appropriate limits for game parks and wilderness

The United States National Park Services identifies that "intrusive" un-natural sounds are of concern for the National Park Services (United States[7]) as many visitors go to parks to enjoy the soundscape (interpreted as natural soundscape). Naturally quiet places will not mean (as per interpretation of the author and available information) that the noise levels in the area will be low but rather that the soundscape contributors are of a natural origin (faunal communication, wind, water etc.).

These natural events could include the dawn chorus when songbirds start to sing at the start of a new day or frogs croaking after a rainfall event. Although game park visitors, receptors in "natural" areas and hospitality industries may not seek intrusive un-natural sounds, the operation of the game park/hospitality industry or receptors dwelling itself is source of anthropogenic noise (vehicles, game park electrical and mechanical

[7] National Park Services, "Soundscape Preservation and Noise Management", 2000, p. 1.

infrastructure etc.). National Parks do though implement their own guidelines/rules regarding noise created by park visitors.

Natural sounds can contribute a meaningful magnitude[8] to the ambient soundscape depending on season, time, faunal species, habitat and habitat fragmentation etc. Although the magnitude may be loud, natural sounds may contain harmonics[9] and other pleasant sounds that visitors seek when going to parks or wilderness areas.

Certain International states have tried implementing laws regarding external environmental "un-natural" noise sources into areas with natural sounds. In USA there exists numerous state and local laws to encourage industries near parks to keep within limits set out by the local authorities[10]. The United States National Park Service's efforts include attempts to reduce the flights over the Grand Canyon due to the introduction of non-natural impulsive noise events at the park.

2.6.8 Environmental Management Systems

Many organisations implement their own Environmental Management Systems tools to for planning, implementing and maintaining policy for environmental protection. The more popular International system is highlighted below.

2.6.8.1 ISO 14000

ISO 14000 is a family of standards related to environmental management that exists to help organizations:

- minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land);
- comply with applicable laws, regulations, and other environmentally oriented requirements, and
- continually improve in the above.

The term continual improvement refers to an on-going process of performance enhancement. In the context of this environmental standard, it means that you need to enhance your organization's overall environmental performance by enhancing its environmental management system and by improving its ability to manage the environmental aspects of its activities, products, and services. Continual

[8] Environ. We Int. Sci. Tech, "Ambient noise levels due to dawn chorus at different habitats in Delhi", 2001, p. 134.
[9] Panatcha Anusasananan, Suksan Suwanarat, Nipon Thangprasert, "Acoustic Characteristics of Zebra Dove in Thailand", p. 4.
[10] E.g. State of Oregon's Environmental Standards for Wilderness Areas

improvements can be achieved by carrying out internal audits, performing management reviews, analysing data, and implementing corrective and preventive actions.

2.6.9 European Parliament Directive 200/14/EC

Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors was adopted by the European Parliament and the Council and first published in May 2000. The Directive was applied from January 3rd, 2002. The directive placed sound power limits on equipment to be used outdoors in a suburban or urban setting. Failure to comply with these regulations may result in products being prohibited from being placed on the EU market. Equipment list is vast and includes machinery such as compaction machineries, dozers, dumpers excavators etc. Manufacturers as a result started to consider noise emission levels from their products to ensure that their equipment will continue to have a market in most countries.

3 CURRENT ENVIRONMENTAL SOUND CHARACTER

3.1 AMBIENT SOUND MEASUREMENTS

Ambient (background) noise levels were previously measured at other locations within 150 km of the proposed development, indicating an area with a sound level character typical of a rural area (away from dwellings, plantations, roads and towns), during periods when wind speeds were below 3 m/s. These measurements were considered applicable, as the topography, vegetation and meteorological conditions are similar.

Wind induced noises are normally seen as unwanted noises, with measurements reflecting acoustic interference (due to wind induced noises) normally discarded. However, for the purpose of this study it will be included, as the typical operating noise of the wind energy facility will only be emitted during times when wind induced noise levels are relevant. Site-specific measurements was conducted during the EIA phase and discussed in the following section.

3.2 MEASUREMENT PROCEDURE

The measurement of ambient sound levels is defined by the South African National Standard SANS 10103:2008 as: "***The measurement and rating of environmental noise with respect to land use, health, annoyance and to speech communication***". The standard specifies the acceptable techniques for sound measurements including:

- type of equipment;
- minimum duration of measurement;
- microphone positions;
- calibration procedures and instrument checks; and
- weather conditions.

As discussed in the previous section, ambient sound measurements are ideally collected when wind speeds are less than 3 m/s with no measurements collected when wind speeds exceed 5 m/s. Due to the fact that wind energy facilities will only be in operation during periods that the wind is blowing, it is critical that ambient sound level measurements reflect expected sound levels at various wind speeds. Because of the complexity of these measurements the following methodology is followed:

- Compliance with the latest version of SANS 10103;

- The sound measuring equipment was calibrated directly before, and directly after the measurements was collected. In all cases drift[11] was less than 0.2 dBA between these two measurements.
- The measurement equipment made use of a windshield specifically designed for outdoor use during increased wind speeds;
- The areas where measurements were recorded was selected so as to limit the risks of direct impacts by the wind on the microphone;
- Measurements took place in 10-minute bins for at least two full night-time periods;
- Noise data was synchronised with the wind data measured onsite using an anemometer at a 1.5 m height.

Ambient sound levels were measured over a period of 2 nights during October 2015 with the locations used to measure ambient (background) sound levels are presented in **Figure 3-1**. Photos taken during the measurement date is presented in **Appendix B**.

3.2.1 Measurement Point KASL01 - (NSD05 – Mr. Müller)

This measurement location was just in front of their front porch, next to their outside barbeque boma. The microphone was approximately 6 m from the front of the house or any significant vegetation.

There were large conifers in the area that created a significant level of the background noise when wind blew through it. Other sounds were the voices of the farmer and his family and workers on the property (doing gardening) as well as some free-roaming chickens. The sound of bird calls were heard at times, although wind-induced noises dominated.

Equipment used to gather data is presented in **Table 3-1**. Measured data is presented in **Figure 3-2** (equivalent and 10-minute A-weighted measurements, impulse and fast descriptor).

Table 3-1: Equipment used to gather data at NSD05

Equipment	Model	Serial no	Calibration
SLM	Svan 977	27637	11th November 2015
Microphone	ACO 7052E	52437	11th November 2015
Calibrator	B & K	1558840	9th January 2015
Weather Station	WH3081PC	-	-

- Microphone fitted with the appropriate windshield.

[11] Changes in instrument readings due to a change in altitude (air pressure), temperature and humidity

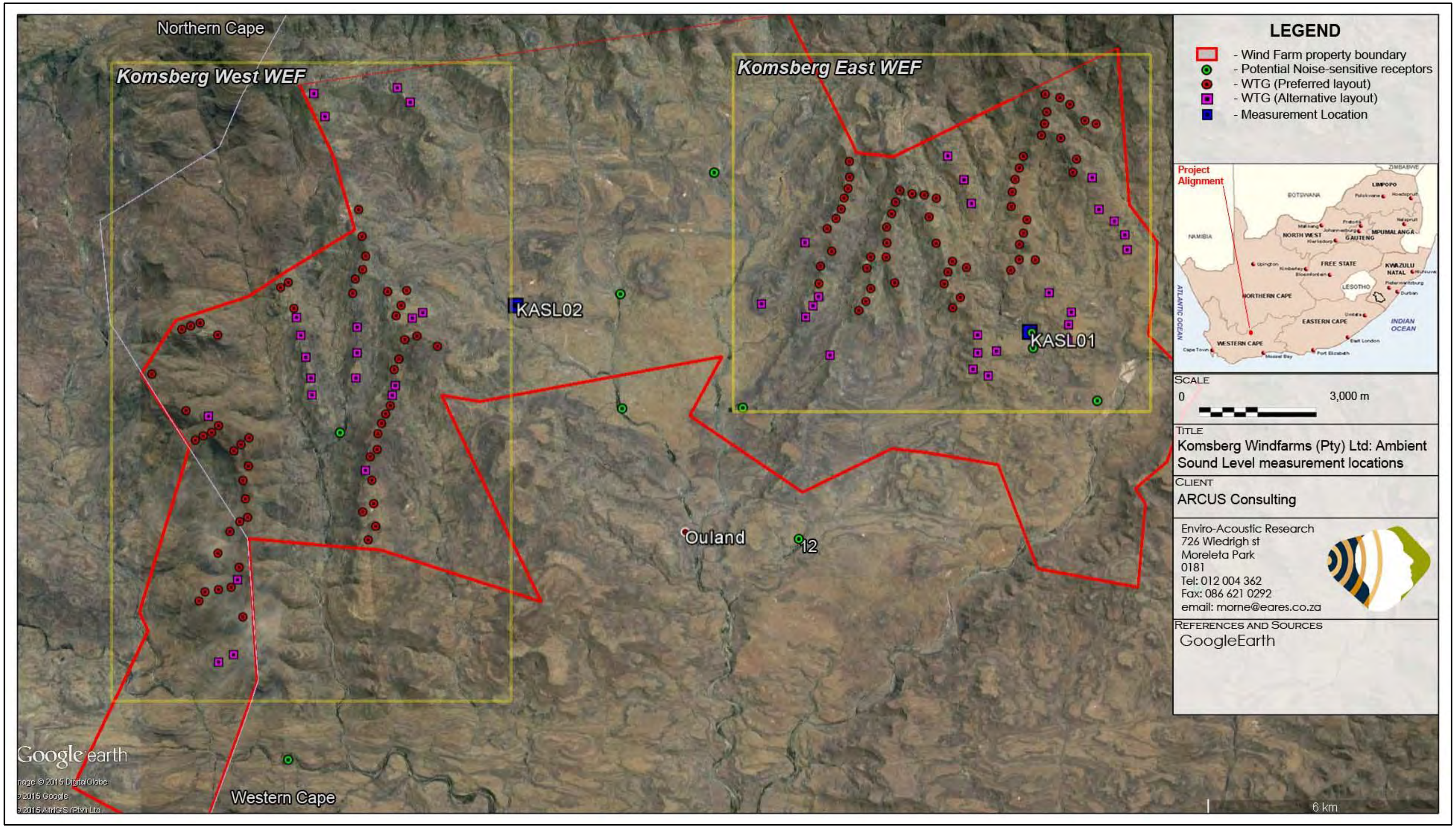

Figure 3-1: Locations where ambient sound levels were measured

Measured $L_{Aeq,i}$ day/night-time data: During the daytime $L_{Aeq,i}$ values ranged from 20.2 to 72.3 dBA. The night-time $L_{Aeq,i}$ values (night-time reference period 22:00 – 06:00) ranged from 19.8 to 55.3 dBA. The daytime arithmetic mean was 45.0 dBA while the night-time average was 32.1 dBA. The equivalent daytime sound levels ("average" value over 16 hours) were 55.4 (afternoon only), 47.0 and 53.0 (morning only) dBA. The equivalent night-time sound levels ("average" value over 8 hours) were 38.9 and 42.7 dBA. Measured data indicated an area that is relatively quiet with natural sounds and wind induced noises impacting on most measurements. Ambient sound levels are illustrated in **Figure 3-2**.

Measured $L_{Aeq,f}$ day/night-time data: During the daytime $L_{Aeq,f}$ values ranged from 19.0 to 67.4 dBA. The night-time $L_{Aeq,f}$ values (night-time reference period 22:00 – 06:00) ranged from 18.7 to 21.2 dBA. The daytime arithmetic mean was 38.6 dBA while the night-time average being 25.7 dBA. The equivalent daytime sound levels were 46.3 (afternoon), 39.7 and 43.4 (morning) dBA. Night-time equivalent sound levels were 30.0 and 32.6 dBA. Ambient sound levels are illustrated in **Figure 3-2**.

Measured 10-minute $L_{A90,f}$ day/night-time data: L_{A90} is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. Daytime values ranged from 18 to 35 dBA90 averaging at 25.8 dBA90. The night-time L_{A90} values ranged from 18 to 21 dBA90 (night-time reference period 22:00 – 06:00) averaging at 18.3 dBA90. Measured L_{A90} data also confirm an area that is quiet, becoming silent at night. This is illustrated in **Figure 3-3**.

$L_{Aeq,i}$ - $L_{Aeq,f}$ average difference, day/night-time: The average daytime difference between the $L_{Aeq,i}$ and $L_{Aeq,f}$ variables was 5 dBA while the night-time average difference was 6.5 dBA. There are various impulsive noises in the area, likely due to bird calls, although the source is unknown.

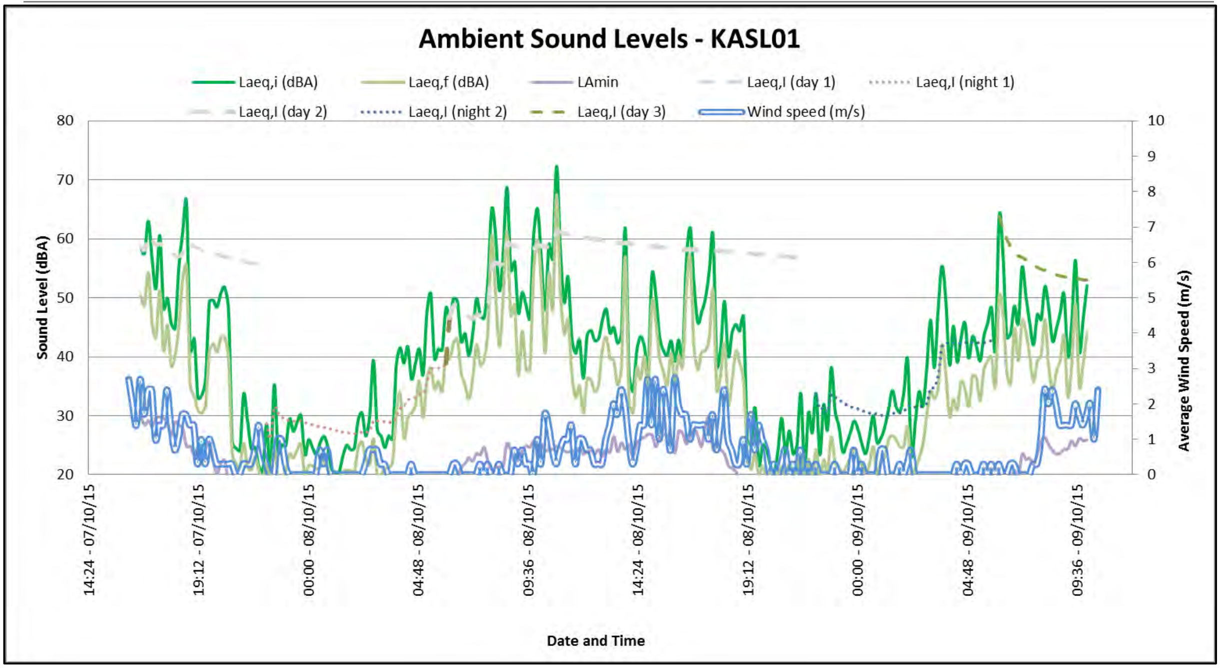

Figure 3-2: Ambient Sound Levels measured at KASL01

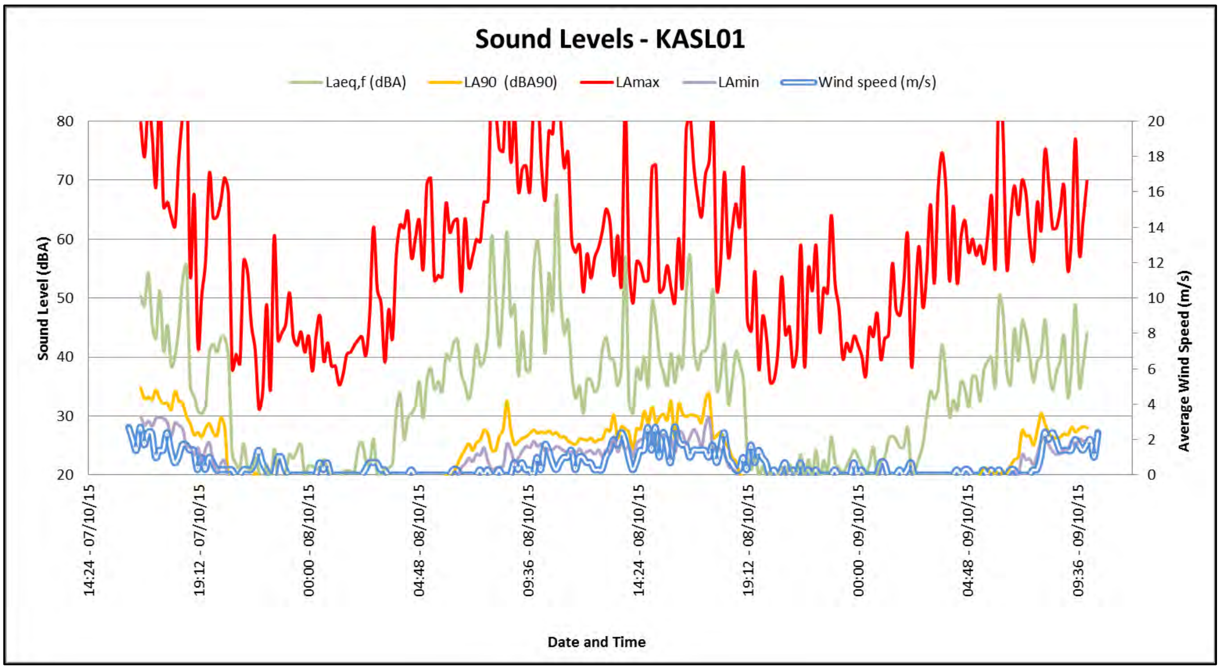

Figure 3-3: 10 minute maximum, 90th percentile, equivalent and minimum sound levels measured at KASL01

L_{Amax} night-time occurrences: There were 8 noise events during the two night-time periods where the sound level exceeded 65 dBA. Night-time maximum noise events may affect sleeping patterns in humans (if they occur frequently at night).[12]

Third octave spectral analysis:

[12] World Health Organization, 2009, '*Night Noise Guidelines for Europe*

Third octaves were measured and are displayed in the following Figures.

Lower frequency (20 – 250 Hz) – Noise sources of significance in this frequency band would include nature (wind especially) and sounds of anthropogenic origin (such as electric motors) and vehicles (engine revolutions). Lower frequencies tend to travel further through the atmosphere than higher frequencies. Daytime measurements indicated some acoustic energy in the very low frequencies, mainly due to wind, with a variety of other sounds from various source and different intensities. Night-time sounds however indicate a sound with a peak frequency at 100 and 160Hz. This may be attributed to an electric motor that was not heard during the times the instruments was deployed or collected (due to a very low level, less than 30 dB).

Third octave surrounding the 1000 Hz – This range contains energy mostly associated with human speech (350 Hz – 2,000 Hz; mostly below 1,000 Hz) and dwelling noises (including sounds from larger animals such as chickens, dogs, goats, sheep and cattle). Daytime sound indicates that wind-induced noises created a constant background noise with a variety of other sounds impacting on the measurements. This was likely due to household and agricultural sounds typical around farming houses during the day. While acoustic energy in the lower frequencies dominated in a number of measurements (due to wind-induced noises), a few measurements indicate noises from different sources, typical of a rural area. It should be noted that the wind induced noises could also mask other noises in this frequency band. Night-time noises showed a clear character with peaks at 315 Hz (likely a harmonic from the electric motor), a peak in the 630 – 800 Hz range and a peak at 1,600 Hz. These sounds were possibly from farm animals (sheep) in the vicinity of the house that was not seen during instrument deployment or collection although the source was not defined.

Higher frequency (2,000 Hz upwards) – Smaller faunal species such as birds, crickets and cicada use this range to communicate and hunt etc. Measurements however indicated relative low sounds in these frequency ranges during the measurement period, likely due to the free-roaming chickens in the area. There were sound with peaks in the 12,500 – 16,000 Hz, generally attributed to cicada species, with significant sounds in the frequencies 20,000 Hz and higher (bats in echolocation range).

Spectral data analysis concludes that the area has few, non-significant, anthropogenic activities impacting on ambient sound levels with wind-induced noises dominating the ambient soundscape (during the day). While elevated sound levels were measured during the day, the site can be considered naturally quiet. The location is very quiet at night.

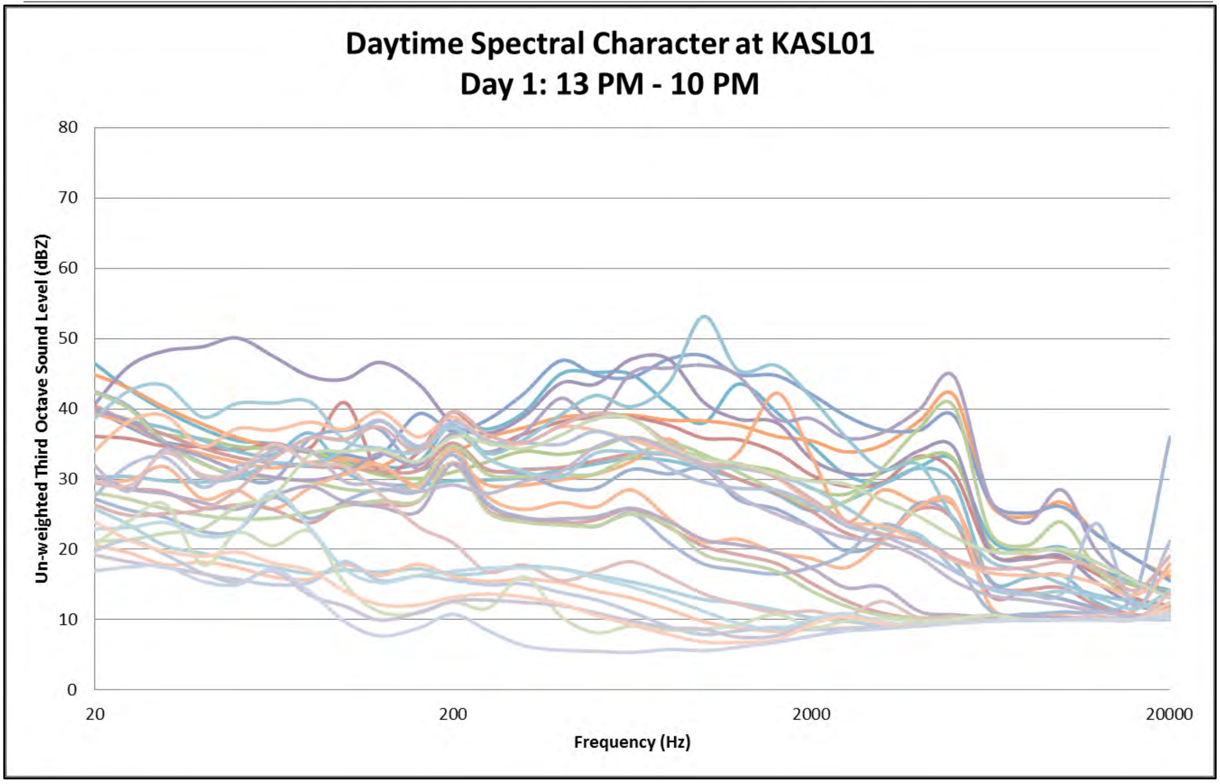

Figure 3-4: Spectral frequency distribution as measured on-site at KASL01 – first day

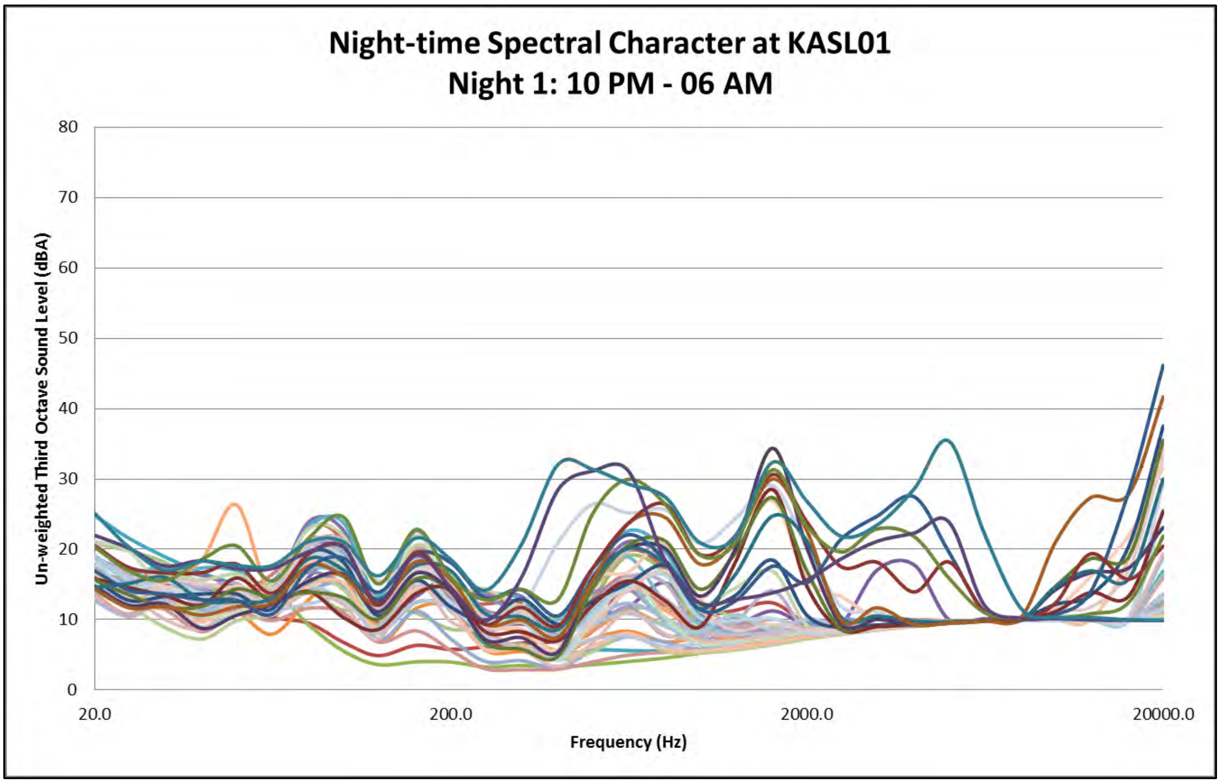

Figure 3-5: Spectral frequency distribution as measured on-site at KASL01 – first night

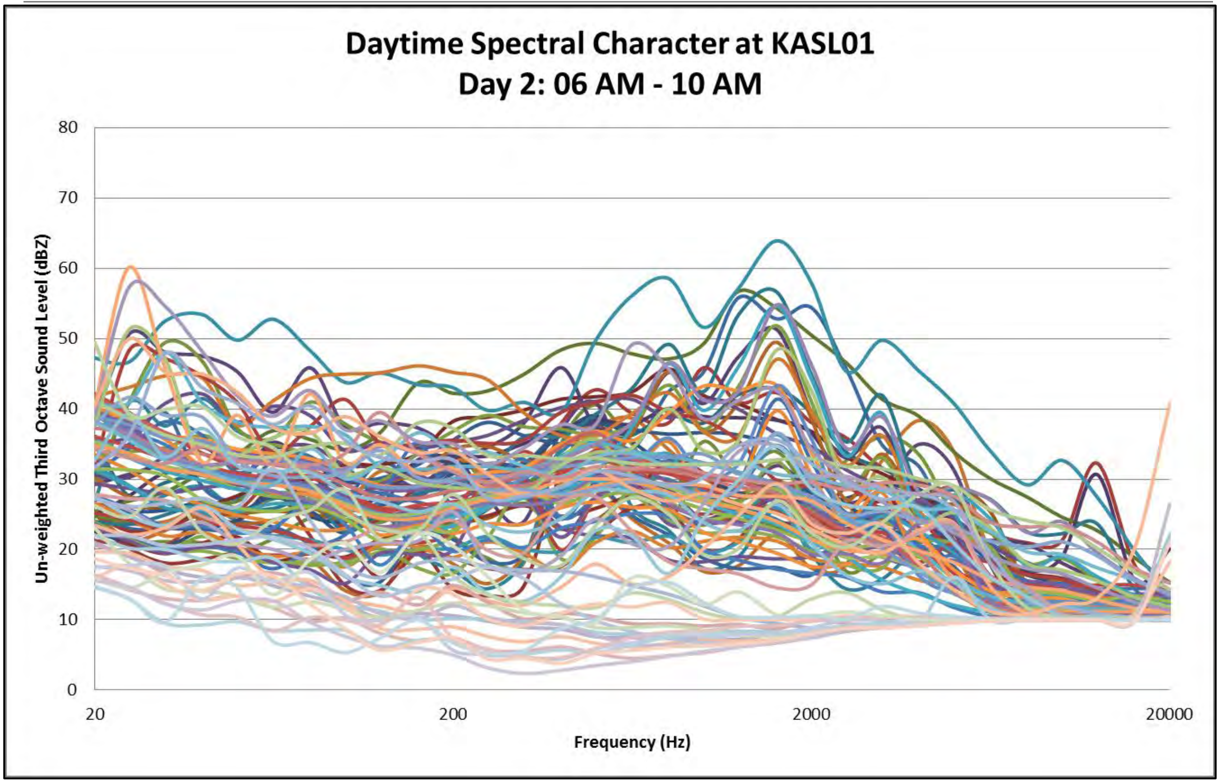

Figure 3-6: Spectral frequency distribution as measured on-site at KASL01 – second day

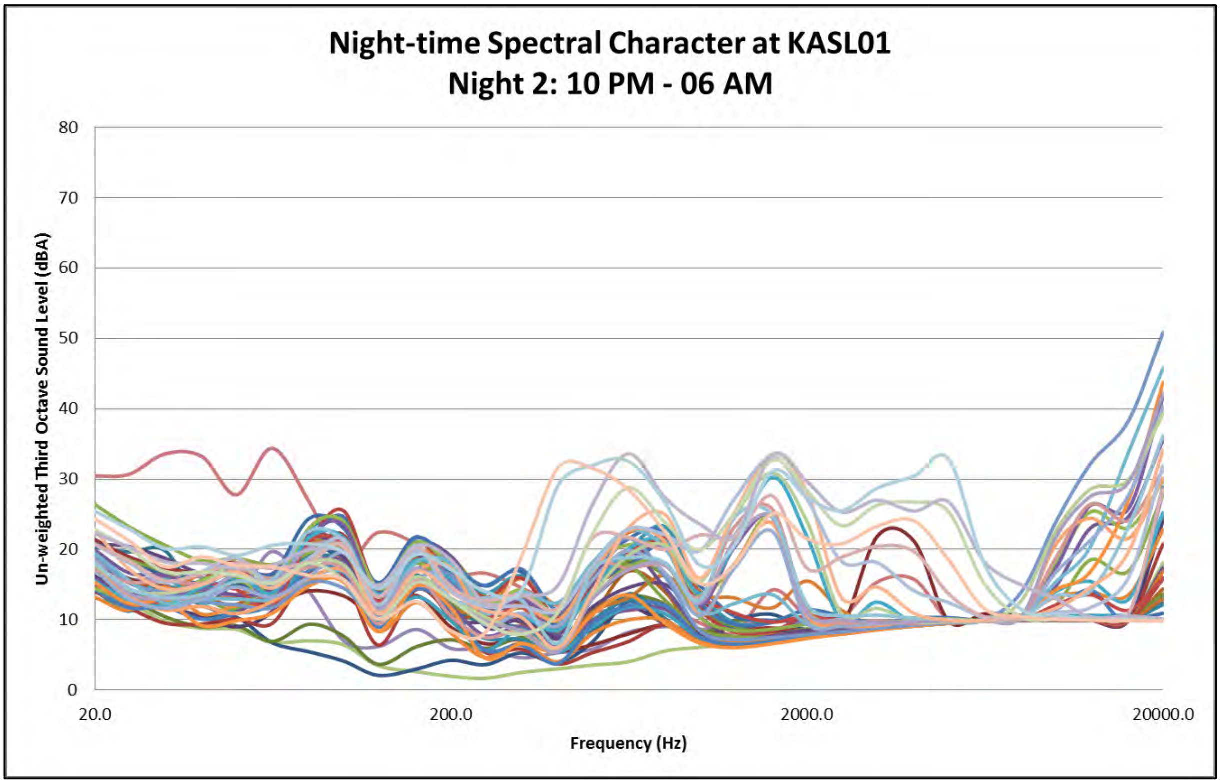

Figure 3-7: Spectral frequency distribution as measured on-site at KASL01 – second night

SANS 10103 Rating Level: While the area have a rural development character, ambient sound level measurements indicated an area where wind-induced and insect sounds raised the ambient sound levels during the day. Other sounds likely relate to agricultural activities in the vicinity of the measurement locations. The character of these noises however is very different from urban areas with sounds from natural origin mainly dominating. The dwelling has a sound character typical of a rural noise district.

3.2.2 Measurement point KASL02 – (NSD02)

The measurement location is at an open area approximately 18 m from the house of the owner. Being in the front yard it was surrounded by bushes and trees, although the closest vegetation was further than 5 m from the microphone. A photo of the measurement location is illustrated in **Appendix B**.

Equipment used is defined in **Table 3-2**. Ambient sound levels measured are illustrated in **Figure 3-2**. The location was very quiet, with wind induced noises dominating.

Table 3-2: Equipment used to gather data at NSD02

Equipment	Model	Serial no	Calibration
SLM	Svan 977	36176	September 2014
Microphone	ACO 7052E	25685	September 2014
Calibrator	B & K	1558840	9th January 2015

*Microphone fitted with the appropriate windshield.

Measured $L_{Aeq,i}$ day/night-time data: During the daytime $L_{Aeq,i}$ values ranged from 30.5 to 77.0 dBA. The night-time $L_{Aeq,i}$ values (night-time reference period 22:00 – 06:00) ranged from 26.8 to 63.9 dBA. The daytime mathematical average was 45.6 dBA while night-time average was 35.0 dBA. The equivalent daytime sound levels ("average" value over 16 hours) were 63.8 (afternoon), 48.2 and 49.9 (morning) dBA. The equivalent night-time sound levels ("average" value over 8 hours) were 42 and 45 dBA. Measured data indicated an area with elevated sound levels. Ambient sound levels are illustrated in **Figure 3-8**.

Measured $L_{Aeq,f}$ day/night-time data: During the daytime $L_{Aeq,f}$ values ranged from 28.3 to 46.5 dBA. The night-time $L_{Aeq,f}$ values (night-time reference period 22:00 – 06:00) ranged from 24.6 to 56.1 dBA. The daytime mathematical average was 39.1 dBA while night-time average was 30.6 dBA. The equivalent daytime sound levels ("average" value over 16 hours) were 52.4 (afternoon), 40.7 and 41.9 (morning) dBA. The equivalent night-time sound levels ("average" value over 8 hours) were 37.7 and 42.0 dBA. This is also shown in **Figure 3-8**.

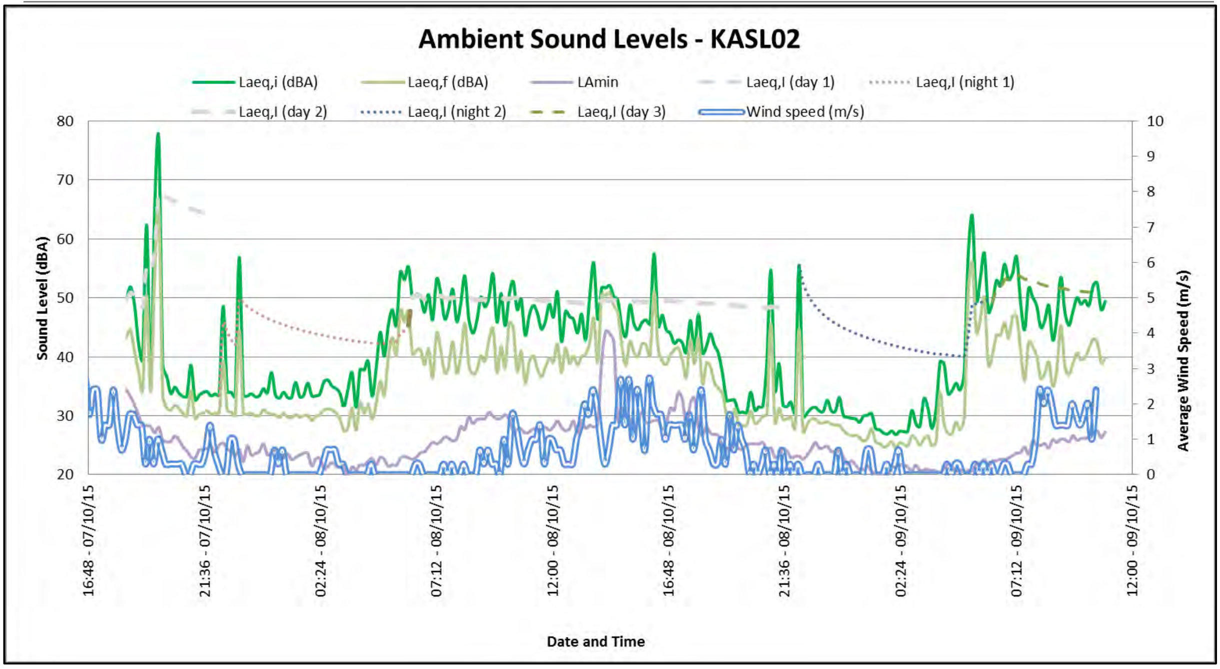

Figure 3-8: Ambient Sound Levels measured at KASL02

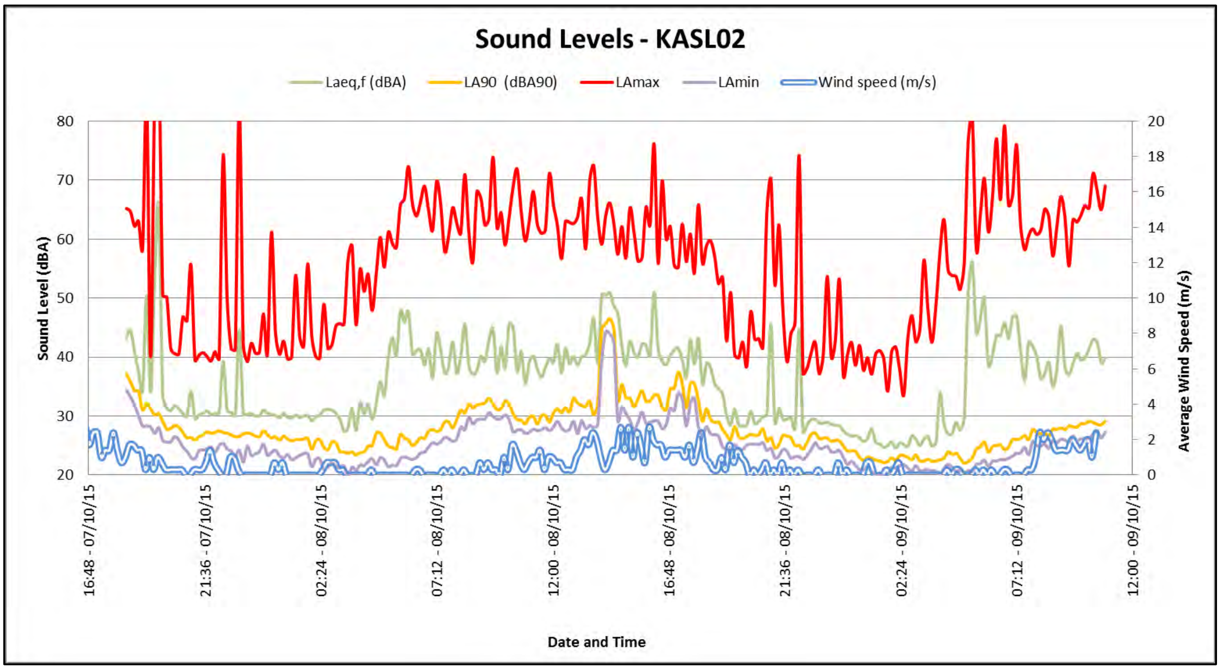

Figure 3-9: 10 minute maximum, 90th percentile, equivalent and minimum sound levels measured at KASL02

$L_{Aeq,i}$ - $L_{Aeq,f}$ average difference, day/night-time: The average daytime difference between the **$L_{Aeq,i}$** and **$L_{Aeq,f}$** variables was 4.8 dB while the night-time was 4.5 dB. There are therefore some impulsive noises in the area.

Measured 10-minute $L_{A90,f}$ day/night-time data: L_{A90} is a statistical indicator that describes the noise level that is exceeded 90% of the time and frequently used to define the background sound level internationally. Daytime values ranged from 23.9 to 46.5 dBA90 averaging at 29.8 dBA90. The night-time L_{A90} values ranged from 22.0 to 27.5 dBA90 (night-time reference period 22:00 – 06:00) averaging at 24.8 dBA90. Measured L_{A90} data indicate an area that is relatively quiet. This is illustrated in **Figure 3-9**.

L_{Amax} night-time occurrences: There were 8 instances where the sound level exceeded 65 dBA during the 2 night-time periods. Most people, when exposed to 10 or noisier events where the maximum sound level exceeds 65 dBA may experience disturbances in sleeping patterns.[13]

Third octave spectral analysis:

Third octaves were measured and are displayed in the following Figures.

Lower frequency (20 – 250 Hz) – As with KASL01, wind induced noises mainly dominated the low frequency bands during the day, especially the second day. There were a number of unidentified extraneous noises at times during the day.

Third octave surrounding the 1000 Hz band – The site was relatively quiet in this frequency band, although there were a few instances during the night and daytime when there were other external noises of sufficient magnitude and duration to impact on the 10-minute measurements.

Higher frequency (2,000 Hz upwards) – Daytime measurements shows a peak in the range 3,150 – 8,000 Hz, likely a combination of birds and/or insects in the garden. As with KASL01 there is evidence of bats in the area (number of measurements indicating sounds at 20,000Hz and higher).

Spectral data analysis concludes that the area has few anthropogenic activities impacting on ambient sound levels. The site can be considered naturally quiet.

SANS 10103 Rating Level: While the area have a rural development character, ambient sound level measurements indicated an area where wind-induced and faunal noises raised the ambient sound levels during the day. The night-time periods are generally quiet with a few external sounds. The character of these noises however is very different from urban areas with sounds from natural origin mainly dominating. The area surrounding the dwelling has a sound character typical of a rural noise district.

[13] World Health Organization, 2009, '*Night Noise Guidelines for Europe*

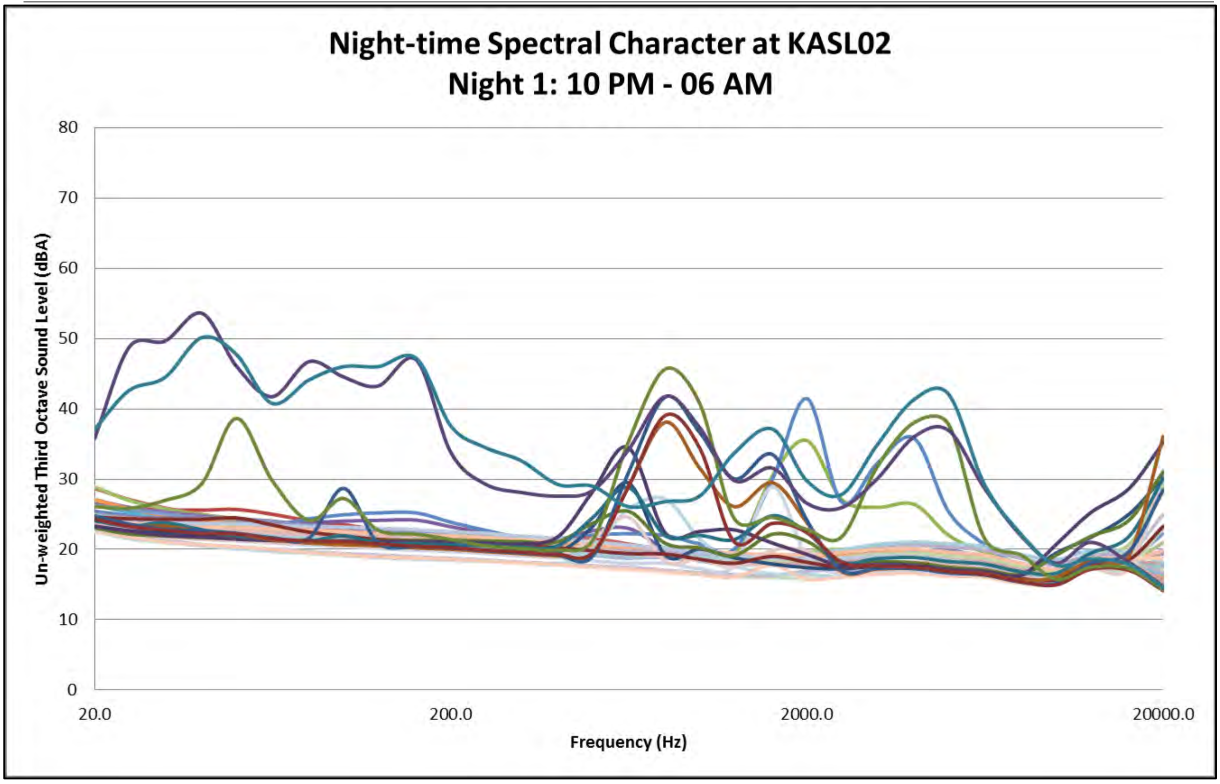

Figure 3-10: Spectral frequency distribution as measured on-site at KASL02 – first night

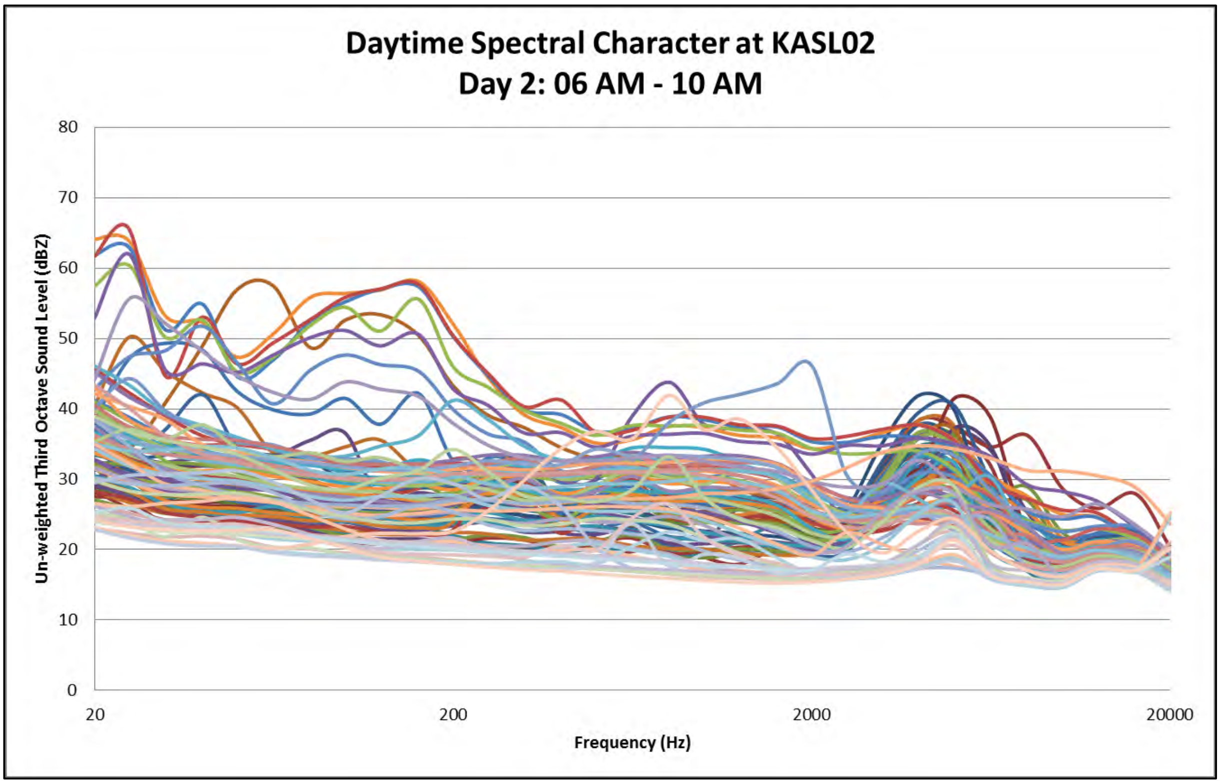

Figure 3-11: Spectral frequency distribution as measured on-site at KASL02 – second day

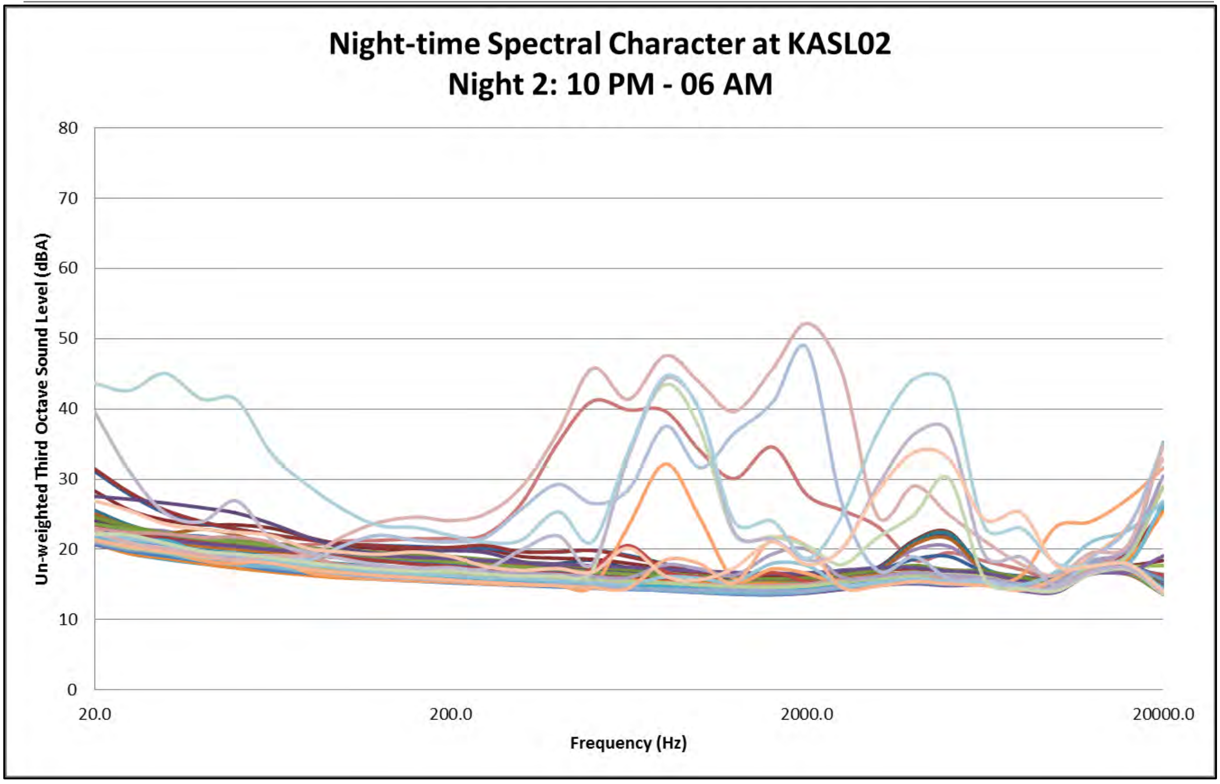

Figure 3-12: Spectral frequency distribution as measured on-site at KASL02 – second night

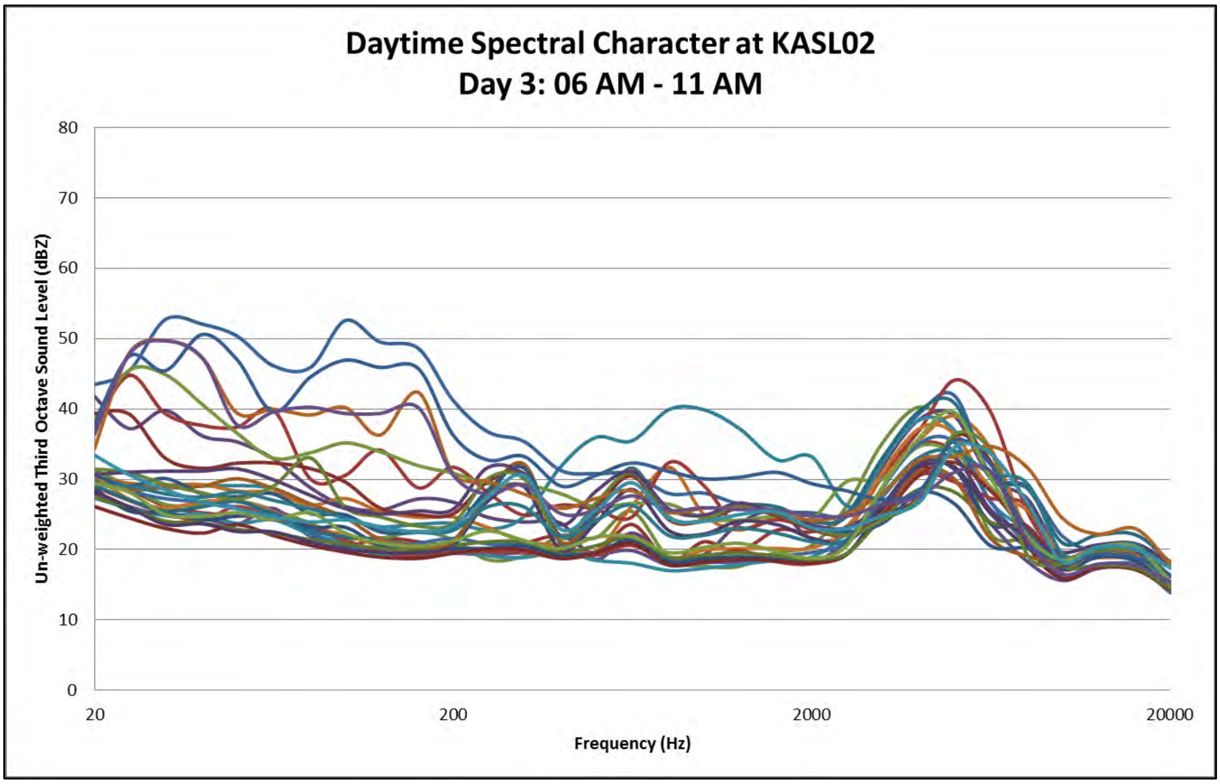

Figure 3-13: Spectral frequency distribution as measured on-site at KASL02 – first day

3.3 AMBIENT SOUND LEVELS – SUMMARY

Considering the results of the ambient sound measurements, the main source of daytime sound was from the wind, with other sounds from various sources raising the sound levels at times. The night-time periods were generally quiet. While the sound levels were slightly elevated at times the area is naturally quiet and the SANS 10103 (see **Table 5-1**) rating levels are typical of a rural noise district.

4 POTENTIAL NOISE SOURCES

Increased noise levels are directly linked to various activities associated with the construction of the facility and related infrastructure as well as the operational phase of the activity.

4.1 POTENTIAL NOISE SOURCES: CONSTRUCTION PHASE

4.1.1 Construction equipment

It is estimated that construction will take approximately 18 - 24 months subject to the final design of the WEF, weather and ground conditions, including time for testing and commissioning. The construction process will consist of the following principal activities:

- Site survey and preparation;
- Establishment of site entrance, internal access roads, contractors compound and passing places;
- Civil works to sections of the public roads to facilitate with turbine delivery;
- Site preparation activities will include clearance of vegetation at the footprint of each turbine as well as crane hard-standing areas. These activities will require the stripping of topsoil which will need to be stockpiled, backfilled and/or spread on site;
- Construct foundations – due to the volume of concrete that will be required, an on-site batching plant could be required to ensure a continuous concreting operation. The source of aggregate is yet undefined but is expected to be derived from an offsite source or brought in as ready-mix. If the stones removed during the digging of foundations are suitable as an aggregate this can be used as the aggregate in the concrete mix.
- Transport of components & equipment to site – all components will be brought to site in sections by means of flatbed trucks. Additionally, components of various specialized construction and lifting equipment are required on site to erect the wind turbines and will need to be transported to site. The typical civil engineering construction equipment will need to be brought to the site for the civil works (e.g. excavators, trucks, graders, compaction equipment, cement trucks, etc.). The transportation of ready-mix concrete to site or the materials for onsite concrete batching will result in temporary increase in heavy traffic (one turbine foundation = 100 concrete trucks, and is undertaken as a continuous pour). The components required for the establishment of the overhead power line (including towers and cabling) will be transported to site as required;

- Establishment of laydown & hard standing areas - laydown areas will need to be established at each turbine position for the placement of wind turbine components. Laydown and storage areas will also be required to be established for the civil engineering construction equipment which will be required on site. Hard standing areas will need to be established for operation of the cranes. Cranes of the size required to erect turbines are sensitive to differential movement during lifting operations and require a hard standing area;
- Erect turbines - a crane will be used to lift the tower sections into place and then the nacelle will be placed onto the top of the assembled tower. The next step will be to assemble or partially assemble the rotor on the ground; it will then be lifted to the nacelle and bolted in place. A small crane will likely be needed for the assembly of the rotor while the large crane will be needed to put it in place;
- Construct substation - the underground cables carrying the generated power from the individual turbines will connect at the substation. The construction of the substation would require a site survey; site clearing and levelling (including the removal / cutting of rock outcrops) and construction of access road/s (where required); construction of a substation terrace and foundation; assembly, erection and installation of equipment (including transformers); connection of conductors to equipment; and rehabilitation of any disturbed areas and protection of erosion sensitive areas;
- Establishment of ancillary infrastructure - A workshop as well as a contractor’s equipment camp may be required. The establishment of these facilities/buildings will require the clearing of vegetation and levelling of the development site and the excavation of foundations prior to construction. A laydown area for building materials and equipment associated with these buildings will also be required;
- An overhead power line to connect to the existing Eskom Komsberg Main Transmission substation; and
- Site rehabilitation - once construction is completed and all construction equipment are removed; the site will be rehabilitated where practical and reasonable.

There are a number of factors that determine the audibility as well as the potential of a noise impact on receptors. Maximum noises generated can be audible over a large distance, however, are generally of very short duration. If maximum noise levels however exceed 65 dBA at a receptor, or if it is clearly audible with a significant number of instances where the noise level exceeds the prevailing ambient sound level with more than 15 dB the noise can increase annoyance levels and may ultimately result in noise complaints. Potential maximum noise levels generated by various construction equipment as well as the potential extent of these sounds are presented in **Table 4-1**.

Average or equivalent sound levels are another factor that impacts on the ambient sound levels and is the constant sound level that the receptor can experience. Typical sound power levels associated with various activities that may be found at a construction site is presented **Table 4-2**.

The equipment likely to be required to complete the above tasks will typically include:

- excavator/graders, bulldozer(s), dump trucks(s), vibratory roller, bucket loader, rock breaker(s), drill rig, flatbed truck(s), pile drivers, TLB, concrete truck(s), crane(s), fork lift(s) and various 4WD and service vehicles.

4.1.2 Material supply: Concrete batching plants and use of Borrow Pits

There exist three options for the supply of the concrete to the development site. These options are:

1. The transport of "ready-mix" concrete from the closest centre to the development.
2. The transport of aggregate and cement from the closest centre to the development, with the establishment of a small concrete batching plant close to the activities. This would most likely be a movable plant. It may be possible to use some of the material obtained from foundation excavation as aggregate if suitable.
3. The development of a small aggregate quarry in the vicinity of the development.

4.1.3 Traffic

A significant source of noise during the construction phase is additional traffic to and from the site, as well as traffic on the site. This will include trucks transporting equipment, cement (possibly aggregate) as well as various components used to develop the wind turbine.

Construction traffic is expected to be generated throughout the entire construction period, however, the volume and type of traffic generated will be dependent upon the construction activities being conducted, which will vary during the construction period. Noise levels due to additional traffic will be estimated using the methods stipulated in SANS 10210:2004 (Calculating and predicting road traffic noise).

Table 4-1: Potential maximum noise levels generated by construction equipment

Equipment Description[14]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Auger Drill Rig	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Backhoe	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Chain Saw	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Compactor (ground)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Compressor (air)	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Concrete Batch Plant	No	117.7	92.7	86.7	80.6	72.7	66.7	63.1	60.6	57.1	52.7	49.2	46.7	40.6
Concrete Mixer Truck	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Concrete Pump Truck	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Concrete Saw	No	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6
Crane	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Dozer	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Drill Rig Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Drum Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Dump Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Flat Bed Truck	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Front End Loader	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Generator (>25KVA)	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Generator (<25KVA)	No	104.7	79.7	73.7	67.6	59.7	53.7	50.1	47.6	44.1	39.7	36.2	33.7	27.6
Grader	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Impact Pile Driver	Yes	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Jackhammer	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Man Lift	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Mounted Impact Hammer	Yes	124.7	99.7	93.7	87.6	79.7	73.7	70.1	67.6	64.1	59.7	56.2	53.7	47.6

[14] Equipment list and Sound Power Level source: http://www.fhwa.dot.gov/environment/noise/construction_noise/handbook/handbook09.cfm

Equipment Description[14]	Impact Device?	Maximum Sound Power Levels (dBA)	Operational Noise Level at given distance considering potential **maximum** noise levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
			5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Paver	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Pickup Truck	No	89.7	64.7	58.7	52.6	44.7	38.7	35.1	32.6	29.1	24.7	21.2	18.7	12.6
Pumps	No	111.7	86.7	80.7	74.6	66.7	60.7	57.1	54.6	51.1	46.7	43.2	40.7	34.6
Rivit Buster/Chipping Gun	Yes	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Rock Drill	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Roller	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sand Blasting (single nozzle)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Scraper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Sheers (on backhoe)	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Slurry Plant	No	112.7	87.7	81.7	75.6	67.7	61.7	58.1	55.6	52.1	47.7	44.2	41.7	35.6
Slurry Trenching Machine	No	116.7	91.7	85.7	79.6	71.7	65.7	62.1	59.6	56.1	51.7	48.2	45.7	39.6
Soil Mix Drill Rig	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Tractor	No	118.7	93.7	87.7	81.6	73.7	67.7	64.1	61.6	58.1	53.7	50.2	47.7	41.6
Vacuum Excavator	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vacuum Street Sweeper	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Ventilation Fan	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibrating Hopper	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Vibratory Concrete Mixer	No	114.7	89.7	83.7	77.6	69.7	63.7	60.1	57.6	54.1	49.7	46.2	43.7	37.6
Vibratory Pile Driver	No	129.7	104.7	98.7	92.6	84.7	78.7	75.1	72.6	69.1	64.7	61.2	58.7	52.6
Warning Horn	No	119.7	94.7	88.7	82.6	74.7	68.7	65.1	62.6	59.1	54.7	51.2	48.7	42.6
Welder/Torch	No	107.7	82.7	76.7	70.6	62.7	56.7	53.1	50.6	47.1	42.7	39.2	36.7	30.6

Table 4-2: Potential equivalent noise levels generated by various equipment

Equipment Description	Equivalent (average) Sound Levels (dBA)	Operational Noise Level at given distance considering equivalent (average) sound power emission levels (Cumulative as well as the mitigatory effect of potential barriers or other mitigation not included – simple noise propagation modelling only considering distance) (dBA)											
		5 m	10 m	20 m	50 m	100 m	150 m	200 m	300 m	500 m	750 m	1000 m	2000 m
Bulldozer CAT D10	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D11	113.3	88.4	82.3	76.3	68.4	62.3	58.8	56.3	52.8	48.4	44.8	42.3	36.3
Bulldozer CAT D9	111.9	86.9	80.9	74.9	66.9	60.9	57.4	54.9	51.3	46.9	43.4	40.9	34.9
Bulldozer CAT D6	108.2	83.3	77.3	71.2	63.3	57.3	53.7	51.2	47.7	43.3	39.8	37.3	31.2
Bulldozer CAT D5	107.4	82.4	76.4	70.4	62.4	56.4	52.9	50.4	46.9	42.4	38.9	36.4	30.4
Bulldozer Komatsu 375	114.0	89.0	83.0	77.0	69.0	63.0	59.5	57.0	53.4	49.0	45.5	43.0	37.0
Bulldozer Komatsu 65	109.5	84.5	78.5	72.4	64.5	58.5	54.9	52.4	48.9	44.5	41.0	38.5	32.4
Diesel Generator (Large - mobile)	106.1	81.2	75.1	69.1	61.2	55.1	51.6	49.1	45.6	41.2	37.6	35.1	29.1
Dumper/Haul truck - CAT 700	115.9	91.0	85.0	78.9	71.0	65.0	61.4	58.9	55.4	51.0	47.5	45.0	38.9
Dumper/Haul truck - Terex 30 ton	112.2	87.2	81.2	75.2	67.2	61.2	57.7	55.2	51.7	47.2	43.7	41.2	35.2
Dumper/Haul truck - Bell 25 ton (B25D)	108.4	83.5	77.5	71.4	63.5	57.5	53.9	51.4	47.9	43.5	40.0	37.5	31.4
Excavator - Cat 416D	103.9	78.9	72.9	66.8	58.9	52.9	49.3	46.8	43.3	38.9	35.4	32.9	26.8
Excavator - Hitachi EX1200	113.1	88.1	82.1	76.1	68.1	62.1	58.6	56.1	52.6	48.1	44.6	42.1	36.1
Excavator - Hitachi 870 (80 t)	108.1	83.1	77.1	71.1	63.1	57.1	53.6	51.1	47.5	43.1	39.6	37.1	31.1
Excavator - Hitachi 270 (30 t)	104.5	79.6	73.5	67.5	59.6	53.5	50.0	47.5	44.0	39.6	36.0	33.5	27.5
FEL - CAT 950G	102.1	77.2	71.2	65.1	57.2	51.2	47.6	45.1	41.6	37.2	33.7	31.2	25.1
FEL - Komatsu WA380	100.7	75.7	69.7	63.7	55.7	49.7	46.2	43.7	40.1	35.7	32.2	29.7	23.7
General noise	108.8	83.8	77.8	71.8	63.8	57.8	54.2	51.8	48.2	43.8	40.3	37.8	31.8
Grader - Operational Hitachi	108.9	83.9	77.9	71.9	63.9	57.9	54.4	51.9	48.4	43.9	40.4	37.9	31.9
Grader	110.9	85.9	79.9	73.9	65.9	59.9	56.4	53.9	50.3	45.9	42.4	39.9	33.9
JBL TLB	108.8	83.8	77.8	71.8	63.8	57.8	54.3	51.8	48.3	43.8	40.3	37.8	31.8
Road Transport Reversing/Idling	108.2	83.3	77.2	71.2	63.3	57.2	53.7	51.2	47.7	43.3	39.7	37.2	31.2
Road Truck average	109.6	84.7	78.7	72.6	64.7	58.7	55.1	52.6	49.1	44.7	41.1	38.7	32.6
Vibrating roller	106.3	81.3	75.3	69.3	61.3	55.3	51.8	49.3	45.8	41.3	37.8	35.3	29.3
Water Dozer, CAT	113.8	88.8	82.8	76.8	68.8	62.8	59.3	56.8	53.3	48.8	45.3	42.8	36.8

4.1.4 Blasting

Blasting may be required as part of the civil works to clear obstacles or to prepare foundations. However, blasting will not be considered during the EIA phase for the following reasons:

- Blasting is highly regulated, and control of blasting to protect human health, equipment and infrastructure will ensure that any blasts will use the minimum explosives and will occur in a controlled manner. The breaking of obstacles with explosives is also a specialized field and when correct techniques are used, causes significantly less noise than using a hydraulic rock-breaker.
- People are generally more concerned about ground vibration and air blast levels that might cause building damage than the impact of the noise from the blast. However, these are normally associated with close proximity mining/quarrying.
- Blasts are an infrequent occurrence, with a loud but a relative instantaneous character. Potentially affected parties generally receive sufficient notice (siren) and the knowledge that the duration of the siren noise as well as the blast will be over relative fast results in a higher acceptance of the noise. Note that with the selection of explosives and blasting methods, noise levels from blasting is relatively easy to control.

4.2 POTENTIAL NOISE SOURCES: OPERATIONAL PHASE

The proposed development would be designed to have an operational life of up to 25 years, although the producer agreement with the state may only be 20 years. During operation of the development, the large majority of the WEF sites will continue with agricultural use as it is currently. The only development related activities on-site will be routine servicing and unscheduled maintenance. The noise impact from maintenance activities is insignificant, with the main noise source being the wind turbine blades and the nacelle (components inside).

Noise emitted by wind turbines can be divided in two types of noise sources. These are aerodynamic sources due to the passage of air over the wind turbine blades and mechanical sources that are associated with components of the power train within the turbine, such as the gearbox and generator and control equipment for yaw, blade pitch, etc. These sources generally have different characteristics and can be considered separately. In addition there are other lesser noise sources, such as the substations themselves, traffic (maintenance) as well as transmission line noise.

4.2.1 Wind Turbine Noise: Aerodynamic sources[15]

Aerodynamic noise is emitted by a wind turbine blade through a number of sources such as:

1. Self-noise due to the interaction of the turbulent boundary layer with the blade trailing edge
2. Noise due to inflow turbulence (turbulence in the wind interacting with the blades)
3. Discrete frequency noise due to trailing edge thickness
4. Discrete frequency noise due to laminar boundary layer instabilities (unstable flow close to the surface of the blade)
5. Noise generated by the rotor tips

Noise due to aerodynamic instabilities (mechanisms 3 and 4) can be reduced to insignificant levels by careful design. The other mechanisms are an inescapable consequence of the aerodynamics of the turbine that produces the power and between them they will make up most, if not all, of the aerodynamic noise radiated by the wind turbine. The relative contribution of each source will depend upon the detailed design of the turbine and the wind speed and turbulence at the time.

The mechanisms responsible for tip noise (mechanism 5) are currently under investigation, but it appears that methods for its control through design of the tip shape might be available. Self-noise (mechanism 1) is most significant at low wind speeds, whereas noise due to inflow turbulence (mechanism 2) becomes the dominant source at the higher wind speeds. Both mechanisms increase in strength as the wind speed increases, particularly inflow turbulence. The overall result is that at low to moderate wind speeds, the noise from a fixed speed wind turbine increases at a rate of 0.5-1.5 dBA /m/s up to a maximum at wind speeds of 7 -12 m/s (noise generated by the WTG does not increase significantly at wind speeds above 12 m/s).

Therefore, as the wind speed increases, noises created by the wind turbine also increases. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops as illustrated in **Figure 4-1**. The sound power emissions (in octave sound power levels) as used in this report are presented in **Table 7-1**.

[15]*Renewable Energy Research Laboratory, 2006; ETSU R97: 1996*

The developer is investigating a number of different wind turbine models; not excluding the possibility of larger models that are not yet available in the commercial market. Therefore, for the purpose of this noise assessment a worse-case scenario will be investigated, making use of the sound power emission levels of the Vestas V117 3.3 MW turbine (refer to **Figure 4-1**).

The developer is also considering the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3000. While the sound power emission levels of the Vestas V126 3.45/3.6 are similar to the Vestas V117 3.3 MW, the sound power emission levels of the Acciona AW125/3000 is approximately 2 dB higher than either the Vestas WTGs.

The propagation model makes use of various frequencies, because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions providing a higher accuracy than models that only use the total sound power level. The octave sound power levels for various wind turbines are presented on **Figure 4-2**.

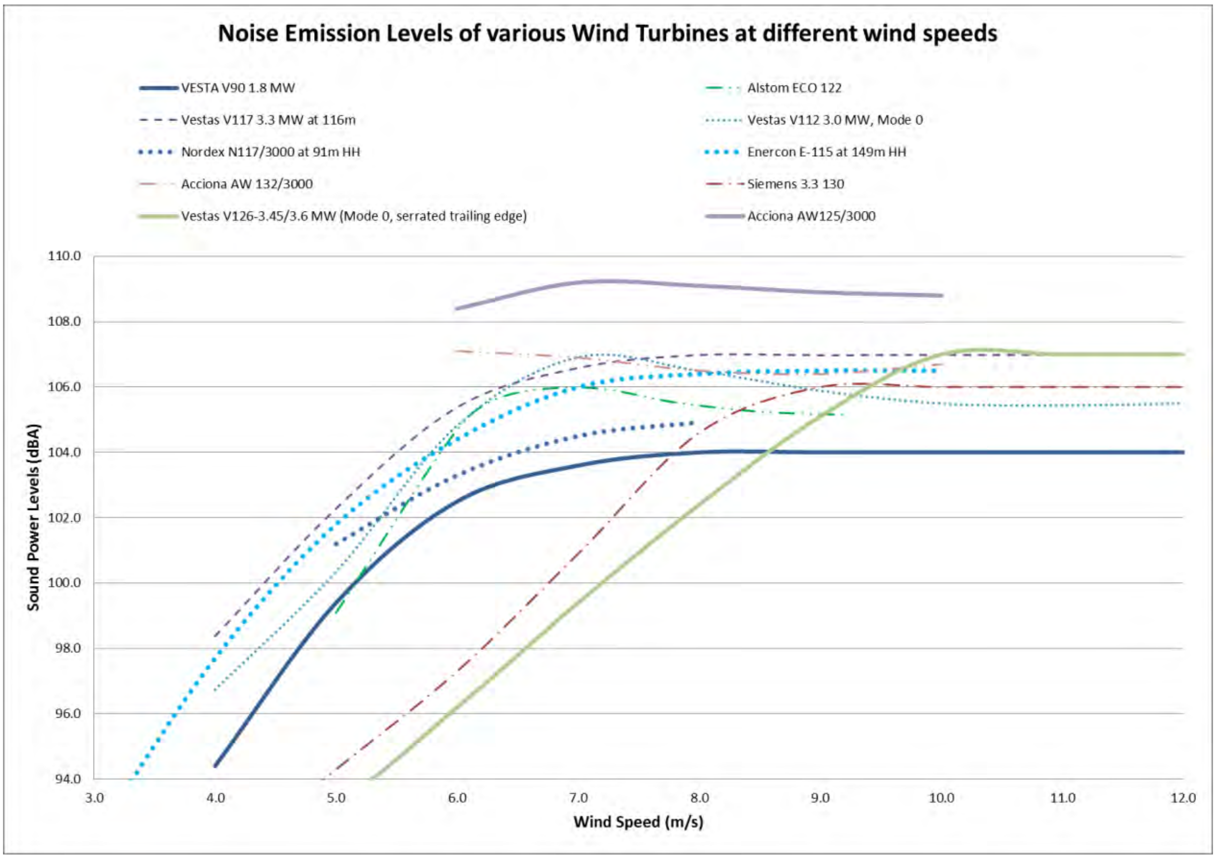

Figure 4-1: Noise Emissions Curve of a number of different wind turbines (figure for illustration purposes only)

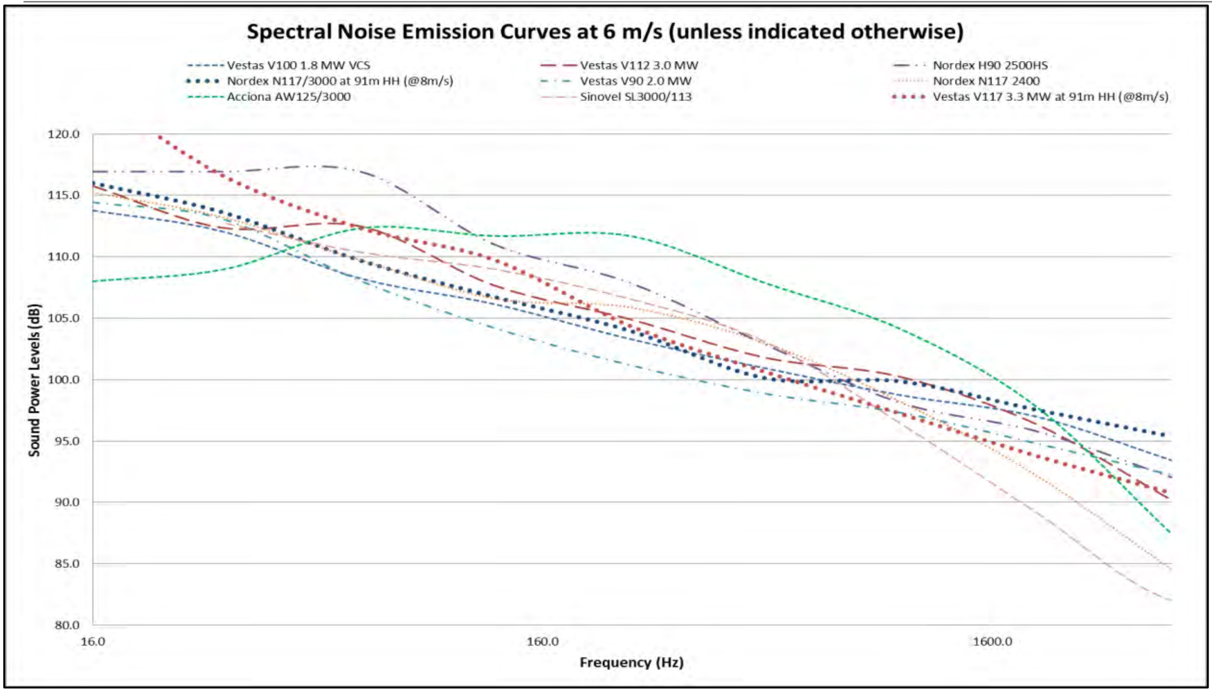

Figure 4-2: Octave sound power emissions of various wind turbines

4.2.1.1 Control Strategies to manage Noise Emissions during operation

Wind turbine manufacturers provide their equipment with control mechanisms to allow for a certain noise reduction during operation that can include:

- A reduction of rotational speed, and/or
- the increase of the pitch angle and/or reduction of nominal generator torque to reduce the angle of attack.

These mechanisms are used in various ways to allow the reduction of noise levels from the wind turbines, although this also results in a reduction of power generation.

4.2.2 Wind Turbine: Mechanical sources[16]

Mechanical noise is generally perceived within the emitted noise from wind turbines as an audible tone(s) that is subjectively more intrusive than a broad band noise of the same sound pressure level. Sources for this noise are generally associated with the gearbox and the tooth mesh frequencies of the step up stages; generator noise caused by coil flexure of the generator windings that is associated with power regulation and control; generator noise caused by cooling fans; and control equipment noise caused by hydraulic compressors for pitch regulation and yaw control.

[16] *Renewable Energy Research Laboratory, 2006; ETSU R97: 1996; Audiology Today, 2010; HGC Engineering, 2007*

Tones are noises with a narrow sound frequency composition (e.g. the whine of an electrical motor). Annoying tones can be created in numerous ways: machinery with rotating parts such as motors, gearboxes, fans and pumps often create tones. An imbalance or repeated impacts may cause vibration that, when transmitted through surfaces into the air, can be heard as tones. Pulsating flows of liquids or gases can also create tones, which may be caused by combustion processes or flow restrictions. The best and most well-known example of a tonal noise is the buzz created by a flying mosquito.

Where complaints have been received due to the operation of wind farms, tonal noise from the installed wind turbines appears to have increased the annoyance perceived by the complainants and indeed has been the primary cause for complaint.

However, tones were normally associated with the older models of turbines. All turbine manufacturers have started to ensure that sufficient forethought is given to the design of quieter gearboxes and the means by which these vibration transmission paths may be broken. Through the use of careful gearbox design and/or the use of anti-vibration techniques, it is possible to minimise the transmission of vibration energy into the turbine supporting structure.

The benefits of these design improvements have started to filter through into wind farm developments which are using these modified wind turbines. ***New generation wind turbine generators should not emit any clearly distinguishable tones***.

4.2.3 Transformer noises (Substations)

Also known as magnetostriction; this is when the sheet steel used in the core of the transformer tries to change shape when being magnetised. When the magnetism is taken away, the shape returns, only to try and deform in a different manner when the polarity is changed.

This deformation is not uniform; consequently it varies all over a sheet. With a transformer core being composed of many sheets of steel, these deformations are taking place erratically all over each sheet, and each sheet is behaving erratically with respect to its neighbour. The resultant is the "hum" frequently associated with transformers. While this may be a soothing sound in small home appliances, various complaints are logged in areas where people stay close to these transformers. At a voltage frequency of 50 Hz, these "vibrations" takes place 100 times a second, resulting in a tonal noise at 100 Hz. This is normally not an issue if the substation is further than 200 meters from a potentially sensitive receptor.

This is a relatively easy noise to mitigate with the use of acoustic shielding and/or placement of the transformer equipment and will not be considered further in the EIA study.

4.2.4 Transmission Line Noise (Corona noise)

Corona noise is caused by the partial breakdown of the insulation properties of air surrounding the conducting wires. It can generate an audible and radio-frequency noise, but generally only occurs in humid conditions as provided by fog or rain. A minimum line potential of 70 kV or higher is generally required to generate corona noise depending on the electrical design. Corona noise does not occur on domestic distribution lines.

Corona noise has two major components: a low frequency tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing', but fortunately it is generally only a feature during fog or rain.

It will not be further investigated, as corona discharges results in:

- Power losses
- Audible noises
- Electromagnetic interference
- A purple glow
- Ozone production
- Insulation damage

In addition this is associated with high voltage transmission lines, and not the lower voltage distribution lines proposed for construction by the developer.

As such, Electrical Service Providers (such as Eskom) go to great lengths to design power transmission equipment to minimise the formation of corona discharges. In addition, it is an infrequent occurrence with a relative short duration compared to other operational noises. At the relative low voltages proposed for this project Corona noises would not be an issue.

4.2.5 Low Frequency Noise[17]

4.2.5.1 Background and Information

Low frequency sound is the term used to describe sound energy in the region below ~200 Hz. The rumble of thunder and the throb of a diesel engine are both examples of sounds with most of their energy in this low frequency range. Infrasound is often used to describe sound energy in the region below 20 Hz.

Almost all noise in the environment has components in this region although they are of such a low level that they are not significant (wind, ocean, thunder). See also **Figure 4-3**, which indicates the sound power levels in the different octave bands from measurements taken at different wind speeds with no other audible noise sources. Sound that has most of its energy in the 'infrasound' range is only significant if it is at a very high level, far above normal environmental levels.

Low frequency noise from wind turbines has in the last few years become more prominent, with various studies and articles covering this subject.

4.2.5.2 The generation of Low Frequency Sounds

Due to the low rotational rates of the blades of a WTG as well as the size of these blades, significant acoustic energy is radiated by large wind turbines in the infrasonic range.

4.2.5.3 Detection of Low Frequency Sounds

The levels of infrasound radiated by the largest wind turbines are very low in comparison to other sources of acoustic energy in this frequency range such as sonic booms, shock waves from explosions, etc. The danger of hearing damage from wind turbine low-frequency emissions is non-existent. However, sounds in a frequency range less than 100 Hz can, under the right circumstances, be responsible for annoying nearby residents. However, except very near the source, most people outside cannot detect the presence of low-frequency noise from a wind turbine, and low-frequency noise from natural events (especially wind related) already exist all over and as illustrated in **Figure 4-3**.

It should be noted that a number of studies highlighted that these sounds are below the threshold of perception (BWEA, 2005), although this should be clarified. Most acousticians would agree that the low frequency sounds are inaudible to most people, yet, there are a

[17] *Renewable Energy Research Laboratory, 2006; DELTA, 2008; DEFRA, 2003; HGC Engineering, 2006; Whitford, Jacques, 2008; Noise-con, 2008; Minnesota DoH, 2009; Kamperman, 2008, Van den Berg, 2004; Bolin, 2011; Thorne, 2010; Ambrose, 2011;* Møller, 2010; O'Neal, 2011

number of studies that highlight that it can be more perceptible to people inside their houses as well as people that are more sensitive to low frequency sounds.

Thorne (2011) notes that;
"*Low frequency sound and infrasound are normal characteristics of a wind farm as they are the normal characteristics of wind, as such. The difference is that "normal" wind is laminar or smooth in effect whereas wind farm sound is non-laminar and presents a pulsing nature*."

Residents studied by Thorne often report that the low frequency sound is noticeably worse in their homes than it is outside[18].

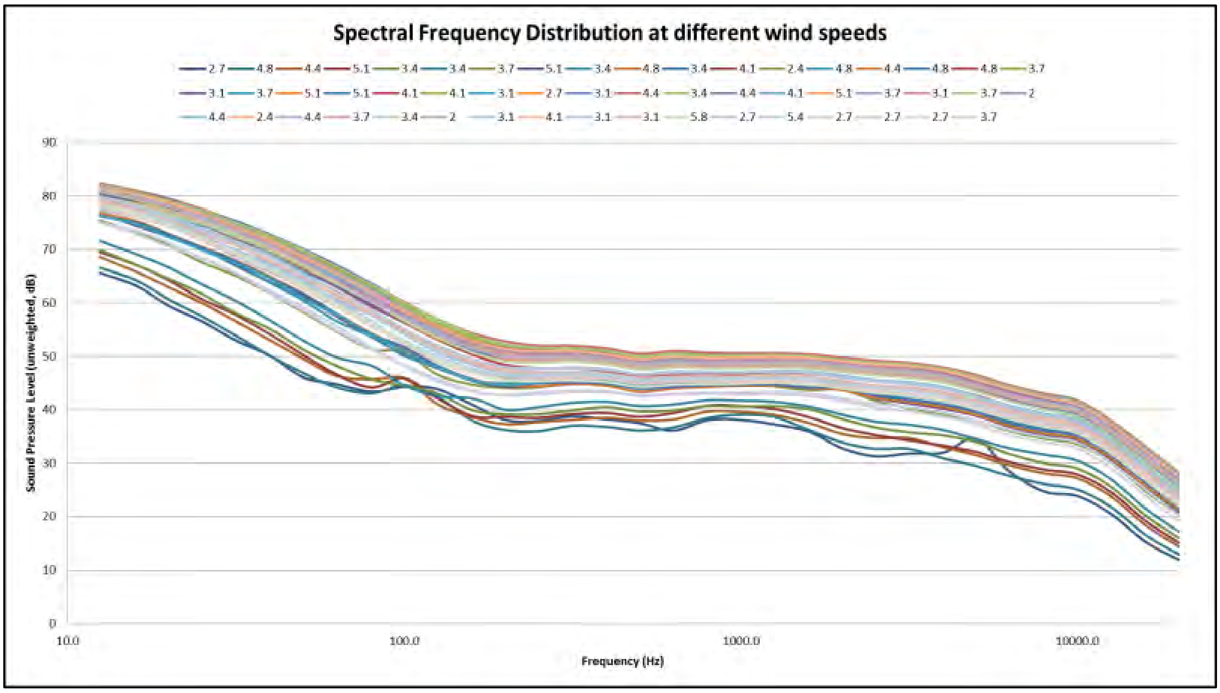

Figure 4-3: Third octave band sound power levels at various wind speeds at a location where wind induced noises dominate

4.2.5.4 Measurement, Isolation and Assessment of Low Frequency Sounds[19]

There remains significant debate regarding the noise from WTGs, public response to that noise, as well as the presence or not of low frequency sound and how it affects people. While low frequency sounds can be measured, it is far more difficult to isolate low frequency sounds due to the numerous sources that generate these sounds.

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18 *Hubbard, 1990; Thorne, 2010; Ambrose, 2011*
19 Hessler, 2011; James,

There isn't a standardised test, nor an assessment procedure available for the assessment of low frequency sounds, neither is there an accepted methodology on how low frequency sounds can be modelled or predicted. This is because low frequency sound can travel large distances, and are present all around us, with a significant component generated by nature itself (ocean, wind, etc.).

SANS 10103 proposes a method to identify whether low frequency noise could be an issue from an operating facility. It proposes that if the difference between the measured A-frequency weighted and the C-frequency weighted equivalent continuous ($L_{Aeq}>>L_{Ceq}$) sound pressure levels is greater than 10 dB, a predominant low frequency component **may** be present. However, in all cases existing acoustic energy in low frequencies associated with wind must be considered.

4.2.5.5 Summary: Low Frequency Noise[20]

Low frequency noise is always present around us as it is produced by both man and nature. While problems have been associated with older downwind wind turbines in the 1980s, this has been considered by the wind industry and modern upwind turbines do not suffer from the same problems. Low Frequency Noise however has been very controversial in the last few years with the anti-wind fraternity claiming measurable impacts, with governments and wind-energy supporter studies indicating no link between low-frequency sound and any health impacts. This study notes the various claims and as such follow a more precautious approach.

4.2.6 Amplitude modulation[21]

Although considered rare, there is one other characteristic of wind turbine sound that increases the sleep disturbance potential above that of other long-term noise sources. The amplitude modulation (AM) of the sound emissions from the wind turbines creates a repetitive rise and fall in sound levels synchronised to the blade rotation speed, sometimes referred to as a "swish" or "thump".

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[20] *BWEA, 2005*
[21] *Renewable Energy Research Laboratory, 2006; Audiology Today, 2010; HGC Engineering, 2007; Whitford, 2008; Noise-con, 2008; DEFRA, 2007; Bowdler, 2008; Smith (2012); Stigwood (2013); Tachibana (2013)*

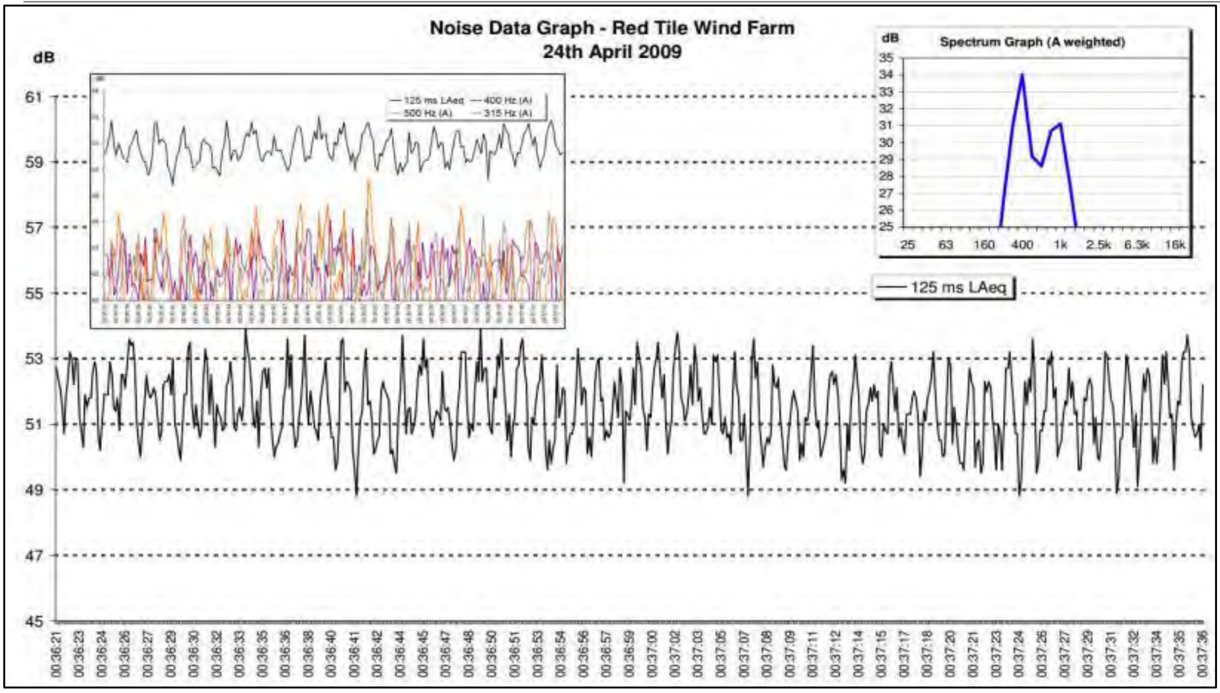

Figure 4-4: Example time-sound series graph illustrating AM as measured by Stigwood[22] (*et al*) (2013)

Pedersen (2003) highlighted a weak correlation between sound pressure level and noise annoyance caused by wind turbines. Residents complaining about wind turbines noise perceived more sound characteristics than noise levels. People were able to distinguish between background ambient sounds and the sounds the blades made. The noise produced by the blades lead to most complaints. Most of the annoyance was experienced between 16:00 and midnight. This could be an issue as noise propagation modelling would be reporting an equivalent, or "average" sound pressure level, a parameter that ignores the "character" of the sound.

The word map (**Figure 4-5**) below categorises some of the many terms used by affected residents to describe AM, including physical likeness of the sound and musical terms describing the character of AM.

[22] Stigwood (*et al*) (2013): "*Audible amplitude modulation – results of field measurements and investigations compared to psycho-acoustical assessments and theoretical research*"; Paper presented at the 5th International Conference on Wind Turbine Noise, Denver 28 – 30 August 2013

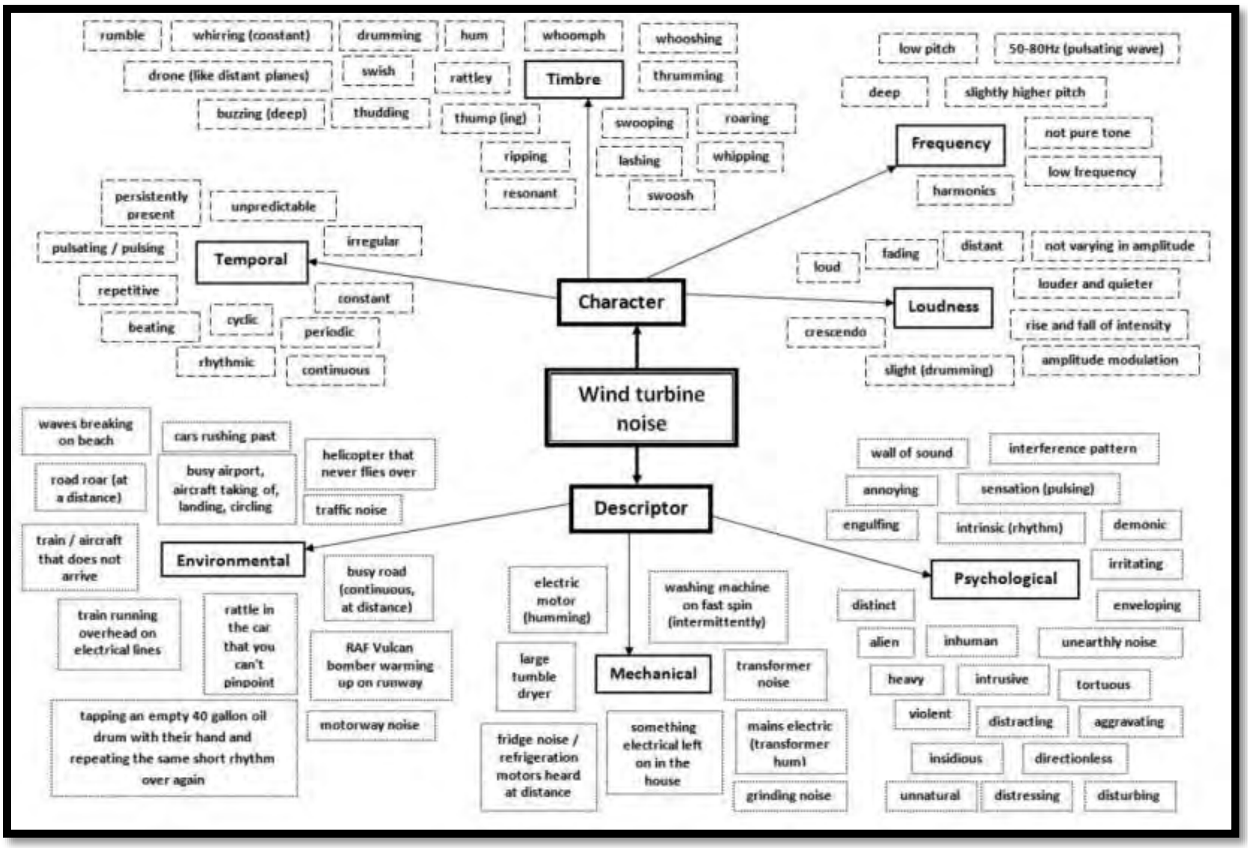

Figure 4-5: Word map of terms used to describe the sound of AM (source: Stigwood (*et al*) (2013))

The mechanism of amplitude modulated noises is not known although various possible reasons have been put forward. Although the prevalence of complaints about amplitude modulation is relatively small, it is not clear whether this is because it does not occur often enough or whether it is because housing is not in the right place to observe it. Furthermore, the fact that the mechanism is unknown means that it is not possible to predict when or whether it will occur.

Bowdler (2008) concludes that there are probably two distinct mechanisms in operation to create AM. The first is swish which is a function of the observers position relative to one turbine. The second is thump which is due to turbine blades passing through uneven air velocities as they rotate. In the second case the uneven air may be due to interaction of other turbines, excessive wind shear or topography. These two mechanisms are entirely separate though it is possible that they interact.

Stigwood (*et al*) (2013) also measured amplitude modulation at distances up to 1000 meters from the closest wind turbines at a number of wind farms in the United Kingdom and have summarized that:

- AM is more common than previously reported.
- AM should be measured during evening (after sunset), night time or early morning periods.
- Meteorological effects, such as atmospheric stability, which lead to downward refraction resulting from changes in the sound speed gradient alter the character and level of AM measured.
- AM is generated by all wind turbines including single turbines.
- Propagation conditions, mostly affected by meteorology and the occurrence of localised heightened noise zones determine locations that will be affected.
- Findings confirm that AM occurrence is frequent (at the eleven wind farms investigated) and can readily be identified in the field by measuring under suitable conditions and using appropriate equipment and settings.
- Audible features of AM including frequency content and periodicity vary both within and between wind farms.
- Noise character can differ considerably within a short time period. The constant change in AM character increases attention and cognitive appraisal and reappraisal, inhibiting acclimatisation to the sound.

That AM can be a risk and significantly increase the annoyance with wind energy facilities cannot be disputed. It has been reported with a number of recent studies confirming this significant noise characteristic. However, even though there is thousands of wind turbine generators in the world, amplitude modulation are still one subject receiving the least complaints and due to this very few complaints, little research went into this subject. Studies as recently as 2012 (Smith, 2012) highlight the need for additional studies and data collection.

However, because of these unknown factors (low frequency noises and AM), this noise study adopts a precautious stance and will consider the worst-case scenario.

4.2.7 Summary Conclusions on Wind Turbine Noise

Wind turbines do generate sound in both the inaudible and audible frequency range. However, the manner how this sound is perceived by people would range between people, communities as well as the surrounding environmental conditions in which they live. There are some studies[23] that shows correlations between noise annoyance and a dislike to the facility, with other studies showing a link between wind turbines and increased annoyance

[23] Gibbons, 2014; Crichton, 2014; Atkinson-Palmbo, 2014; Chapman, 2013; Pedersen, 2003.

levels[24]. Annoyance levels can be further subdivided into people that are annoyed by increased noise levels to the point where people report having to leave their houses to get relieve from the noise.

How widespread annoyance and health issues reports are, are yet to be defined, as there has not been an industry wide scientific study covering noise from wind turbines. Values of 5 – 15% appear to be the most cited, although it depends on the source (it must be reiterated that these are simply reports[25]).

A search on the internet identifies groups that scour the internet for studies, reports and articles about wind energy; some focusing on the positive stories yet others gathering everything mentioned about the negatives, unfortunately also reporting all the negatives as fact without considering all the data. There are numerous wind farms where there has been no noise complaints (a UK study suggest that about 20% of wind farms generated noise complaints, (Cummings, 2011), yet there has been no study assessing the differences between these wind farms.

Cummings (2012) also reports that:
"*it's notable that in ranching country, where most residents are leaseholders and many live within a quarter to half mile of turbines, health and annoyance complaints are close to non-existent; some have suggested that this is evidence of an antidote to wind turbine syndrome: earning some money from the turbines. More to the point, though, the equanimity with which turbine sound is accommodated in ranching communities again suggests that those who see turbines as a welcome addition to their community are far less likely to be annoyed, and thus to trigger indirect stress-related effects. Equally important to consider, ranchers who work around heavy equipment on a daily basis are also likely to be less noise sensitive than average, whereas people who live in the country for peace and quiet and solitude are likely more noise-sensitive than average. And, there are some indications that in flat ranching country, turbine noise levels may be more steady, less prone to atmospheric conditions that make turbines unpredictably louder or more intrusive. When considering the dozens of wind farms in the Midwest and west where noise complaints are minimal or non-existent, it remains true that the vast majority of U.S. wind turbines are built either far from homes or in areas where there is widespread tolerance for the noise they add to the local soundscape.*"

[24] Thorne, 2010; *Ambrose, 2011; Pierpont, 2009; Nissenbaum, 2012; Knopper, 2011; Kroesen, 2011; Philips, 2011; Shepherd, 2011a; Shepherd, 2011b; Pedersen, 2011; Wang, 2011; Cooper, 2012; McMurtry, 2011; Havas, 2011; Jeffery, 2013*

[25] Cummings, 2012

However, on the other hand, there are reports of significant annoyance (that can lead to increased stress levels that can result in other health problems or increase existing problems) from individuals and communities, frequently from people that value the rural quiet and sense of place.

Therefore, when assessing the potential noise impacts one has to consider:

- the complex characteristic of noise from wind turbines (numerous factors that are not yet fully understood);
- the numerous reports about noise impacts;
- the rural character and existing sense of place from a noise perspective;
- the recommendations from recognised acousticians.

The assessment methodology does consider these factors as discussed in the following section.

5 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

5.1 NOISE IMPACT ON ANIMALS[26]

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources.

Overall, the research suggests that species differ in their response to:

- Various types of noise;
- Durations of noise; and
- Sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- which species is exposed;
- whether there is one animal or a group; and
- whether there have been some previous exposures.

Unfortunately, there are numerous other factors in the environment of animals that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic. This hinders the ability to define the real impact of noise on animals.

From these and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate.
- Animals of most species exhibit adaptation with noise, including aircraft noise and sonic booms.
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate.
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals.

[26] Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010

5.1.1 Domestic Animals

It has been observed that most domestic animals are generally not bothered by noise, excluding most impulsive noises.

5.1.2 Wildlife

Studies showed that most animals adapt to noises, and would even return to a site after an initial disturbance, even if the noise is continuous. The more sensitive animals that might be impacted by noise would most likely relocate to a quieter area. Noise impacts are therefore very highly species dependent.

5.2 WHY NOISE CONCERNS COMMUNITIES[27]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered "disturbing". One can refer to a dripping tap in the quiet of the night, or the irritating "thump-thump" of the music from a neighbouring house at night when one would like to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to;

[27] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

5.3 IMPACT ASSESSMENT CRITERIA

5.3.1 Overview: The common characteristics

The word "noise" is generally used to convey a negative response or attitude to the sound received by a listener. There are four common characteristics of sound, any or all of which determine listener response and the subsequent definition of the sound as "noise". These characteristics are:

- Intensity;
- Loudness;
- Annoyance; and
- Offensiveness.

Of the four common characteristics of sound, intensity is the only one which is not subjective and can be quantified. Loudness is a subjective measure of the effect sound has on the human ear. As a quantity it is therefore complicated, but has been defined by experimentation on subjects known to have normal hearing.

The annoyance and offensive characteristics of noise are also subjective. Whether or not a noise causes annoyance mostly depends upon its reception by an individual, the environment in which it is heard, the type of activity and mood of the person and how acclimatised or familiar that person is to the sound.

5.3.2 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts considering the latest EIA Regulations, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 5-1**.

- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas. See also **Table 5-1**.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

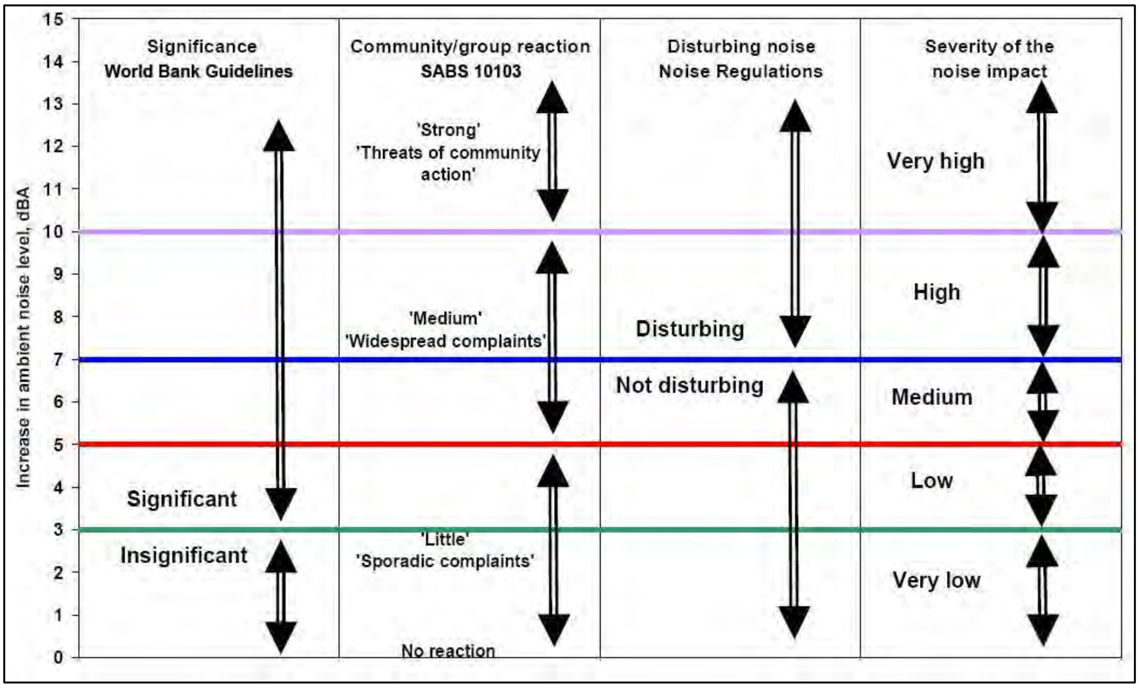

Figure 5-1: Criteria to assess the significance of impacts stemming from noise

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008 (See also **Table 5-1**). It provides the equivalent ambient noise levels (referred to as Rating Levels), $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed.

While acoustical measurements indicated an area where the ambient sound levels are slight higher than typically associated for a rural area, the potential noise impact will be evaluated in terms of (i.t.o.) the rural acceptable rating level as well as the IFC noise-limits as defined below:

- "Rural Noise Districts" (45 and 35 dBA day/night-time Rating i.t.o. SANS 10103:2008).
- "Equator principles" (55 and 45 dBA day/night-time limits i.t.o. IFC Noise Limits).

SANS 10103:2008 also provides a guideline for estimating community response to an increase in the general ambient noise level caused by an intruding noise. If Δ is the increase in sound level, the following criteria are of relevance:

- **Δ ≤ 3 dBA:** An increase of 3 dBA or less will not cause any response from a community. It should be noted that for a person with average hearing acuity an increase of less than 3 dBA in the general ambient noise level would not be noticeable.
- **3 < Δ ≤ 5 dBA:** An increase of between 3 dBA and 5 dBA will elicit 'little' community response with 'sporadic complaints'. People will just be able to notice a change in the sound character in the area.
- **5 < Δ ≤ 15 dBA:** An increase of between 5 dBA and 15 dBA will elicit a 'medium' community response with 'widespread complaints'. In addition, an increase of 10 dBA is subjectively perceived as a doubling in the loudness of a noise. For an increase of more than 15 dBA the community reaction will be 'strong' with 'threats of community action'.

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

Table 5-1: Acceptable Zone Sound Levels for noise in districts (SANS 10103:2008)

1	2	3	4	5	6	7
Type of district	Equivalent continuous rating level ($L_{Req.T}$) for noise dBA					
	Outdoors			Indoors, with open windows		
	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]	Day/night $L_{R,dn}$ [a]	Daytime $L_{Req,d}$ [b]	Night-time $L_{Req,n}$ [b]
a) Rural districts	45	45	35	35	35	25
b) Suburban districts with little road traffic	50	50	40	40	40	30
c) Urban districts	55	55	45	45	45	35
d) Urban districts with one or more of the following: workshops; business premises; and main roads	60	60	50	50	50	40
e) Central business districts	65	65	55	55	55	45
f) Industrial districts	70	70	60	60	60	50

5.3.3 Determining appropriate Zone Sound Levels

SANS 10103:2008 does not cater for instances when background ambient sound levels change due to the impact of external forces. Locations close (closer than 500 meters from coastline) from the sea for instance always has an ambient sound level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not considered in the SANS standard.

Setting noise limits relative to the ambient sound level is relatively straightforward when the prevailing ambient sound level and source level are constant. However, wind turbines only start to operate when wind speeds exceed 3 m/s. Noise emissions therefore relates to the wind speed and similarly, the environment in which they are heard also depends upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive an ambient sound level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the ambient sound level in the same wind conditions.

5.3.3.1 Using International Guidelines to set Noise Limits

When assessing the overall noise levels emitted by a Wind Energy Facility, it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5 m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35 m/s measured at the hub height of a wind turbine. However, ETSU-R97 (1996) proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12 m/s at 10 m height;
2. Reliable measurements of background ambient sound levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced;
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons; and
4. If a wind farm meets noise limits at wind speeds lower than 12m/s, it is most unlikely to cause any greater loss of amenity at higher wind speeds. Turbine noise levels increase only slightly as wind speeds increase; however, background ambient sound levels increase significantly with increasing wind speeds due to the force of the wind.

Ambient sound vs. wind speed data is presented in **Figure 5-2**[28]. This is a quiet (as per the opinion of the author) location[29] where there were no apparent or observable sounds that would have impacted on the measurements, presenting the A-Weighted sound levels at an inland area. The figures clearly indicate a trend where sound levels increase if the wind speed increases. This has been found at all locations where measurements have been done for a sufficiently long enough period of time (more than 30 locations – more than 38,000 measurements).

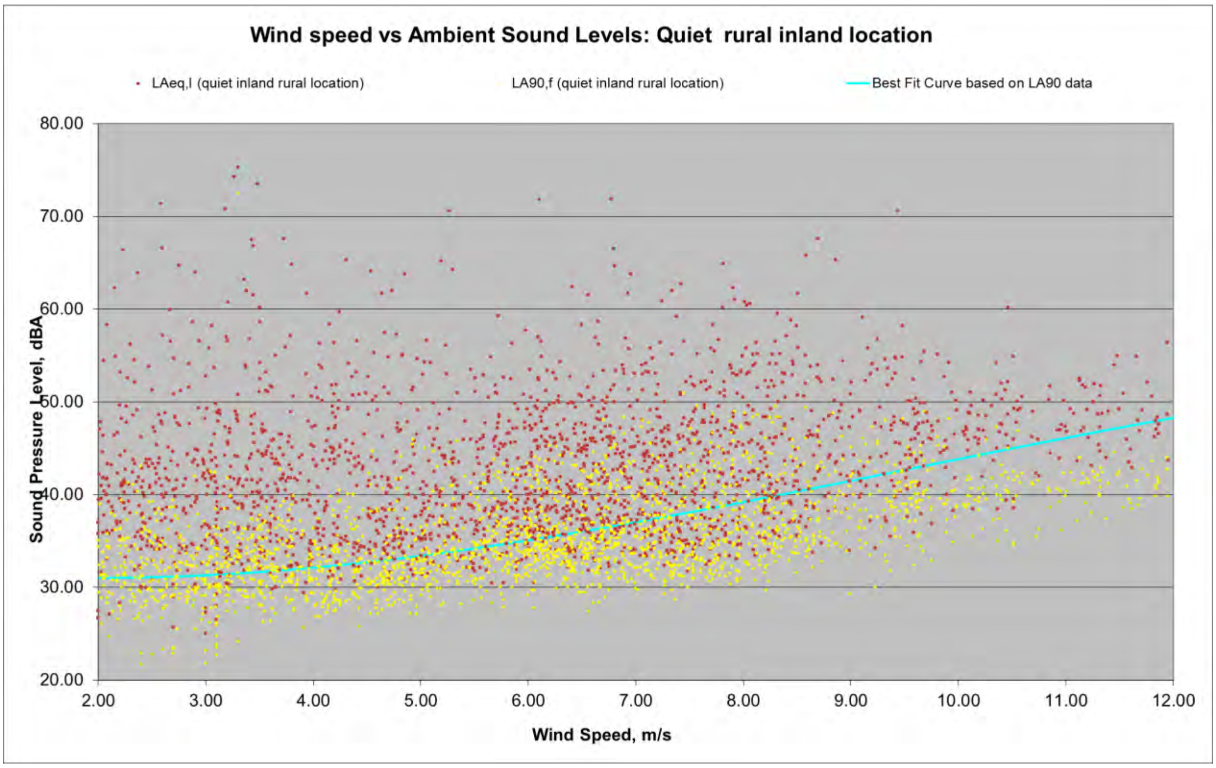

Figure 5-2: Ambient sound levels – quiet inland location (A-Weighted)

Considering this data as well as the international guidelines (IFC, see **2.6.6**; MOE, see **Section 2.6**), noise limits starting at 40 dB that increases to more than 45 dB (as wind speeds increase) is acceptable. It does not state daytime limits.

In addition, project participants could be exposed to noise levels up to 45 dBA (ETSU-R97) at lower wind speeds.

[28] The sound level measuring instruments were located at a quiet location in the garden of the various houses. Data was measured in 10-minute bins and then co-ordinated with the 10 m wind speed derived from the wind mast of the developer. This wind mast normally was not close to the dwelling, at times being further than 5,000 meters from the measurement location. It is possible that the wind may be blowing at the location of the wind mast with no wind at the measurement location, resulting in low sound levels recorded.

[29] Different area where longer measurements were collected.

5.3.3.2 Using local regulations to set noise limits

Noise limits as set by the National Noise Control Regulations (GN R154 of 1992 - **section 2.2.1**) as well as the Western Cape Provincial Noise Control Regulations (PN.20 of 2013 – **section 2.2.2**) defines a "**disturbing noise**" as the noise that —
- exceeds the rating level by 7 dBA;
- exceeds the residual noise level (where the residual noise level is higher than the rating level);
- exceeds the residual noise level by 3 dBA where the residual noise level is lower than the rating level (Western Cape); or
- in the case of a low-frequency noise, exceeds the level specified in Annex B of SANS 10103;

Accepting that the area is a rural district, night-time rating levels would be 35 dBA and a noise level exceeding 42 dBA could be a disturbing noise (therefore the noise limit). The daytime rating level is 45 dBA (52 dBA for a disturbing noise).

5.3.4 Other Factors that must be considered for Wind Energy Facilities

5.3.4.1 Relationship between wind speed at different levels and noise at ground level

Generally, as the height above ground level increases, wind speed also increases. For acoustical purposes prediction of the wind speed at hub height is based on the wind speed v_{ref} at the reference height (normally 10 meters) for wind speed measurements, extrapolated to a wind speed v_h at hub height, using the widely used formula:

$$v_h = v_{ref} \times \frac{\log\left(h/m\right)}{\log\left(h_{ref}/m\right)}$$

However, depending on topographical layout, this relationship may not be true at all times. Authors such as Van den Berg (2003) indicated that wind speeds at hub height could be significantly higher than expected, at the same time being significantly higher than ground level wind speeds. In these cases, the wind turbines are operational and emitting noise, yet the wind induced ambient sound levels is less than expected (less masking of turbine noise).

This should be considered when evaluating the significance of the impact, especially when the wind turbines are situated on a hill, with the prevailing wind direction being in the direction of potential sensitive receptors living in a valley downwind of the wind energy facility. It is proposed by this author that the precautionary approach be considered, and when there is one or more turbine within 1,000 metres from a downwind receptor(s), that the probability of this impact occurring be elevated with at least one step/factor (e.g. from ***Likely*** to ***Highly Likely***).

Similarly, if the area frequently experience weather phenomena such as temperature inversion[30], the developer should consider this. Generally, this information is site specific and not available for remote areas and as a result it is difficult to consider in this study.

5.3.4.2 Annoyance associated with Wind Energy Facilities[31]

Annoyance is the most widely acknowledged effect of environmental noise exposure, and is considered to the most widespread. It is estimated that less than a third of the individual noise annoyance is accounted for by acoustic parameters, and that non-acoustic factors plays a major role. Non-acoustic factors that have been identified include age, economic dependence on the noise source, attitude towards the noise source and self-reported noise sensitivity.

On the basis of a number of studies into noise annoyance, exposure-response relationships were derived for high annoyance from different noise sources. These relationships, illustrated in **Figure 5-3**, are recommended in a European Union position paper published in 2002, stipulating policy regarding the quantification of annoyance.

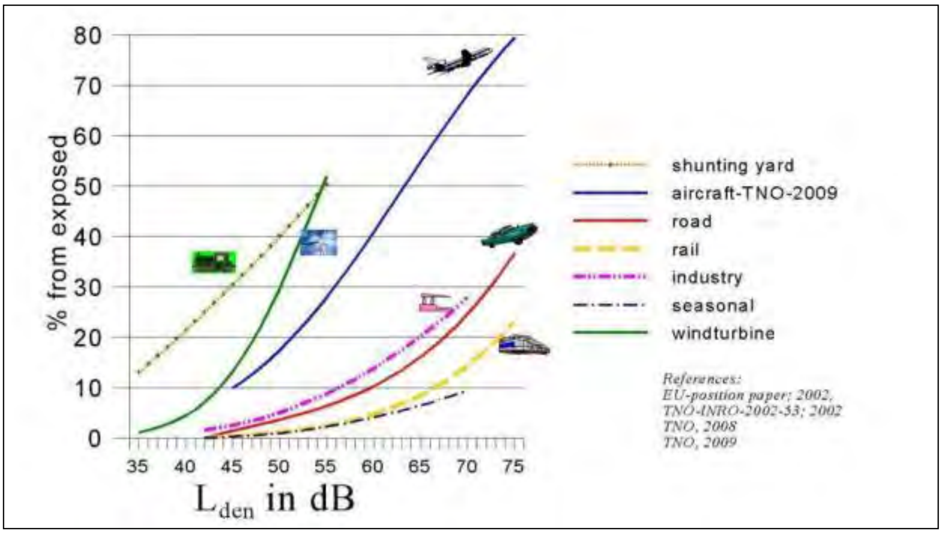

Figure 5-3: Percentage of annoyed persons as a function of the day-evening-night noise exposure at the façade of a dwelling

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[30]http://en.wikipedia.org/wiki/Inversion_(meteorology)
[31]Van den Berg, 2011; Milieu, 2010.

This can be used in Environmental Health Impact Assessment and cost-benefit analysis to translate noise maps into overviews of the numbers of persons that may be annoyed, thereby giving insight into the situation expected in the long term. It is not applicable to local complaint type situations or to an assessment of the short-term effects of a change in noise climate.

5.3.5 Other noise sources of significance

In addition, other noise sources that may be present should also be considered. During the day, people are generally bombarded with the sounds from numerous sources considered "normal", such as animal sounds, conversation, amenities and appliances (TV/Radio/CD playing in background, computer(s), freezers/fridges, etc.). This excludes activities that may generate additional noise associated with normal work.

At night, sounds that are present are natural sounds from animals, wind as well as other sounds we consider "normal", such as the hum from a variety of appliances (magnetostriction) drawing standby power, freezers and fridges.

5.3.6 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria.

The significance of environmental impacts is a function of the environmental aspects that are present and to be impacted on, the probability of an impact occurring and the consequence of such an impact occurring before and after implementation of proposed mitigation measures.

For such purposes each aspect was assigned a value as defined in the third column in the tables below.

5.3.6.1 Extent (spatial scale) of impact

L	M	H
Impact is localized within site boundary	Widespread impact beyond site boundary; Local	Impact widespread far beyond site boundary; Regional/national

Factors with regards to extent that will be considered include:

- Access to resources (amenity);
- Threats to lifestyles, traditions and values; and

- Cumulative impacts, including possible changes to land uses at and around the site.

5.3.6.2 Duration of noise impact

L	M	H
Quickly reversible, less than project life, short term (0-5 years)	Reversible over time; medium term to life of project	Long term; beyond closure; permanent; irreplaceable or irretrievable commitment of resources

Factors with regards to extent that will be considered include the cost – benefit, both economically and socially (e.g. long or short term costs/benefits).

5.3.6.3 Intensity (severity or magnitude) of noise impact

Type of Criteria	Negative noise impact		
	H-	**M-**	**L-**
Qualitative	Substantial deterioration, death, illness or injury, loss of habitat/diversity or resource, severe alteration or disturbance of important processes.	Moderate deterioration, discomfort, Partial loss of habitat/biodiversity/resource or slight or alteration	Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration.
Quantitative	Measurable deterioration, recommended level will often be violated (e.g. pollution)	Measurable deterioration, recommended level will occasionally be violated	No measurable change; Recommended level will never be violated
Community response	Vigorous	Widespread complaints	Sporadic complaints

Type of Criteria	Positive noise impact		
	L+	**M+**	**H+**
Qualitative	Minor improvement, restoration, improved management	Moderate improvement, restoration, improved management, substitution	Substantial improvement, substitution
Quantitative	No measurable change; Within or better than recommended level.	Measurable improvement	Measurable improvement
Community response	No observed reaction	Some support	Favourable publicity

Factors with regards to intensity that will be considered include:

- Cost – benefit economically and socially (e.g. high net cost = substantial deterioration);
- Impacts on human-induced climate change;

- Impacts on future management (e.g. easy/practical to manage with change or recommendation).

5.3.6.4 Probability of occurrence:

L	**M**	**H**
Unlikely; low likelihood; Seldom. No known risk or vulnerability to natural or induced hazards.	Possible, distinct possibility, frequent. Low to medium risk or vulnerability to natural or induced hazards.	Definite (regardless of prevention measures), highly likely, continuous. High risk or vulnerability to natural or induced hazards.

5.3.6.5 Significance of noise impact

Based on a synthesis of the information contained in sub-sections **5.3.6.1** to **5.3.6.4** above, it will be possible to calculate a significance of the potential noise impacts in terms of the following criteria:

Significance: (Duration X Extent X Intensity)

Intensity = Low				
Duration	**H**			
	M			Medium
	L	Low		
Intensity = Medium				
Duration	**H**			High
	M		Medium	
	L	Low		
Intensity = High				
Duration	**H**			
	M			High
	L	Medium		
		L	M	H
		Extent		

Positive impacts would be ranked in the same way as negative impacts, but result in high, medium or low positive consequence.

5.4 REPRESENTATION OF NOISE LEVELS

Noise rating levels will be calculated in the ENIA report using the appropriate sound propagation models as defined. It is therefore important to understand the difference between sound or noise level as well as the noise rating level (also see Glossary of Terms, **Appendix A**).

Sound or noise levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In the ENIA it will be used to illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time.

6 ASSUMPTIONS AND LIMITATIONS

6.1 MEASUREMENTS OF AMBIENT SOUND LEVELS

- Ambient sound levels are the cumulative effects of innumerable sounds generated at various instances both far and near. High measurements may not necessarily mean that noise levels in the area are high. Similarly, a low sound level measurement will not necessarily mean that the area is always quiet, as sound levels will vary over seasons, time of the day, faunal characteristics, vegetation in the area and meteorological conditions (especially wind). This is excluding the potential effect of sounds from anthropogenic origin. It is impossible to quantify and identify the numerous sources that influenced one 10-minute measurement using the reading result at the end of the measurement. Therefore trying to define ambient sound levels using the result of one 10-minute measurement will be very inaccurate (very low confidence level in the results) for the reasons mentioned above. The more measurements that can be collected at a location the higher the confidence levels in the ambient sound level determined. The more complex the sound environment, the longer the required measurement. It is assumed that the measurement locations represents other residential dwellings in the area (similar environment), yet, in practice this can be highly erroneous as there are numerous factors that can impact on ambient sound levels, including;
  - the distance to closest trees, number and type of trees as well as the height of trees;
  - available habitat and food for birds and other animals;
  - distance to residential dwelling, type of equipment used at dwelling (compressors, air-cons);
  - general maintenance condition of house (especially during windy conditions); and
  - a number and type of animals kept in the vicinity of the measurement locations.
- Measurement locations for this project were selected to be in a relative quiet area, away from the residential dwelling to minimize the potential of extraneous noises impacting on the ambient sound levels,
- Exact location of a sound level meter in an area in relation to structures, infrastructure, vegetation and external noise sources will influence measurements. It may determine whether one is measuring anthropogenic sounds from a receptors dwelling, or environmental ambient soundscape contributors of significance (faunal, roads traffic, railway line movement etc.). At times there are extraneous noises that

cannot be heard during deployment, or not operational, that can significantly impact on readings (such as water pumps, transformers, faunal communication, etc.);

- Determination of existing road traffic and other noise sources of significance are important (traffic counts etc.) – when close to any busy or significant roads. Traffic however is highly dependent on the time of day as well as general agricultural activities taking place during the site investigation. Traffic noise is one of the major components in urban areas and could be a significant source of noise during busy periods. This study found that traffic in the area was very low, yet it cannot be assumed that it is always low.
- Measurements over wind speeds of 3 m/s could provide data influenced by wind-induced noises. While the windshields used limits the effect of fluctuating pressure across the microphone diaphragm, the effect of wind-induced noises in the trees in the vicinity of the microphone did impact on the ambient sound levels. The site visit unfortunately coincided with a relatively windy period;
- Ambient sound levels are depended not only time of day and meteorological conditions, but also change due to seasonal differences. Ambient sound levels are generally higher in summer months when faunal activity is higher and lower during the winter due to reduced faunal activity. Winter months unfortunately also coincide with lower temperatures and very stable atmospheric conditions, ideal conditions for propagation of noise. Many faunal species are more active during warmer periods than colder periods. Certain cicada species can generate noise levels up to 120 dB for mating or distress purposes, sometimes singing in synchronisation magnifying noise levels they produce from their tymbals[32];
- Ambient sound levels recorded near rivers, streams, wetlands, trees and bushy areas can be high. This is due to faunal activity which can dominate the sound levels around the measurement location. This generally is still considered naturally quiet and understood and accepted as features of the natural soundscape, and in various cases sought after and pleasing;
- Considering one or more sound descriptor or equivalent can improve an acoustical assessment. Parameters such as L_{AMin}, L_{AIeq}, L_{AFeq}, L_{Ceq}, L_{AMax}, L_{A10}, L_{A90} and spectral analysis forms part of the many variables that can be considered; and
- As a residential area develops the presence of people will result in increased sounds. These are generally a combination of traffic noise, voices, animals and equipment (incl. TV's and Radios). The result is that ambient sound levels will increase as an area matures.

[32] Clyne, D. *"Cicadas: Sound of the Australian Summer, Australian Geographic"* Oct/Dec Vol 56. 1999.

6.2 CALCULATING NOISE EMISSIONS ADEQUACY OF PREDICTIVE METHODS

The noise emissions into the environment from the various sources as defined will be calculated for the operational phase in detail, using the sound propagation model described in ISO 9613-2.

The following was considered:

- The octave band sound pressure emission levels of processes and equipment;
- The distance of the receiver from the noise sources;
- The impact of atmospheric absorption;
- The operational details of the proposed project, such as projected areas where activities will be taking place;
- Topographical layout,
- Acoustical characteristics of the ground. 50% soft ground conditions were modelled, as the area where the activity would be taking place is acceptably vegetated and sufficiently uneven to allow the consideration of relatively soft ground conditions. This is because the use of hard ground conditions could represent a too precautionary situation.

The noise emission into the environment due to additional traffic will be calculated using the sound propagation model described in SANS 10210. Corrections such as the following will be considered:

- Distance of receptor from the road;
- Road construction material;
- Average speeds of travel;
- Types of vehicles used;
- Ground acoustical conditions

It is important to understand the difference between sound or noise level as well as the noise rating level (also see Glossary of Terms).

Sound or noise levels generally refers to a sound pressure level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In this project it illustrates the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time. It is used to define potential issues of concern and not to predict a noise level at a potential noise-sensitive receptor. For this the selected model is internationally recognised and considered adequate.

6.3 ADEQUACY OF UNDERLYING ASSUMPTIONS

Noise experienced at a certain location is the cumulative result of innumerable sounds emitted and generated both far and close, each in a different time domain, each having a different spectral character at a different sound level. Each of these sounds are also impacted differently by surrounding vegetation, structures and meteorological conditions that result in a total cumulative noise level represented by a few numbers on a sound level meter.

As previously mentioned, it is not the purpose of noise modelling to accurately determine a likely noise level at a certain receptor, but to calculate a noise rating level that is used to identify potential issues of concern.

6.4 UNCERTAINTIES ASSOCIATED WITH MITIGATION MEASURES

Any noise impact can be mitigated to have a low significance, however, the cost of mitigating this impact may be prohibitive, or the measure may not be socially acceptable (such as the relocation of a NSD), or the mitigation may result in the project not being economically viable. These mitigation measures may be engineered, technological or due to management commitment.

For the purpose of the EIA (determination of the significance of the noise impact) mitigation measures will be selected that is feasible, mainly focussing on management of noise impacts using rules, policy and require a management commitment. This however does not mean that noise levels cannot be reduced further, only that to reduce the noise levels further may require significant additional costs (whether engineered, technological or management).

It will be assumed the mitigation measures proposed for the construction phase were implemented and continued during the operational phase.

6.5 UNCERTAINTIES OF INFORMATION PROVIDED

While it is difficult to define the character of a measured noise in terms of numbers (third octave sound power levels in this case), it is as difficult to accurately model noise levels at a receptor from any operation. The projected noise levels are the output of a numerical model with the accuracy depending on the assumptions made during the setup of the model. Assumptions include:

- The octave sound power levels selected for processes and equipment accurately represent the sound character and power levels of this processes/equipment. The determination of these levels in itself is subject to errors, limitations and assumptions with any potential errors carried over to any model making use of these results;
- Sound power emission levels from processes and equipment change depending on the load the process and equipment is subject too. While the octave sound power level is the average (equivalent) result of a number of measurements, this measurement relates to a period that the process or equipment was subject to a certain load. Normally these measurements are collected when the process or equipment is under high load. The result is that measurements generally represent a worst-case scenario;
- As it is unknown which processes and equipment will be operational (and when operational and for how long), modelling considers a scenario where all processes and equipment are under full load for a set time period. Modelling assumptions comply with the precautionary principle and operational time periods are frequently overestimated. The result is that projected noise levels would likely over-estimate noise levels;
- Ambient sound levels vary over time of day, season and largely depend on the complexity and development character of the surrounding environment. To allow the calculation of change in ambient sound levels, a potential ambient sound level of 35 dBA is assumed. This level represents a quiet environment;
- Modelling cannot capture the potential impulsive character of a noise that can increase the potential nuisance factor;
- The impact of atmospheric absorption is simplified and very uniform meteorological conditions are considered. This is an over-simplification and the effect of this in terms of sound propagation modelling is difficult to quantify; and
- Acoustical characteristics of the ground are over-simplified with ground conditions accepted as uniform. 75% hard ground conditions will be modelled even though the area is where the facility will be located is relatively well vegetated and uneven, this will allow a more worst-case scenario.

7 PROJECTED NOISE RATING LEVELS

7.1 CURRENT NOISE LEVELS (CONCEPTUAL)

The Ambient sound levels were low and the area is considered naturally quiet. It is too far from any roads or any other significant noise sources to consider the potential cumulative impacts. As the night-time environment is of interest other activities in the area are highly unlikely to influence night-time sound levels. The larger project area is considered to have a sound character typical of a rural noise district.

7.2 PROPOSED CONSTRUCTION PHASE NOISE IMPACT

This section investigates the conceptual construction activities as discussed in **section 4.1**. Construction activities are highly dependent on the final operational layout. The two layouts as provided by the developer for the two WEFs are presented in **Figure 7-1** (Alternative layouts) and **Figure 7-2** (Preferred layouts). As can be seen from these layouts, a number of different activities might take place close to potentially sensitive receptors, each with a specific potential impact.

7.2.1 Description of Construction Activities Modelled

The following construction activities could take place simultaneously and were considered:

- General work at a temporary workshop area. This would be activities such as equipment maintenance, off-loading and material handling. All vehicles will travel to this site where most equipment and material will be off-loaded (general noise, crane). Material, such as aggregate and building sand, will be taken directly to the construction area (foundation establishment). It was assumed that activities will be taking place for 16 hours during the 16 hour daytime period.
- Surface preparation prior to civil work. This could be the removal of topsoil and levelling with compaction, or the preparation of an access road (bulldozer/grader). Activities will be taking place for 8 hours during the 16 hour daytime period.
- Preparation of foundation area (sub-surface removal until secure base is reached – excavator, compaction, and general noise). Activities will be taking place for 10 hours during the 16 hour daytime period.
- Pouring and compaction of foundation concrete (general noise, electric generator/compressor, concrete vibration, mobile concrete plant, TLB). As foundations must be poured in one go, the activity is projected to take place over the full 16 hour day time period.

- Erecting of the wind turbine generator (general noise, electric generator/compressor and a crane). Activities will be taking place for 16 hours during the 16 hour daytime period.
- Traffic on the site (trucks transporting material, aggregate/concrete, work crews) moving from the workshop/store area to the various activity sites. All vehicles to travel at less than 60 km/h, with a maximum of five (5) trucks and vehicles per hour to be modelled travelling to the areas where work is taking place (red line).

There will be a number of smaller equipment, but the addition of the general noise source (at each point) covers most of these noise sources. It is assumed that all equipment would be operating under full load (generate the most noise) at a number of locations and that atmospheric conditions would be ideal for sound propagation. This is likely the worst case scenario that can occur during the construction of the facility.

As it is unknown where the different activities may take place it was selected to model the impact of the noisiest activity (laying of foundation totalling 113.6 dBA cumulative noise impact – various equipment operating simultaneously) at all locations (over the full daytime period of 16 hours) where wind turbines (or power pylons) may be erected for both layouts, calculating how this may impact on potential noise-sensitive developments (see **Figure 7-3** and **Figure 7-4**). Noise created due to linear activities (roads) were also evaluated and plotted against distance as illustrated in **Figure 7-5**[33].

Even though construction activities are projected to take place only during day time, it might be required at times that construction activities take place during the night (particularly for a large project). Construction activities that may occur during night time:

- Concrete pouring: Large portions of concrete do require pouring and vibrating to be completed once started, and work is sometimes required until the early hours of the morning to ensure a well-established concrete foundation. However the work force working at night for this work will be considerably smaller than during the day.
- Working late due to time constraints: Weather plays an important role in time management in construction. A spell of bad weather can cause a construction project to fall behind its completion date. Therefore, it is hard to judge beforehand if a construction team would be required to work late at night.

[33] Sound level at a receiver set at a certain distance from a road – 10 trucks per hour gravel and tar roads

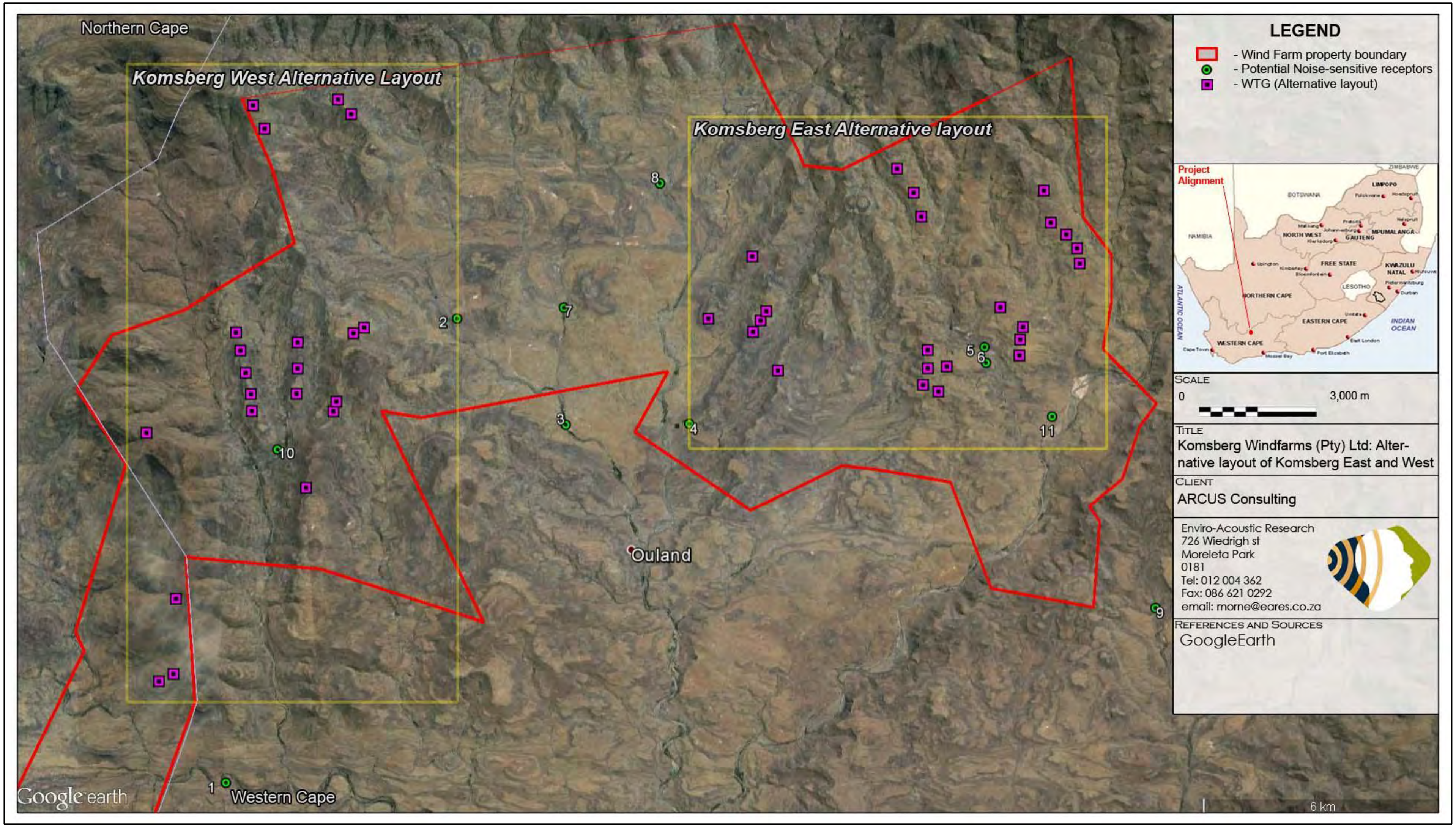

Figure 7-1: Wind Turbine Locations – Alternative layout, both Komsberg East and West WEF's

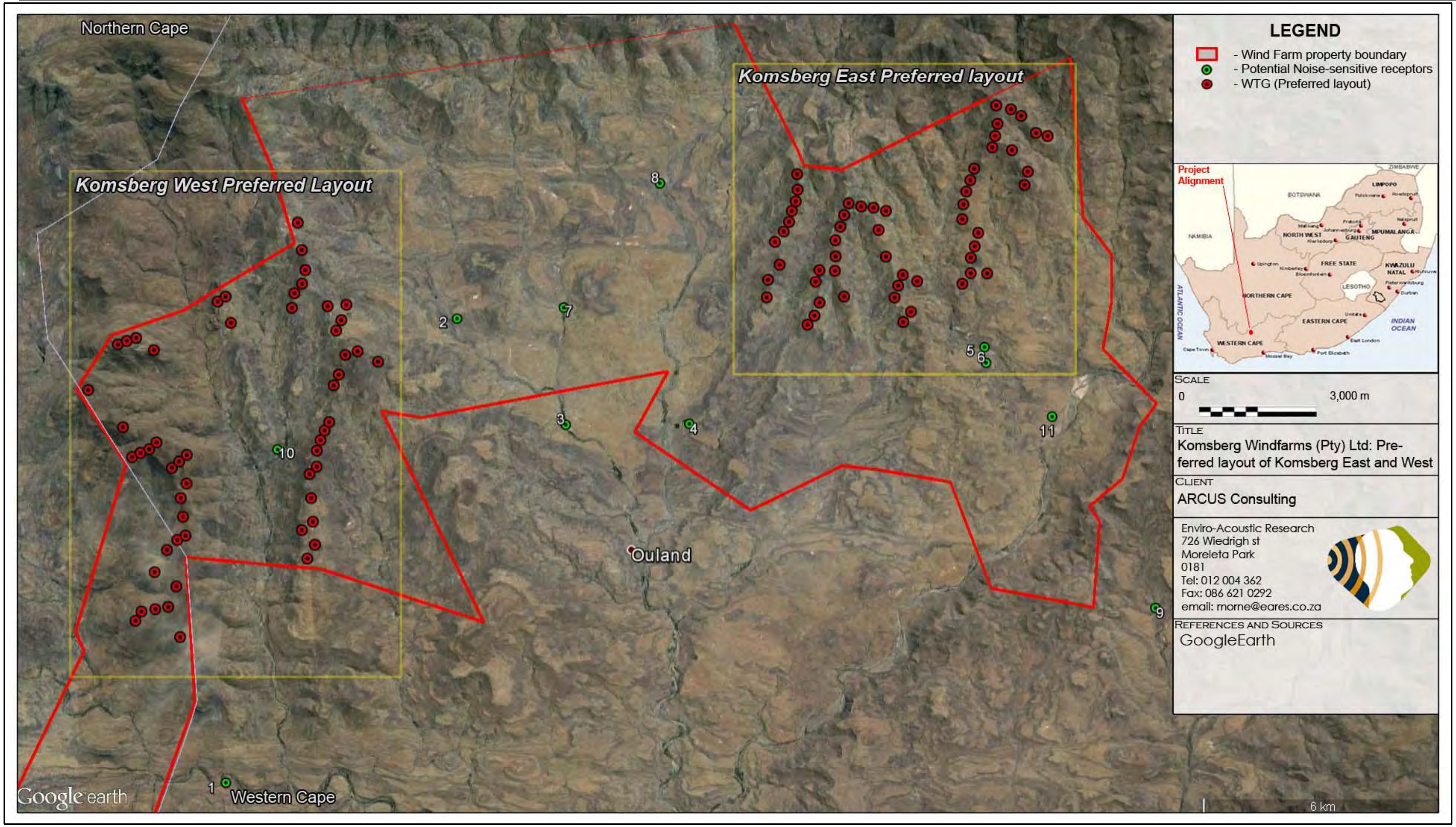

Figure 7-2: Wind Turbine Locations – Preferred layout, both Komsberg East and West WEF's

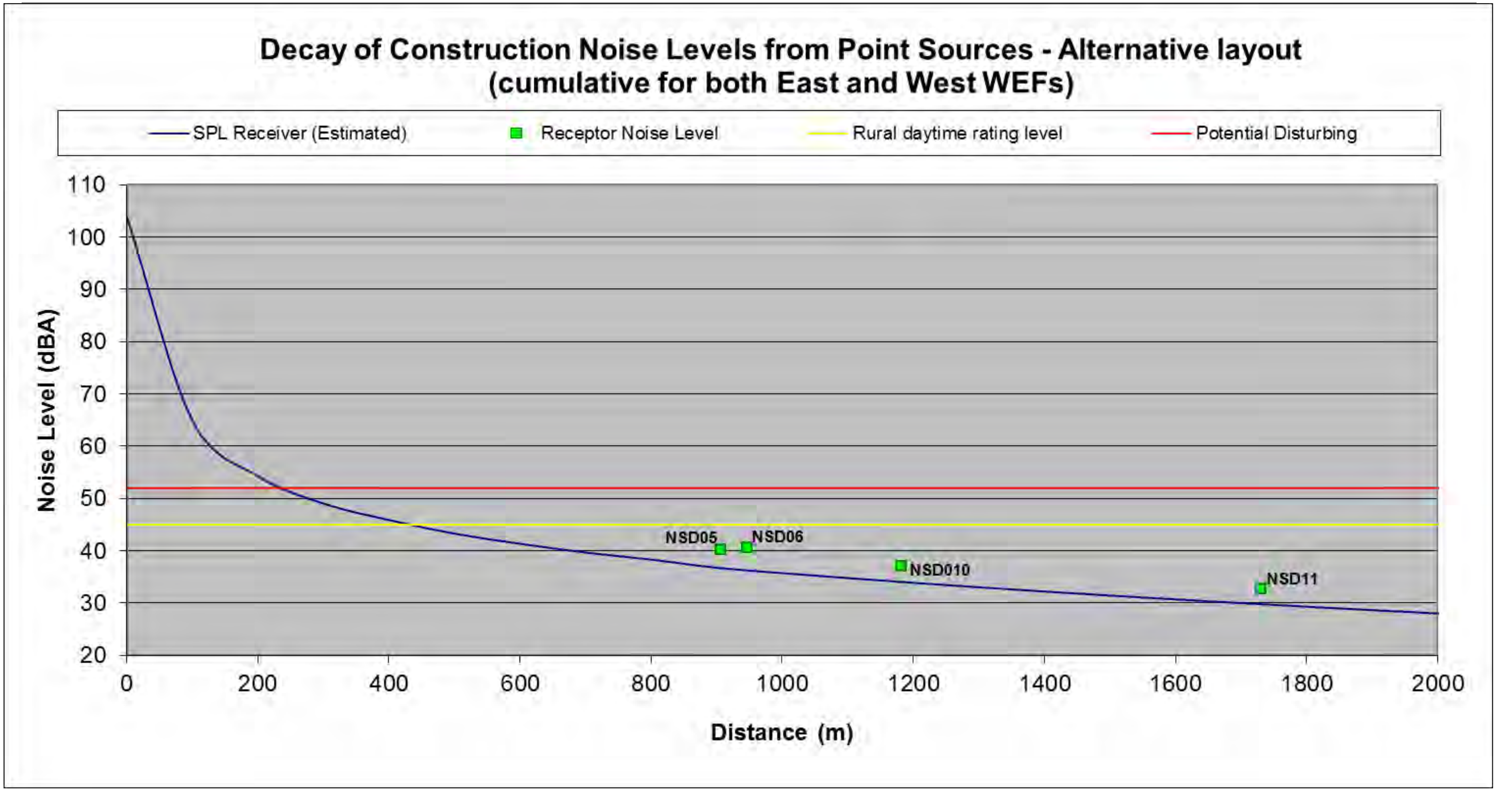

Figure 7-3: Projected conceptual construction noise levels[34] – Decay of noise from construction activities (Alternative Layout)

[34] The SPL Receiver graph can also be used for the construction of the overhead power line to allow connection to the ESKOM grid. Any activities further than 500 m from any receiver will have a noise impact of low significance.

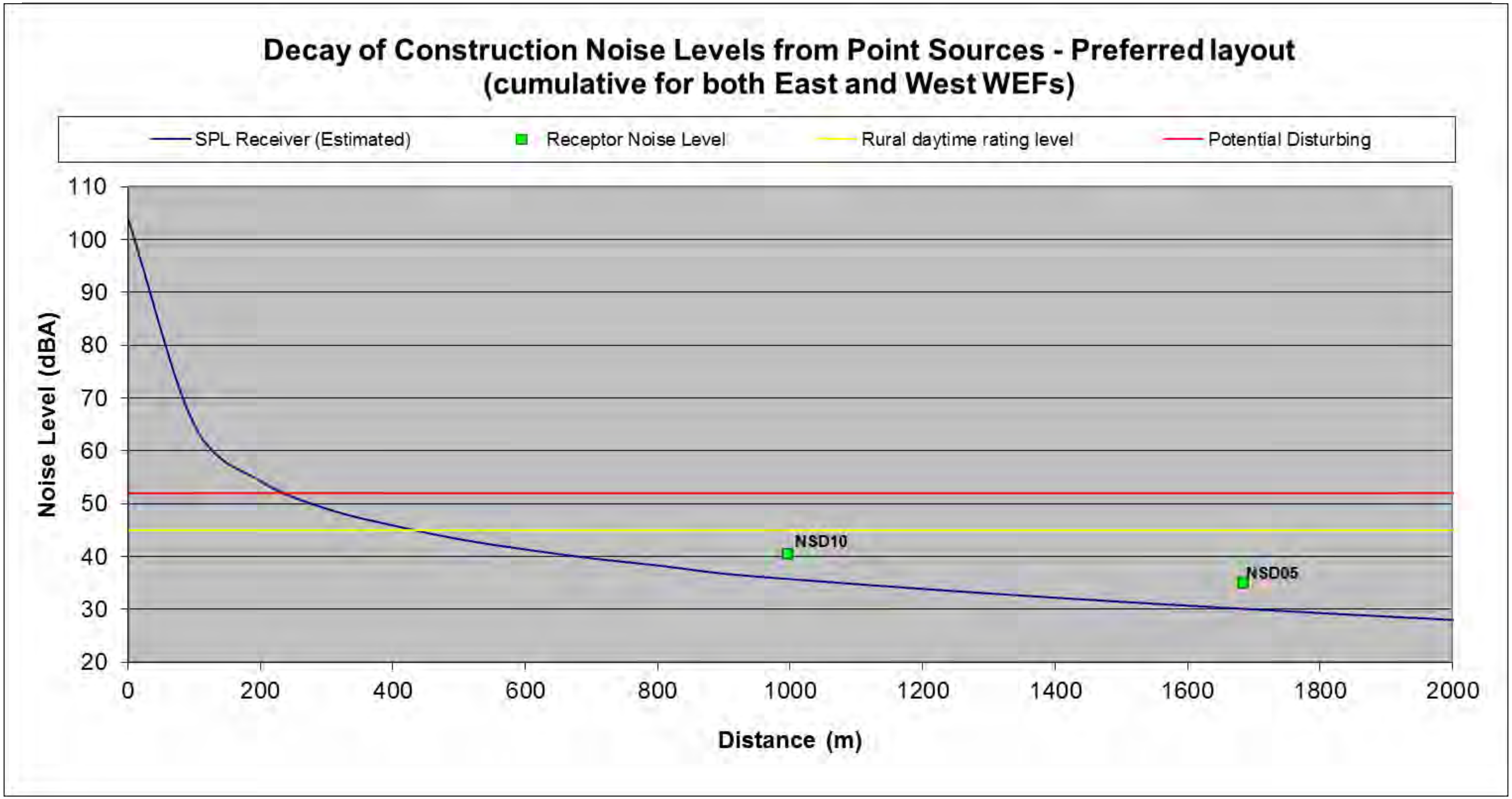

Figure 7-4: Projected conceptual construction noise levels – Decay of noise from construction activities (Preferred Layout)

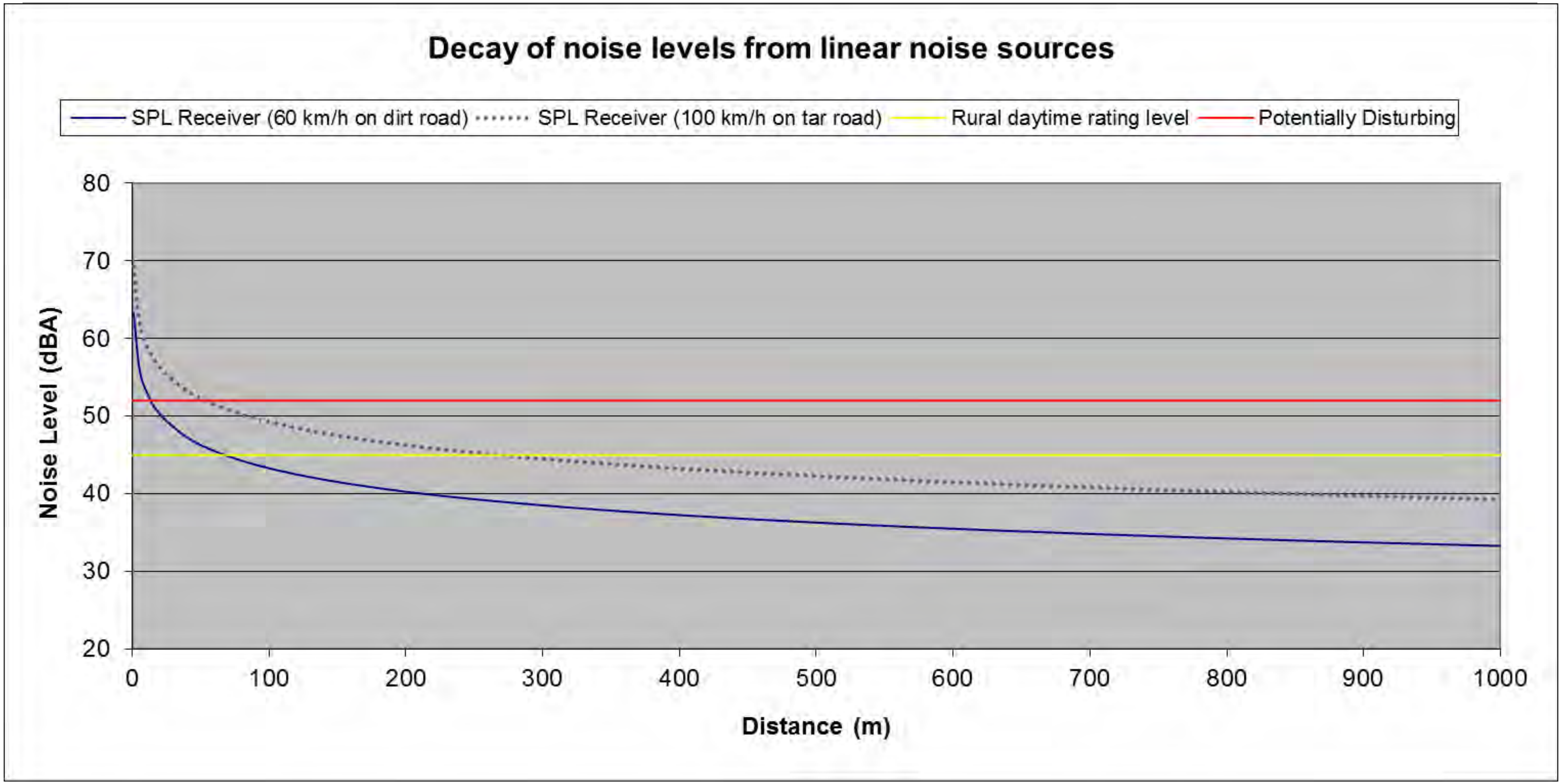

Figure 7-5: Projected conceptual construction noise levels – Decay over distance from linear activities

7.3 Operational Phase Noise Impact

Typical day time activities would include:

- The operation of the various Wind Turbines,
- Maintenance activities (relatively insignificant noise source).

The daytime period however, was not considered for the EIA because noise generated during the day by the WEF is generally masked by other noises from a variety of sources surrounding potentially noise-sensitive developments. However, times when a quiet environment is desired (at night for sleeping, weekends etc.) ambient sound levels are more critical. The time period investigated therefore would be a quieter period, normally associated with the 22:00 – 06:00 timeslot. Maintenance activities would therefore not be considered, concentrating on the ambient sound levels created due to the operation of the various Wind Turbine Generators (WTGs) at night.

For each facility (East and West WEF) two layouts were considered, namely an alternative (see **Figure 7-1**) and a preferred layout (see **Figure 7-2**). This report makes use of the sound power emission levels for a Vestas V117 3.3MW wind turbine. The developer is also considering the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3000 (refer to **Figure 4-1**). While the sound power emission levels of the Vestas V126 3.45/3.6 are similar to the Vestas V117 3.3 MW, the sound power emission levels of the Acciona AW125/3000 is approximately 2 dB higher than either the Vestas WTGs.

The calculated octave sound power levels of the Vestas V117 3.3MW wind turbine as used for modelling are presented in **Table 7-1**. The maximum sound power emission levels were used for all calculations. The difference between the proposed height of the nacelle (120 m) and height used for modelling (115 m) will have a negligible impact on the results. It should be noted, that changes in hub-height generally do not change the sound power emission level (for the same wind turbine), or the change is insignificantly small.

Table 7-1: Octave Sound Power Emission Levels used for modelling: Vestas V117 3.3 MW

Wind Turbine: Vestas V117 3.3 MW at 116.5 m HH										
Source Reference: DMS no.: 0038-6455-V00, 2013-06-07										
Z-Weighted Octave Sound Power Levels (dB)										
Frequency	16.0	31.0	63.0	125.0	250.0	500.0	1000.0	2000.0	4000.0	Total (dBA)
3.0	104.6	103.2	108.1	103.1	97.5	91.8	88.6	83.7	80.4	95.2
4.0	110.9	107.9	108.6	104.6	100.4	95.9	92.3	87.2	83.2	98.4
5.0	116.0	111.3	109.7	107.3	103.9	100.3	96.5	91.6	86.8	102.3
6.0	119.8	114.1	111.6	110.0	106.3	103.4	99.8	95.4	90.2	105.4
7.0	121.7	116.1	113.2	111.2	106.8	104.1	101.3	97.7	92.1	106.6
8.0	123.3	118.6	115.2	111.4	106.3	103.7	101.9	99.1	93.5	107.0
9.0	125.2	121.3	116.8	110.9	105.4	102.8	102.0	99.8	94.4	107.0
10.0	128.6	123.6	116.8	110.2	105.2	102.9	101.9	100.0	94.7	107.0

7.3.1 Review of the Alternative and Preferred layouts of the East WEF

Total noise rating levels considering the alternative layout of the East WEF is presented in **Figure 7-6**, with **Figure 7-7** illustrating the noise rating levels considering the preferred layout. The cumulative noise rating levels was not considered due to the distance between the East and West facilities, illustrated in **Figure 7-10**.

Table 7-2 defines the noise rating levels at the closest potential noise-sensitive receptors for the two layouts for the East WEF for the Vestas turbines, with Table 7-3 estimating the noise levels due to the Acciona turbine.

Table 7-2: Noise rating levels at closest potential noise-sensitive receptors, East WEF (noise rating levels for Vestas WTG)

NSD	Alternative Layout (dBA)	Preferred Layout (dBA)
1	less than 30 dBA	less than 30 dBA
2	less than 30 dBA	less than 30 dBA
3	less than 30 dBA	less than 30 dBA
4	less than 30 dBA	less than 30 dBA
5	41.2	34.5
6	40.3	33.4
7	less than 30 dBA	less than 30 dBA
8	less than 30 dBA	less than 30 dBA
9	less than 30 dBA	less than 30 dBA
10[35]	less than 30 dBA	less than 30 dBA
11	32.2	less than 30 dBA

[35] Reported as Abandoned / old homestead by the developer

12	less than 30 dBA	less than 30 dBA

Table 7-3: Noise rating levels at closest potential noise-sensitive receptors, East WEF (approximate noise rating levels – Acciona WTG)

NSD	Alternative Layout (dBA)	Preferred Layout (dBA)
1	less than 30 dBA	less than 30 dBA
2	less than 30 dBA	less than 30 dBA
3	less than 30 dBA	less than 30 dBA
4	less than 30 dBA	less than 30 dBA
5	43.2	36.5
6	42.3	35.4
7	less than 30 dBA	less than 30 dBA
8	less than 30 dBA	31.1
9	less than 30 dBA	less than 30 dBA
10[36]	less than 30 dBA	less than 30 dBA
11	34.2	less than 30 dBA
12	less than 30 dBA	less than 30 dBA

7.3.2 Review of the Alternative and Preferred layout, West WEF

Total noise rating levels considering the alternative layout of the East WEF is presented in **Figure 7-8**, with **Figure 7-9** illustrating the noise rating levels for the preferred layout.

The cumulative noise rating levels due to both phases operating simultaneously is illustrated in **Figure 7-10**. **Table 7-4** defines the noise rating levels at the closest potential noise-sensitive receptors considering the Vestas turbines.

[36] Abandoned / old homestead

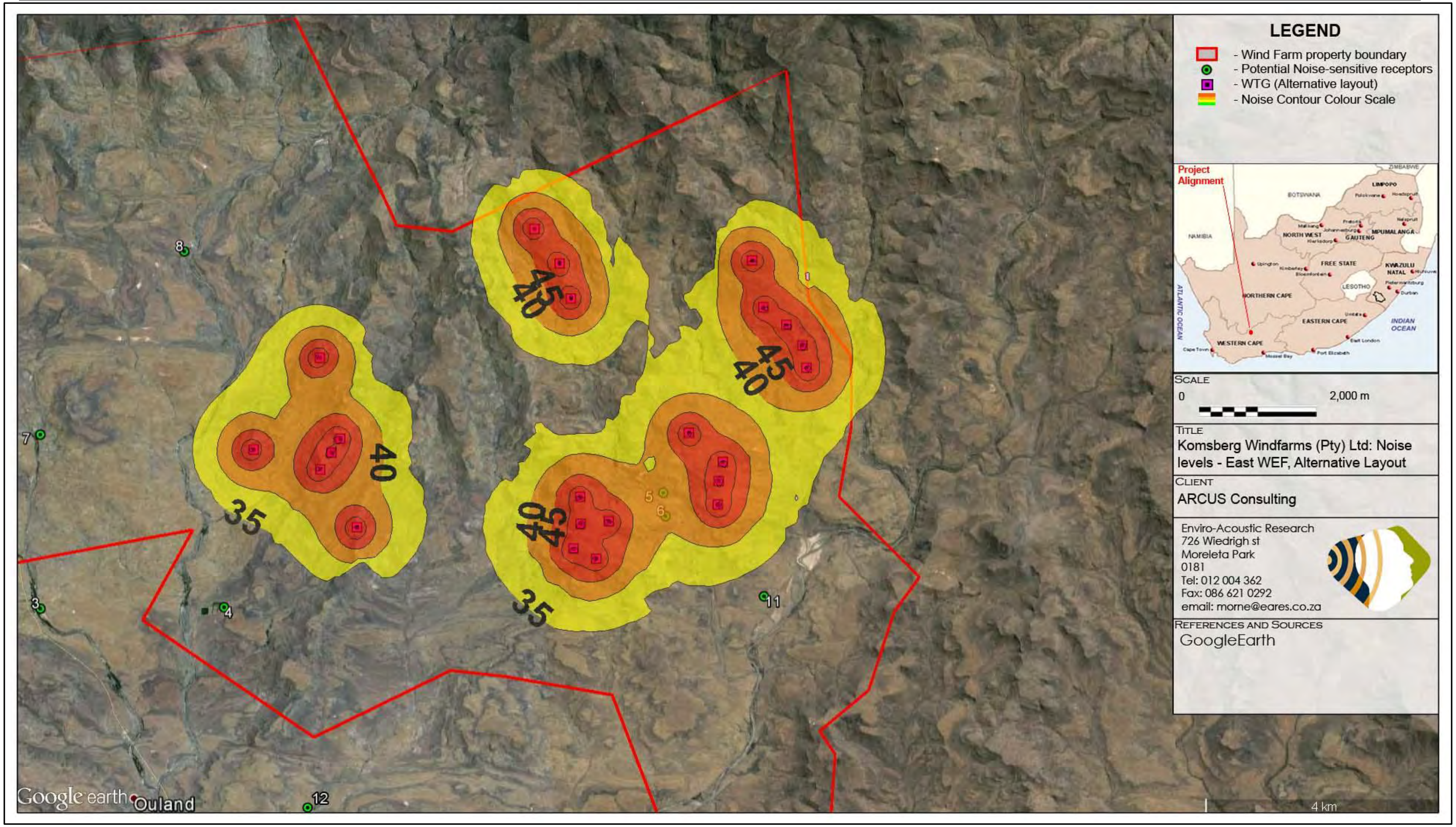

Figure 7-6: Projected conceptual night-time noise rating levels during operation – East WEF, Alternative layout (Vestas WTG)

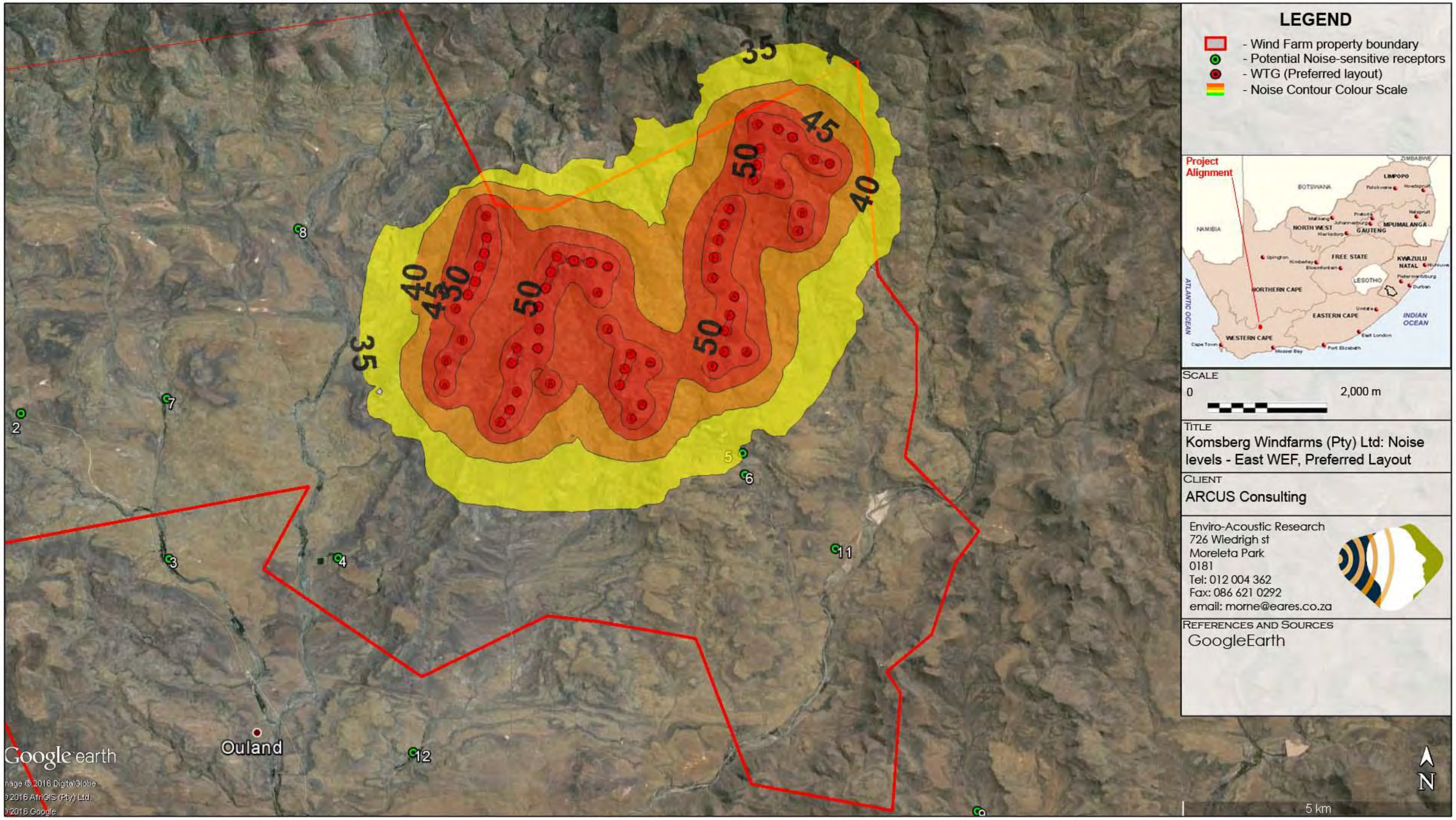

Figure 7-7: Projected conceptual night-time noise rating levels during operation – East WEF, Preferred layout (Vestas WTG)

Table 7-4: Noise rating levels at closest potential noise-sensitive receptors, West WEF (noise rating levels for Vestas WTG)

NSD	Alternative Layout (dBA)	Preferred Layout (dBA)
1	less than 30 dBA	less than 30 dBA
2	less than 30 dBA	less than 30 dBA
3	less than 30 dBA	less than 30 dBA
4	less than 30 dBA	less than 30 dBA
5	less than 30 dBA	less than 30 dBA
6	less than 30 dBA	less than 30 dBA
7	less than 30 dBA	less than 30 dBA
8	less than 30 dBA	less than 30 dBA
9	less than 30 dBA	less than 30 dBA
10[37]	32.8	37.1
11	less than 30 dBA	less than 30 dBA
12	less than 30 dBA	less than 30 dBA

Table 7-5 defines the approximate noise rating levels using the Acciona turbine.

Table 7-5: Noise rating levels at closest potential noise-sensitive receptors, West WEF (approximate noise levels – Acciona WTG)

NSD	Alternative Layout (dBA)	Preferred Layout (dBA)
1	less than 30 dBA	less than 30 dBA
2	less than 30 dBA	less than 30 dBA
3	less than 30 dBA	less than 30 dBA
4	less than 30 dBA	less than 30 dBA
5	less than 30 dBA	less than 30 dBA
6	less than 30 dBA	less than 30 dBA
7	less than 30 dBA	less than 30 dBA
8	less than 30 dBA	less than 30 dBA
9	less than 30 dBA	less than 30 dBA
10[37]	34.8	39.1
11	less than 30 dBA	less than 30 dBA
12	less than 30 dBA	less than 30 dBA

7.4 DECOMMISSIONING AND CLOSURE PHASE NOISE IMPACT

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and operational phases and noise from the decommissioning and closure phases will therefore not be investigated further.

[37] Reported as Abandoned / old homestead by the developer

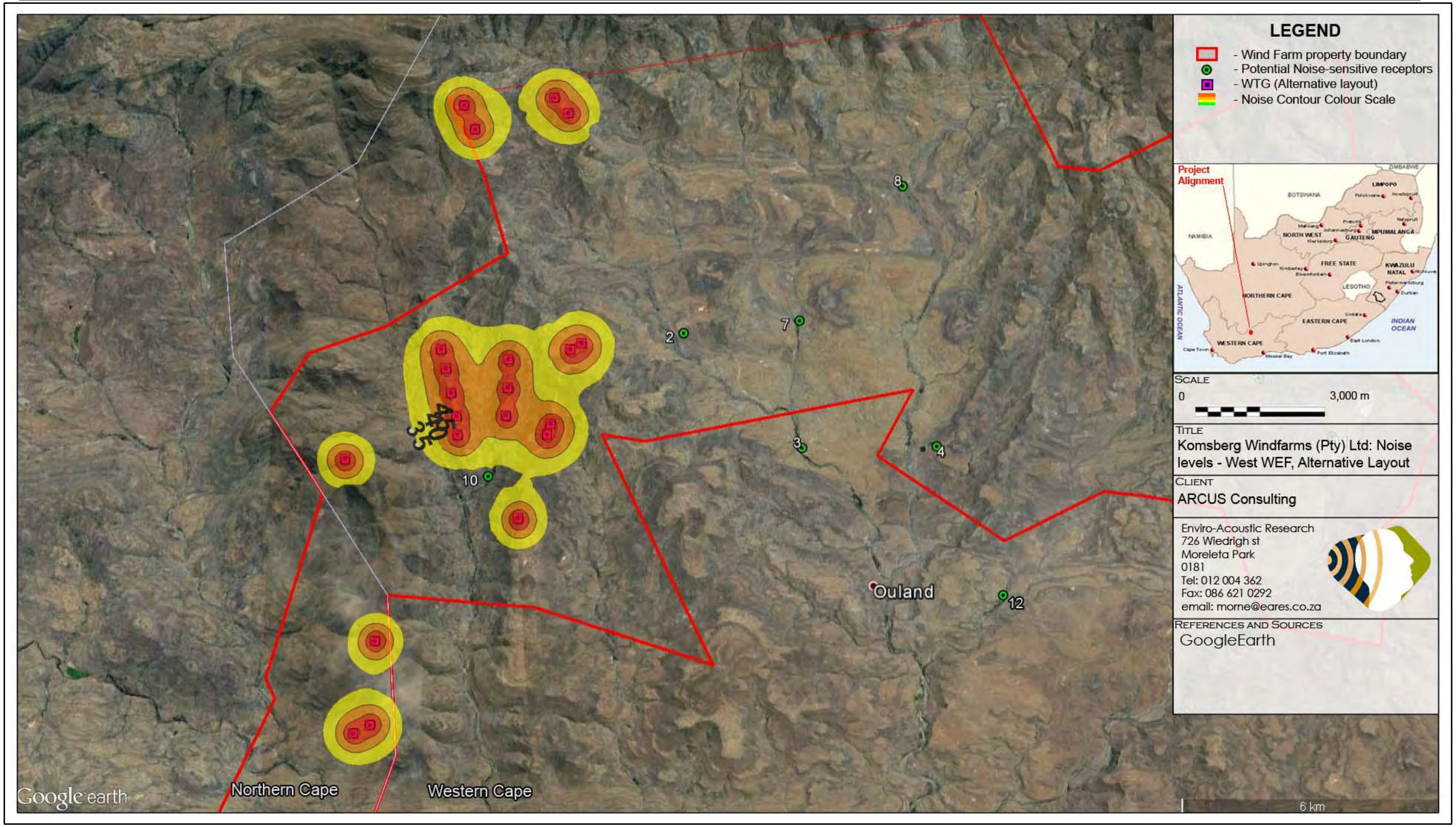

Figure 7-8: Projected conceptual night-time noise rating levels during operation – West WEF, Alternative layout (Vestas WTG)

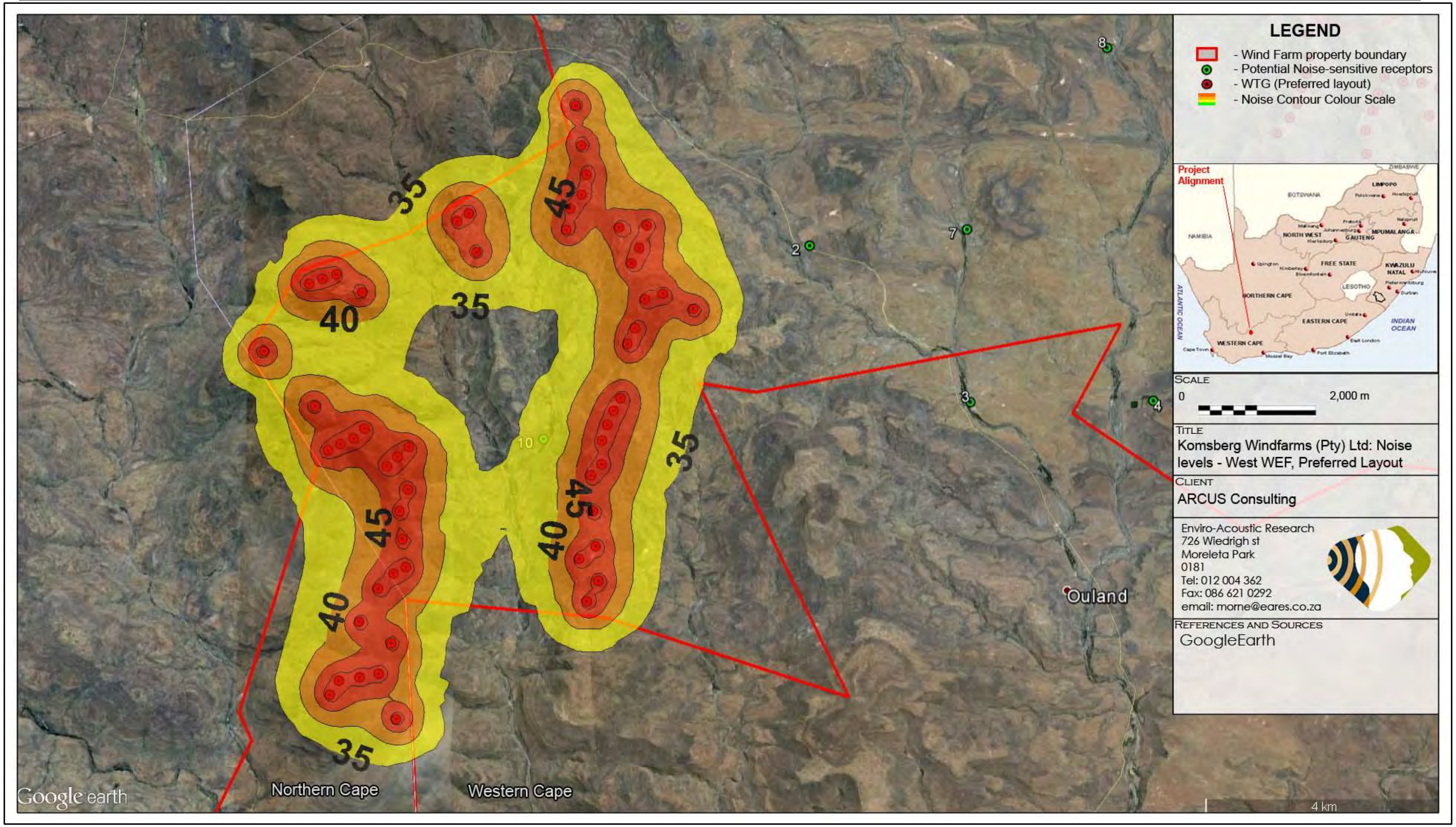

Figure 7-9: Projected conceptual night-time noise rating levels during operation – Phase 2 of the 245 MW Layout (Vestas WTG)

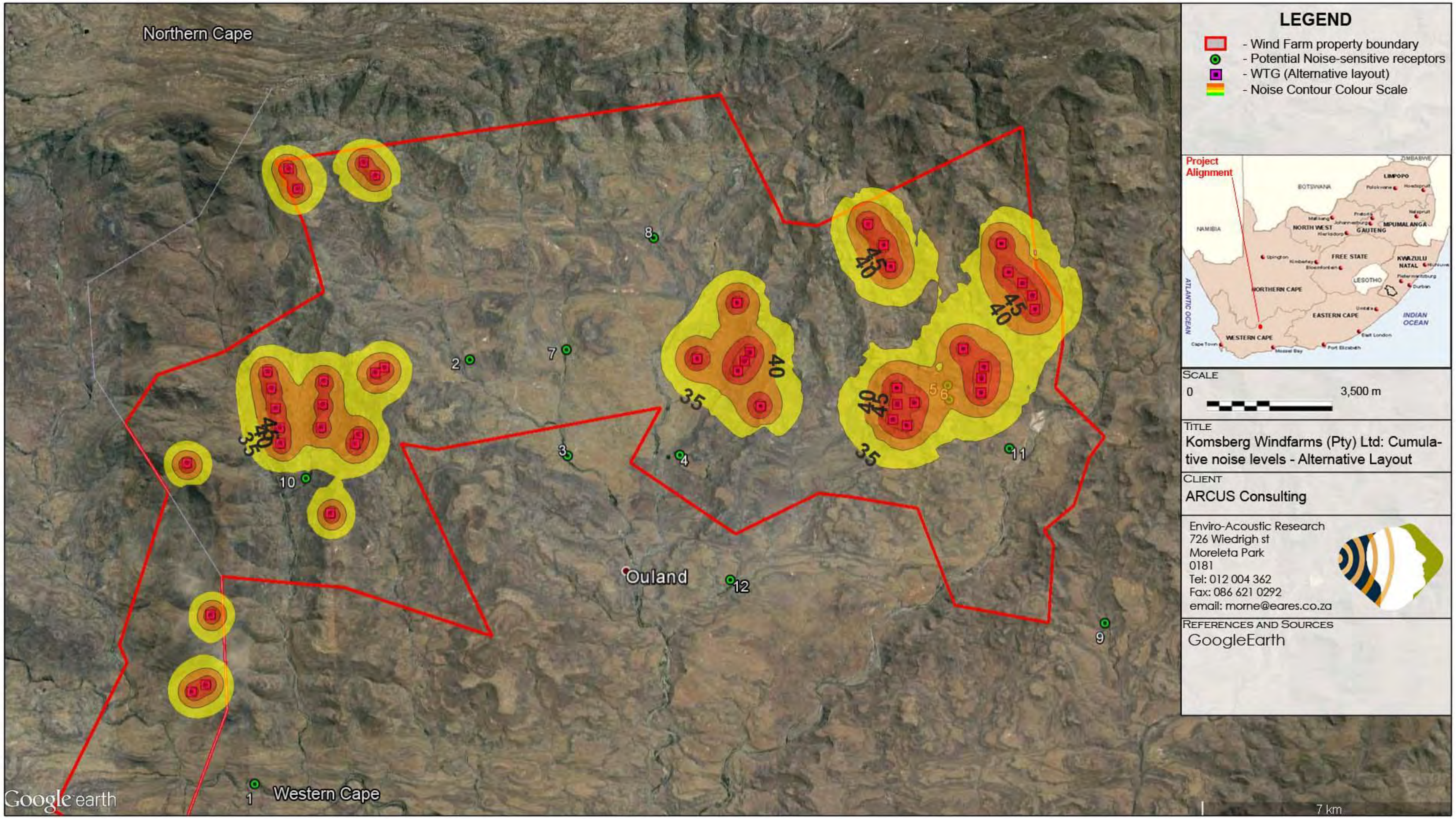

Figure 7-10: Projected conceptual night-time noise rating levels during operation – Alternative layout, East and West WEFs (Vestas WTG)

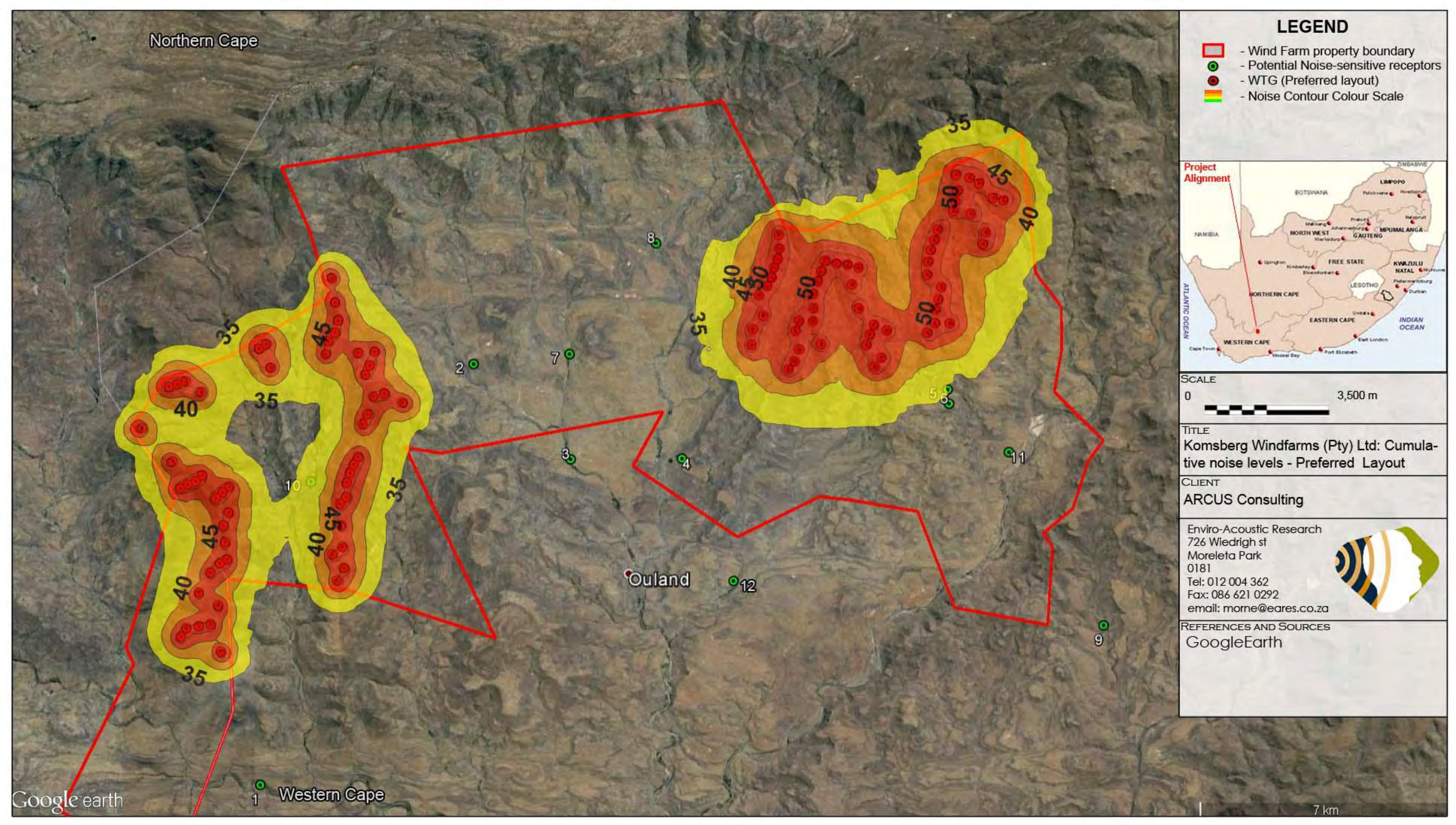

Figure 7-11: Projected conceptual night-time noise rating levels during operation – Preferred layout, East and West WEFs (Vestas WTG)

8 SIGNIFICANCE OF THE NOISE IMPACT

8.1 PLANNING PHASE NOISE IMPACT

No noise is associated with the planning phase and this will not be investigated in further.

8.2 CONSTRUCTION PHASE NOISE IMPACT

The impact assessment for the various construction activities are described in **Section 4.1**, defined and assessed in **section 7.2**. Considering the projected noise levels (all significantly less than 45 dBA) as well as the expected daytime ambient sound level (higher than 45 dBA), there is a very low risk for a noise impact during the construction phase (for each WEF and layout). The noise impact is summarized in **Table 8-1**.

The noise levels associated with the construction of the overhead power line (to allow connection to the grid) can be estimated using **Figure 7-3.** From this figure it can be seen that the construction noise levels will be well within the acceptable daytime rating levels if these activities are further than approximately 500 m from the closest receptors. As all the identified receptors are further than 500m from this overhead line, the projected noise levels (as well as the significance of the noise impact) of this activity will be low (see also **Table 8-2**).

8.3 OPERATIONAL PHASE NOISE IMPACT

Only the night-time scenario was assessed as this is the most critical time period when a quiet environment is desired.

8.3.1 Impact – East WEF, Alternative Layout

The impact assessment for the various activities defined in **section 4.2** and **7.3.1**, with the projected noise levels calculated in **section 7.3.1**.

As can be seen from **Table 7-2**, the projected noise levels will be higher than the rural rating level at NSD05 and NSD06, although the projected noise levels will not exceed the 42 dBA noise limit as proposed in **section 5.3.3.2** when using the Vestas WTG. The noise levels will be slightly higher than the 42 dBA noise limit as proposed when considering the Acciona WTG. The extent of the impact is limited to an area approximately 1,000m from the wind turbines (for all the wind turbines considered), the intensity is medium on NSD05 and 06 (it may be measured) and of medium duration (life of project). The significance of the noise impact is considered to be low on all receptors for both wind turbines.

The significance of the noise impact is assessed and summarized in **Table 8-3** for the Vestas WTGs, with **Table 8-4** presenting the impact significance for the Acciona WTG.

8.3.2 Impact – East WEF, Preferred layout

The impact assessment for the various activities defined in **section 4.2** and **7.3.1**, with the projected noise levels calculated in **section 7.3.1**. As can be seen from **Table 7-2**, the projected noise levels will be lower than the rural rating level at all receptors with this layout. The extent of the impact is limited to an area approximately 1,000m from the wind turbines, the intensity is low on all receptors and of medium duration (life of project) for all the WTG considered. The significance of the noise impact is considered to be low on all receptors. The noise impact is assessed and summarized in **Table 8-5** for the Vestas WTGs, with **Table 8-6** presenting the impact significance for the Acciona WTG.

In terms of noise there is no preference between the Alternative and Preferred layouts for the East WEF when using the Vestas WTGs, but the Preferred layout is recommended should the developer make use of the Acciona WTG[38].

8.3.3 Impact – West WEF, Alternative layout

The impact assessment for the various activities defined in **section 4.2** and **7.3.2**, with the projected noise levels calculated in **section 7.3.2**. As can be seen from **Table 7-4**, the projected noise levels will be lower than the rural rating level at all receptors with this layout. The extent of the impact is limited to an area approximately 1,000m from the wind turbines, the intensity is low on all receptors and of medium duration (life of project). The significance of the noise impact is considered to be low on all receptors for all the WTGs considered. The noise impact is assessed and summarized in **Table 8-7** for the Vestas WTGs, with **Table 8-8** presenting the impact significance for the Acciona WTG.

8.3.4 Impact – West WEF, Preferred layout

The impact assessment for the various activities defined in **section 4.2** and **7.3.2**, with the projected noise levels calculated in **section 7.3.2**. As can be seen from **Table 7-4**, the projected noise levels will be slightly higher at NSD10 with this layout. The increase in noise level at NSD10 is insignificant. The extent of the impact is limited to an area

[38] While noise levels will be slightly higher for the Acciona WTG, this level is relatively low and considered of low concern.

approximately 1,000m from the wind turbines, the intensity is medium on NSD10 (low on the other receptors) and of medium duration (life of project) for all the WTGs considered. The significance of the noise impact is considered to be low on all receptors. The noise impact is assessed and summarized in **Table 8-9** for the Vestas WTGs, with **Table 8-10** presenting the impact significance for the Acciona WTG.

In terms of noise there is no preference between the Alternative and Preferred layouts for the West WEF[39].

8.4 IMPACT – CUMULATIVE LAYOUT

Because of the significant distance (more than 8,000m) between the East and West facilities (whether the alternative or preferred layouts) the risk of a cumulative noise impact is minimal. The significance of the noise impact is considered to be low on all receptors. The noise impact is assessed and summarized in **Table 8-11** for the Vestas WTGs, with **Table 8-12** presenting the impact significance for the Acciona WTG.

8.5 DECOMMISSIONING PHASE NOISE IMPACT

Final decommissioning activities will have a noise impact lower than either the construction or operational phases. This is because decommissioning and closure activities normally take place during the day using minimal equipment (due to the decreased urgency of the project). While there may be various activities, there is a very small risk for a noise impact.

[39] While noise levels will be slightly higher for the Acciona WTG, this level is relatively low and considered of low concern.

Table 8-1: Impact Assessment: Construction Activities (both East and West WEFs)

	Alternative layouts	Preferred layouts	Typical daytime ambient sound levels	Extent	Intensity	Duration	Significance
Receiver no	**Leq - dB(A)**	**Leq - dB(A)**			**Negative**		
1	31.4	32.8	45 - 55 dBA	Low	Low	Low	Low
2	31.6	33.3	45 - 55 dBA	Low	Low	Low	Low
3	31.3	32.7	45 - 55 dBA	Low	Low	Low	Low
4	31.7	32.8	45 - 55 dBA	Low	Low	Low	Low
5	40.6	35.0	45 - 55 dBA	Low	Low	Low	Low
6	40.2	34.1	45 - 55 dBA	Low	Low	Low	Low
7	31.3	32.7	45 - 55 dBA	Low	Low	Low	Low
8	31.4	33.0	45 - 55 dBA	Low	Low	Low	Low
9	31.3	32.7	45 - 55 dBA	Low	Low	Low	Low
10	37.0	40.4	45 - 55 dBA	Low	Low	Low	Low
11	32.8	32.8	45 - 55 dBA	Low	Low	Low	Low
12	31.3	32.7	45 - 55 dBA	Low	Low	Low	Low

Comments:

Probability of impact	Very low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required
Cumulative impacts	Construction noises will cumulatively add to any other noises in the area, but it will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-2: Impact Assessment: Construction Activities (overhead line)

	Overhead line	Typical daytime ambient sound levels	Extent	Intensity	Duration	Significance
Receiver no	**Leq - dB(A)**			**Negative**		
1	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
2	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
3	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
4	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
5	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
6	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
7	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
8	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
9	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
10	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
11	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low
12	Less than 35 dBA	45 - 55 dBA	Low	Low	Low	Low

Comments:

Probability of impact	Very low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required
Cumulative impacts	Construction noises will cumulatively add to any other noises in the area, but it will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-3: Impact Assessment: Operational Activities – Alternative Layout, East WEF (Vestas turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	41.2	30 - 40 dBA	Low	Medium	Medium	Low
6	40.3	30 - 40 dBA	Low	Medium	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
11	32.2	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-4: Impact Assessment: Operational Activities – Alternative Layout, East WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	43.2	30 - 40 dBA	Low	Medium	Medium	Low
6	42.3	30 - 40 dBA	Low	Medium	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
11	34.2	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-5: Impact Assessment: Operational Activities – Preferred layout, East WEF (Vestas turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	34.5	30 - 40 dBA	Low	Low	Medium	Low
6	33.4	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-6: Impact Assessment: Operational Activities – Preferred layout, East WEF (Acciona turbines)

Receiver no	**Projected Noise Level (dBA)**	**Typical night-time ambient sound levels**	**Extent**	**Intensity**	**Duration**	**Significance**
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	36.5	30 - 40 dBA	Low	Low	Medium	Low
6	35.4	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	31.1	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-7: Impact Assessment: Operational Activities – Alternative layout, West WEF (Vestas turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
6	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	32.8	30 - 40 dBA	Low	Low	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-8: Impact Assessment: Operational Activities – Alternative layout, West WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
6	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	32.8	30 - 40 dBA	Low	Low	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-9: Impact Assessment: Operational Activities – Preferred layout, East WEF (Vestas turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
6	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	37.1	30 - 40 dBA	Low	Medium	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-10: Impact Assessment: Operational Activities – Preferred layout, East WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
6	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	39.1	30 - 40 dBA	Low	Medium	Medium	Low
11	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-11: Impact Assessment: Operational Activities – Maximum potential cumulative noise levels (Vestas turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	41.2	30 - 40 dBA	Low	Medium	Medium	Low
6	40.3	30 - 40 dBA	Low	Medium	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	37.1	30 - 40 dBA	Low	Medium	Medium	Low
11	32.2 Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:	
Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

Table 8-12: Impact Assessment: Operational Activities – Maximum potential cumulative noise levels (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	43.2	30 - 40 dBA	Low	Medium	Medium	Low
6	42.3	30 - 40 dBA	Low	Medium	Medium	Low
7	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
8	31.1	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
10	39.1	30 - 40 dBA	Low	Medium	Medium	Low
11	34.2 Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 30 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

8.6 Evaluation of Alternatives

8.6.1 Alternative 1: No-go option

The ambient sound levels will remain as is (relatively low).

8.6.2 Alternative 2: Proposed Renewable Power Generation activities

The proposed renewable power generation activities (worse-case evaluated) will raise the noise levels at a number of potential noise-sensitive developments slightly. These noises can be disturbing and may impact on the quality of living for the receptors although this is highly unlikely. Therefore, in terms of acoustics there is no benefit to the surrounding environment (closest receptors). The potential noise impacts however are very low and the significance is low. With regards to noise, there is no preference to either the alternative versus the preferred layouts.

The project will greatly assist in the provision of energy, which will allow further economic growth and development in South Africa and locally. The project will generate short and long-term employment and other business opportunities and promote renewable energy in South Africa and locally. People in the area that is not directly affected by increased noises will have a positive perception of the project and will see the need and desirability of the project.

8.6.3 Location alternatives

The development of a wind energy facility is highly dependent on the prevailing wind quality and character. The wind turbines will be located on the top of ridges that are not used by people. Located in an area where the population density is relatively low, the location of the facility is ideal.

As discussed in **section 5.1.2**, the more sensitive animals that might be impacted by noise would most likely relocate to a quieter area.

9 MITIGATION OPTIONS

9.1 CONSTRUCTION PHASE MITIGATION MEASURES

The study considers the potential noise impact on the surrounding environment due to construction activities during the daytime periods. It was determined that the potential noise impact would be of low significance and mitigation measures are not required or recommended.

The developer must know that community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. At all stages surrounding receptors should be informed about the project, providing them with factual information without setting unrealistic expectations. It is counterproductive to suggest that the activities (or facility) will be inaudible due to existing high ambient sound levels. The magnitude of the sound levels will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, because it depends on the relationship between the sound level from the activities, the spectral character and that of the surrounding soundscape (both level and spectral character).

9.1.1 Mitigation options available to reduce Construction Noise Impact

Mitigation options included both management measures as well as technical changes. While not required (due to the low significance of a noise impact during the construction phase) the following measures are included for the developer to consider. General measures that should be applicable for both the construction phase includes:

- The use the smaller/quieter equipment when operating near receptors;
- Where possible only operate during the day. If night-time activities is required, do not operate closer than 500m from any receptors (prevent noise impact of high significance)
- Ensure a good working relationship between the developer/contractor and all potentially noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them (especially if work is to take place within 500m from them at night). Information that should be provided to potentially sensitive receptor(s) includes:
    - Proposed working dates, the duration that work will take place in an area and working times;
    - The reason why the activity is taking place;

  - The construction methods that will be used; and
  - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When simultaneous noise emitting activities are to take place close to potential noise-sensitive receptors, co-ordinate the working time with periods when the receptors are not at home. An example would be to work within the 8 am to 2 pm time-slot if possible, as:
  - Potential noise-sensitive receptors are most likely to be at school or work; and
  - Normal daily household activities (cleaning, listening to TV/Radio, etc.) will generate other noises that would most likely mask construction noises, thus minimizing the effects of cumulative noise impacts.
- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures if available. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised.

9.2 OPERATIONAL PHASE MITIGATION MEASURES

9.2.1 Mitigation options available to reduce Operational Noise Impact

The significance of noise during the operational phase is low and additional mitigation measures are not required.

9.3 SPECIAL CONDITIONS

9.3.1 Mitigation options that should be included in the EMP

No mitigation measures are recommended for inclusion in the EMP or Environmental Authorization.

9.3.2 Special conditions that should be included in the Environmental Authorization

1. The potential noise impact must again be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD.
2. The developer must investigate any reasonable and valid noise complaint if registered by a receptor staying within 2,000 m from location where construction activities are taking place or operational wind turbine.

10 ENVIRONMENTAL MANAGEMENT OBJECTIVES

Environmental Management Objectives is difficult to be defined for noise because ambient sound levels would slowly increase as developmental pressures increase in the area. This is due to increased traffic associated with increased development, human habitation, agriculture and even eco-tourism and is irrespective whether the activity starts. While these increases in ambient sound levels may be low (and insignificant) it has the effect of cumulatively increasing the ambient sound levels.

The moment the facility stops ambient sound levels will drop similar to the pre-WEF levels (typical of other areas with a similar developmental character).

11 ENVIRONMENTAL MONITORING PLAN

Environmental Noise Measurement can be divided into two distinct categories, namely:

- Passive measuring – the registering of any complaints (reasonable and valid) regarding noise; and
- Active measuring – the measurement of noise levels at identified locations.

No active environmental noise monitoring is recommended due to the low significance for a noise impact to develop. However, should a reasonable and valid complaint about noise be registered, it is the responsibility of the developer to investigate this complaint as per the following sections. It is recommended that the noise investigation be done by an independent acoustic consultant.

While this section recommends a noise monitoring programme, it should be used as a guideline as site specific conditions may require that the monitoring locations, frequency or procedure be adapted.

11.1 MEASUREMENT LOCALITIES AND PROCEDURES

11.1.1 Measurement Localities

No routine noise measurements or locations are recommended. Noise measurements must be conducted at the location of the person that registered a valid and reasonable noise complaint. The measurement location should consider the direct surroundings to ensure that other sound sources cannot influence the reading. A second instrument must be deployed at a control point away from the potential noise source during the measurement period.

11.1.2 Measurement Frequencies

Once-off measurements if and when a reasonable and valid noise complaint is registered. Results and feedback must be provided to the complainant. If required and recommended by an acoustic consultant, there may be follow-up measurements or a noise monitoring programme can be implemented.

11.1.3 Measurement Procedures

Ambient sound measurements should be collected as defined in SANS 10103:2008. Due to the variability that naturally occurs in sound levels at most locations, it is recommended that semi-continuous measurements are conducted over a period of at least 24 hours, covering at least a full day- (06:00 – 22:00) and night-time (22:00 – 06:00) period. Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as $L_{Aeq,I}$ (National Noise Control Regulation requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{Aeq,f}$ (Noise level used to compare with IFC noise limit). Spectral frequencies should also be measured to define the potential origin of noise. When a noise complaint is being investigated, measurements should be collected during a period or in conditions similar to when the receptor experienced the disturbing noise event.

11.2 RELEVANT STANDARD FOR NOISE MEASUREMENTS

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992), Western Cape Noise Control Regulations (PN 200 of 2013) and SANS 10103:2008. It should be noted that the SANS standard also refers to a number of other standards.

11.3 DATA CAPTURE PROTOCOLS

11.3.1 Measurement Technique

Noise measurements must be conducted as required by the National Noise Control Regulations (GN R154 of 1992), Western Cape Noise Control Regulations (PN 200 of 2013) and SANS 10103:2008.

11.3.2 Variables to be analysed

Measurements should be collected in 10-minute bins defining the 10-minute descriptors such as $L_{Aeq,I}$ (National Noise Control Regulation requirement), $L_{A90,f}$ (background noise level as used internationally) and $L_{Aeq,f}$ (Noise level used to compare with IFC noise limit). Noise levels should be co-ordinated with the 10-m wind speed. Spectral frequencies should also be measured to define the potential origin of noise.

11.3.3 Database Entry and Backup

Data must be stored unmodified in the electronic file saved from the instrument. This file can be opened to extract the data to a spread sheet system to allow the processing of the data and to illustrate the data graphically. Data and information should be safeguarded from accidental deletion or corruption.

11.3.4 Feedback to Receptor

A measurement report must be compiled considering the requirements of the National Noise Control Regulations (GN R154 of 1992) and SANS 10103:2008. The facility must provide feedback to the potential noise-sensitive receptors using the channels and forums established in the area to allow interaction with stakeholders, alternatively in a written report.

11.4 STANDARD OPERATING PROCEDURES FOR REGISTERING A COMPLAINT

When a noise complaint is registered, the following information must be obtained:

- Full details (names, contact numbers, location) of the complainant;
- Date and approximate time when this non-compliance occurred;
- Description of the noise or event;
- Description of the conditions prevalent during the event (if possible).

12 CONCLUSIONS AND RECOMMENDATIONS

Enviro-Acoustic Research CC was contracted by ARCUS Consulting (the EAP) to conduct an Environmental Noise Impact Assessment (ENIA) to determine the potential noise impact on the surrounding environment due to the development of the Komsberg Wind Farm between Laingsburg and Sutherland, Western and Northern Cape.

Ambient sound levels were measured at two locations for two night-time periods during October 2015 using two class-1 Sound Level Meters as well as a portable weather station. The sound level meters would measure "average" sound levels over 10 minutes periods, save the data and start with a new 10 minute measurement till the instrument was stopped. The area has a rural character in terms of appearance and development, confirmed by the ambient sound levels.

Measured data indicated daytime ambient sound levels typical of a rural noise district with night-time levels indicating a rural noise district. The slightly higher expected daytime ambient sound levels are likely due to agricultural activities in the vicinity of the measurement locations.

As most of the area were considered naturally quiet, it was selected to assign an acceptable noise rating level of a rural noise district (as per SANS 10103:2008).

The potential noise impact was evaluated using a sound propagation model. Conceptual scenarios were developed for a construction and operational phase. The output of the modelling exercise indicated that there is low risk of a noise impact (low significance of a noise impact) for either the East or West WEFs (for both the alternative and preferred layouts). Mitigation is not required although generic measures are recommended for the developer to note to ensure that any potential noise impacts are minimised (construction phase).

Due to the low significance of a noise impact, no routine noise measurement programme is recommended. Measurement locations, frequencies and procedures are provided as a guideline for the developer to consider should there be a noise complaint.

Due to economic and environmental advantages, renewable power generation does provide valuable employment, business opportunities and green energy. It must be noted when such projects are close to potential noise-sensitive receptors, consideration must be given to ensuring a compatible co-existence. The potential sensitive receptors should not be adversely affected and yet, at the same time wind energy facilities need to reach an optimal scale in terms of layout and production.

This does not suggest that the sound from the facility should not be audible under all circumstances this is an unrealistic expectation that is not required or expected from any other agricultural, commercial, industrial or transportation related noise source,– but rather that the sound due to the power generation activities should be at a reasonable level in relation to the ambient sound levels.

While this project will have a very slight noise impact at a number of the closest noise-sensitive receptors, these impacts is of low significance and can be considered insignificant. It is however important that the potential noise impact be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD.

It is therefore the opinion of the Author that the increases in noise levels are of minor significance. It is therefore the recommendation that the project should be authorised (from a noise impact perspective).

13 THE AUTHOR

The Author started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc] and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 15 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During that period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 8 years, and was involved with the following projects in the last few years:

Wind Energy Facilities	*Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Saldanha WEF (Terramanzi), Loeriesfontein (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Plateau East and West (Aurecon), Saldanha (Aurecon), Veldrift (Aurecon), Tsitsikamma (SE), AB (SE), West Coast One (SE), Namakwa Sands (SE), Dorper (SE), VentuSA Gouda (SE), Amakhala Komsberg (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Canyon Springs (Canyon Springs), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Outeniqwa (Aurecon), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Rhenosterberg (SiVEST), Bannf (Vidigenix), Wolf WEF (Aurecon)*
Mining and	*BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon*

Industry	*Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum (AGES), Tweefontein Colliery (Cleanstream), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Delft Sand (AGES), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream), Stuart Coal – Weltevreden (CleanStream), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream), EastPlats (CleanStream), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali)*
Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional, Sephaku Delmas (AGES), Amakhala Komsberg WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon)*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), Natref (NEMAI), RareCo (SE), Struisbaai WEF (SE)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), Amakhala Komsberg (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy)*

14 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2010, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process; and
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010.

____
Signature of the environmental practitioner:

Enviro-Acoustic Research cc
Name of company:

____
Date:

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74. World Health Organization, 1999: *Protection of the Human Environment; Guidelines for Community Noise*

APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period extending from 06:00 to 24:00 as calculated in accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise", published under

	Government Notice No. 358 of 20 February 1987, and projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (c) industrial noise in the vicinity of an industry- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or (ii) the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too

	rapidly fluctuating sound.
Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	the sound level exceeded for the 90% of the time under consideration
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} *and* L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.

Mitigation	To cause to become less harsh or hostile.
Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.

Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

APPENDIX B

Photos of measurement locations

Photo 1: Measurement Location KASL01 (Anysrivier – Mr. Hennie Müller)

Photo 2: Measurement Location KASL02 (Mr. Billy Myburgh)

Komsberg Windfarms (Pty) Ltd

ADDENDUM TO ENVIRONMENTAL NOISE IMPACT ASSESSMENT

for the

Proposed Komsberg Wind Energy Facility between Laingsburg and Sutherland, Northern and Western Cape

Study done for:

ARCUS

Prepared by:

EAR
Enviro Acoustic Research

P.O. Box 2047, Garsfontein East, 0060
Tel: 012 – 004 0362, Fax: 086 – 621 0292, E-mail: info@eares.co.za

EXECUTIVE SUMMARY

INTRODUCTION AND PURPOSE

Enviro-Acoustic Research cc was requested to review a revised layout for the proposed Komsberg East and West WEF's. It is recommended that this addendum be read in conjunction with the original report, titled: M. de Jager,2015 *"Environmental Noise Impact Assessment for the proposed Komsberg wind energy facility between Laingsburg and Sutherland, Northern and Western Cape"*.

PROJECT DESCRIPTION

The windfarm will be divided into two projects, namely the Komsberg West and Komsberg East Wind Farms. Each facility will have a potential maximum installed capacity of 275MW (megawatts), this being based on the use of 55 Wind Turbine Generators (WTG) with each WTG's having a potential maximum rated power of up to 5MW each.

The developer is investigating a number of different wind turbine models, not excluding the possibility of larger models that are not yet available in the commercial market. These include the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3150. For the purpose of this noise assessment the sound power emission levels of the Acciona AW125/3000 turbine will be used.

NOISE IMPACT DETERMINATION AND FINDINGS

The potential noise impact was evaluated using a sound propagation model, using the Concawe algorithms for the construction phase and the algorithms defined by ISO 9613-2 for operation. Conceptual scenarios were developed for a construction and operational phase. The output of the modelling exercise indicated that there is low risk of a noise impact (low significance of a noise impact) for either the East or West WEF's for all locations where people stays. A potential medium significance for a noise impact at receptor NSD10 is of no concern, as the dwelling is not used for residential purposes. Mitigation is not required although generic measures are recommended for the developer to ensure that any potential noise impacts are minimised (construction phase).

NEED AND DESIRABILITY OF PROJECT

The proposed project will raise the noise levels at a number of potential NSD (noise-sensitive developments), however these noise levels are considered to be of an insignificant magnitude and unlikely to be audible when considering the likely ambient sound levels during the operational phase.

The project will greatly assist in the provision of energy, which will allow further economic growth and development in South Africa. The project will generate short and long-term employment and other business opportunities and promote renewable energy in South Africa. People in the area that are not directly affected by increased noises will have a positive perception of the project and will see the need and desirability of the project.

MANAGEMENT AND MITIGATION OF NOISE IMPACT

Due to the low significance of a noise impact (at potential noise-sensitive receptors), no routine noise measurement programme is recommended. Guidelines for potential measurement locations, frequencies and procedures are provided in the original Noise Study (dated October 2015) as advice for the developer to consider should there be a noise complaint.

RECOMMENDATIONS

While this project will have a very slight noise impact at a number of the closest noise-sensitive receptors, these impacts is of low significance and can be considered insignificant. It is however important that the potential noise impact be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD.

It is the opinion of the Author that the increases in noise levels are of minor significance. It is recommended that the project should be authorised (from a noise impact perspective).

CONTENTS OF THE SPECIALIST REPORT – CHECKLISTS

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 6	Cross-reference in this report
(a) details of— the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	**Section 9**
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	**Section 10** (also separate document to this report)
(c) an indication of the scope of, and the purpose for which, the report was prepared;	**Section 1.1**
(d) the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Original noise report dated October 2015
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process;	Original noise report dated October 2015
(f) the specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;	Original noise report dated October 2015
(g) an identification of any areas to be avoided, including buffers;	Not relevant and required.
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Buffers not required.
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	Original noise report dated October 2015
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	**Sections 5** and **Sections 6**
(k) any mitigation measures for inclusion in the EMPr;	**Sections 7.3.1**
(l) any conditions for inclusion in the environmental authorisation;	**Sections 7.3.2**
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Original noise report dated October 2015
(n) a reasoned opinion— i. as to whether the proposed activity or portions thereof should be authorised; and ii. if the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	i. **Section 8** ii. **Sections 7.3.1** and **Sections 7.3.2**
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	See Section 1.4
(p) any other information requested by the competent authority	Nothing requested

Contents of this report in terms of Regulation GNR 982 of 2014, Appendix 3 - Environmental Impact Assessment Process	**Cross-reference in this report**
Describe any policies or legislation relevant to your field that the applicant will need to comply with.	Original noise report dated October 2015
Comment on need/desirability of the proposal in terms your field and in terms of the proposal's location.	**Section 6.5**
Determine the-- (i) nature, significance, consequence, extent, duration and probability of the impacts occurring to inform identified preferred alternatives; and (ii) degree to which these impacts- (aa) can be reversed; (bb) may cause irreplaceable loss of resources, and (cc) can be avoided, managed or mitigated;	**Sections 6.2**, **6.3.1**, **6.3.2** and **6.3.3**. Also see original report dated October 2015.
Determine what the most ideal location within the site for the activity is in terms of your field.	**Section 6.5**
Identify suitable measures to avoid, manage or mitigate identified impacts.	(i) **planning, design and pre-construction**; Section 6.1 (iii) **construction**; Section 6.2 (iv) **operation;** Section 6.3 (v) **decommissioning, closure & rehabilitation**. Section 6.4
Identify residual risks that need to be managed and monitored.	There will be no residual risks after closure.
Include a concluding statement indicating a preferred alternative in terms of your field.	Original noise report dated October 2015

This report should be sited as:

De Jager, M. (2016): "*Addendum to the Environmental Noise Impact Assessment for the proposed Komsberg wind energy facility between Laingsburg and Sutherland, Northern and Western Cape*". Enviro-Acoustic Research CC, Pretoria

Client:

Arcus Consulting
for
Komsberg Windfarms (Pty) Ltd

Office 211 Cube Workspace
Cnr Long Street and Hans Strijdom Road
Cape Town
8001

Report no:

AC-KWF/A-ENIA/201603-Rev 0

Author:

M. de Jager *(B. Ing (Chem))*

Review:

Shaun Weinberg *(B.Sc. Applied Mathematics in Physics Stream – in process)*

Date:

March 2016

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GLOSSARY OF ABBREVIATIONS

DoE	Department of Energy
EAP	Environmental Assessment Practitioner
EARES	Enviro Acoustic Research cc
ECA	Environment Conservation Act (Act 78 of 1989)
EMP	Environmental Management Plan
FEL	Front End Loader
i.e.	that is
IFC	International Finance Corporation
km	kilometres (measurement of distance)
LDV	Light delivery vehicle
LHD	Load haul dumper
m	meters (measurement of distance)
m^2	Square meter
m^3	Cubic meter
mamsl	Meters above mean sea level
m/s	meters per second
MW	Megawatts
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NCR	Noise Control Regulations (under Section 25 of the ECA)
NSD	Noise-sensitive development
SABS	South African Bureau of Standards
SANS	South African National Standards
SUV	Sports Utility Vehicle
TLB	Tip Load Bucket
ToR	Terms of Reference
UTM	Universal Transverse Mercator
WHO	World Health Organisation
WEF	Wind Energy Facility
WTG	Wind Turbine Generators

1 INTRODUCTION

1.1 INTRODUCTION AND PURPOSE

Enviro-Acoustic Research (EARES) was requested to review revised layouts for the Komsberg East and West Wind Farms. This facility will be located on various farms between Laingsburg and Sutherland in the Western and Northern Cape (see **Figure 1-1** for study area).

This addendum report describes the potential noise impact that this facility may have on the surrounding sound environment, including potentially noise-sensitive developments. The report should ideally be read in conjunction with the original report, titled: M. de Jager,2015 *"Environmental Noise Impact Assessment for the proposed Komsberg wind energy facility between Laingsburg and Sutherland, Northern and Western Cape"*.

1.2 BRIEF PROJECT DESCRIPTION

Komsberg Windfarms (Pty) Ltd (the developer) proposes the establishment of a commercial Wind Energy Facility (WEF) and associated infrastructure on various farms just between Laingsburg and Sutherland in the Western and Northern Cape.

The WEF will be divided into two projects, namely the Komsberg West and Komsberg East Wind Farms. It is proposed that Komsberg West and East WEF's will each have a potential maximum installed capacity of 275MW[1](megawatt), this being based on the use of 55 Wind Turbine Generators (WTG) with WTG's having a potential maximum rated power of 5MW each[2].

The developer is investigating a number of different wind turbine models; not excluding the possibility of larger models that are not yet available in the commercial market. These include the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3250. For the purpose of this noise assessment the sound power emission levels of the Acciona AW125/3000 turbine will be used.

[1] The maximum capacity applied for in this application is greater than the current Department of Energy (DoE) limit of 140MW installed capacity. The reason for applying for a greater capacity at this point in time is due to the long lead times involved in wind farm developments (2 – 5 years) from conception to construction. Hence, the applicant is applying for 275MW in order to cater for a potential change in policy in future Government procurement processes where the limit may be increased.

[2] The level of installed capacity applied for (275MW) also relies on the proposed use of a 5MW wind turbine. The developer will only select a wind turbine at a later stage when more meteorological data is available and technical or commercial viability can be confirmed.

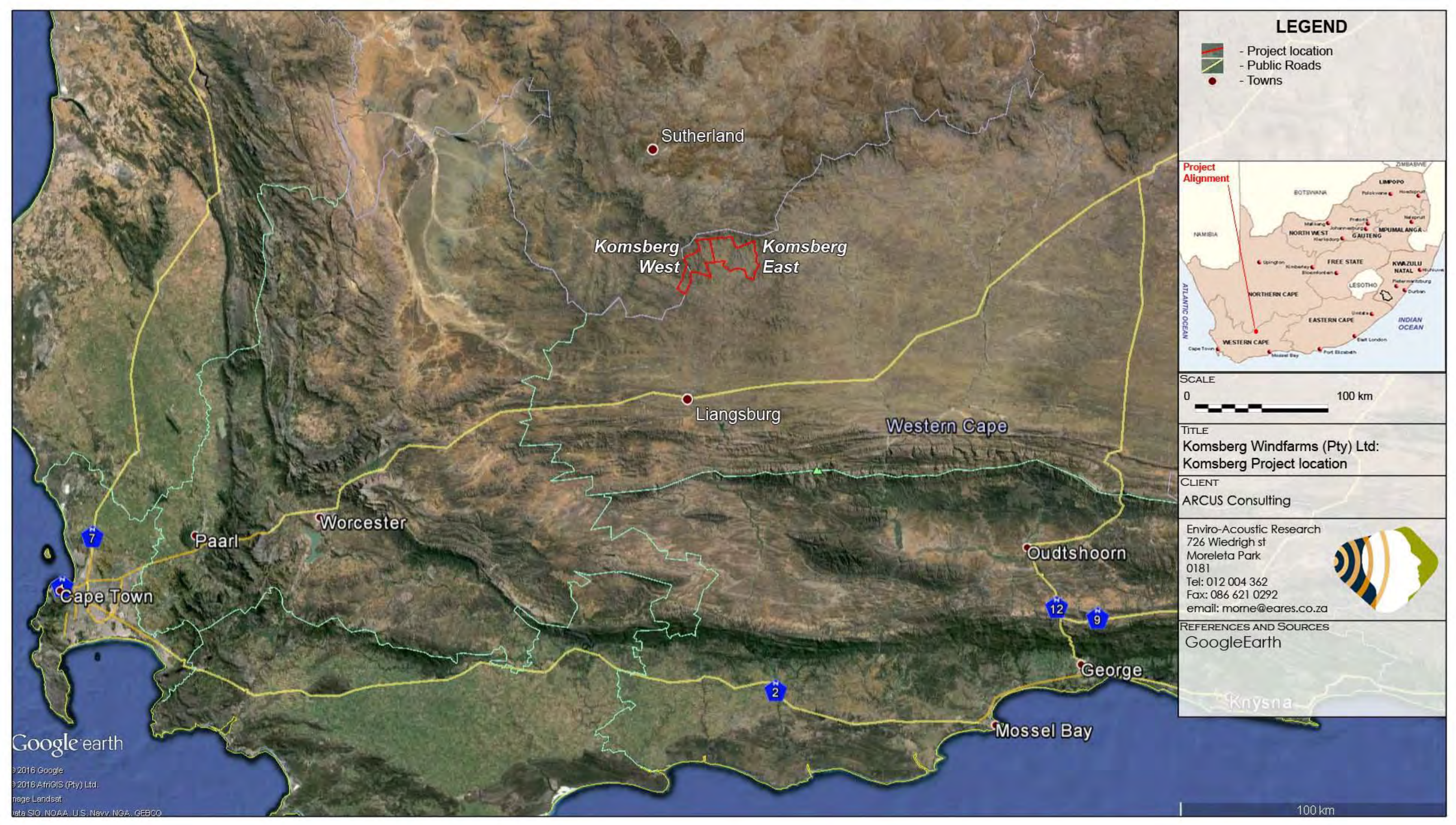

Figure 1-1: Locality map indicating the two Wind Farms of the Komsberg Project

1.3 POTENTIAL NOISE-SENSITIVE RECEPTORS (DEVELOPMENTS) AND NO-GO AREAS

Potentially sensitive receptors, also known as noise-sensitive developments (NSDs), located within or close to the WEF's were identified using Google Earth® during the Scoping Phase, confirmed by means of a site visit to define the status of the identified dwellings.

1.4 COMMENTS REGARDS TO NOISE RECEIVED DURING THIS PROJECT

Three comments were received from Interested and Affected Parties (I&AP) in the area as highlighted below.

I&AP	Comment from I&AP	Feedback
Falcon Oil and Gas	Concern about the potential impact of noise and vibrations (from the wind turbines) on future seismic exploration surveys for shale gas resources.	Opinion that this is a matter that should be dealt with on a corporate level, and, should there be a real need for an investigation this should be done by a specialist in this particular field.
Mr. Johan Biesenbach	Potential of traffic noise if the project makes use of the access road passing his dwelling.	The access routes avoids this dwelling.
	Question whether helicopters will be used to deliver some equipment.	It is the understanding that helicopters will not be used to deliver equipment.
	Specific request that they be added as a potential noise-sensitive receptor. Projected noise impact to be assessed at their dwelling.	Receptor has been included (NSD12 **Figure 1-2**).

1.5 TERMS OF REFERENCE (TOR)

The ToR is to remodel and assess the potential noise impact on all identified potential noise-sensitive receptors during the construction and operational phases from the two wind farms. The methodology will be similar than the one employed and defined in the original noise study dated October 2015.

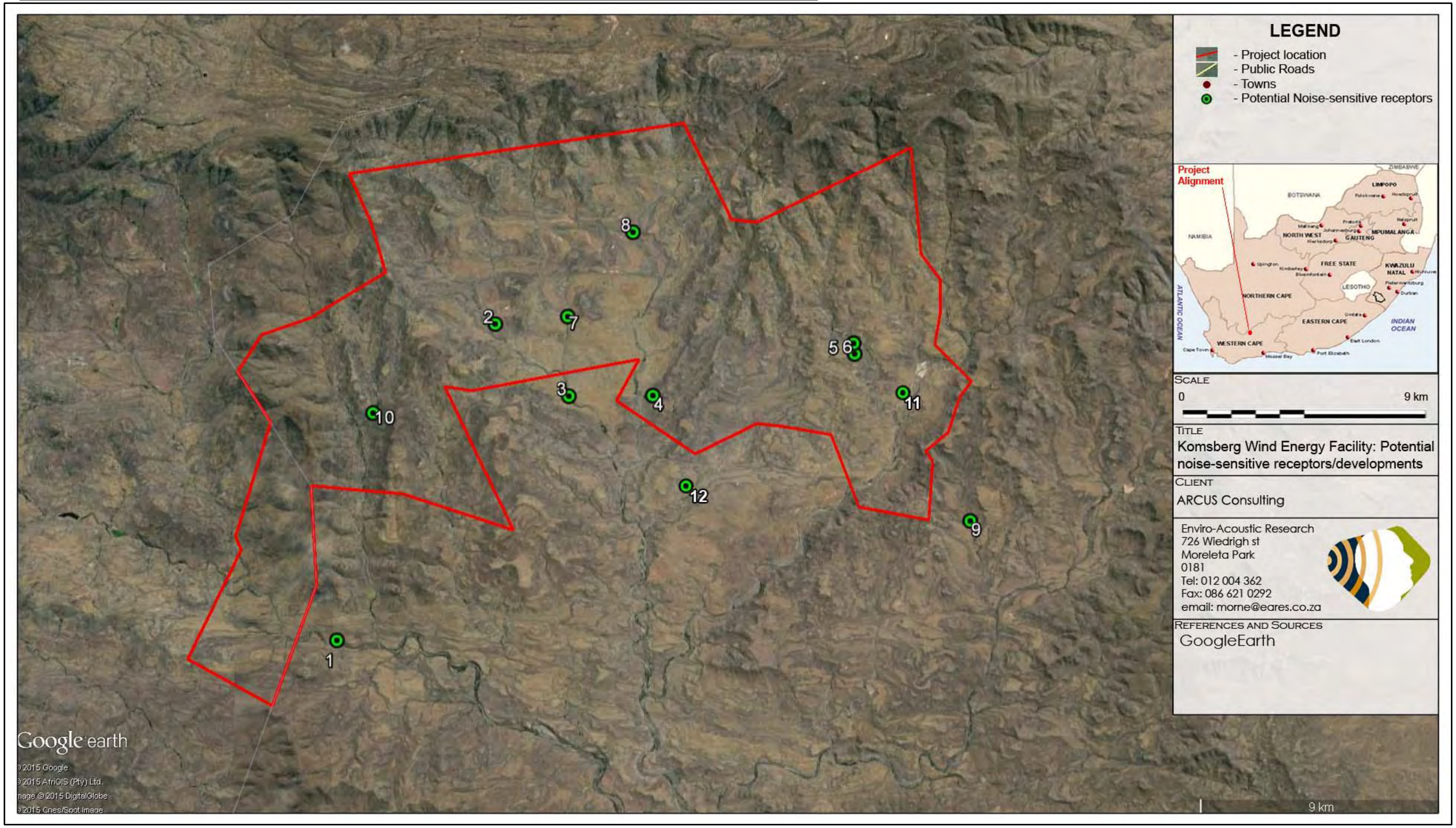

Figure 1-2: Aerial image indicating potentially noise-sensitive receptors[3]

[3] Reported by developer that NSD10 is Abandoned / old homestead

2 AMBIENT SOUND LEVELS AND CHARACTER

Ambient sound levels were measured at two locations over a period of two nights during October 2015. It is the opinion of the author that the sound levels as measured would be typical of the sound levels around dwellings in the area. It should be noted that the data includes measurements collected when the wind speed exceeded 3 m/s.

Wind induced noises are normally seen as unwanted noises, with measurements reflecting acoustic interference (due to wind induced noises) normally discarded. However, for the purpose of this study it was included, as the typical operating noise of the wind energy facility will only be emitted during times when wind induced noise levels are relevant.

Measurements were collected at the main dwelling at NSD05 (Mr. Müller) as well as the dwelling of NSD02 (Mr. Myburg). Both locations indicated that the area is very quiet at times[4], with the L_{A90} values indicating that the area is generally quiet. While a few measurements indicate sounds typically associated with anthropogenic activities (mainly during the day), the area can be considered naturally quiet and of rural character.

While the sound levels were slightly elevated at times, the ambient sound levels are typical of a rural noise district and rating levels as recommended by SANS 10103:2008 will be rural (45 dBA during the day, 35 dBA at night). Considering the equivalent fast-weighted data, sound levels are well within the noise limits set by the International Finance Corporation (55 dBA day, 45 dBA night).

[4] Sound levels were slightly higher at the dwelling of Mr. Myburg.

3 POTENTIAL NOISE SOURCES

3.1 POTENTIAL NOISE SOURCES: CONSTRUCTION PHASE

It is estimated that construction will take approximately 18 - 24 months subject to the final design of the WEF, weather and ground conditions, including time for testing and commissioning. Activities associated with the construction phase are discussed in more detail in the Noise Report dated October 2015. This review will consider the following:

- Construction of the wind turbines (Excavator, TLB, possibly small scale crushing, Concrete Mixing or supply trucks, road trucks, mobile cranes, possibly rock breakers, general noise);
- Various other activities associated with construction, such as construction of substations, laydown areas, culverts and office/workshop buildings.
- The construction activities associated with the Overhead Power Lines (TLB, Concrete Mixing or supply trucks, road trucks, mobile crane, possibly rock breakers, general noise);
- The construction activities associated with the access roads (bulldozer or grader, road trucks, possibly vibratory roller);
- Increased construction traffic (abnormal road trucks, road trucks, low-bed trucks, delivery vehicles, LDV and SUV's);
- Commissioning activities (typical of operational wind turbine noise, addressed in the operational noise impact section).

Of these, the construction of the wind turbines generates the most noise, due to the number of equipment operating simultaneously at the same location for a number of days. Construction may also take place at a number of locations simultaneously in a certain area.

3.2 POTENTIAL NOISE SOURCES: OPERATIONAL PHASE

The proposed development would be designed to have an operational life of up to 25 years, although the producer agreement with the state may only be 20 years. During operation of the development, the large majority of the WEF sites will continue with agricultural use as it is currently. The only development related activities on-site will be routine servicing and unscheduled maintenance. The noise impact from maintenance activities is insignificant, with the main noise source being the wind turbine blades and the nacelle (components inside).

Noises created by the wind turbine also increases as the wind speed increase. At a low wind speed the noise created by the wind turbine is generally (relatively) low, and increases to a maximum at a certain wind speed when it either remains constant, increase very slightly or even drops as illustrated in **Figure 3-1**. The sound power emissions (in octave sound power levels) as used in this report are presented in **Table 5-1**.

The developer is investigating a number of different wind turbine models, not excluding the possibility of larger models that are not yet available in the commercial market. Therefore, for the purpose of this noise assessment a worse-case scenario will be investigated, making use of the sound power emission levels of the Acciona AW125/3000 turbine (refer to **Figure 3-1**).

The developer is also considering the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3150. While the sound power emission levels of the Vestas V126 3.45/3.6 are similar to the Vestas V117 3.3 MW, the sound power emission levels of the Acciona AW125/3000 is approximately 1.5 dB higher than either the Vestas WTGs.

The propagation model makes use of various frequencies, because these frequencies are affected in different ways as it propagates through air, over barriers and over different ground conditions providing a higher accuracy than models that only use the total sound power level. The octave sound power levels for various wind turbines are presented on **Figure 3-2**.

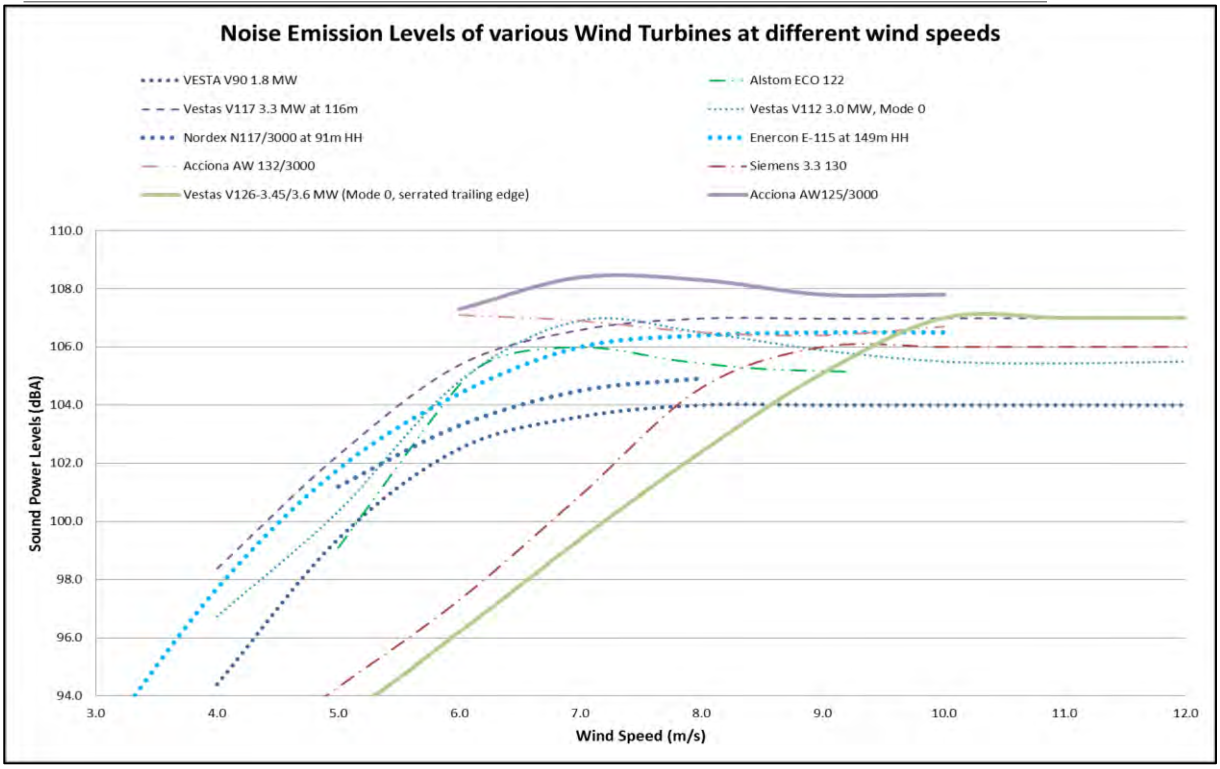

Figure 3-1: Noise Emissions Curve of a number of different wind turbines (figure for illustration purposes only)

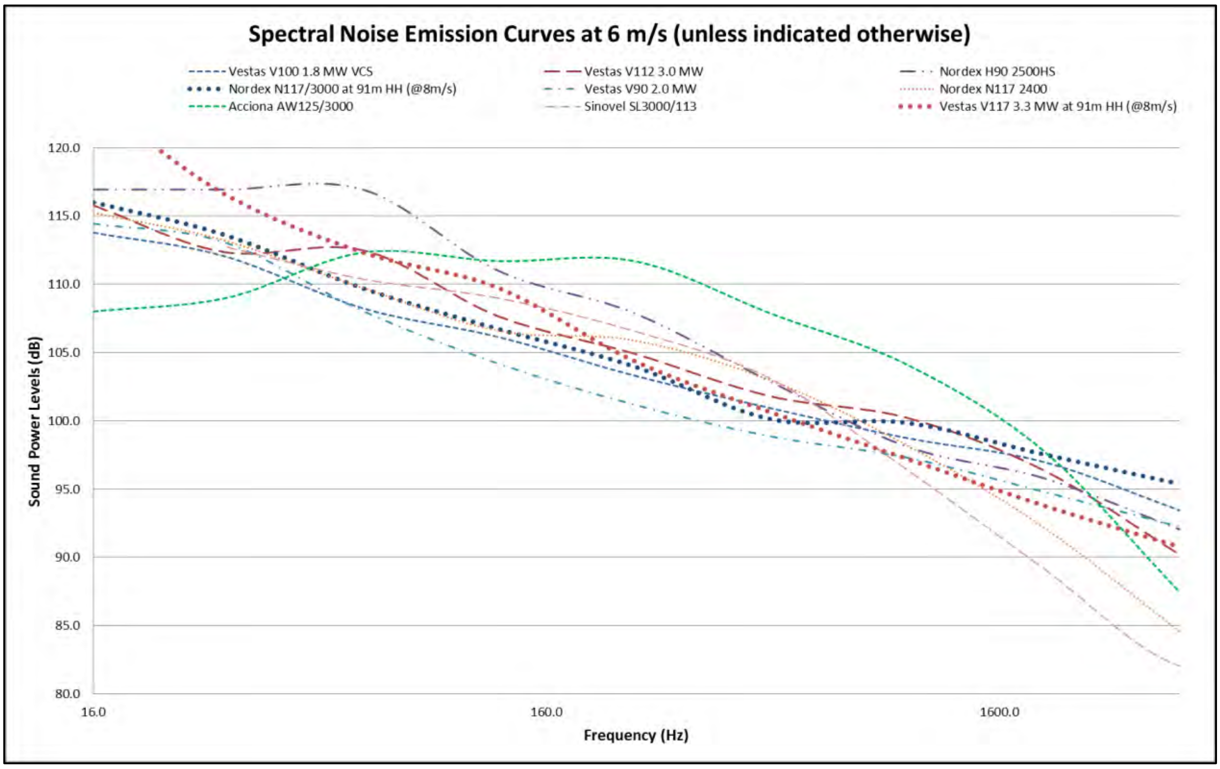

Figure 3-2: Octave sound power emissions of various wind turbines

3.2.1.1 Control Strategies to manage Noise Emissions during operation

Wind turbine manufacturers provide their equipment with control mechanisms to allow for a certain noise reduction during operation that can include:

- A reduction of rotational speed, and/or
- the increase of the pitch angle and/or reduction of nominal generator torque to reduce the angle of attack.

These mechanisms are used in various ways to allow the reduction of noise levels from the wind turbines, although this also results in a reduction of power generation. Enabling these various noise control strategies can reduce noise emissions up to 3 dB.

4 METHODS: NOISE IMPACT ASSESSMENT AND SIGNIFICANCE

4.1 NOISE IMPACT ON ANIMALS[5]

A great deal of research was conducted in the 1960's and 1970's on the effects of aircraft noise on animals. While aircraft noise have a specific characteristic that might not be comparable with industrial noise, the findings should be relevant to most noise sources.

Overall, the research suggests that species differ in their response to:

- Various types of noise;
- Durations of noise; and
- Sources of noise.

A general animal behavioural reaction to aircraft noise is the startle response. However, the strength and length of the startle response appears to be dependent on:

- which species is exposed;
- whether there is one animal or a group; and
- whether there have been some previous exposures.

Unfortunately, there are numerous other factors in the environment of animals that also influence the effects of noise. These include predators, weather, changing prey/food base and ground-based disturbance, especially anthropogenic (people walking and driving). This hinders the ability to define the real impact of noise on animals.

From these and other studies the following can be concluded:

- Animals respond to impulsive (sudden) noises (higher than 90 dBA) by running away. If the noises continue, animals would try to relocate.
- Animals of most species exhibit adaptation with noise, including aircraft noise and sonic booms.
- More sensitive species would relocate to a more quiet area, especially species that depend on hearing to hunt or evade prey, or species that makes use of sound/hearing to locate a suitable mate.
- Noises associated with helicopters, motor- and quad bikes significantly impact on animals.

[5] Report to Congressional Requesters, 2005; USEPA, 1971; Autumn, 2007; Noise quest, 2010

4.2 WHY NOISE CONCERNS COMMUNITIES[6]

Noise can be defined as "unwanted sound", and an audible acoustic energy that adversely affects the physiological and/or psychological well-being of people, or which disturbs or impairs the convenience or peace of any person. One can generalise by saying that sound becomes unwanted when it:

- Hinders speech communication;
- Impedes the thinking process;
- Interferes with concentration;
- Obstructs activities (work, leisure and sleeping); and
- Presents a health risk due to hearing damage.

However, it is important to remember that whether a given sound is "noise" depends on the listener or hearer. The driver playing loud rock music on their car radio hears only music, but the person in the traffic behind them hears nothing but noise.

Response to noise is unfortunately not an empirical absolute, as it is seen as a multi-faceted psychological concept, including behavioural and evaluative aspects. For instance, in some cases, annoyance is seen as an outcome of disturbances, in other cases it is seen as an indication of the degree of helplessness with respect to the noise source.

Noise does not need to be loud to be considered "disturbing". One can refer to a dripping tap in the quiet of the night, or the irritating "thump-thump" of the music from a neighbouring house at night when one would like to sleep.

Severity of the annoyance depends on factors such as:

- Background sound levels, and the background sound levels the receptor is used to;
- The manner in which the receptor can control the noise (helplessness);
- The time, unpredictability, frequency distribution, duration, and intensity of the noise;
- The physiological state of the receptor; and
- The attitude of the receptor about the emitter (noise source).

[6] World Health Organization, 1999; Noise quest, 2010; Journal of Acoustical Society of America, 2009

4.3 IMPACT ASSESSMENT CRITERIA

4.3.1 Noise criteria of concern

The criteria used in this report were drawn from the criteria for the description and assessment of environmental impacts considering the latest EIA Regulations, SANS 10103:2008 as well as guidelines from the World Health Organization.

There are a number of criteria that are of concern for the assessment of noise impacts. These can be summarised in the following manner:

- *Increase in noise levels:* People or communities often react to an increase in the ambient noise level they are used to, which is caused by a new source of noise. With regards to the Noise Control Regulations (promulgated in terms of the ECA), an increase of more than 7 dBA is considered a disturbing noise. See also **Figure 4-1**.
- *Zone Sound Levels:* Previously referred to as the acceptable rating levels, it sets acceptable noise levels for various areas.
- *Absolute or total noise levels:* Depending on their activities, people generally are tolerant to noise up to a certain absolute level, e.g. 65 dBA. Anything above this level will be considered unacceptable.

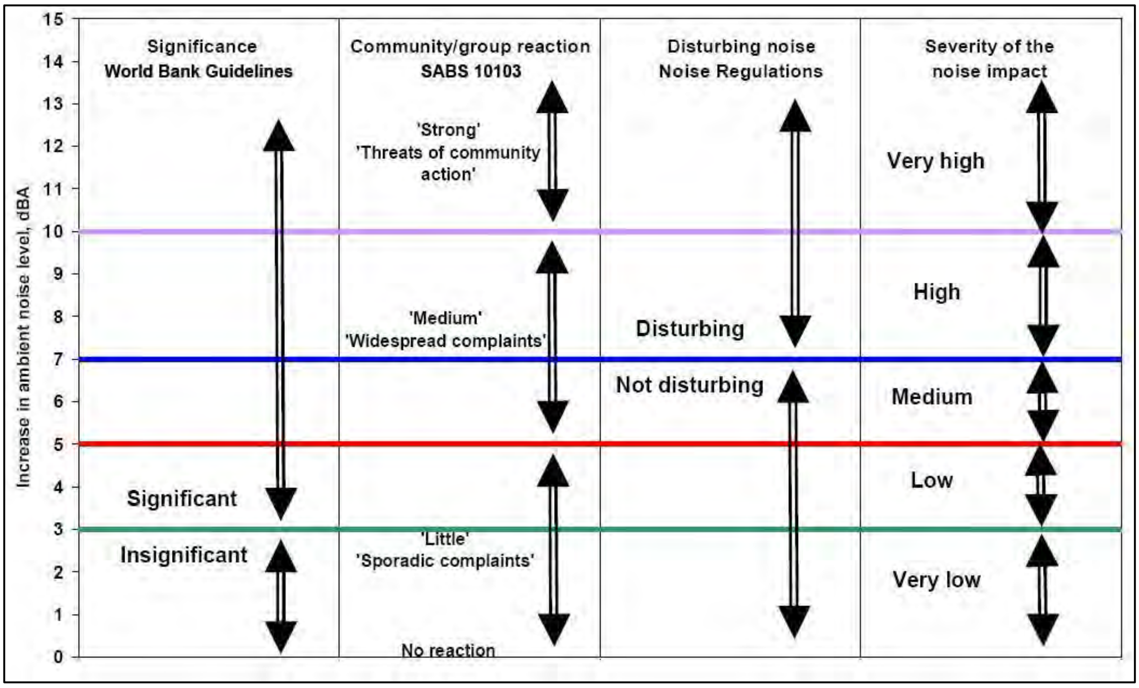

Figure 4-1: Criteria to assess the significance of impacts stemming from noise

In South Africa, the document that addresses the issues concerning environmental noise is SANS 10103:2008. It provides the equivalent ambient noise levels (referred to as Rating

Levels), $L_{Req,d}$ and $L_{Req,n}$, during the day and night respectively to which different types of developments may be exposed.

While acoustical measurements indicated an area where the ambient sound levels are slight higher than typically associated for a rural area, the potential noise impact will be evaluated in terms of (i.t.o.) the rural acceptable rating level as well as the IFC noise-limits as defined below:

- "Rural Noise Districts" (45 and 35 dBA day/night-time Rating i.t.o. SANS 10103:2008).
- "Equator principles" (55 and 45 dBA day/night-time limits i.t.o. IFC Noise Limits).

Note that an increase of more than 7 dBA is defined as a disturbing noise and prohibited (National and Provincial Noise Control Regulations).

4.3.2 Determining appropriate Zone Sound Levels

SANS 10103:2008 does not cater for instances when background ambient sound levels change due to the impact of external forces. Locations close (closer than 500 meters from coastline) from the sea for instance always has an ambient sound level exceeding 35 dBA, and, in cases where the sea is rather turbulent, it can easily exceed 45 dBA. Similarly, noise induced by high winds is not considered in the SANS standard.

Setting noise limits relative to the ambient sound level is relatively straightforward when the prevailing ambient sound level and source level are constant. However, wind turbines only start to operate when wind speeds exceed 3 m/s. Noise emissions therefore relates to the wind speed and similarly, the environment in which they are heard also depends upon the strength of the wind and the noise associated with its effects. It is therefore necessary to derive an ambient sound level that is indicative of the noise environment at the receiving property for different wind speeds so that the turbine noise level at any particular wind speed can be compared with the ambient sound level in the same wind conditions.

4.3.2.1 Using International Guidelines to set Noise Limits

When assessing the overall noise levels emitted by a Wind Energy Facility, it is necessary to consider the full range of operating wind speeds of the wind turbines. This covers the wind speed range from around 3-5 m/s (the turbine cut-in wind speed) up to a wind speed range of 25-35 m/s measured at the hub height of a wind turbine. However, ETSU-R97 (1996) proposes that noise limits only be placed up to a wind speed of 12 m/s for the following reasons:

1. Wind speeds are not often measured at wind speeds greater than 12 m/s at 10 m height;

2. Reliable measurements of background ambient sound levels and turbine noise will be difficult to make in high winds due to the effects of wind noise on the microphone and the fact that one could have to wait several months before such winds were experienced;
3. Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons; and
4. If a wind farm meets noise limits at wind speeds lower than 12m/s, it is most unlikely to cause any greater loss of amenity at higher wind speeds. Turbine noise levels increase only slightly as wind speeds increase; however, background ambient sound levels increase significantly with increasing wind speeds due to the force of the wind.

Ambient sound vs. wind speed data is presented in **Figure 4-2**[7]. It indicates sound levels as measured at quiet (as per the opinion of the author) locations[8] where there were no apparent or observable sounds that would have impacted on the measurements, presenting the A-Weighted sound levels at an inland area. The figures clearly indicate a trend where sound levels increase if the wind speed increases. This has been found at all locations where measurements have been done for a sufficiently long enough period of time (more than 30 locations – more than 38,000 measurements).

[7] The sound level measuring instruments were located at a quiet location in the garden of the various houses. Data was measured in 10-minute bins and then co-ordinated with the 10 m wind speed derived from the wind mast of the developer. This wind mast normally was not close to the dwelling, at times being further than 5,000 meters from the measurement location. It is possible that the wind may be blowing at the location of the wind mast with no wind at the measurement location, resulting in low sound levels recorded (and visa versa).

[8] Different area where longer measurements were collected.

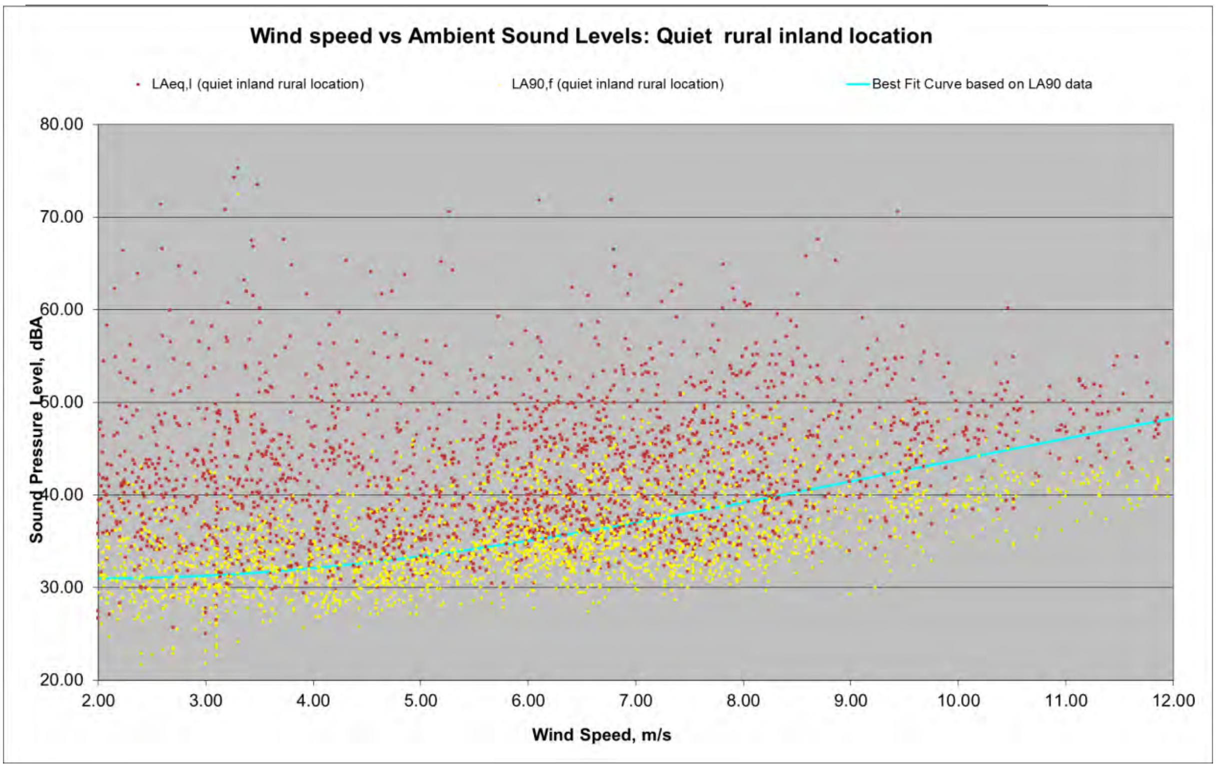

Figure 4-2: Ambient sound levels – quiet inland location (A-Weighted)

Considering this data as well as the international guidelines, noise limits starting at 40 dB that increases to more than 45 dB (as wind speeds increase) is acceptable. It does not state daytime limits.

In addition, project participants could be exposed to noise levels up to 45 dBA (ETSU-R97) at lower wind speeds.

4.3.2.2 Using local regulations to set noise limits

Noise limits as set by the Western Cape Provincial Noise Control Regulations (PN.20 of 2013 defines a "**disturbing noise**" as the noise that —

- exceeds the rating level by 7 dBA;
- exceeds the residual noise level (where the residual noise level is higher than the rating level);
- exceeds the residual noise level by 3 dBA where the residual noise level is lower than the rating level (Western Cape); or
- in the case of a low-frequency noise, exceeds the level specified in Annex B of SANS 10103;

Accepting that the area is a rural district, night-time rating levels would be 35 dBA and a noise level exceeding 42 dBA could be a disturbing noise (therefore the noise limit). The daytime rating level is 45 dBA (52 dBA for a disturbing noise).

4.3.3 Determining the Significance of the Noise Impact

The level of detail as depicted in the EIA regulations was fine-tuned by assigning specific values to each impact. In order to establish a coherent framework within which all impacts could be objectively assessed, it was necessary to establish a rating system, which was applied consistently to all the criteria.

The significance of environmental impacts is a function of the environmental aspects that are present and to be impacted on, the probability of an impact occurs and the consequence of such an impact occurring before and after implementation of proposed mitigation measures.

For such purposes each aspect was assigned a value as defined in the third column in the tables below.

4.3.3.1 Extent (spatial scale) of impact

L	M	H
Impact is localized within site boundary	Widespread impact beyond site boundary; Local	Impact widespread far beyond site boundary; Regional/national

Factors with regards to extent that will be considered include:

- Access to resources (amenity);
- Threats to lifestyles, traditions and values; and
- Cumulative impacts, including possible changes to land uses at and around the site.

4.3.3.2 Duration of noise impact

L	M	H
Quickly reversible, less than project life, short term (0-5 years)	Reversible over time; medium term to life of project	Long term; beyond closure; permanent; irreplaceable or irretrievable commitment of resources

Factors with regards to extent that will be considered include the cost – benefit, both economically and socially (e.g. long or short term costs/benefits).

4.3.3.3 Intensity (severity or magnitude) of noise impact

Type of Criteria	**Negative noise impact**		
	H-	**M-**	**L-**
Qualitative	Substantial deterioration, death, illness or injury, loss of habitat/diversity or resource, severe alteration or disturbance of important processes.	Moderate deterioration, discomfort, Partial loss of habitat/biodiversity/resource or slight or alteration	Minor deterioration, nuisance or irritation, minor change in species/habitat/diversity or resource, no or very little quality deterioration.
Quantitative	Measurable deterioration, recommended level will often be violated (e.g. pollution)	Measurable deterioration, recommended level will occasionally be violated	No measurable change; Recommended level will never be violated
Community response	Vigorous	Widespread complaints	Sporadic complaints

Type of Criteria	**Positive noise impact**		
	L+	**M+**	**H+**
Qualitative	Minor improvement, restoration, improved management	Moderate improvement, restoration, improved management, substitution	Substantial improvement, substitution
Quantitative	No measurable change; Within or better than recommended level.	Measurable improvement	Measurable improvement
Community response	No observed reaction	Some support	Favourable publicity

Factors with regards to intensity that will be considered include:

- Cost – benefit economically and socially (e.g. high net cost = substantial deterioration);
- Impacts on human-induced climate change;
- Impacts on future management (e.g. easy/practical to manage with change or recommendation).

4.3.3.4 Probability of occurrence:

L	**M**	**H**
Unlikely; low likelihood; Seldom. No known risk or vulnerability to natural or induced hazards.	Possible, distinct possibility, frequent. Low to medium risk or vulnerability to natural or induced hazards.	Definite (regardless of prevention measures), highly likely, continuous. High risk or vulnerability to natural or induced hazards.

4.3.3.5 Significance of noise impact

Based on a synthesis of the information contained in sub-sections **4.3.3.1** to **4.3.3.4** above, it will be possible to calculate a significance of the potential noise impacts in terms of the following criteria:

Significance: (Duration X Extent X Intensity)

Intensity = Low				
Duration	**H**			
	M			Medium
	L	Low		
Intensity = Medium				
Duration	**H**			High
	M		Medium	
	L	Low		
Intensity = High				
Duration	**H**			
	M			High
	L	Medium		
		L	M	H
		Extent		

Positive impacts would be ranked in the same way as negative impacts, but result in high, medium or low positive consequence.

4.4 REPRESENTATION OF NOISE LEVELS

Noise rating levels will be calculated in the ENIA report using the appropriate sound propagation models as defined. It is therefore important to understand the difference between sound or noise level as well as the noise rating level.

Sound or noise levels generally refers to a level as measured using an instrument, whereas the noise rating level refers to a calculated sound exposure level to which various corrections and adjustments was added. These noise rating levels are further processed into a 3D map illustrating noise contours of constant rating levels or noise isopleths. In the ENIA it will be used to illustrate the potential extent of the calculated noises of the complete project and not noise levels at a specific moment in time.

5 PROJECTED NOISE RATING LEVELS

5.1 PROPOSED CONSTRUCTION PHASE NOISE IMPACT

Construction noises are mainly associated with point sources, typically stationary noise sources, such as an excavator or crane operating at one location for a certain amount of time. Noise sources that moves slowly (such as a grader) is taken as a stationary noise source.

While traffic does contribute to construction noises, it is significantly lower. This is because a noise impact are measured as the average over a set time period, and, while traffic can increase noise levels significantly while passing a potential noise-sensitive receptor, if the traffic is not constant, it does not impact significantly on the time-weighted averages. It however can increase annoyance with a project.

The wind turbine layout, location of the overhead lines as well as the proposed access roads is presented in **Figure 5-1**. These are locations where construction activities may take place. Not shown on this figure are locations where other construction activities may take place, including the building of culverts, temporary site camps and laydown areas. These locations are not shown as it clutters **Figure 5-1**, although the noise from these locations were considered and assessed. The projected noise levels are graphed in **Figure 5-2**. Noise created due to linear activities were also evaluated and plotted against distance as illustrated in **Figure 5-3**[9].

As it is unknown where the different activities may take place it was selected to model the impact of the noisiest activity (laying of foundation totalling 113.6 dBA cumulative noise impact – various equipment operating simultaneously) at all locations (over the full daytime period of 16 hours) where wind turbines (or power pylons or road construction activities) may take place for both layouts, calculating how this may impact on potential noise-sensitive developments.

[9] Sound level at a receiver set at a certain distance from a road – 10 trucks per hour gravel and tar roads

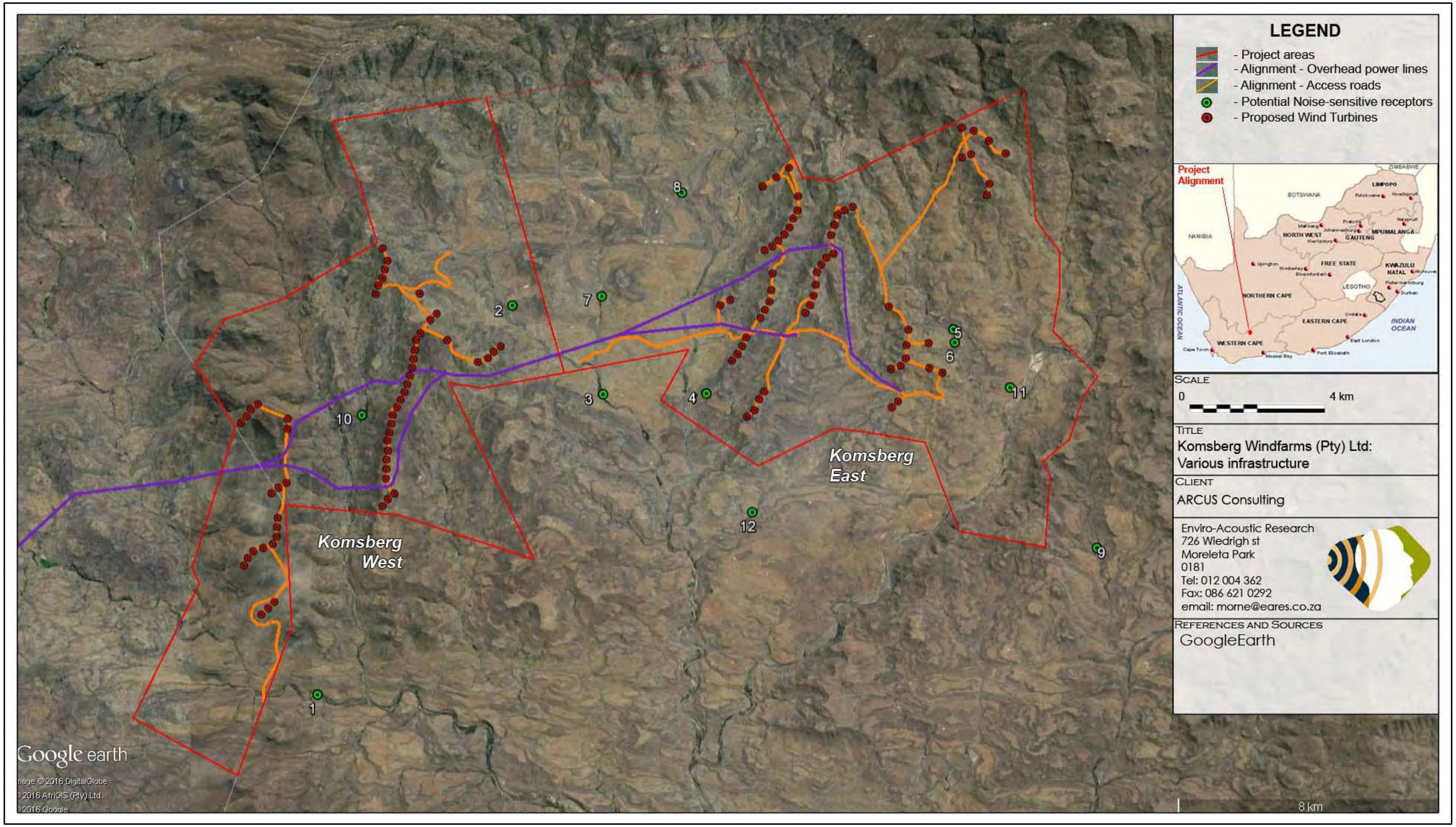

Figure 5-1: Infrastructure Locations – Locations where construction activities may take place

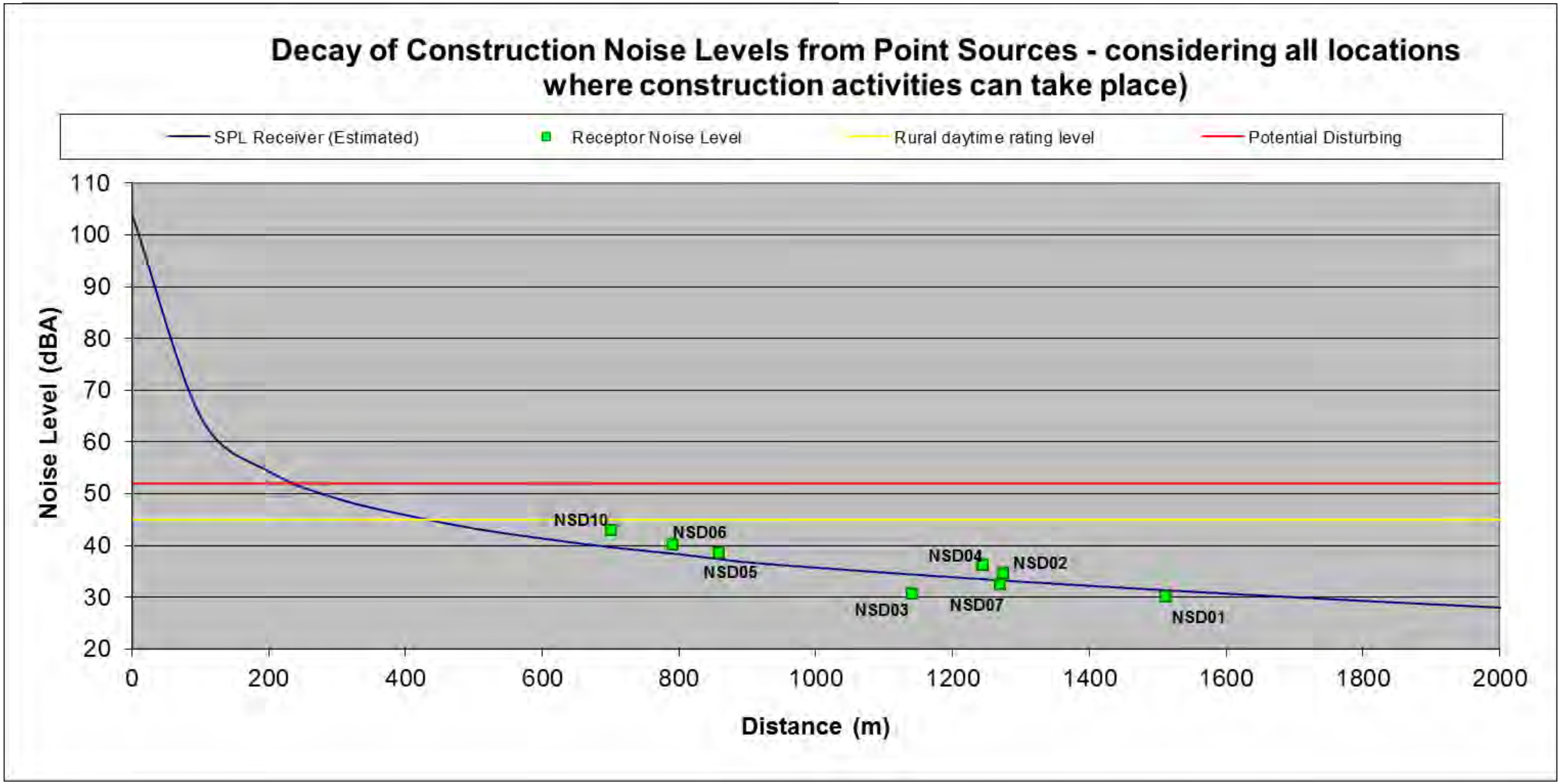

Figure 5-2: Projected conceptual construction noise levels[10] – Decay of noise from construction activities

[10] The graph includes all construction activities, including road, pylon and wind turbine construction as well as other small construction projects where significant noise can be generated.

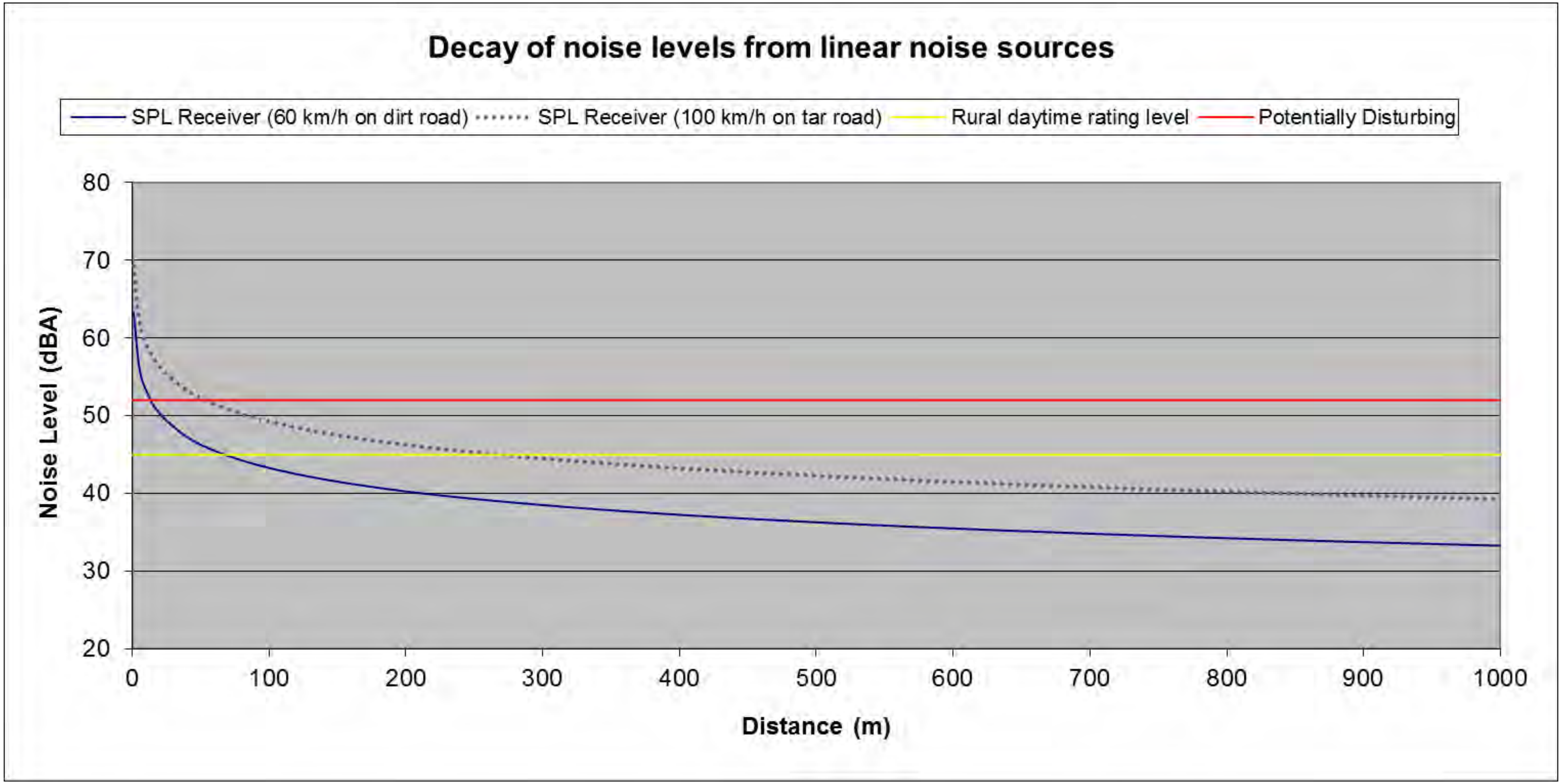

Figure 5-3: Projected conceptual construction noise levels – Decay over distance from linear activities

Even though construction activities are projected to take place only during day time, it might be required at times that construction activities take place during the night (particularly for a large project). Construction activities that may occur during night time:

- Concrete pouring: Large portions of concrete do require pouring and vibrating to be completed once started, and work is sometimes required until the early hours of the morning to ensure a well-established concrete foundation. However the work force working at night for this work will be considerably smaller than during the day.
- Working late due to time constraints: Weather plays an important role in time management in construction. A spell of bad weather can cause a construction project to fall behind its completion date. Therefore, it is hard to judge beforehand if a construction team would be required to work late at night.

5.2 OPERATIONAL PHASE NOISE IMPACT

Typical day time activities would include:

- The operation of the various Wind Turbines,
- Maintenance activities (relatively insignificant noise source).

The daytime period however, was not considered for the EIA because noise generated during the day by the WEF is generally masked by other noises from a variety of sources surrounding potentially noise-sensitive developments. However, times when a quiet environment is desired (at night for sleeping, weekends etc.) ambient sound levels are more critical. The time period investigated therefore would be a quieter period, normally associated with the 22:00 – 06:00 timeslot. Maintenance activities would therefore not be considered, concentrating on the ambient noise levels due to the operation of the various Wind Turbine Generators (WTGs) at night.

One layout was considered for each facility (East and West WEF, see **Figure 5-1**). This report makes use of the sound power emission levels for an Acciona AW125/3000 although the developer is also considering the use of the Vestas V126 3.45/3.6 MW and the Acciona AW125/3150 (refer to **Figure 3-1**) as well as other wind turbines as they enter the market.

The octave sound power levels of the Acciona AW125/3000 wind turbine used for modelling are presented in **Table 5-1**. The maximum sound power emission levels were used for all calculations. This model used a hub height of 87.5 m, but the results should be applicable for other hub heights for the same wind turbine, as changes in hub-height generally do not change the sound power emission level (for the same wind turbine), or the change is insignificantly small.

Table 5-1: Octave Sound Power Emission Levels used for modelling

Wind Turbine: Acciona AW125/3000 at hub height 87.5m										
Source Reference: Acciona Windpower. General Document DG200383, Rev D dated 04/04/14										
Maximum expected A-weighted Octave Sound Power Levels (dB re 1 pW)										
Frequency	**16**	**31.5**	**63**	**125**	250.0	**500**	**1000**	**2000**	**4000**	**8000**
Lpa (dB)	*not reported*	117.3	111.5	110.9	109.9	107.0	103.3	97.0	86.6	81.3
L_{WA} (dBA)	*not reported*	77.4	85.3	94.7	101.2	103.8	103.3	98.2	87.6	81.3

Wind speed at 10m height	Wind speed at hub height	A-Weighted Sound Power Level
6 m/s	8.5 m/s	107.3 dBA
7 m/s	9.9 m/s	108.4 dBA
8 m/s	11.3 m/s	108.3 dBA
9 m/s	12.7 m/s	107.8 dBA
10 m/s	14.1 m/s	107.8 dBA

5.2.1 Review of East WEF Layout for the Acciona WTG

Total noise rating levels considering the layout of the East WEF are presented in **Figure 5-4** with **Table 5-2** defining the noise rating levels at the closest potential noise-sensitive receptors for the East WEF for the Acciona turbine.

Table 5-2: Noise rating levels at closest potential noise-sensitive receptors, East WEF (approximate noise rating levels – Acciona WTG)

NSD	East WEF Layout (dBA)	NSD	East WEF Layout (dBA)
1	Less than 20	7	22.2
2	Less than 20	8	Less than 20
3	26.7	9	Less than 20
4	40.0	10[11]	Less than 20
5	41.1	11	31.9
6	40.2	12	28.8

5.2.2 Review of the West WEF Layout for the Acciona WTG

Total noise rating levels considering the layout of the West WEF is presented in **Figure 5-5**. **Table 5-3** defines the noise rating levels at the closest potential noise-sensitive receptors considering the Acciona AW125/3000 wind turbines.

[11] Abandoned / old homestead

Table 5-3: Noise rating levels at closest potential noise-sensitive receptors, West WEF (noise rating levels for Acciona WTG)

NSD	East WEF Layout (dBA)	NSD	East WEF Layout (dBA)
1	26.0	7	26.4
2	38.2	8	Less than 20
3	24.9	9	Less than 20
4	Less than 20	10[12]	43.6
5	Less than 20	11	Less than 20
6	Less than 20	12	Less than 20

5.2.3 Cumulative Noise Impact – Acciona WTG

The cumulative noise rating levels due to both East and West phases operating simultaneously is illustrated in **Figure 5-6** with the potential cumulative noise rating levels defined in **Table 5-4**.

Table 5-4: Noise rating levels at closest potential noise-sensitive receptors, Cumulative from West and East WEFs

NSD	Cumulative Noise Rating Levels (dBA)	NSD	Cumulative Noise Rating Levels (dBA)
1	26.0	7	27.8
2	38.2	8	33.9
3	28.9	9	Less than 20
4	40.0	10[13]	43.6
5	41.1	11	31.9
6	40.2	12	28.8

5.3 DECOMMISSIONING AND CLOSURE PHASE NOISE IMPACT

The potential for a noise impact to occur during the decommissioning and closure phase will be much lower than that of the construction and operational phases and noise from the decommissioning and closure phases will therefore not be investigated further.

[12] Abandoned / old homestead
[13] Abandoned / old homestead

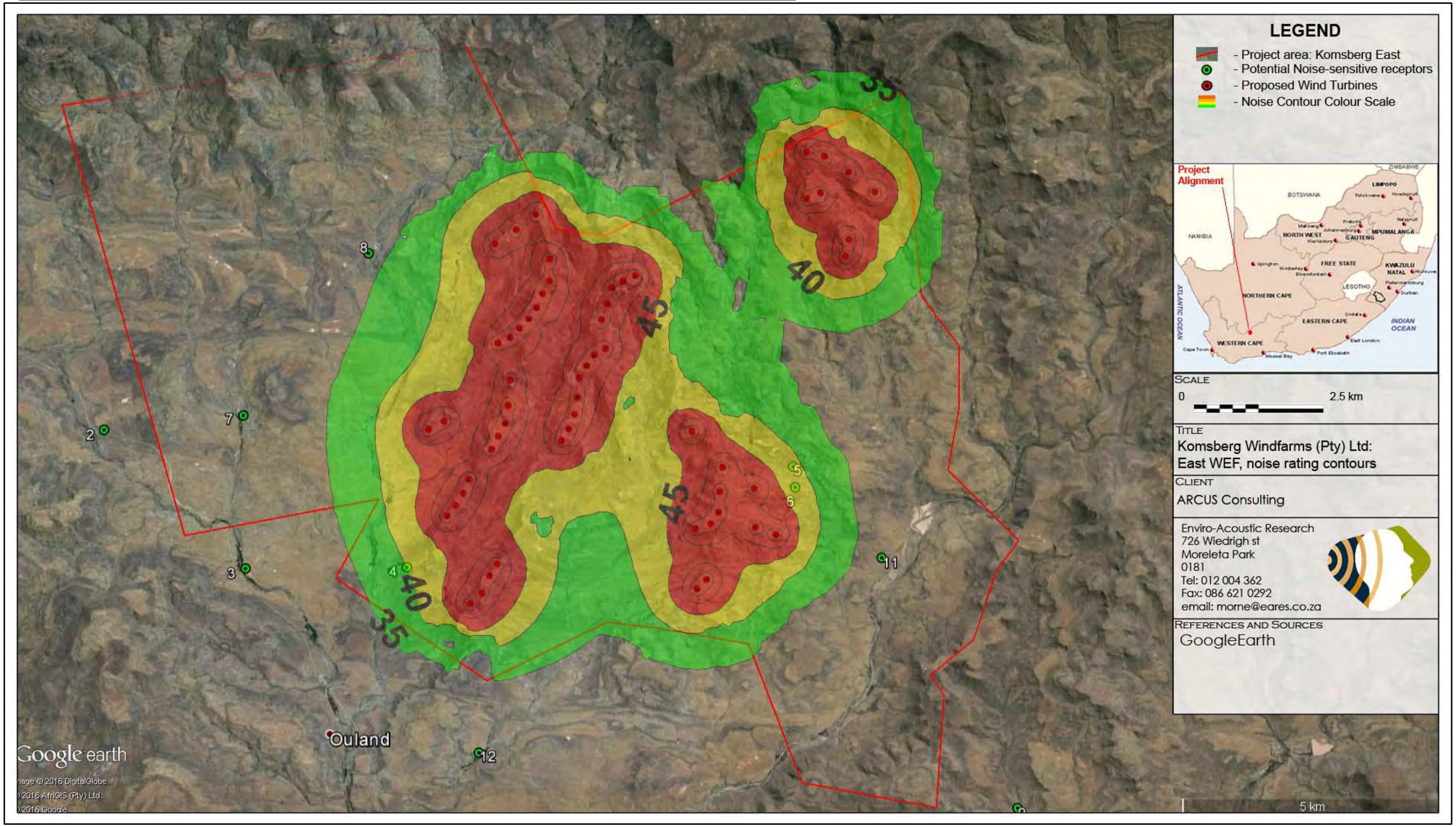

Figure 5-4: Projected conceptual night-time noise rating levels during operation – East WEF (Acciona WTG)

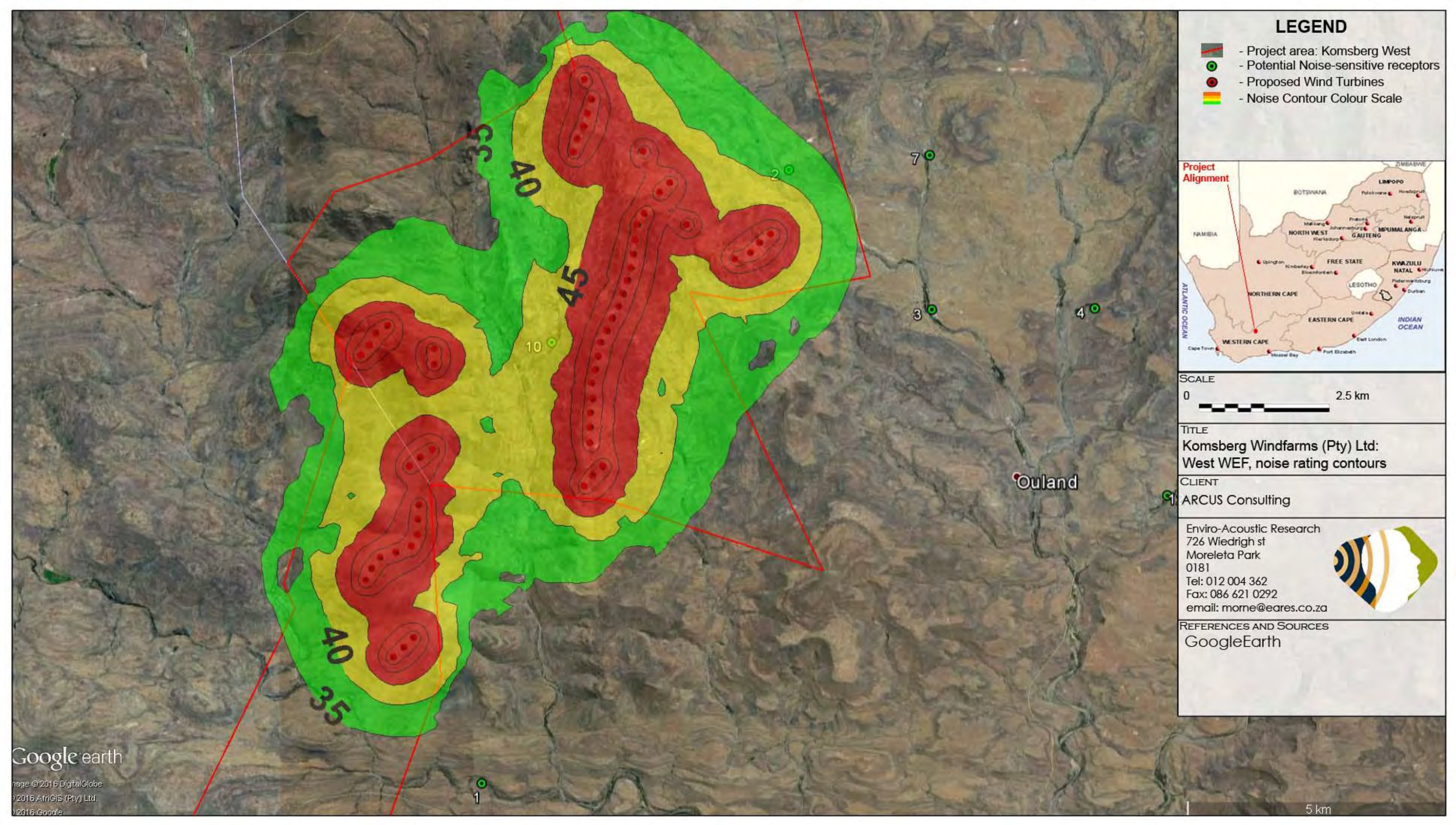

Figure 5-5: Projected conceptual night-time noise rating levels during operation – West WEF (Acciona WTG)

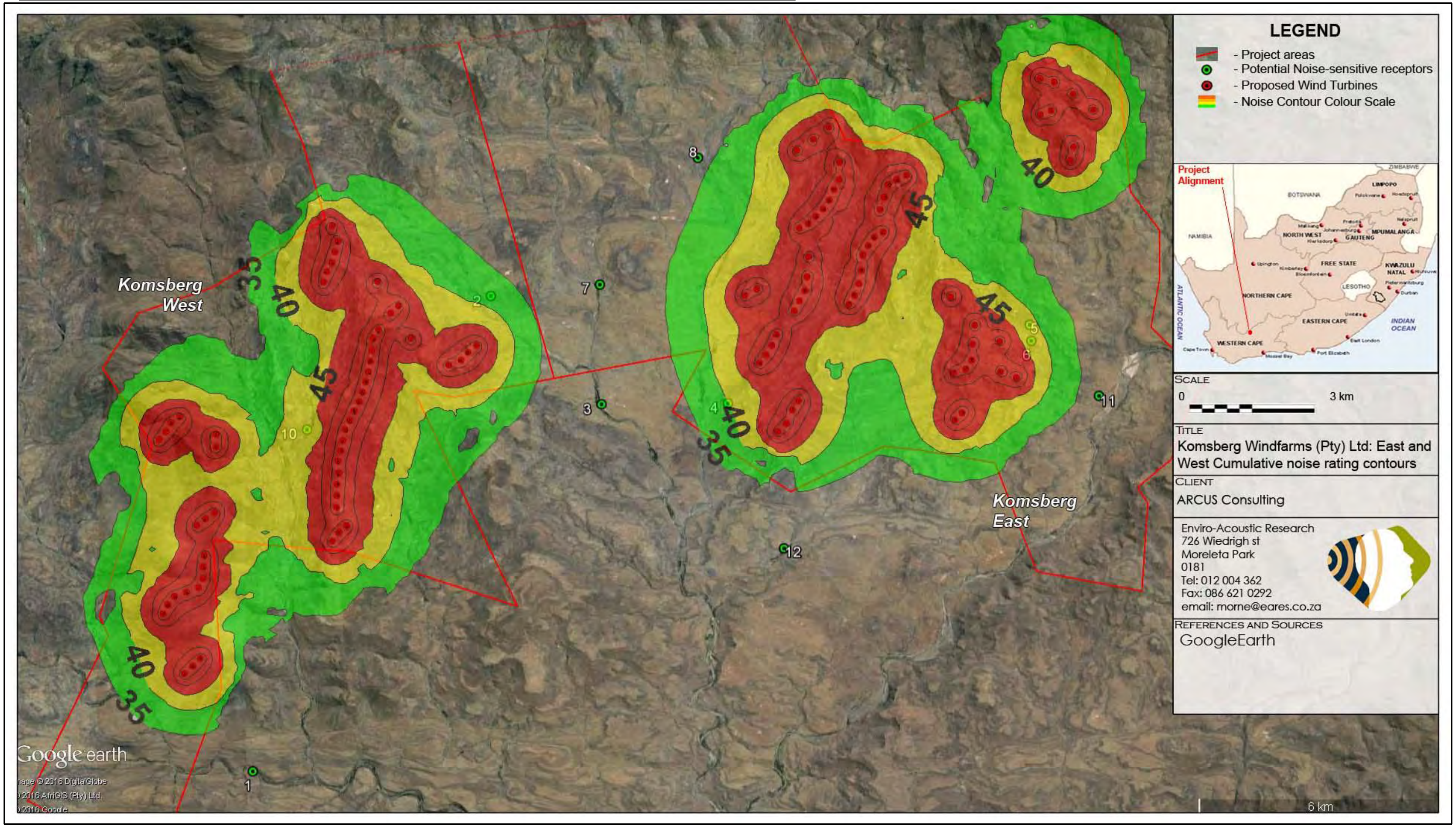

Figure 5-6: Projected conceptual night-time noise rating levels during operation – Komsberg Cumulative (Acciona WTG)

6 SIGNIFICANCE OF THE NOISE IMPACT

6.1 PLANNING PHASE NOISE IMPACT

No noise is associated with the planning phase and this will not be investigated in further.

6.2 CONSTRUCTION PHASE NOISE IMPACT

The noise sources associated with the various activities are described in **Section 3.1**, assessed and defined in **section 5.1**. Considering the projected noise levels (all significantly less than 45 dBA) as well as the expected daytime ambient sound level (higher than 45 dBA), there is a very low risk for a noise impact during the construction phase (for each WEF and all construction activities). The noise impact is quantified in **Table 6-1**. The potential noise impact from road traffic is quantified in **Table 6-2**.

6.3 OPERATIONAL PHASE NOISE IMPACT

Only the night-time scenario was assessed as this is the most critical time period when a quiet environment is desired.

6.3.1 Noise Impact Assessment – East WEF

The noise sources associated with the various activities are defined in **section 3.2**, with the projected noise levels calculated in **section 5.2.1**.

As can be seen from **Table 5-2**, the projected noise levels will be higher than the rural rating level at NSD04, NSD05 and NSD06, although the projected noise levels will not exceed the 42 dBA noise limit as proposed in **section 4.3.2.2** when considering the Acciona WTG. The extent of the impact is limited to an area approximately 1,000m from the wind turbines (for all the wind turbines considered), the intensity is medium on NSD04, NSD05 and NSD06 (it may be measured) and of medium duration (life of project). The significance of the noise impact is considered to be low on all receptors.

The significance of the noise impact is assessed and summarized in **Table 6-3** for the Acciona WTGs.

6.3.2 Noise Impact Assessment – West WEF

The noise sources associated with the various activities are defined in **section 3.2**, with the projected noise levels calculated in **section 5.2.2**. As can be seen **Table 5-3**, the projected noise levels will be higher than the rural rating level at NSD02 and NSD10, with the projected noise level higher than the 42 dBA limit at NSD10. While it was confirmed that the dwelling at location NSD10 is not used, it was kept in this assessment. The developer should get confirmation from the land owner that this dwelling will no longer be used for residential purposes. The extent of the impact is limited to an area approximately 1,000m from the wind turbines, the intensity is low on all receptors but NSD10 (potential high intensity) and of medium duration (life of project).

The significance of the noise impact is considered to be low on all receptors, medium on NSD10. The noise impact is assessed and summarized in **Table 6-4**.

6.3.3 Cumulative Noise Impact Assessment – East and West WEF

The noise sources associated with the various activities are defined in **section 3.2**, with the projected noise levels calculated in **section 5.2.3**.

As can be seen **Table 5-4**, the projected noise levels will be higher than the rural rating level at NSD02, NSD04, NSD05 and NSD06, with the projected noise rating level higher than the 42 dBA limit at NSD10. While it was confirmed that the dwelling at location NSD10 is not used, it was kept in this assessment as this was identified as a NSD during the scoping phase. The developer should get confirmation from the land owner that this dwelling will no longer be used for residential purposes. The extent of the impact is limited to an area approximately 1,000m from the wind turbines, the intensity is a potential medium on NSD04, NSD05 and NSD06, with a potential high intensity for receptor NSD10. Significance is low except for NSD 10, which is medium (but as mentioned, this is an abandoned dwelling).

The cumulative noise impact is assessed and summarized in **Table 6-5** for the Acciona WTG specifications.

6.4 DECOMMISSIONING PHASE NOISE IMPACT

Final decommissioning activities will have a noise impact lower than either the construction or operational phases. This is because decommissioning and closure activities normally take place during the day using minimal equipment (due to the decreased urgency of the project). While there may be various activities, there is a very small risk for a noise impact.

Table 6-1: Construction Activities (wind turbines, pylons, roads) – Noise Impact Assessment

Receiver no	**All construction activities – Noise rating level** **Leq - dBA**	**Typical daytime ambient sound levels**	**Extent**	**Intensity** **Negative**	**Duration**	**Significance**
1	30.0	45 - 55 dBA	Low	Low	Low	Low
2	34.6	45 - 55 dBA	Low	Low	Low	Low
3	30.7	45 - 55 dBA	Low	Low	Low	Low
4	36.3	45 - 55 dBA	Low	Low	Low	Low
5	38.5	45 - 55 dBA	Low	Low	Low	Low
6	40.2	45 - 55 dBA	Low	Low	Low	Low
7	32.4	45 - 55 dBA	Low	Low	Low	Low
8	30.7	45 - 55 dBA	Low	Low	Low	Low
9	29.6	45 - 55 dBA	Low	Low	Low	Low
10[14]	*43.0*	*45 - 55 dBA*	*Low*	*Low*	*Low*	*Low*
11	30.8	45 - 55 dBA	Low	Low	Low	Low
12	30.0	45 - 55 dBA	Low	Low	Low	Low

Comments:

Probability of impact	Very low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required
Cumulative impacts	Construction noises will cumulatively add to any other noises in the area, but it will be insignificant.
Residual Impacts:	This impact will only disappear after the construction phase.

[14] Confirmed that dwelling is not used. NSD kept in Impact Assessment as it was identified during Scoping as a dwelling.

Table 6-2: Construction Activities – Noise Impact Assessment: Road traffic

	Construction road traffic noise, average	**Typical daytime ambient sound levels**	**Extent**	**Intensity**	**Duration**	**Significance**
Receiver no	**Leq - dB(A)**			**Negative**		
1	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
2	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
3	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
4	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
5	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
6	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
7	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
8	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
9	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
10[15]	*Less than 20 dBA*	*45 - 55 dBA*	*Low*	*Low*	*Low*	*Low*
11	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low
12	Less than 20 dBA	45 - 55 dBA	Low	Low	Low	Low

Comments:	
Probability of impact	Very low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required
Cumulative impacts	Road traffic noises will cumulatively add to any other noises in the area, but it will be insignificant.
Residual Impacts:	This impact will only disappear after the construction phase.

[15] Confirmed that dwelling is not used. NSD kept in Impact Assessment as it was identified during Scoping as a dwelling.

Table 6-3: Operational Activities – Noise Impact Assessment: East WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
2	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
3	26.7	30 - 40 dBA	Low	Low	Medium	Low
4	40.0	30 - 40 dBA	Low	Medium	Medium	Low
5	41.1	30 - 40 dBA	Low	Medium	Medium	Low
6	40.2	30 - 40 dBA	Low	Medium	Medium	Low
7	22.2	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
10[16]	*Less than 20 dBA*	*30 - 40 dBA*	*Low*	*Low*	*Medium*	*Low*
11	31.9	30 - 40 dBA	Low	Low	Medium	Low
12	28.8	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

[16] Confirmed that dwelling is not used. NSD kept in Impact Assessment as it was identified during Scoping as a dwelling.

Table 6-4: Operational Activities – Noise Impact Assessment: West WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	26.0	30 - 40 dBA	Low	Low	Medium	Low
2	38.2	30 - 40 dBA	Low	Low	Medium	Low
3	24.9	30 - 40 dBA	Low	Low	Medium	Low
4	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
5	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
6	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
7	26.4	30 - 40 dBA	Low	Low	Medium	Low
8	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
10[17]	*43.6*	*30 - 40 dBA*	*Low*	*High*	*Medium*	*Medium*
11	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
12	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low

Comments:

Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

[17] Confirmed that dwelling is not used. NSD kept in Impact Assessment as it was identified during Scoping as a dwelling.

Table 6-5: Operational Activities – Noise Impact Assessment: Cumulative, East and West WEF (Acciona turbines)

Receiver no	Projected Noise Level (dBA)	Typical night-time ambient sound levels	Extent	Intensity	Duration	Significance
1	26.0	30 - 40 dBA	Low	Low	Medium	Low
2	38.2	30 - 40 dBA	Low	Low	Medium	Low
3	28.9	30 - 40 dBA	Low	Low	Medium	Low
4	40.0	30 - 40 dBA	Low	Medium	Medium	Low
5	41.1	30 - 40 dBA	Low	Medium	Medium	Low
6	40.2	30 - 40 dBA	Low	Medium	Medium	Low
7	27.8	30 - 40 dBA	Low	Low	Medium	Low
8	33.9	30 - 40 dBA	Low	Low	Medium	Low
9	Less than 20 dBA	30 - 40 dBA	Low	Low	Medium	Low
10[18]	*43.6*	*30 - 40 dBA*	*Low*	*High*	*Medium*	*Medium*[19]
11	31.9	30 - 40 dBA	Low	Low	Medium	Low
12	28.8	30 - 40 dBA	Low	Low	Medium	Low

Comments:	
Probability of impact	Low
Confidence in finding	Very high
Mitigation measures	Mitigation is not required due to low significance of noise impact.
Cumulative impacts	Ambient sound levels will increase slightly at all close NSDs, but this increase will be insignificant.
Residual Impacts:	This impact will only disappear after the operational phase finished and rehabilitation of the area is completed.

[18] Confirmed that dwelling is not used. NSD kept in Impact Assessment as it was identified during Scoping as a dwelling.
[19] If dwelling is used for residential purposes. While not used developer should get commitment from owner that it will not be used in future.

6.5 Evaluation of Alternatives

6.5.1 Alternative 1: No-go option

The ambient sound levels will remain as is (relatively low).

6.5.2 Alternative 2: Proposed Renewable Power Generation activities

The proposed renewable power generation activities (worse-case evaluated) will raise the noise levels at a number of potential noise-sensitive developments. These noises can be disturbing and may impact on the quality of living for the receptors although this is highly unlikely due to very low levels of noise and significance. In terms of acoustics there is no benefit to the surrounding environment (closest receptors), yet the significance of the potential noise impacts are low at the locations where people stay. As the dwelling at NSD10 is not being used, the medium significance is of no concern.

The project will greatly assist in the provision of energy, which will allow further economic growth and development in South Africa and locally. The project will generate short and long-term employment and other business opportunities and promote renewable energy in South Africa and locally. People in the area that is not directly affected by increased noises will have a positive perception of the project and will see the need and desirability of the project.

6.5.3 Location alternatives

The development of a wind energy facility is highly dependent on the prevailing wind quality and character. The wind turbines will be located on the top of ridges that are not used by people. Located in an area where the population density is relatively low, the location of the facility is ideal.

7 MITIGATION OPTIONS

The developer must know that community involvement needs to continue throughout the project. Annoyance is a complicated psychological phenomenon; as with many industrial operations, expressed annoyance with sound can reflect an overall annoyance with the project, rather than a rational reaction to the sound itself. At all stages surrounding receptors should be informed about the project, providing them with factual information without setting unrealistic expectations. It is counterproductive to suggest that the activities (or facility) will be inaudible due to existing high ambient sound levels. The magnitude of the sound levels will depend on a multitude of variables and will vary from day to day and from place to place with environmental and operational conditions. Audibility is distinct from the sound level, because it depends on the relationship between the sound level from the activities, the spectral character and that of the surrounding soundscape (both level and spectral character).

7.1 CONSTRUCTION PHASE MITIGATION MEASURES

The study considers the potential noise impact on the surrounding environment due to construction activities during the daytime periods. It was determined that the potential noise impact would be of low significance and mitigation measures are not required or recommended.

Mitigation options included both management measures as well as technical changes. While not required (due to the low significance of a noise impact during the construction phase) the following measures are included for the developer to consider. General measures that should be applicable for both the construction phase includes:

- The use the smaller/quieter equipment when operating near receptors;
- Where possible only operate during the day. If night-time activities is required, do not operate closer than 500m from any receptors (prevent noise impact of high significance)
- Ensure a good working relationship between the developer/contractor and all potentially noise-sensitive receptors. Communication channels should be established to ensure prior notice to the sensitive receptor if work is to take place close to them (especially if work is to take place within 500m from them at night). Information that should be provided to potentially sensitive receptor(s) includes:
    - Proposed working dates, the duration that work will take place in an area and working times;
    - The reason why the activity is taking place;

  - The construction methods that will be used; and
  - Contact details of a responsible person where any complaints can be lodged should there be an issue of concern.
- When simultaneous noise emitting activities are to take place close to potential noise-sensitive receptors, co-ordinate the working time with periods when the receptors are not at home. An example would be to work within the 8 am to 2 pm time-slot if possible, as:
  - Potential noise-sensitive receptors are most likely to be at school or work; and
  - Normal daily household activities (cleaning, listening to TV/Radio, etc.) will generate other noises that would most likely mask construction noises, thus minimizing the effects of cumulative noise impacts.
- Ensure that equipment is well maintained and fitted with the correct and appropriate noise abatement measures if available. Engine bay covers over heavy equipment could be pre-fitted with sound absorbing material. Heavy equipment that fully encloses the engine bay should be considered, ensuring that the seam gap between the hood and vehicle body is minimised.

7.2 OPERATIONAL PHASE MITIGATION MEASURES

7.2.1 Mitigation options available to reduce Operational Noise Impact

Excluding the unoccupied dwelling at NSD10, the significance of noise during the operational phase is low and additional mitigation measures are not required. Because of a potential medium significance for a noise impact at this location, the developer should get confirmation from the land owner that this dwelling will not be used for residential purposes during the operational phase.

7.3 SPECIAL CONDITIONS

7.3.1 Mitigation options that should be included in the EMP

No mitigation measures are recommended for inclusion in the EMP or Environmental Authorization.

7.3.2 Special conditions that should be included in the Environmental Authorization

1. The potential noise impact must again be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD.

2. The developer must investigate any reasonable and valid noise complaint if registered by a receptor staying within 2,000 m from location where construction activities are taking place, or operational wind turbine are located.

8 CONCLUSIONS AND RECOMMENDATIONS

Enviro-Acoustic Research CC was contracted by ARCUS Consulting (the EAP) to review the updated layouts for the Komsberg East and West WEF's.

The potential noise impact was evaluated using a sound propagation model. Conceptual scenarios were developed for a construction and operational phase. The output of the modelling exercise indicated that there is low risk of a noise impact (low significance of a noise impact) for either the East or West WEF's and for all locations where people stay. The potential medium significance for a noise impact at receptor NSD10 is of no concern, as the dwelling is not used for residential purposes. Mitigation is not required although generic measures are recommended for the developer to ensure that any potential noise impacts are minimised (construction phase).

Due to the low significance of a noise impact, no routine noise measurement programme is recommended. Guidelines for potential measurement locations, frequencies and procedures are provided in the original Noise Study (dated October 2015) as advice for the developer to consider should there be a noise complaint.

While this project will have a very slight noise impact at a number of the closest noise-sensitive receptors, these impacts is of low significance and can be considered insignificant. It is however important that the potential noise impact be evaluated should the layout be changed where any wind turbines are located closer than 1,000m from a confirmed NSD.

It is therefore the opinion of the Author that the increases in noise levels are of minor significance. It is therefore the recommendation that the project should be authorised (from a noise impact perspective).

9 THE AUTHOR

The Author started his career in the mining industry as a bursar Learner Official (JCI, Randfontein), working in the mining industry, doing various mining related courses (Rock Mechanics, Surveying, Sampling, Safety and Health [Ventilation, noise, illumination etc] and Metallurgy. He did work in both underground (Coal, Gold and Platinum) as well as opencast (Coal) for 4 years. He changed course from Mining Engineering to Chemical Engineering after his second year of his studies at the University of Pretoria.

After graduation he worked as a Water Pollution Control Officer at the Department of Water Affairs and Forestry for two years (first year seconded from Wates, Meiring and Barnard), where duties included the perusal (evaluation, commenting and recommendation) of various regulatory required documents (such as EMPR's, Water Licence Applications and EIA's), auditing of licence conditions as well as the compilation of Technical Documents.

Since leaving the Department of Water Affairs, Morné has been in private consulting for the last 15 years, managing various projects for the mining and industrial sector, private developers, business, other environmental consulting firms as well as the Department of Water Affairs. During that period he has been involved in various projects, either as specialist, consultant, trainer or project manager, successfully completing these projects within budget and timeframe. During that period he gradually moved towards environmental acoustics, focusing on this field exclusively since 2007.

He has been interested in acoustics as from school days, doing projects mainly related to loudspeaker design. Interest in the matter brought him into the field of Environmental Noise Measurement, Prediction and Control. He has been doing work in this field for the past 8 years, and was involved with the following projects in the last few years:

Wind Energy Facilities	*Zen (Savannah Environmental – SE), Goereesoe (SE), Springfontein (SE), Garob (SE), Project Blue (SE), ESKOM Kleinzee (SE), iNCa Gouda (Aurecon SA), Kangnas (Aurecon), Walker Bay (SE), Oyster Bay (SE), Hidden Valley (SE), Happy Valley (SE), Deep River (SE), Saldanha WEF (Terramanzi), Loeriesfontein (SiVEST), Noupoort (SiVEST), Prieska (SiVEST), Plateau East and West (Aurecon), Saldanha (Aurecon), Veldrift (Aurecon), Tsitsikamma (SE), AB (SE), West Coast One (SE), Namakwa Sands (SE), Dorper (SE), VentuSA Gouda (SE), Amakhala Komsberg (SE), Klipheuwel (SE), Cookhouse (SE), Cookhouse II (SE), Canyon Springs (Canyon Springs), Rheboksfontein (SE), Suurplaat (SE), Karoo Renewables (SE), Outeniqwa (Aurecon), Koningaas (SE), Eskom Aberdene (SE), Spitskop (SE), Rhenosterberg (SiVEST), Bannf (Vidigenix), Wolf WEF (Aurecon)*
Mining and Industry	*BECSA – Middelburg (Golder Associates), Kromkrans Colliery (Geovicon Environmental), SASOL Borrow Pits Project (JMA Consulting), Lesego Platinum*

	(AGES), Tweefontein Colliery (Cleanstream), Evraz Vametco Mine and Plant (JMA), Goedehoop Colliery (Geovicon), Hacra Project (Prescali Environmental), Der Brochen Platinum Project (J9 Environment), Delft Sand (AGES), Brandbach Sand (AGES), Verkeerdepan Extension (CleanStream), Dwaalboom Limestone (AGES), Jagdlust Chrome (MENCO), WPB Coal (MENCO), Landau Expansion (CleanStream), Stuart Coal – Weltevreden (CleanStream), Otjikoto Gold (AurexGold), Klipfontein Colliery (MENCO), Imbabala Coal (MENCO), ATCOM East Expansion (Jones and Wagner), IPP Waterberg Power Station (SE), Kangra Coal (ERM), Schoongesicht (CleanStream), EastPlats (CleanStream), Chapudi Coal (Jacana Environmental), Generaal Coal (JE), Mopane Coal (JE), Boshoek Chrome (JMA), Langpan Chrome (PE), Vlakpoort Chrome (PE), Sekoko Coal (SE), Frankford Power (REMIG), Strahrae Coal (Ferret Mining), Transalloys Power Station (Savannah), Pan Palladum Smelter, Iron and PGM Complex (Prescali)
Road and Railway	*K220 Road Extension (Urbansmart), Boskop Road (MTO), Sekoko Mining (AGES), Davel-Swaziland-Richards Bay Rail Link (Aurecon), Moloto Transport Corridor Status Quo Report and Pre-Feasibility (SiVEST), Postmasburg Housing Development (SE), Tshwane Rapid Transport Project, Phase 1 and 2 (NRM Consulting/City of Tshwane)*
Airport	*Oudtshoorn Noise Monitoring (AGES), Sandton Heliport (Alpine Aviation), Tete Airport Scoping*
Noise monitoring	*Peerboom Colliery (EcoPartners), Thabametsi (Digby Wells), Doxa Deo (Doxa Deo), Harties Dredging (Rand Water), Xstrata Coal – Witbank Regional, Sephaku Delmas (AGES), Amakhala Komsberg WEF (Windlab Developments), Oyster Bay WEF (Renewable Energy Systems), Tsitsikamma WEF (Cennergi and SE), Hopefield WEF (Umoya), Wesley WEF (Innowind), Ncora WEF (Innowind), Boschmanspoort (Jones and Wagner), Nqamakwe WEF (Innowind), Dassiesfontein WEF Noise Analysis (BioTherm), Transnet Noise Analysis (Aurecon)*
Small Noise Impact Assessments	*TCTA AMD Project Baseline (AECOM), NATREF (Nemai Consulting), Christian Life Church (UrbanSmart), Kosmosdale (UrbanSmart), Louwlardia K220 (UrbanSmart), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Slag Milling Plant (AGES), Arcelor Mittal WEF (Aurecon), RVM Hydroplant (Aurecon), Grootvlei PS Oil Storage (SiVEST), Rhenosterberg WEF, (SiVEST), Concerto Estate (BPTrust), Ekuseni Youth Centre (MENCO), Kranskop Industrial Park (Cape South Developments), Pretoria Central Mosque (Noman Shaikh), Soshanguve Development (Maluleke Investments), Seshego-D Waste Disposal (Enviroxcellence), Zambesi Safari Equipment (Owner), Noise Annoyance Assessment due to the Operation of the Gautrain (Thornhill and Lakeside Residential Estate), Upington Solar (SE), Ilangalethu Solar (SE), Pofadder Solar (SE), Flagging Trees WEF (SE), Uyekraal WEF (SE), Ruuki Power Station (SE), Richards Bay Port Expansion (AECOM), Babalegi Steel Recycling (AGES), Safika Ladium (AGES), Safika Cement Isando (AGES), Natref (NEMAI), RareCo (SE), Struisbaai WEF (SE)*
Project reviews and amendment reports	*Loperberg (Savannah), Dorper (Savannah), Penhoek Pass (Savannah), Oyster Bay (RES), Tsitsikamma (Cennergi), Amakhala Komsberg (Windlab), Spreeukloof (Savannah), Spinning Head (Savannah), Kangra Coal (ERM), West Coast One (Moyeng Energy), Rheboksfontein (Moyeng Energy)*

10 DECLARATION OF INDEPENDENCE

I, Morné de Jager declare that:

- I act as the independent environmental practitioner in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting environmental impact assessments, including knowledge of the National Environmental Management Act (107 of 1998), the Environmental Impact Assessment Regulations of 2010, and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in regulation 8 of the regulations when preparing the application and any report relating to the application;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- I will ensure that information containing all relevant facts in respect of the application is distributed or made available to interested and affected parties and the public and that participation by interested and affected parties is facilitated in such a manner that all interested and affected parties will be provided with a reasonable opportunity to participate and to provide comments on documents that are produced to support the application;
- I will ensure that the comments of all interested and affected parties are considered and recorded in reports that are submitted to the competent authority in respect of the application, provided that comments that are made by interested and affected parties in respect of a final report that will be submitted to the competent authority may be attached to the report without further amendment to the report;
- I will keep a register of all interested and affected parties that participated in a public participation process; and
- I will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not
- all the particulars furnished by me in this form are true and correct;
- will perform all other obligations as expected from an environmental assessment practitioner in terms of the Regulations; and
- I realise that a false declaration is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.

Disclosure of Vested Interest

- I do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2010.

____
Signature of the environmental practitioner:

Enviro-Acoustic Research cc
Name of company:

____
Date:

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APPENDIX A

Glossary of Acoustic Terms, Definitions and General Information

1/3-Octave Band	A filter with a bandwidth of one-third of an octave representing four semitones, or notes on the musical scale. This relationship is applied to both the width of the band, and the centre frequency of the band. See also definition of octave band.
A – Weighting	An internationally standardised frequency weighting that approximates the frequency response of the human ear and gives an objective reading that therefore agrees with the subjective human response to that sound.
Air Absorption	The phenomena of attenuation of sound waves with distance propagated in air, due to dissipative interaction within the gas molecules.
Alternatives	A possible course of action, in place of another, that would meet the same purpose and need (of proposal). Alternatives can refer to any of the following, but are not limited hereto: alternative sites for development, alternative site layouts, alternative designs, alternative processes and materials. In Integrated Environmental Management the so-called "no go" alternative refers to the option of not allowing the development and may also require investigation in certain circumstances.
Ambient	The conditions surrounding an organism or area.
Ambient Noise	The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.
Ambient Sound	The all-encompassing sound at a point being composite of sounds from near and far.
Ambient Sound Level	Means the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes after such a meter was put into operation. In this report the term Background Ambient Sound Level will be used.
Amplitude Modulated Sound	A sound that noticeably fluctuates in loudness over time.
Applicant	Any person who applies for an authorisation to undertake a listed activity or to cause such activity in terms of the relevant environmental legislation.
Assessment	The process of collecting, organising, analysing, interpreting and communicating data that is relevant to some decision.
Attenuation	Term used to indicate reduction of noise or vibration, by whatever method necessary, usually expressed in decibels.
Audible frequency Range	Generally assumed to be the range from about 20 Hz to 20,000 Hz, the range of frequencies that our ears perceive as sound.
Ambient Sound Level	The level of the ambient sound indicated on a sound level meter in the absence of the sound under investigation (e.g. sound from a particular noise source or sound generated for test purposes). Ambient sound level as per Noise Control Regulations.
Broadband Noise	Spectrum consisting of a large number of frequency components, none of which is individually dominant.
C-Weighting	This is an international standard filter, which can be applied to a pressure signal or to a *SPL* or *PWL* spectrum, and which is essentially a pass-band filter in the frequency range of approximately 63 to 4000 Hz. This filter provides a more constant, flatter, frequency response, providing significantly less adjustment than the A-scale filter for frequencies less than 1000 Hz.
Controlled area (as per National Noise Control Regulations)	a piece of land designated by a local authority where, in the case of- (a) road transport noise in the vicinity of a road- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period extending from 06:00 to 24:00 while such meter is in operation, exceeds 65 dBA; or (ii) the equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period extending from 06:00 to 24:00 as calculated in accordance with SABS 0210-1986, titled: "Code of Practice for calculating and predicting road traffic noise", published under

	Government Notice No. 358 of 20 February 1987, and projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; (b) aircraft noise in the vicinity of an airfield, the calculated noisiness index, projected for a period of 15 years following the date on which the local authority has made such designation, exceeds 65 dBA; or (c) industrial noise in the vicinity of an industry- (i) the reading on an integrating impulse sound level meter, taken outdoors at the end of a period of 24 hours while such meter is in operation, exceeds 61 dBA; or (ii) the calculated outdoor equivalent continuous "A"-weighted sound pressure level at a height of at least 1,2 metres, but not more than 1,4 metres, above the ground for a period of 24 hours, exceeds 61 dBA;
dB(A)	Sound Pressure Level in decibel that has been A-weighted, or filtered, to match the response of the human ear.
Decibel (db)	A logarithmic scale for sound corresponding to a multiple of 10 of the threshold of hearing. Decibels for sound levels in air are referenced to an atmospheric pressure of 20 μ Pa.
Diffraction	The process whereby an acoustic wave is disturbed and its energy redistributed in space as a result of an obstacle in its path, Reflection and refraction are special cases of diffraction.
Direction of Propagation	The direction of flow of energy associated with a wave.
Disturbing noise	Means a noise level that exceeds the zone sound level or, if no zone sound level has been designated, a noise level that exceeds the ambient sound level at the same measuring point by 7 dBA or more.
Environment	The external circumstances, conditions and objects that affect the existence and development of an individual, organism or group; these circumstances include biophysical, social, economic, historical, cultural and political aspects.
Environmental Control Officer	Independent Officer employed by the applicant to ensure the implementation of the Environmental Management Plan (EMP) and manages any further environmental issues that may arise.
Environmental impact	A change resulting from the effect of an activity on the environment, whether desirable or undesirable. Impacts may be the direct consequence of an organisation's activities or may be indirectly caused by them.
Environmental Impact Assessment	An Environmental Impact Assessment (EIA) refers to the process of identifying, predicting and assessing the potential positive and negative social, economic and biophysical impacts of any proposed project, plan, programme or policy that requires authorisation of permission by law and that may significantly affect the environment. The EIA includes an evaluation of alternatives, as well as recommendations for appropriate mitigation measures for minimising or avoiding negative impacts, measures for enhancing the positive aspects of the proposal, and environmental management and monitoring measures.
Environmental issue	A concern felt by one or more parties about some existing, potential or perceived environmental impact.
Equivalent continuous A-weighted sound exposure level ($L_{Aeq,T}$)	The value of the average A-weighted sound pressure level measured continuously within a reference time interval *T*, which have the same mean-square sound pressure as a sound under consideration for which the level varies with time.
Equivalent continuous A-weighted rating level ($L_{Req,T}$)	The Equivalent continuous A-weighted sound exposure level *($L_{Aeq,T}$)* to which various adjustments has been added. More commonly used as ($L_{Req,d}$) over a time interval 06:00 – 22:00 (T=16 hours) and ($L_{Req,n}$) over a time interval of 22:00 – 06:00 (T=8 hours). It is a calculated value.
F (fast) time weighting	(1) Averaging detection time used in sound level meters. (2) Fast setting has a time constant of 125 milliseconds and provides a fast reacting display response allowing the user to follow and measure not too rapidly fluctuating sound.

Footprint area	Area to be used for the construction of the proposed development, which does not include the total study area.
Free Field Condition	An environment where there is no reflective surfaces.
Frequency	The rate of oscillation of a sound, measured in units of Hertz (Hz) or kiloHertz (kHz). One hundred Hz is a rate of one hundred times per second. The frequency of a sound is the property perceived as pitch: a low-frequency sound (such as a bass note) oscillates at a relatively slow rate, and a high-frequency sound (such as a treble note) oscillates at a relatively high rate.
Green field	A parcel of land not previously developed beyond that of agriculture or forestry use; virgin land. The opposite of Greenfield is Brownfield, which is a site previously developed and used by an enterprise, especially for a manufacturing or processing operation. The term Brownfield suggests that an investigation should be made to determine if environmental damage exists.
G-Weighting	An International Standard filter used to represent the infrasonic components of a sound spectrum.
Harmonics	Any of a series of musical tones for which the frequencies are integral multiples of the frequency of a fundamental tone.
I (impulse) time weighting	(1) Averaging detection time used in sound level meters as per South African standards and Regulations. (2) Impulse setting has a time constant of 35 milliseconds when the signal is increasing (sound pressure level rising) and a time constant of 1,500 milliseconds while the signal is decreasing.
Impulsive sound	A sound characterized by brief excursions of sound pressure (transient signal) that significantly exceed the ambient sound level.
Infrasound	Sound with a frequency content below the threshold of hearing, generally held to be about 20 Hz. Infrasonic sound with sufficiently large amplitude can be perceived, and is both heard and felt as vibration. Natural sources of infrasound are waves, thunder and wind.
Integrated Development Plan	A participatory planning process aimed at developing a strategic development plan to guide and inform all planning, budgeting, management and decision-making in a Local Authority, in terms of the requirements of Chapter 5 of the Municipal Systems Act, 2000 (Act 32 of 2000).
Integrated Environmental Management	IEM provides an integrated approach for environmental assessment, management, and decision-making and to promote sustainable development and the equitable use of resources. Principles underlying IEM provide for a democratic, participatory, holistic, sustainable, equitable and accountable approach.
Interested and affected parties	Individuals or groups concerned with or affected by an activity and its consequences. These include the authorities, local communities, investors, work force, consumers, environmental interest groups and the general public.
Key issue	An issue raised during the Scoping process that has not received an adequate response and that requires further investigation before it can be resolved.
L_{A90}	the sound level exceeded for the 90% of the time under consideration
Listed activities	Development actions that is likely to result in significant environmental impacts as identified by the delegated authority (formerly the Minister of Environmental Affairs and Tourism) in terms of Section 21 of the Environment Conservation Act.
L_{AMin} *and* L_{AMax}	Is the RMS (root mean squared) minimum or maximum level of a noise source.
Loudness	The attribute of an auditory sensation that describes the listener's ranking of sound in terms of its audibility.
Magnitude of impact	Magnitude of impact means the combination of the intensity, duration and extent of an impact occurring.
Masking	The raising of a listener's threshold of hearing for a given sound due to the presence of another sound.
Mitigation	To cause to become less harsh or hostile.

Negative impact	A change that reduces the quality of the environment (for example, by reducing species diversity and the reproductive capacity of the ecosystem, by damaging health, or by causing nuisance).
Noise	a. Sound that a listener does not wish to hear (unwanted sounds). b. Sound from sources other than the one emitting the sound it is desired to receive, measure or record. c. A class of sound of an erratic, intermittent or statistically random nature.
Noise Level	The term used in lieu of sound level when the sound concerned is being measured or ranked for its undesirability in the contextual circumstances.
Noise-sensitive development	developments that could be influenced by noise such as: a) districts (see table 2 of SANS 10103:2008) 1. rural districts, 2. suburban districts with little road traffic, 3. urban districts, 4. urban districts with some workshops, with business premises, and with main roads, 5. central business districts, and 6. industrial districts; b) educational, residential, office and health care buildings and their surroundings; c) churches and their surroundings; d) auditoriums and concert halls and their surroundings; e) recreational areas; and f) nature reserves. In this report Noise-sensitive developments is also referred to as a Potential Sensitive Receptor
Octave Band	A filter with a bandwidth of one octave, or twelve semi-tones on the musical scale representing a doubling of frequency.
Positive impact	A change that improves the quality of life of affected people or the quality of the environment.
Property	Any piece of land indicated on a diagram or general plan approved by the Surveyor-General intended for registration as a separate unit in terms of the Deeds Registries Act and includes an erf, a site and a farm portion as well as the buildings erected thereon
Public Participation Process	A process of involving the public in order to identify needs, address concerns, choose options, plan and monitor in terms of a proposed project, programme or development
Reflection	Redirection of sound waves.
Refraction	Change in direction of sound waves caused by changes in the sound wave velocity, typically when sound wave propagates in a medium of different density.
Reverberant Sound	The sound in an enclosure which results from repeated reflections from the boundaries.
Reverberation	The persistence, after emission of a sound has stopped, of a sound field within an enclosure.
Significant Impact	An impact can be deemed significant if consultation with the relevant authorities and other interested and affected parties, on the context and intensity of its effects, provides reasonable grounds for mitigating measures to be included in the environmental management report. The onus will be on the applicant to include the relevant authorities and other interested and affected parties in the consultation process. Present and potential future, cumulative and synergistic effects should all be taken into account.
S (slow) time weighting	(1) Averaging times used in sound level meters. (2) Time constant of one [1] second that gives a slower response which helps average out the display fluctuations.
Sound Level	The level of the frequency and time weighted sound pressure as determined by a sound level meter, i.e. A-weighted sound level.
Sound Power	Of a source, the total sound energy radiated per unit time.
Sound Pressure Level (SPL)	Of a sound, 20 times the logarithm to the base 10 of the ratio of the RMS sound pressure level to the reference sound pressure level. International

	values for the reference sound pressure level are 20 micropascals in air and 100 millipascals in water. SPL is reported as L_p in dB (not weighted) or in various other weightings.
Soundscape	Sound or a combination of sounds that forms or arises from an immersive environment. The study of soundscape is the subject of acoustic ecology. The idea of soundscape refers to both the natural acoustic environment, consisting of natural sounds, including animal vocalizations and, for instance, the sounds of weather and other natural elements; and environmental sounds created by humans, through musical composition, sound design, and other ordinary human activities including conversation, work, and sounds of mechanical origin resulting from use of industrial technology. The disruption of these acoustic environments results in noise pollution.
Study area	Refers to the entire study area encompassing all the alternative routes as indicated on the study area map.
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of "needs", in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and the future needs (Brundtland Commission, 1987).
Tread braked	The traditional form of wheel brake consisting of a block of friction material (which could be cast iron, wood or nowadays a composition material) hung from a lever and being pressed against the wheel tread by air pressure (in the air brake) or atmospheric pressure in the case of the vacuum brake.
Zone of Potential Influence	The area defined as the radius about an object, or objects beyond which the noise impact will be insignificant.
Zone Sound Level	Means a derived dBA value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area. This is similar to the Rating Level as defined in SANS 10103:2008.

KOMSBERG EAST WIND FARM TRANSPORT ASSESSMENT

Reference: 111391/KBEWF
Prepared for: Komsberg Wind Farm (Pty) Ltd
Revision: 2
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Document control record

Document prepared by:
Aurecon South Africa (Pty) Ltd
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City, Cape Town, 7441

T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

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Author signature		Approver signature	
Name	Samuel Lombard	Name	Jannie Conradie
Title	Civil Engineer	Title	Technical Director

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Reference 111391/KBEWF
Revision 2

Aurecon South Africa (Pty) Ltd
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City, Cape Town, 7441
T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

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EXECUTIVE SUMMARY

This report details the investigation of the transport needs for the proposed Komsberg East Wind Farm (KEWF), located in the Western Cape Province, on the farms Taayboschkraal (12/1, 3 and 4), Boschmans Kloof (9/3), Koornplaats (41/2), Anys Riviers Plaat (13/0) and Dwars Rivier (14/0). The purpose of the investigation is to identify potential access routes, including site access, for the development of the facility.

The general freight for the wind farm will comprise building materials (including gravel and aggregate), turbine components, power transformers and other minor electrical and mechanical equipment. The imported freight will preferably be transported along the 463km long route from Saldanha Port to the site.

The preferred route is predominantly on National or Provincial Roads, with suitable conditions for the transport of normal freight, or abnormal loads with permits. Abnormal permits will be required for transport of the wind turbine components and power transformers; such permits are common and normally easily attained. Most of the route is surfaced, with the final 45km or 56km to the site consisting of gravel roads, depending on the option chosen for the final section of the route.

Building materials will most likely be transported from Worcester, while certain elements will be transported from various manufacturing centres in South Africa - most likely Cape Town for tower sections and Johannesburg for transformers. The transport of elements from these manufacturing centres will be predominantly on National and Provincial roads, which presents no limitations for normal freight.

Due to the distance from Worcester to site (approximately 218km), significant reductions in heavy vehicle trips and material costs could be achieved by sourcing road building materials and concrete aggregate from new quarries or borrow pits in proximity to the site. However the time frames to obtain approvals for such sourcing must be included in the planning programme.

There is a limited risk of delays to the various deliveries required for the construction of the facility, due to potential routine maintenance works (such as repairs and reseals), however this may be mitigated by the use of the alternative routes.

It is noted that the exact position of the site access point will have to be reviewed, based on sight distances, and approved by the Western Cape Provincial Government.

In general, no obvious problems were identified associated with the transport of freight along the proposed routes to the site, nor for the accesses required for the construction and maintenance of the facility. It will, however, be necessary to confirm certain aspects such as clearances, bridge capacities, etc., by the logistics contractor as part of their preparation as this will be dependent on the actual vehicles configuration used.

1 INTRODUCTION

Komsberg Wind Farm (Pty) Ltd., has engaged Aurecon to prepare a Transport Assessment, with particular focus on the access to the site, for the proposed Komsberg East Wind Farm (KEWF), in support of the environmental approval application. The site is situated approximately 50km south-east of Sutherland, in the Western Cape Province, and is located on the farms Taayboschkraal (farm 12, portions 1, 3 and 4), Boschmans Kloof (farm 9, portion 3), Koornplaats (farm 41, portion 2), Anys Riviers Plaat (farm 13, portion 0) and Dwars Rivier (farm 14, portion 0).

The site location is indicated on the Key Plan in Figure 1:

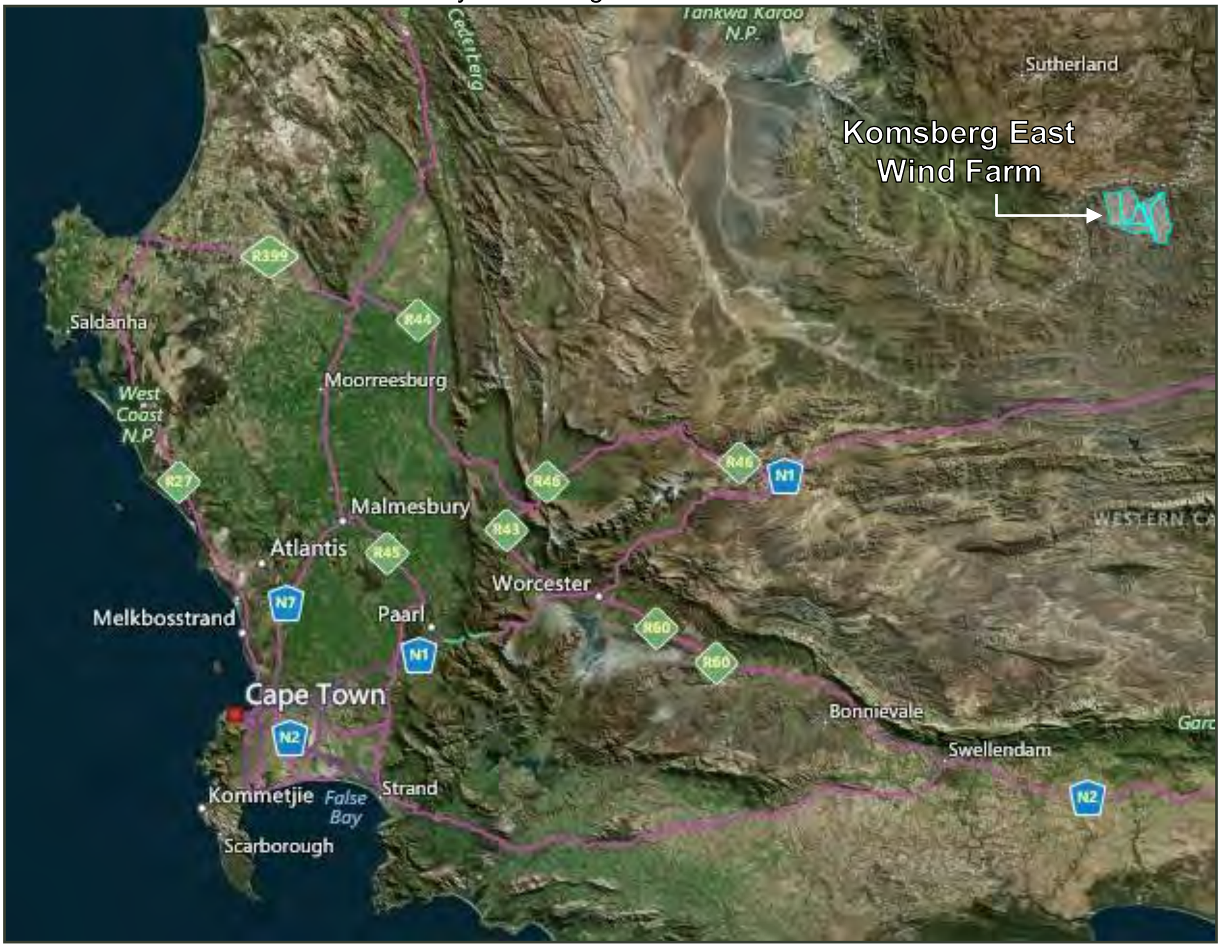


Figure 1: Key Plan detail

The proposed KEWF is expected to comprise:

- Up to 55 Wind Turbine Generators (WTG's)
- Up to 5 MW per WTG
- Hub height of up to 120m
- Rotor diameter of up to 140m
- Capacity of up to 275MW

Figure 2 shows the public roads in the vicinity of the site, all roads shown are Provincial gravel roads:

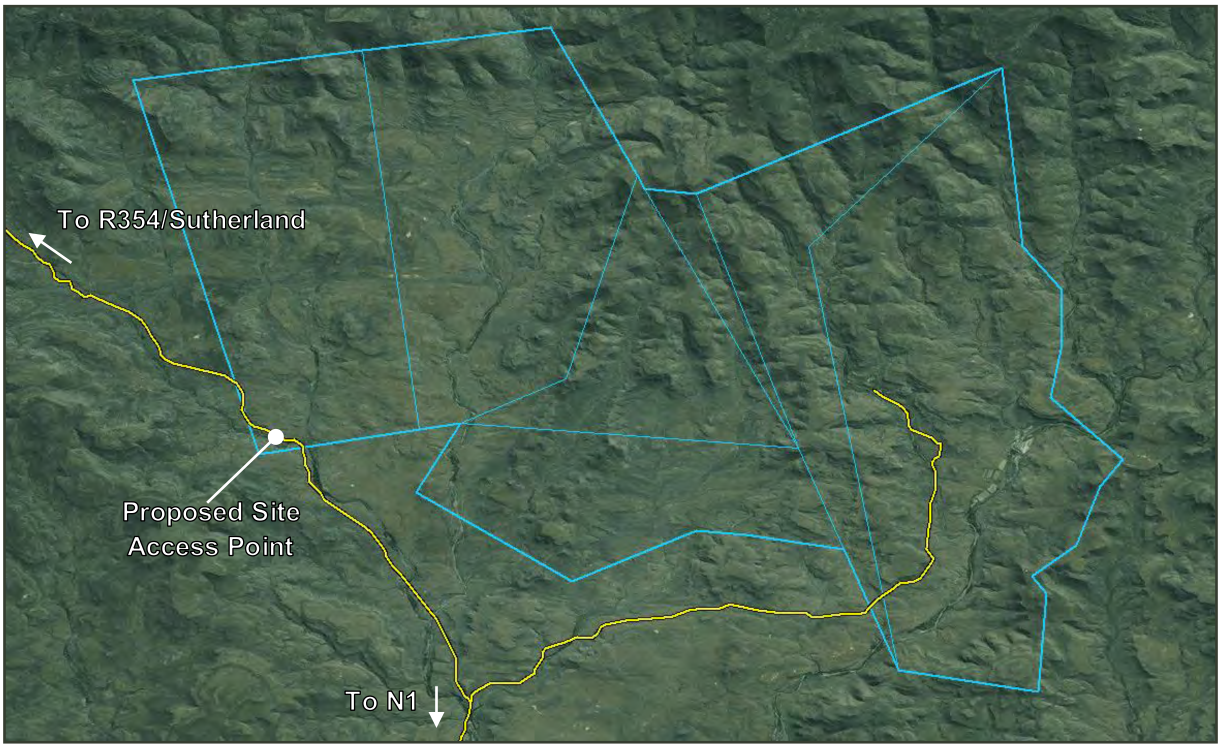


Figure 2: Site location

The scope of the study is to evaluate the transport requirements to implement the development of the KEWF, with particular focus on the access to site from the N1.

The scope of the Transport Assessment Study includes, inter alia:

- Determine the access freight routes between point of delivery (i.e. the preferred port) and the wind farm, for the wind turbine generator (WTG) components.
- Confirm the associated clearances required for the necessary equipment to be transported from the point of delivery to the wind farm.
- Confirm freight requirements.
- Determine (abnormal) permit requirements, if any.
- Consider feasibility of alternative accesses to the site from the N1
- Propose traffic accommodation measures during potential upgrading of the access on the Provincial or National Roads.

2 BASIS AND ASSUMPTIONS

The following parameters have been defined / assumed, based on Aurecon's domain knowledge and relevant experience:

- Imported elements, including major turbine components, are shipped to and transported from the nearest or most practical South African Port to the site.
- Certain elements are transported from manufacturing centres within South Africa.
- Materials for concrete foundation structures and road construction are obtained locally from closest available commercial source, but could also be potentially be sourced from new borrow pits and quarries on the site, to limit carting of materials over long distances and at steep grades.
- The largest potential loads with respect to weight will be:
  - Transformer(s) with a payload of approximately 85t
  - Nacelle for each turbine – up to approx. 100t
- Long distance freight will be transported predominantly on surfaced roads.
- Foundations will ultimately be dictated by site geotechnical conditions but generally comprise of large diameter (in the order of 15m to 22m) concrete bases supported on rock or suitable strata.
- The geometric standards applied were such that blades up to 70m in length could be accommodated on the access roads to the proposed development.
- The standard vehicle for the transportation of said turbine blades was assumed to have a wheel base of approximately 45m.
- A minimum road width of 4.5m with 0.25m rounding each side was assumed.
- The preliminary alignments were based on satellite imagery as the only available topographical information.
- The turbines will ultimately be removed from the site during the de-commissioning stage, while the turbine bases will be partially demolished to 1m below natural ground level.

3 ASSESSMENT

3.1 General Freight Requirements

3.1.1 Legislation

Currently, the general limitations on road freight transport are:

- Axle load limitation of 7.7t on front axle and 9.0t on single rear axles.
- Axle unit limitations are 18t for dual axle units and 24t for 3 axle units.
- Bridge formula requirements to limit concentration of loads and to regulate load distribution on the vehicle.
- Gross vehicle mass of 56t. This means a typical payload of about 30t.
- Maximum vehicle length of 22m for interlinks, 18.5m for horse and trailers and 13.5m for single units.
- Width limit of 2.6m.
- Height limit 4.3m with a 0.3m tolerance.

Abnormal permits are required for vehicles exceeding these limits, which will be required for this project.

3.1.2 Facility Freight

Materials and equipment transported to the site will comprise:

- Building materials (concrete aggregates, cement, reinforcement and gravel).
- Construction equipment such as road building equipment, excavators and cranes.
- Turbine components (blades, towers and nacelles).
- Transformers and cables.

A breakdown of transport requirements for the respective phases of the project follows:

3.1.2.1 During the Construction Phase:

– Building materials, comprising reinforced concrete materials for turbine foundations and gravel materials for road layer works. These materials will be transported using conventional trucks, which are expected to adhere to legal limits.

– WTG components will most likely be transported by abnormal vehicles from the nearest suitable South African port, which is Saldanha Port (Section 3.3 refers). The number of loads will be a function of the number of turbines to be constructed.

– WTG towers will be manufactured locally, with steel towers shipped from Atlantis or Port Elizabeth, and concrete towers manufactured on site, or in Cape Town and transported to site in segments.

– Power transformers will most probably be transported by abnormal vehicles from manufacturing centres in Johannesburg.

- 132kV OHL components will be transported from various manufacturing centres as well as ports for some the components. However all components will be transported by means of general freight. The number of loads will be a function of the final configuration.

3.1.2.2 During the Operational Phase:

- Potential replacement of WTG elements, which would require the employment of cranes and transport equipment. However, this is expected to have a low probability of occurrence.

3.1.2.3 During the De-commissioning Phase:

- The removal of turbine components from the site to a suitable spoil / recovery / recycling site, which could potentially imply shipping items out of the country, and which would require abnormal transport to the approved recovery sites.
- Re-instatement of the disturbed areas, such as ripping of access roads and reinstating of vegetation, by use of suitable construction equipment.
- The turbine bases will have to be demolished partially, which will require heavy demolishing equipment.
- OHL components from the site to a suitable spoil / recovery / recycling site. Support foundation will be partially demolished.

Examples of the abnormal loads which are most pertinent to the wind farm logistics are illustrated in Figure 3 and Figure 4:

Figure 3: Abnormal freight (tower section in low-load configuration (top), and blade (bottom))

Figure 4: Minor wind farm components delivered to a wind farm site with normal freight

3.2 Traffic Statement

The traffic volumes will have three different patterns for the construction, operational and de-commissioning stages of the project, respectively.

3.2.1 Traffic during the Construction Phase

Based on Aurecon's experience with similar projects, it is estimated that the number of expected trips per turbine would be:

- Abnormal vehicles: 10 (turbine components)
- Heavy vehicles: 60 (reinforcement and concrete)
- Heavy Vehicles: 90 (road layer works)
- **TOTAL: 150 / 10 (Heavy / Abnormal) per turbine**

The wind farm capacity and the specific WTG model to be used has not yet been confirmed and it is therefore not possible to accurately calculate the total expected trips for the construction of the facility. However, the range of potential configurations for the wind farm, as listed in Table 1, provides a basis for the estimation of the total trips that will be required. In the table, 140MW and 275MW are considered to be the possible site capacities, while the options of 3.5MW and 5MW WTGs are considered as representing the outer limits of the range of possible machines to be utilised.

Table 1: Range of Potential Wind Farm Configurations

WTG Capacity	140MW Facility	275MW Facility
3.5MW	40 no.	-
5MW	-	55 no.

Based on the above, the total trips for the ultimate 55 turbine facility is estimated to be 550 abnormal and 8250 heavy vehicle trips. However, based on the current 140MW limitation in the REIPPP on wind farm capacity, it is likely that a maximum of 40 turbines (400 abnormal and 6000 heavy vehicle loads) will be constructed in the initial stage of the project, over an estimated period of 18 months. Should concrete towers be used, the number of abnormal loads would decrease, with heavy loads increasing.

If the concrete and road building materials could be sourced from newly developed sources in proximity to the site, the number of heavy vehicles on the access roads could be reduced substantially.

In the worst case, the number of heavy vehicle trips per day would be in the order of 15 to 20 round trips. The impact of this on the general traffic would therefore be negligible, as the peak hour traffic would be increased by 5 trips at most.

Based on previous experience, the personnel during construction is estimated to total 300 - 400 persons. The personnel will most likely reside in Sutherland, Matjiesfontein or Laingsburg as the closest communities. It is recommended that the majority of construction personnel be transported to and from site by means of busses.

This personnel transport will total approximately 15 to 25 daily trips. The impact of this on the general traffic would therefore also be considered negligible, as the peak hour traffic would be increased by 10 trips at most.

3.2.1.1 Traffic during the Construction of Grids/Power lines

The grids/power lines to be constructed during the project will be 132KV power lines. The main components being the support mast, cables, connectors, transformers, etc. All the components will be transported by means of general freight. Aurecon is of opinion that the traffic impact for this construction activity will be minimal and that the additional generated traffic is negligible.

3.2.2 Traffic during the Operational Phase

After construction, the generated site traffic would be limited to maintenance support, with only a few light vehicles accessing the site per day.

3.2.3 Traffic during the De-commissioning Phase

Traffic is expected to be very similar to the construction phase. The impact of this on the general traffic would therefore also be considered negligible.

3.2.4 Summary of Traffic Statement

Current traffic volumes on N1 near Matjiesfontein (Between Laingsburg and Touwsrivier) are estimated from the most recent SANRAL yearbook at about 3834 ADT (Average Daily Traffic), 1497 ADTT (Average Daily Truck Traffic) (both directions with a 50/50 split) and a maximum hourly flow of about 800 veh/h for this section of road.

The current traffic volumes on the R354 (Western Cape Provincial Road: Trunk Road 20/1) is in the order of 140 vehicles per day with a 13% heavy vehicle component.

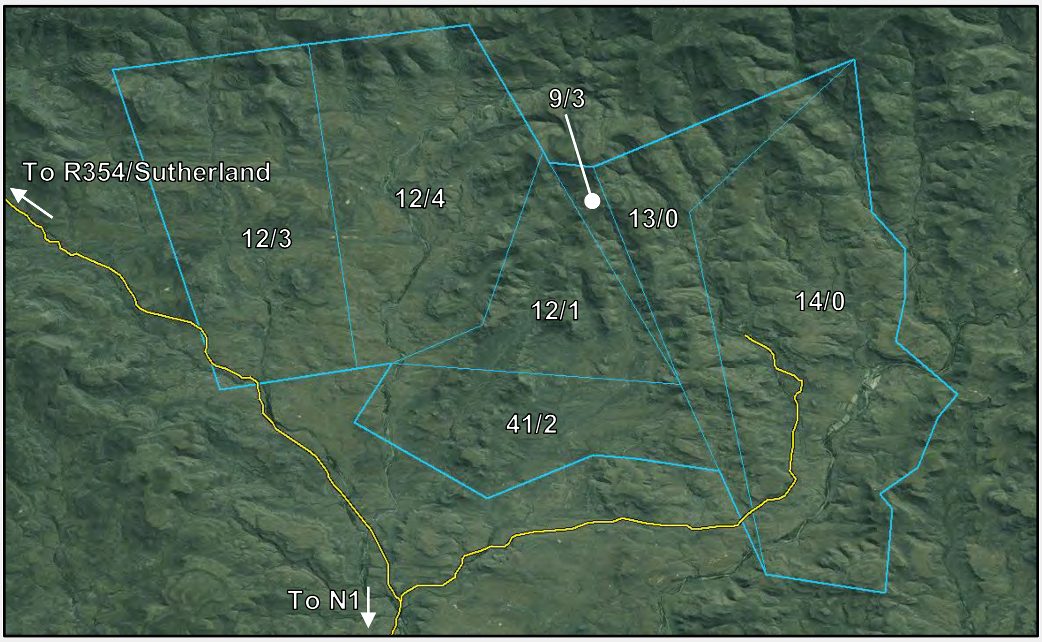
It can therefore be stated that the construction traffic and the post construction traffic would be low without any significant impact on the existing traffic flows on the N1 or provincial roads. It will also have a negligible impact on the pavement structures. Furthermore, the impact of the traffic on the provincial gravel access roads will also be negligible with respect to service levels.

3.3 Access Route

3.3.1 Site Description

A summary of the site description, as provided in Section 1, is given in Table 2:

Table 2: Summary of Site Description



Location (Centre Point)	32° 43' 23.7" S 20° 59' 51.6" E
Distance of Centre Point SE of Sutherland	50km
Generation Capacity	140MW-275MW
Distance from Ports **Saldanha** **Cape Town** **Port Elizabeth**	 463km 326km 616km
Farms (farm/portion)	Taayboschkraal (12/1, 12/3, 12/4), Boschmans Kloof (9/3), Koornplaats (41/2), Anys Riviers Plaat (13/0) and Dwars Rivier (14/0)

3.3.2 Preferred Route from Port

The starting point of the route for the transportation of imported equipment is the port at either Saldanha, Cape Town or Port Elizabeth. Of these, Saldanha is the preferred port, with a route length of 470km, as indicated in Figure 5. Two equally viable alternatives exist for the final section of the route (A1 – from the north via Verlatenkloof Pass and Komsberg Pass, and A2 – from the north via D2243). These two options are discussed in Sections 3.3.7. Section views of the roads are shown in Appendix A, while urban section views along the preferred route are shown in Appendix B.

It should be noted that the Ports Authority also has preferences on freight imports, which should be respected.

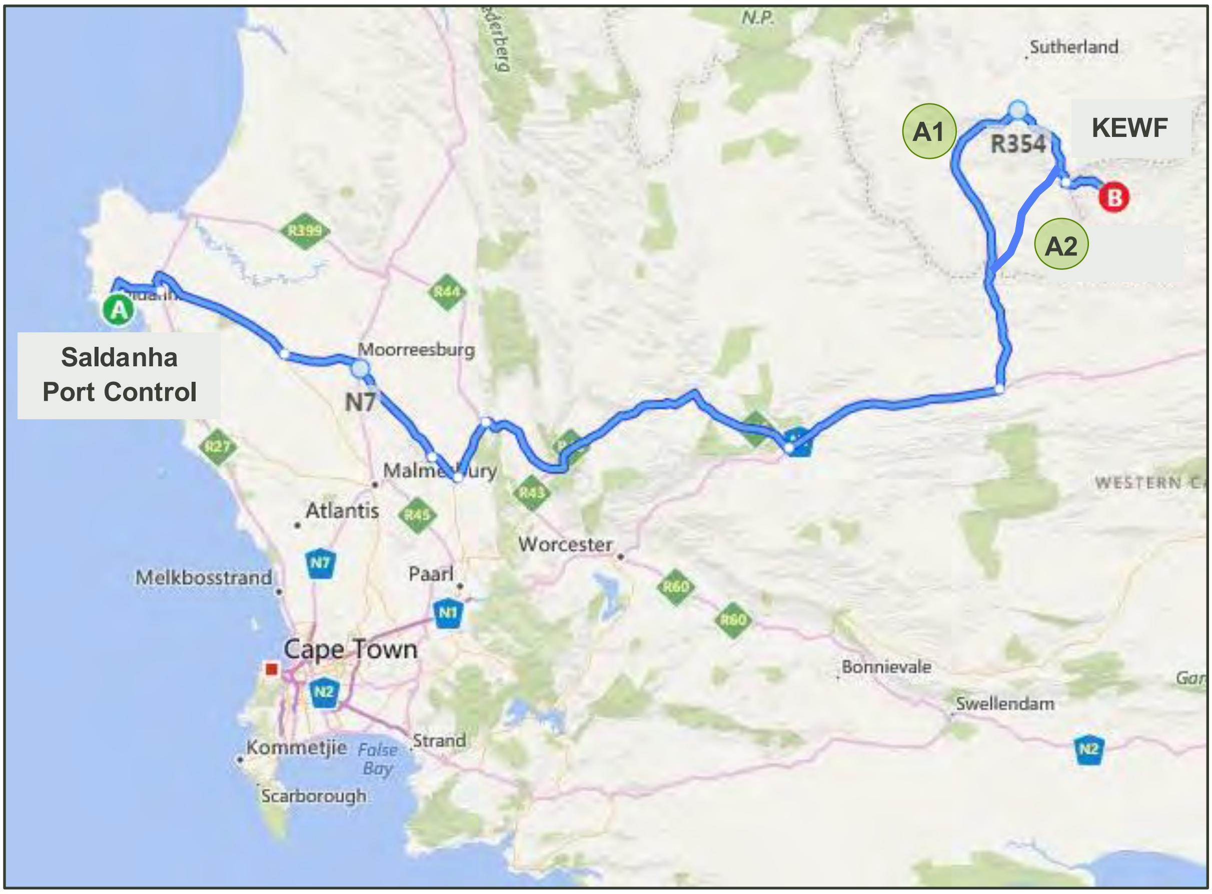


Figure 5: Preferred freight route

The route from the alternative port of Port Elizabeth is about 616km and is the least preferred route; however, it still offers an alternative, should Saldanha Port not be available for any reason. While Cape Town Port is the closest port to the site, it would most probably not be able to accommodate the imported turbine elements, due to current activities.

Alternatives to the preferred route exist and are shown in Figure 6.

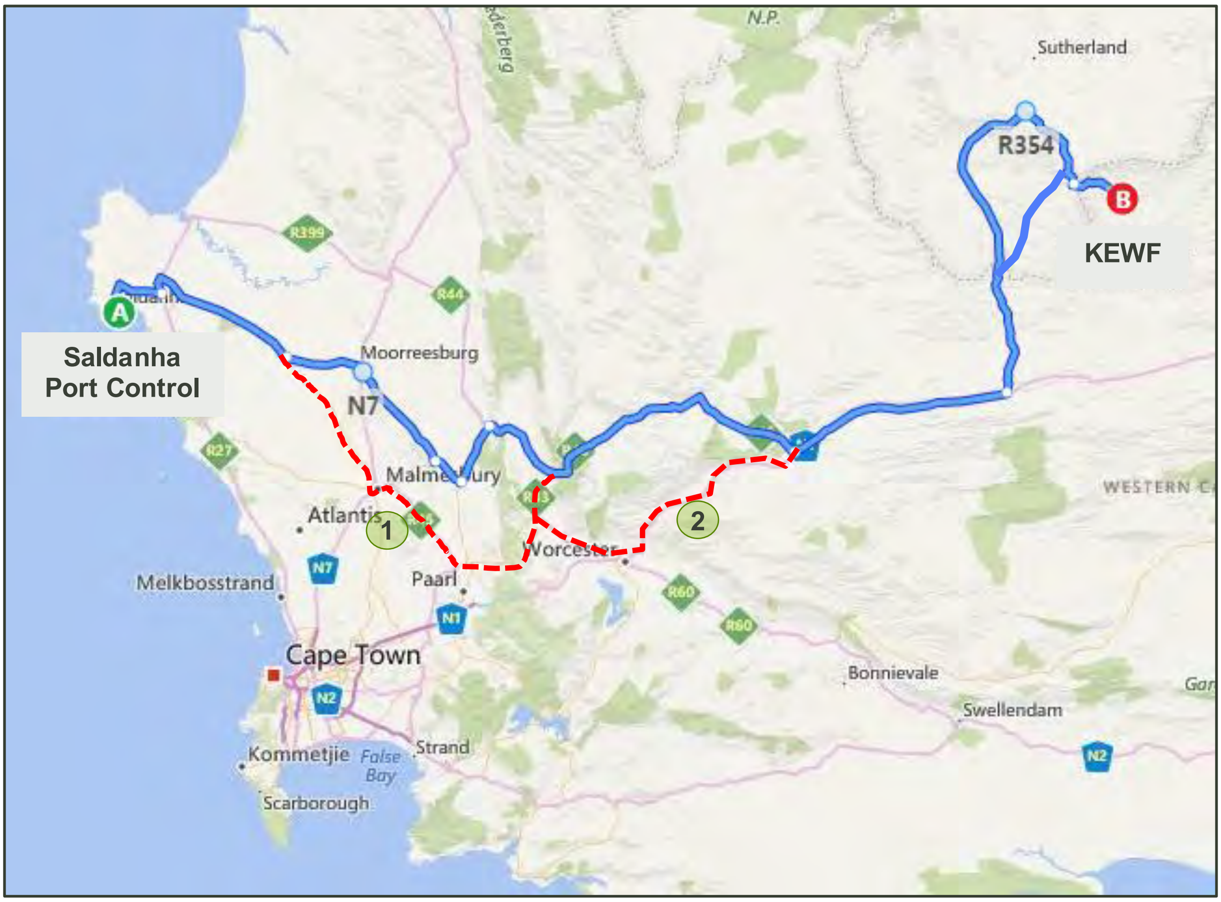


Figure 6: Alternative freight routes from Saldanha Port

The following is noted regarding deviations from the preferred route:

1. This alternative passes through the town of Malmesbury, where an urban intersection limits the maximum turning radius. This alternative will be restricted for abnormal loads that require a large turning radius (e.g. vehicles transporting wind turbine blades).
2. This alternative passes through Worcester and De Doorns, along the N1. However, one of the bridges over the N1, between Worcester and De Doorns, is of concern. It is estimated that the bridge is lower than 5m, limiting the maximum height of freight that can be transported along this route.

The alternatives shown in Figure 6 are presented for the cases where the preferred route of travel is unavailable due to maintenance, or any other reason. The alternatives that are presented have certain constraints (as mentioned) and may not be able to accommodate all of the abnormal loads. An alternative of accessing the site from Laingsburg was not considered, due to the excessive length of gravel roads along the route, which will required significant upgrades.

It is suggested that the transporting contractor executes a more detailed study before transporting any of the components, to confirm the preferred and alternative routes for each type of load configuration. Should any of the preferred sections be unavailable for any reason, a combination of routes should also be considered

3.3.3 Route for Construction Materials

Material sources for road building and concrete works are available in Worcester and all material will most likely be transported from this town on the N1 and the R354. As stated earlier, to reduce traffic on the access roads, consideration could be given to sourcing material for road building and concrete aggregate from new quarries/sources in the vicinity of the site, provided that it is feasible with respect to the target implementation programme. It is noted that the approval period for such quarries/sources is typically between 12 to 18 months. The possible siting of quarries and/or borrow pits will be confirmed prior to construction, once a geotechnical investigation has been conducted

The closest manufacturing centre will most likely be Cape Town, which is situated 326km from the site. For the largest part of the route from Cape Town, the N1 (which is surfaced) will be used. There are, however, toll fees present on this specific route, which can be avoided by use of alternatives.

3.3.4 Authority and Permit Requirements

The following is noted:

a) No toll fees are required on the routes from the Saldanha Port. On the routes from the other manufacturing centres, certain portions of the National Roads are tolled, but the related fees can be avoided by use of alternatives.

b) Abnormal permits will be required for the transport of the transformer and the turbine elements by the logistics contractor. The estimated permit value will be a function of the actual vehicle configuration, but is estimated at R9000 – R15000 per trip (dependent on the weight of the load and escorting requirements by Provincial Traffic). In extreme cases, permits could cost as much as R50 000 per trip. The abnormal application process would take approximately one month to complete and should be applied for, by the logistics contractor, once the project is awarded preferred bidder status.

3.3.5 Route Limitations of the Preferred Route from the Port

The identified route has possible limitations that will necessitate more detailed investigations to determine the level of upgrading that will be required (if any) to accommodate the abnormal loads. All the possible limitations (apart from the capacity of the bridges on the R354, discussed in Section 3.3.6) will potentially be encountered on the gravel roads from the R354 intersection to the prospective site. Possible limitations, other than capacity of the bridges on the R354, that require investigation may include: motor grid gates with loading constraints, overhead power and telecommunication lines with an insufficient ground clearance, substandard geometry of roads and bridges, and drainage issues.

3.3.6 Capacity of Bridges

The section of the preferred route along the R354 between Matjiesfontein (N1) and Sutherland does not form part of a heavy freight route. Several bridges exist along this road that will have to be crossed by abnormal loads. Elevation and approach views of a typical bridge on the R354 are shown in Figure 7 and Figure 8.

Figure 7: Elevation view of typical bridge on R354

Figure 8: Approach view of typical bridge on R354

A high order investigation was performed to identify limitations on the loading capacity of the existing bridges along this section of road. Aurecon believes it is unlikely that there would be any problems with the loading capacity of these bridges with regards to the delivery of abnormal loads (provided the requirements of the Bridge Formula are met). However, a detailed investigation should be undertaken by the transport contractor, to confirm that the vehicle configuration is suited to the maximum axle loading for the bridges.

3.3.7 Site Access Road

Two equally viable alternatives for the final section of the route to the site exist. These routes to the proposed site access point are shown in Figure 9.

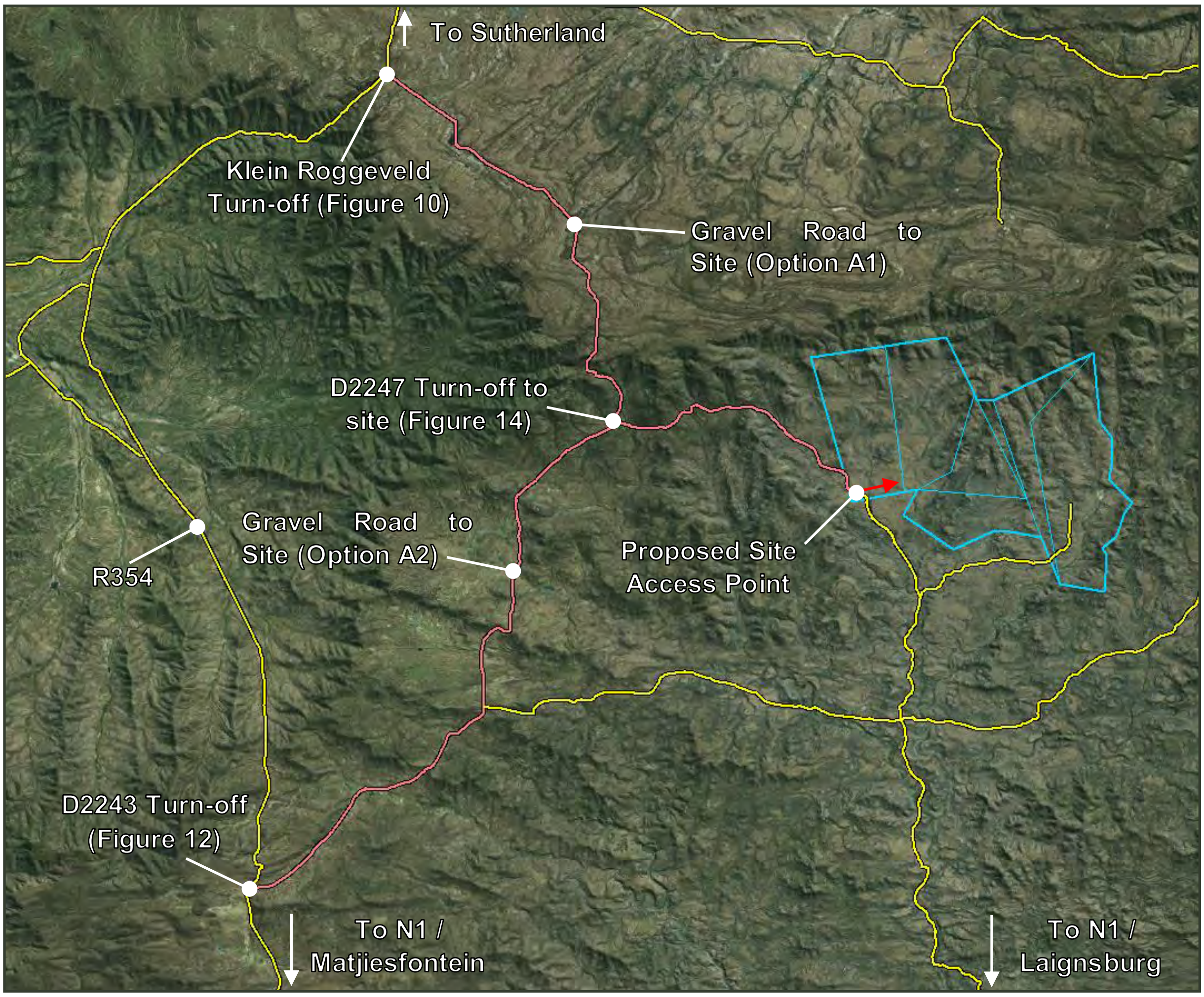


Figure 9: Access position to site

The proposed site access position is situated roughly 11km south-east of the border between the Northern Cape and Western Cape and is to be approved by the Western Cape Provincial Government. The sufficiency of the sight distances (stopping and shoulder) at the proposed site entrance are to be reviewed and approved by the local authority. The two alternative routes from the R354 are discussed in the subsequent sections.

3.3.7.1 Road to Site Access Point (Option A1)

For this option, the proposed access position for the site is located approximately 45km from the R354 turn-off to Klein Roggeveld. Figure 10 shows the Klein Roggeveld turn-off from the R354. The remainder of the route to site from this point consists of gravel roads.

Figure 10: Klein Roggeveld turn-off

Prior to the final turn-off to site, the road goes down Komsberg Pass. The road is in a good condition, but navigation down the pass will present some difficulties and falling rocks may result in unwanted issues (Figure 11). The safety for using the pass road will have to be confirmed prior to the transport of loads. Potential removal of unstable material could improve safety.

Figure 11: Falling rocks at Komsberg Pass

3.3.7.2 Road to Site Access Point (Option A2)

For this option, the site access point is located approximately 56km from the R354 turn-off on to D2243, shown in Figure 12. Following this turn-off, the road is surfaced for about 130m, after which the remainder of the route to site consists of gravel roads.

Figure 12: D2243 Turn-off to Komsberg

Even though this alternative results in a shorter overall route length from port than Option A1, upgrades in the form of a bridge widening, addressing drainage issues and the widening of cattle grid gates are required. The potential bridge widening is shown in Figure 13.

Figure 13: Possible bridge widening for Route Option A2

The distance to be travelled on gravel roads for this alternative is also 16km longer than for Option A1. Furthermore, this route passes some farm homesteads and farm owners will have to be consulted before this route is deemed a viable option. Dust suppression and consultation will be required in certain cases.

The majority of these constraints should however be eliminated when this route is upgraded as part of the other proposed wind farm projects in the area whose construction precedes that of KEWF, in 2016 and 2017. The final 7.7km until the final turnoff of the route will however not be upgraded as part of a preceding wind farm construction. It is therefore recommended that the final choice between Options A1 and A2 be made closer to the time of construction, with a possibility to use both routes.

3.3.7.3 Route from Final Turn-off

A final turn-off on to D2247 (shown in Figure 14) is located approximately 28km from the Klein Roggeveld turn-off (and about 39km from the D2243 turn-off), at the location where Options A1 and A2 converge. The turning radius appears to be adequate, however further detail investigation into the width adequacy of the cattle grid and farm gate is to be undertaken. The site is located approximately 17km after the final turn-off.

Figure 14: D2247 Final turn-off to KEWF

Existing roads will be utilised as far as possible, with upgrades to be performed where necessary. Due to the relatively long section of gravel roads from the R354 to the site, the likelihood of upgrade requirements is increased, especially on the last 17km section. The possible need of an additional wearing course on certain sections of the road exists to improve riding quality, along with the potential widening or strengthening of cattle grid gates, as mentioned earlier. A typical farm gate on the preferred route is shown in Figure 15.

Figure 15: Farm gate

Drainage issues also need to be addressed along certain sections of the road. It is proposed that a hydraulic structure such as a causeway be constructed at the river crossing situated approximately 5.5km from the site's entrance (Figure 16) to ensure crossing during flooding. Else regular maintenance will be required to remove debris from the roadway.

Figure 16: River crossing before KEWF

3.3.7.4 Road from Site Access Point to Site

The proposed access road to the site is approximately 5.5km in length and has to be newly constructed. Allowance for adequate turning radii are to be made, along with sufficient sight distances. The location of the proposed access road is shown in Figure 17.

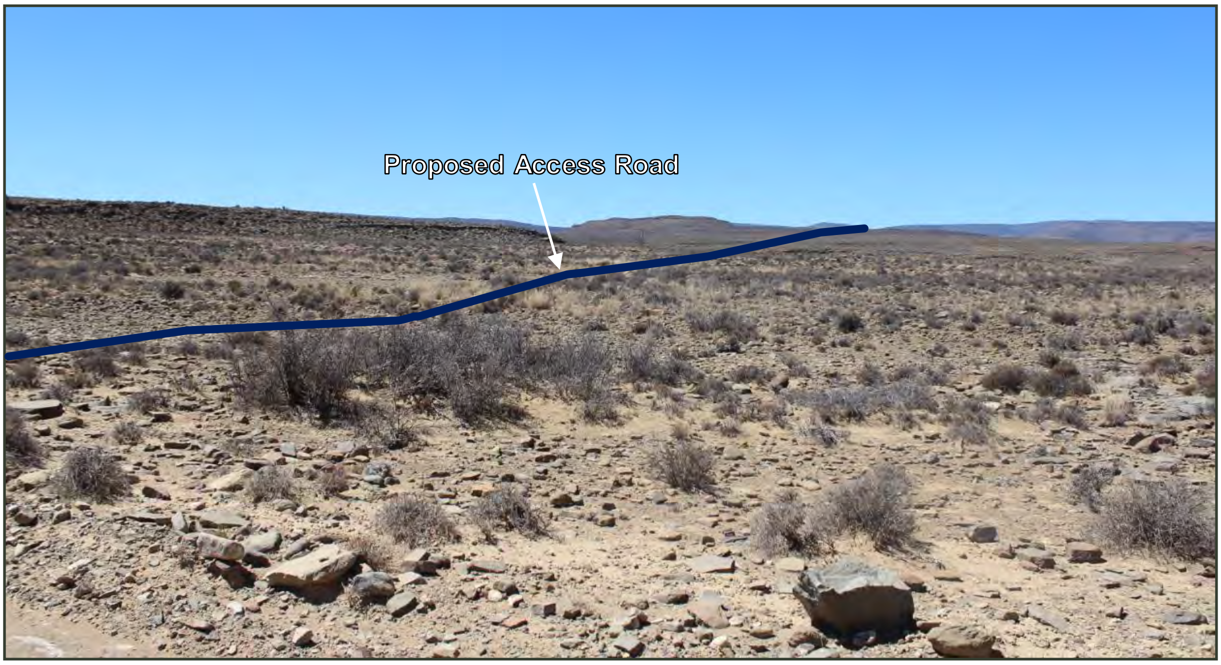


Figure 17: KEWF Access road to site

There are three unavoidable river crossings on the proposed access road, of which the largest is shown in Figure 18. Low-level Bridges or causeways are to be constructed at these crossings.

Figure 18: KEWF Access - Largest river crossing

The final section of the proposed access road, just after the river crossing shown above, leading up to the hill is shown in Figure 19.

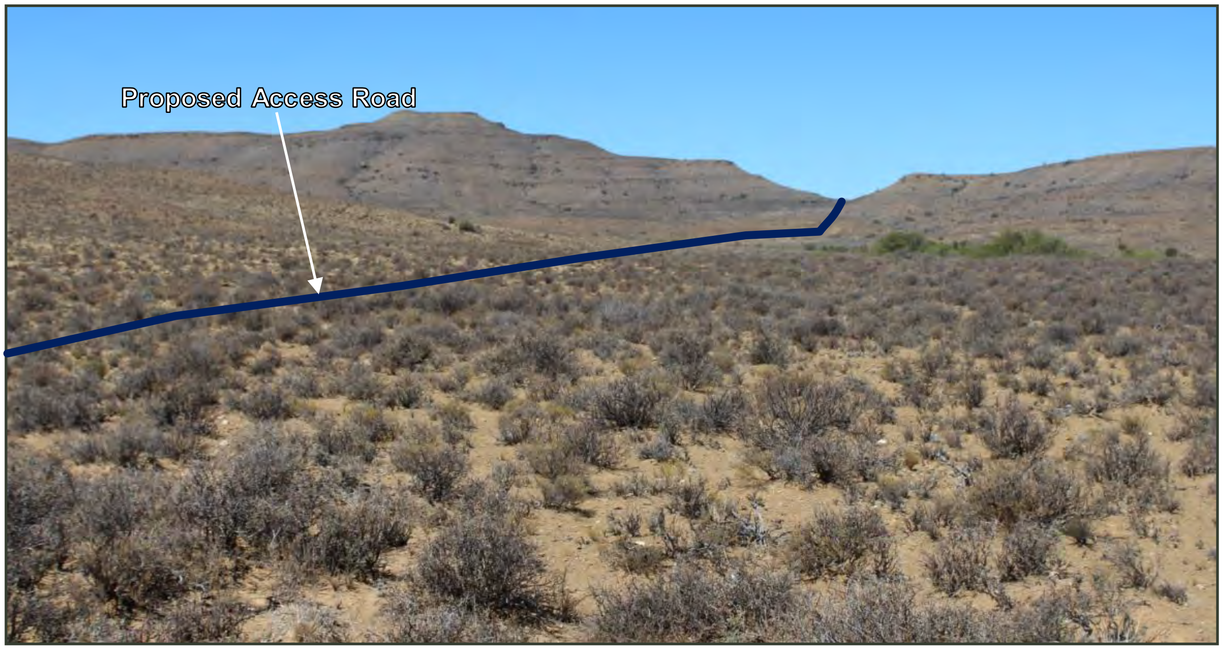


Figure 19: KEWF Access - Final section of access road

Access roads between the turbines will be required for construction, and later for maintenance purposes. The internal access roads will be confirmed once the final positioning of the wind turbines are available and a more detailed design is required. These roads will obviously have to be constructed before any components are delivered to site.

3.3.8 Accommodation of Traffic during Construction

SANRAL and Provincial Authority may require upgrading of the access intersection to the site from National or Provincial Roads. During upgrading of the access, traffic will have to be accommodated, as per SADC Road Traffic Signs Manual requirements. The typical minimum signage requirements, shown in Figure 20, will have to be implemented to ensure safety, should the closure of the road be required during construction.

The accommodation of traffic on the proposed access road, from the gravel road leading to the site, would require consultation with the farm users. As only one-way traffic is likely to be possible on this road, it will likely have to be closed to local traffic at times.

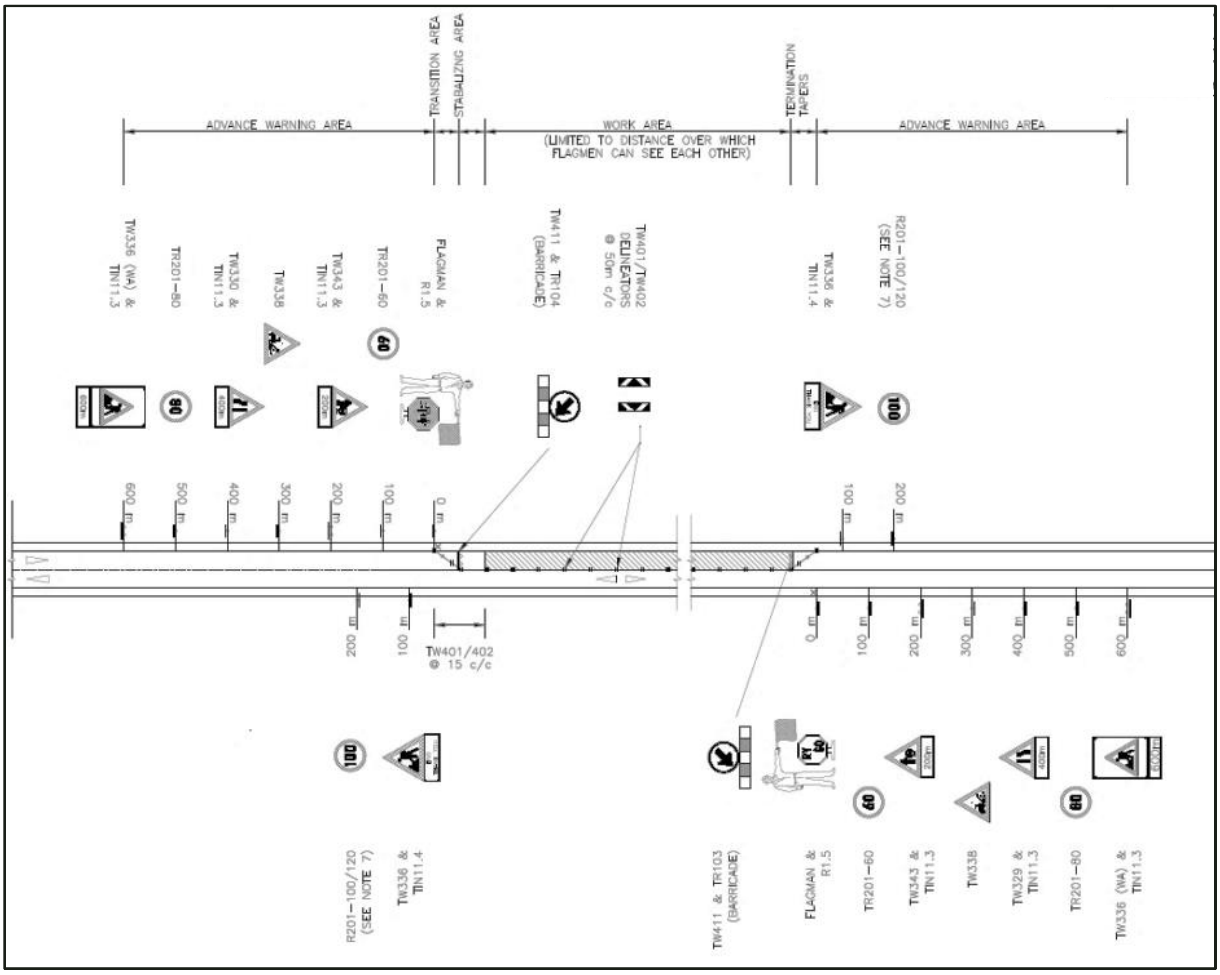


Figure 20: Accommodation of traffic - typical layout

4 CONCLUSION

The transport needs for the proposed Komsberg East Wind Farm, located in the Western Cape Province, on the farms Taayboschkraal (12/1, 3 and 4), Boschmans Kloof (9/3), Koornplaats (41/2), Anys Riviers Plaat (13/0) and Dwars Rivier (14/0), was investigated to identify potential access routes, including site access, for the development of the facility. The general freight for the wind farm will comprise building materials, blades, nacelles, towers, hubs, cables and transformers.

The imported freight will preferably be transported from Saldanha Port to the site. The preferred freight route from Saldanha Port, via Moorreesburg (a distance of 463km), comprises of surfaced roads for the majority of the way (the final 45km or 56km – depending on the final route chosen - to the site entrance from the R354 consists of gravel roads). This route is predominantly on National or Provincial Roads, with suitable conditions for the transport of normal freight, or abnormal loads with permits. No toll fees are required on this route, however, abnormal permits will be required for the transport of the transformers and turbine components, irrespective of the final route determined by the logistics contractor.

Building materials will most likely be transported from Worcester, while certain elements will be transported from various manufacturing centres in South Africa - most likely Cape Town for tower sections and Johannesburg for transformers. The transport of elements from these manufacturing centres will be predominantly on National and Provincial roads, which presents no limitations for normal freight.

Due to the distance from Worcester to site (approximately 218km), significant reductions in heavy vehicle trips could be achieved by sourcing road building materials and concrete aggregate from new quarries or borrow pits in proximity to the site, provided that it is a feasible with respect to the target implementation programme. The possible siting of quarries and/or borrow pits will be confirmed prior to construction, once a geotechnical investigation has been conducted

There is a limited risk of delays to the various deliveries required for the construction of the facility, due to potential routine maintenance works (such as repairs and reseals). The impact of such activities is dependent on the scheduling of deliveries and of roads contracts, and may be mitigated by the use of the alternative routes proposed in this report.

In general, no obvious problems were identified associated with the transport of freight along the proposed routes to the site, nor for the accesses required for the construction and maintenance of the facility. It will, however, be necessary to confirm certain aspects such as clearances, bridge capacities, etc., by the logistics contractor as part of their preparation as this will be dependent on the actual vehicles configuration used.

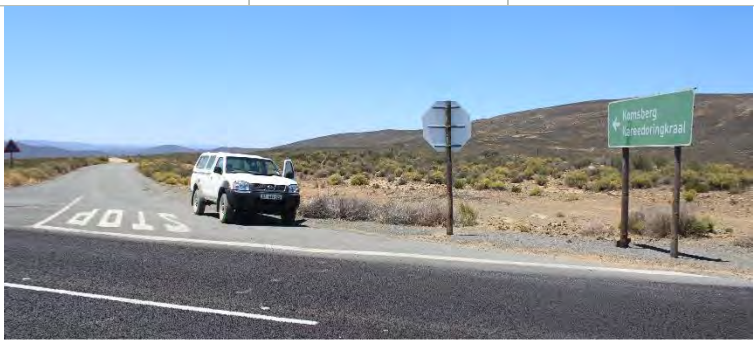
Appendix A: Elements of Preferred Route

Table 3: Elements of preferred route

Element	Route Name	From	To	Distance [km]	Type
1	R45	Saldanha	Moorreesburg	84.9	Surfaced Provincial Road
				The R45 is a single carriageway, two lane road with surfaced shoulders.	
2	R311	Moorreesburg	Riebeeck Kasteel	35.4	Surfaced Provincial Road
				The R311 is a single carriageway, two lane road with surfaced shoulders.	
3	R46	Riebeeck Kasteel	Hermon	9.9	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders.	

Element	Route Name	From	To	Distance [km]	Type
4	R46	Hermon	Wolseley	42.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders. There are mountain passes along this section of the route.	
5	R46	Wolseley	Ceres	16.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders. There are mountain passes along this section of the route.	
6	R46	Ceres	Touwsrivier	80.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with gravel shoulders. There are mountain passes along this section of the route.	

Element	Route Name	From	To	Distance [km]	Type
7	N1	Touwsrivier	Matjiesfontein	56.7	Surfaced National Road
				The N1 is a single carriageway, two lane road with surfaced shoulders.	
8	R354	Matjiesfontein	D2243 (North) Klein Roggeveld Turn-Off	95	Surfaced Provincial Road
			D2243 (South) Turn-off	33.3	
				The R356 is a single carriageway, two lane road with gravel shoulders (surfaced shoulders in places). There are mountain passes along this section of the route.	
9A	D2243	D2243 (North) Klein Roggeveld Turn-Off	D2247 Turn-Off	28	Gravel Road
				Provincial gravel road potentially requiring minor upgrades (improvement of vertical alignment, drainage, gate widenings, etc.) and routine maintenance.	

Element	Route Name	From	To	Distance [km]	Type
9B	D2243	D2243 (South) Turn-off	D2247 Turn-off	39	Gravel Road
				Provincial gravel road potentially requiring significant upgrades (bridge widening, road improvements, drainage, gate widenings, etc.) and routine maintenance.	
10	D2247	D2247 Turn-Off	Site Access Point	17	Gravel Road
				Provincial gravel road potentially requiring minor upgrades (widening of bridges and cattle grids) and routine maintenance	

Appendix B: Urban sections along the preferred route

Table 4: Urban sections on preferred route

Element	Route Name	Town	Type
2	R311	Moorreesburg	Surfaced Provincial Road
			
3	R46	Riebeeck Kasteel	Surfaced Provincial Road
			

Element	Route Name	Town	Type
6	R46	Ceres	Surfaced Provincial Road
	 		

Aurecon South Africa (Pty) Ltd
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City, Cape Town, 7441
T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ethiopia, Ghana, Hong Kong, Indonesia, Lesotho, Libya, Malawi, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.

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KOMSBERG WEST WIND FARM
TRANSPORT ASSESSMENT

Reference: 111391/KWWF
Prepared for: Komsberg Wind Farm (Pty) Ltd
Revision: 2
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Document prepared by:
Aurecon South Africa (Pty) Ltd

Aurecon Centre

1 Century City Drive

Waterford Precinct
Century City, Cape Town, 7441

T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

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Author signature		Approver signature	
Name	Samuel Lombard	Name	Jannie Conradie
Title	Civil Engineer	Title	Technical Director

KOMSBERG WEST WIND FARM

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Aurecon South Africa (Pty) Ltd
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City, Cape Town, 7441
T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

Contents

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EXECUTIVE SUMMARY

This report details the investigation of the transport needs for the proposed Komsberg West Wind Farm (KWWF), located on the border between the Western Cape and Northern Cape Provinces, on the farms Taayboschkraal (12/2), Vlak Kloof (11/0), Welgemoed (268/3 and 4), Schalkwykskraal (204/2) and De Plaat (205/1). The purpose of the investigation is to identify potential access routes, including site access, for the development of the facility. The general freight for the wind farm will comprise building materials, blades, nacelles, towers, hubs, cables and transformers.

The imported freight will preferably be transported from Saldanha Port to the site. The preferred freight route from Saldanha Port, via Moorreesburg (a distance of 458km), comprises surfaced roads for the majority of the way (the final 40km or 51km – depending on the final route chosen - to the site entrance from the R354 consists of gravel roads). This route is predominantly on National or Provincial Roads, with suitable conditions for the transport of normal freight, or abnormal loads with permits. No toll fees are required on this route, however, abnormal permits will be required for the transport of the transformers and turbine components, irrespective of the final route determined by the logistics contractor.

Building materials will most likely be transported from Worcester, while certain elements will be transported from various manufacturing centres in South Africa - most likely Cape Town for tower sections and Johannesburg for transformers. The transport of elements from these manufacturing centres will be predominantly on National and Provincial roads, which presents no limitations for normal freight.

Due to the distance from Worcester to site (approximately 218km), significant reductions in heavy vehicle trips could be achieved by sourcing road building materials and concrete aggregate from new quarries or borrow pits in proximity to the site, provided that it is a feasible with respect to the target implementation programme. The possible siting of quarries and/or borrow pits will be confirmed prior to construction, once a geotechnical investigation has been conducted.

There is a limited risk of delays to the various deliveries required for the construction of the facility, due to potential routine maintenance works (such as repairs and reseals). The impact of such activities is dependent on the scheduling of deliveries and of roads contracts, and may be mitigated by the use of the alternative routes proposed in this report.

In general, no obvious problems were identified associated with the transport of freight along the proposed routes to the site, nor for the accesses required for the construction and maintenance of the facility. It will, however, be necessary to confirm certain aspects such as clearances, bridge capacities, etc., by the logistics contractor as part of their preparation as this will be dependent on the actual vehicles configuration used.

1 INTRODUCTION

Komsberg Wind Farm (Pty) Ltd., has engaged Aurecon to prepare a Transport Assessment, with particular focus on the access to the site, for the proposed Komsberg West Wind Farm (KWWF), in support of the environmental approval application. The site is situated approximately 45km south-east of Sutherland, on the border between the Western Cape and Northern Cape Provinces, and is located on the farms Taayboschkraal (farm 12, portion 2), Vlak Kloof (farm 11, portion 0), Welgemoed (farm 268, portions 3 and 4), Schalkwykskraal (farm 204, portion 2) and De Plaat (farm 205, portion 1).

The site location is indicated on the Key Plan in Figure 1:

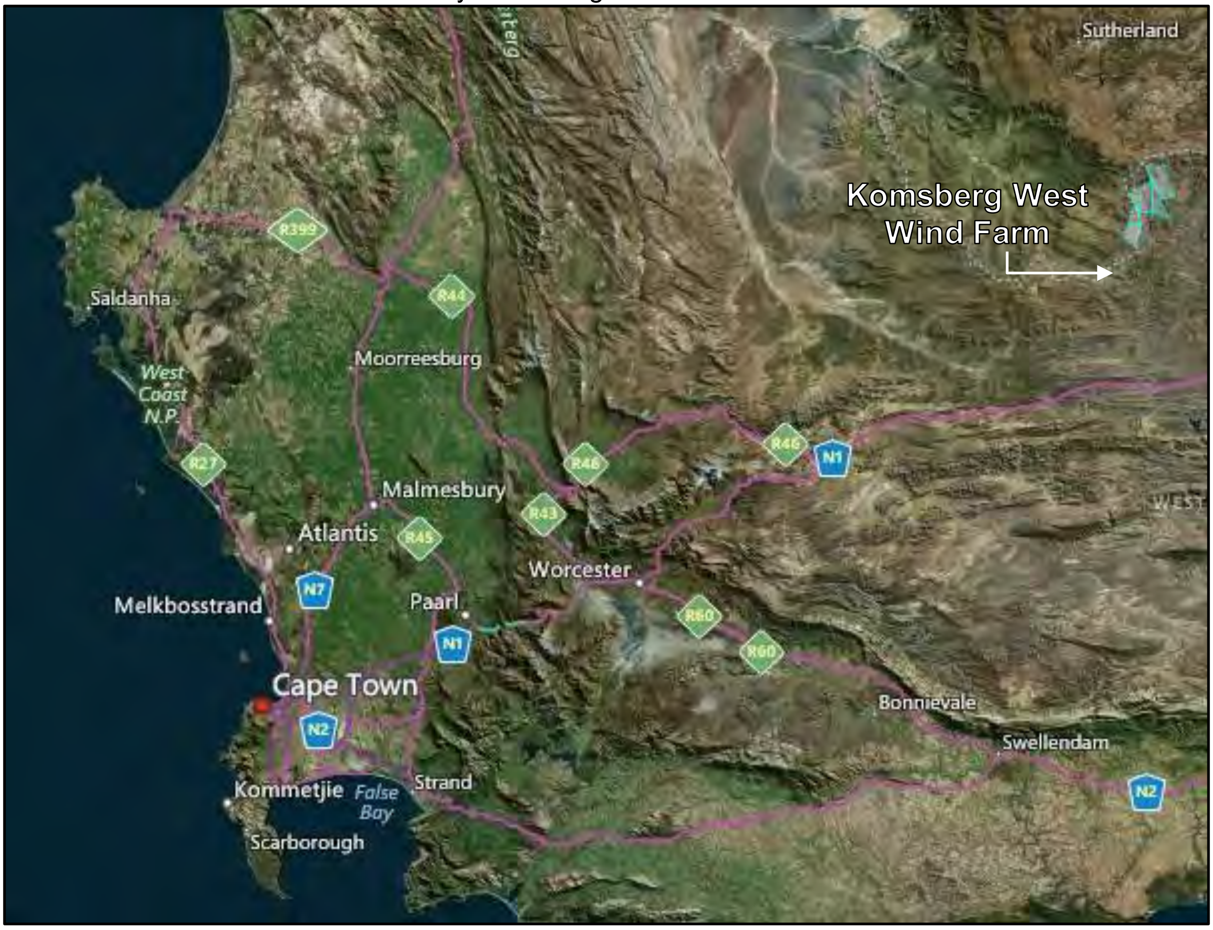


Figure 1: Key Plan detail

The proposed KWWF is expected to comprise:

- Up to 55 Wind Turbine Generators (WTG's)
- Up to 5MW per WTG
- Hub height of up to 120m
- Rotor diameter of up to 140m
- Capacity of up to 275MW

Figure 2 shows the public roads in the vicinity of the site, all roads shown are Provincial gravel roads:

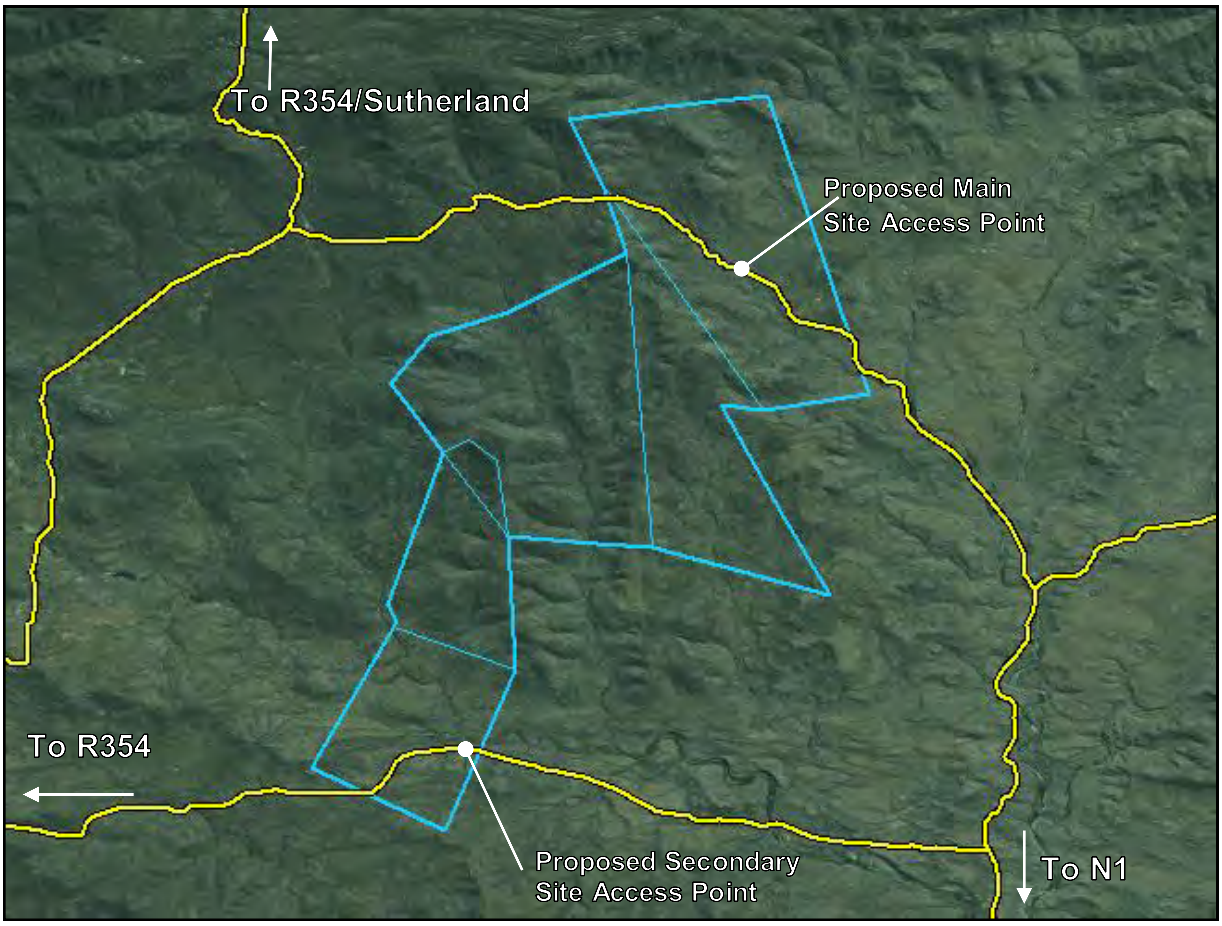


Figure 2: Site location

The scope of the study is to evaluate the transport requirements to implement the development of the KWWF, with particular focus on the access to site from the N1.

The scope of the Transport Assessment Study includes, inter alia:

- Determine the access freight routes between point of delivery (i.e. the preferred port) and the wind farm, for the wind turbine generator (WTG) components.
- Confirm the associated clearances required for the necessary equipment to be transported from the point of delivery to the wind farm.
- Confirm freight requirements.
- Determine (abnormal) permit requirements, if any.
- Consider feasibility of alternative accesses to the site from the N1
- Propose traffic accommodation measures during potential upgrading of the access on the Provincial or National Roads.

2 BASIS AND ASSUMPTIONS

The following parameters have been defined / assumed, based on Aurecon's domain knowledge and relevant experience:

- Imported elements, including major turbine components, are shipped to and transported from the nearest or most practical South African Port to the site.
- Certain elements are transported from manufacturing centres within South Africa.
- Materials for concrete foundation structures and road construction are obtained locally from closest available commercial source, but could also be sourced from new borrow pits and quarries on the site, to limit carting of materials over long distances and at steep grades.
- The largest potential loads with respect to weight will be:
  - Transformer(s) with a payload of approximately 85t
  - Nacelle for each turbine – up to approx. 100t
- Long distance freight will be transported predominantly on surfaced roads.
- The geometric standards applied were such that blades up to 70m in length could be accommodated on the access roads to the proposed development.

Foundations will ultimately be dictated by site geotechnical conditions but generally comprise of large diameter (in the order of 15m to 22m) concrete bases supported on rock or suitable strata.

- The standard vehicle for the transportation of said turbine blades was assumed to have a wheel base of approximately 45m.
- A minimum road width of 4.5m with 0.25m rounding each side was assumed.
- The preliminary alignments were based on satellite imagery as the only available topographical information.
- The turbines will ultimately be removed from the site during the de-commissioning stage, while the turbine bases will be partially demolished to 1m below natural ground level.

3 ASSESSMENT

3.1 General Freight Requirements

3.1.1 Legislation

Currently, the general limitations on road freight transport are:

- Axle load limitation of 7.7t on front axle and 9.0t on single rear axles.
- Axle unit limitations are 18t for dual axle units and 24t for 3 axle units.
- Bridge formula requirements to limit concentration of loads and to regulate load distribution on the vehicle.
- Gross vehicle mass of 56t. This means a typical payload of about 30t.
- Maximum vehicle length of 22m for interlinks, 18.5m for horse and trailers and 13.5m for single units.
- Width limit of 2.6m.
- Height limit 4.3m with a 0.3m tolerance.

Abnormal permits are required for vehicles exceeding these limits, which will be required for this project.

3.1.2 Facility Freight

Materials and equipment transported to the site will comprise:

- Building materials (concrete aggregates, cement, reinforcement and gravel).
- Construction equipment such as road building equipment, excavators and cranes.
- Turbine components (blades, towers and nacelles).
- Transformers and cables.

A breakdown of transport requirements for the respective phases of the project follows:

3.1.2.1 During the Construction Phase:

- Building materials, comprising reinforced concrete materials for turbine foundations and gravel materials for road layer works. These materials will be transported using conventional trucks, which are expected to adhere to legal limits.
- WTG components will most likely be transported by abnormal vehicles from the nearest suitable South African port, which is Saldanha Port (Section 3.3 refers). The number of loads will be a function of the number of turbines to be constructed.
- WTG towers will be manufactured locally, with steel towers shipped from Atlantis or Port Elizabeth, and concrete towers manufactured on site, or in Cape Town and transported to site in segments.
- Power transformers will most probably be transported by abnormal vehicles from manufacturing centres in Johannesburg.
- 132kV OHL components will be transported from various manufacturing centres as well as ports for some the components. However all components will be transported by means of general freight. The number of loads will be a function of the final configuration.

3.1.2.2 During the Operational Phase:

- Potential replacement of WTG elements, which would require employment of cranes and transport equipment. However, this is expected to have a low probability of occurrence.

3.1.2.3 During the de-commissioning phase:

- The removal of turbine components from the site to a suitable spoil / recovery / recycling site, which could potentially imply shipping items out of the country, and which would require abnormal transport to the approved recovery sites.
- Re-instatement of the disturbed areas, such as ripping of access roads and reinstating of vegetation, by use of suitable construction equipment.
- The turbine bases will have to be demolished partially, which will require heavy demolishing equipment.

Examples of the abnormal loads which are most pertinent to the wind farm logistics are illustrated in Figure 3 and Figure 4:

Figure 3: Abnormal freight (tower section in low-load configuration (top), and blade (bottom))

Figure 4: Minor wind farm components delivered to a wind farm site with normal freight

3.2 Traffic Statement

The traffic volumes will have three different patterns for the construction, operational and de-commissioning stages of the project, respectively.

3.2.1 Traffic during the Construction phase

Based on Aurecon's experience with similar projects, it is estimated that the number of expected trips per turbine would be:

- Abnormal vehicles: 10 (turbine components)
- Heavy vehicles: 60 (reinforcement and concrete)
- Heavy Vehicles: 90 (road layer works)
- **TOTAL: 150 / 10 (Heavy / Abnormal) per turbine**

The wind farm capacity and the specific WTG model to be used has not yet been confirmed and it is therefore not possible to accurately calculate the total expected trips for the construction of the facility. However, the range of potential configurations for the wind farm, as listed in Table 1, provides a basis for the estimation of the total trips that will be required. In the table, 140MW and 275MW are considered to be the possible site capacities, while the options of 3.5MW and 5MW WTGs are considered as representing the outer limits of the range of possible machines to be utilised.

Table 1: Range of Potential Wind Farm Configurations

WTG Capacity	140MW Facility	275MW Facility
3.5MW	40 no.	-
5MW	-	55 no.

Based on the above, the total trips for the ultimate 55 turbine facility is estimated to be 550 abnormal and 8250 heavy vehicle trips. However, based on the current 140MW limitation in the REIPPP on wind farm capacity, it is likely that a maximum of 40 turbines (400 abnormal and 6000 heavy vehicle loads) will be constructed in the initial stage of the project, over an estimated period of 24 months. Should concrete towers be used, the number of abnormal loads would decrease, with heavy loads increasing.

If the concrete and road building materials could be sourced from newly developed sources in proximity to the site, the number of heavy vehicles on the access roads could be reduced substantially.

In the worst case, the number of heavy vehicle trips per day would be in the order of 15 to 20 round trips. The impact of this on the general traffic would therefore be negligible, as the peak time traffic would be increased by 5 trips at most.

Based on previous experience, the personnel during construction is estimated to total 300 - 400 persons. The personnel will most likely reside in Sutherland, Matjiesfontein or Laingsburg as the closest communities. It is recommended that the majority of construction personnel be transported to and from site by means of busses.

This personnel transport will total approximately 15 to 25 daily trips. The impact of this on the general traffic would therefore also be considered negligible, as the peak hour traffic would be increased by 10 trips at most.

3.2.1.1 Traffic during the Construction of Grids/Power lines

The grids/power lines to be constructed during the project will be 132KV power lines. The main components being the support mast, cables, connectors, transformers, etc. All the components will be transported by means of general freight. Aurecon is of opinion that the traffic impact for this construction activity will be minimal and that the additional generated traffic is negligible.

3.2.2 Traffic during the Operational phase

After construction, the generated site traffic would be limited to maintenance support, with only a few light vehicles accessing the site per day.

3.2.3 Traffic during the De-commissioning Phase

Traffic is expected to be very similar to the construction phase. The impact of this on the general traffic would therefore also be considered negligible.

3.2.4 Summary of Traffic Statement

Current traffic volumes on N1 near Matjiesfontein (Between Laingsburg and Touwsrivier) are estimated from the most recent SANRAL yearbook at about 3834 ADT (Average Daily Traffic), 1497 ADTT (Average Daily Truck Traffic) (both directions with a 50/50 split) and a maximum hourly flow of about 800 veh/h for this section of road.

The current traffic volumes on the R354 (Western Cape Provincial Road: Trunk Road 20/1) is in the order of 140 vehicles per day with a 13% heavy vehicle component.

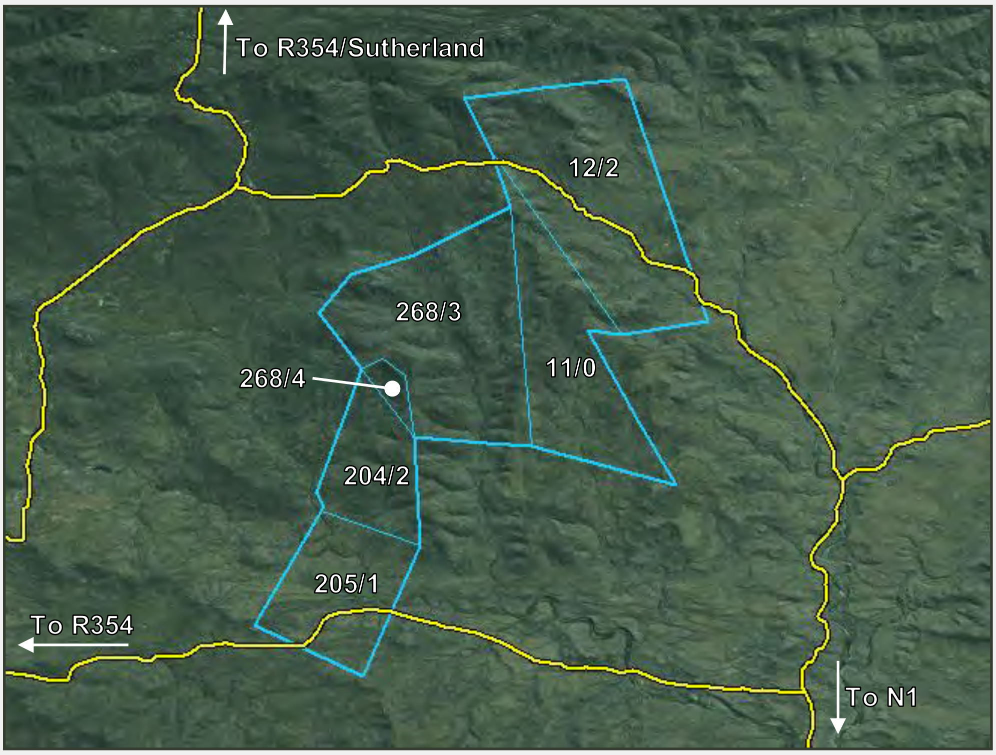
It can therefore be stated that the construction traffic and the post construction traffic would be low without any significant impact on the existing traffic flows on the N1 or provincial roads. It will also have a negligible impact on the pavement structures. Furthermore, the impact of the traffic on the provincial gravel access roads will also be negligible with respect to service levels.

3.3 Access Route

3.3.1 Site Description

A summary of the site description, as provided in Section 1, is given in Table 2:

Table 2: Summary of Site Description



Location (Centre Point)	32° 45' 25.4" S 20° 51' 13.3" E
Distance of Centre Point SE of Sutherland	45km
Generation Capacity	140MW-200MW
Distance from Ports **Saldanha** **Cape Town** **Port Elizabeth**	 458km 326km 616km
Farms (farm/portion)	Taayboschkraal (12/2), Vlak Kloof (11/0), Welgemoed (268/3, 268/4), Schalkwykskraal (204/2) and De Plaat (205/1)

3.3.2 Preferred Route from Port

The starting point of the route for the transportation of imported equipment is the port at either Saldanha, Cape Town or Port Elizabeth. Of these, Saldanha is the preferred port, with a route length of 458km, as indicated in Figure 5. Two equally viable alternatives exist for the final section of the route (A1 – from the north via Verlatenkloof Pass and Komsberg Pass, A2 – from the north via D2243, A3 – from the south via D2246). These options are discussed in Sections 3.3.7. Section views of the roads along the preferred route are shown in Appendix A, while urban section views along this route are shown in Appendix B.

It should be noted that the Ports Authority also has preferences on freight imports, which should be respected.

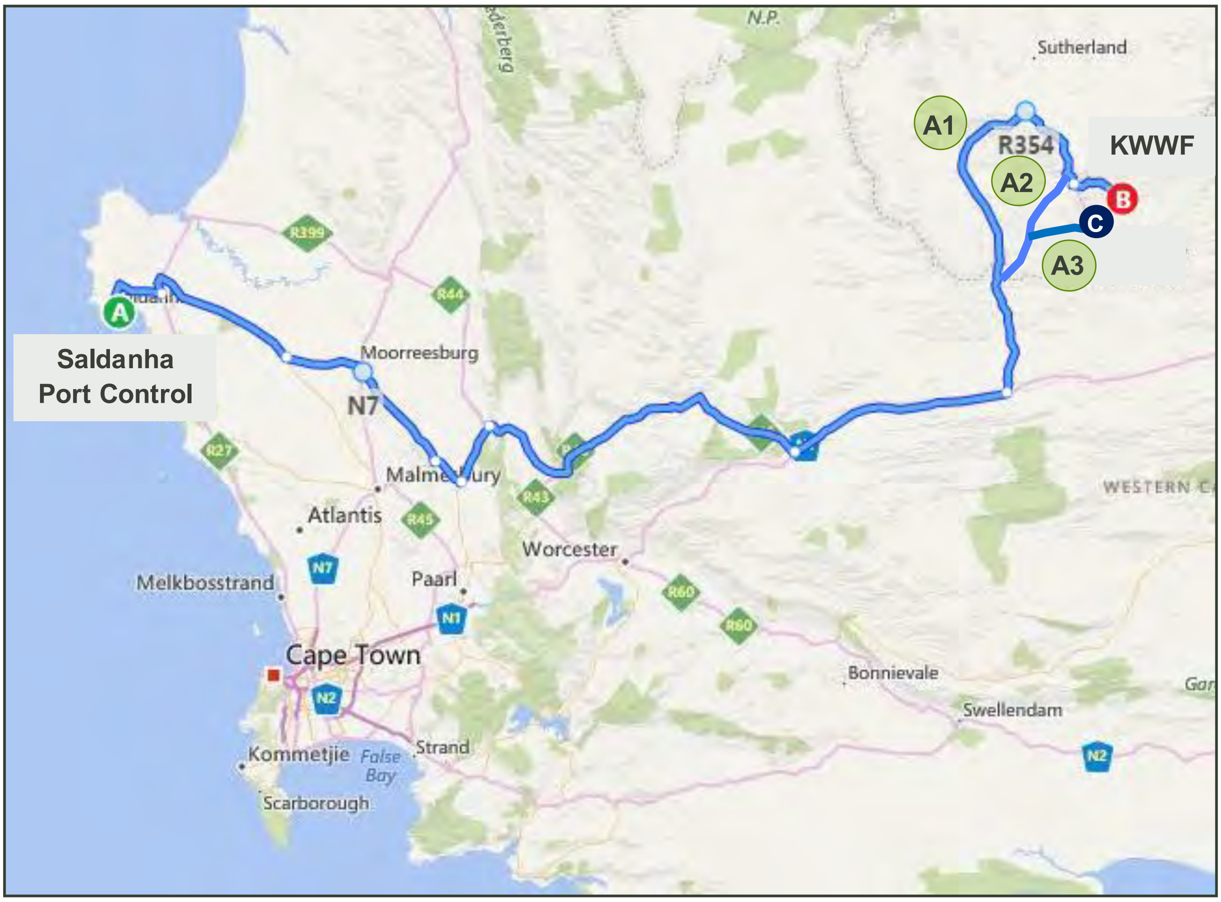


Figure 5: Preferred freight route

The route from the alternative port of Port Elizabeth is about 616km and is the least preferred route; however, it still offers an alternative, should Saldanha Port not be available for any reason. While Cape Town Port is the closest port to the site, it would most probably not be able to accommodate the imported turbine elements, due to current activities.

Alternatives to the preferred route exist and are shown in Figure 6.

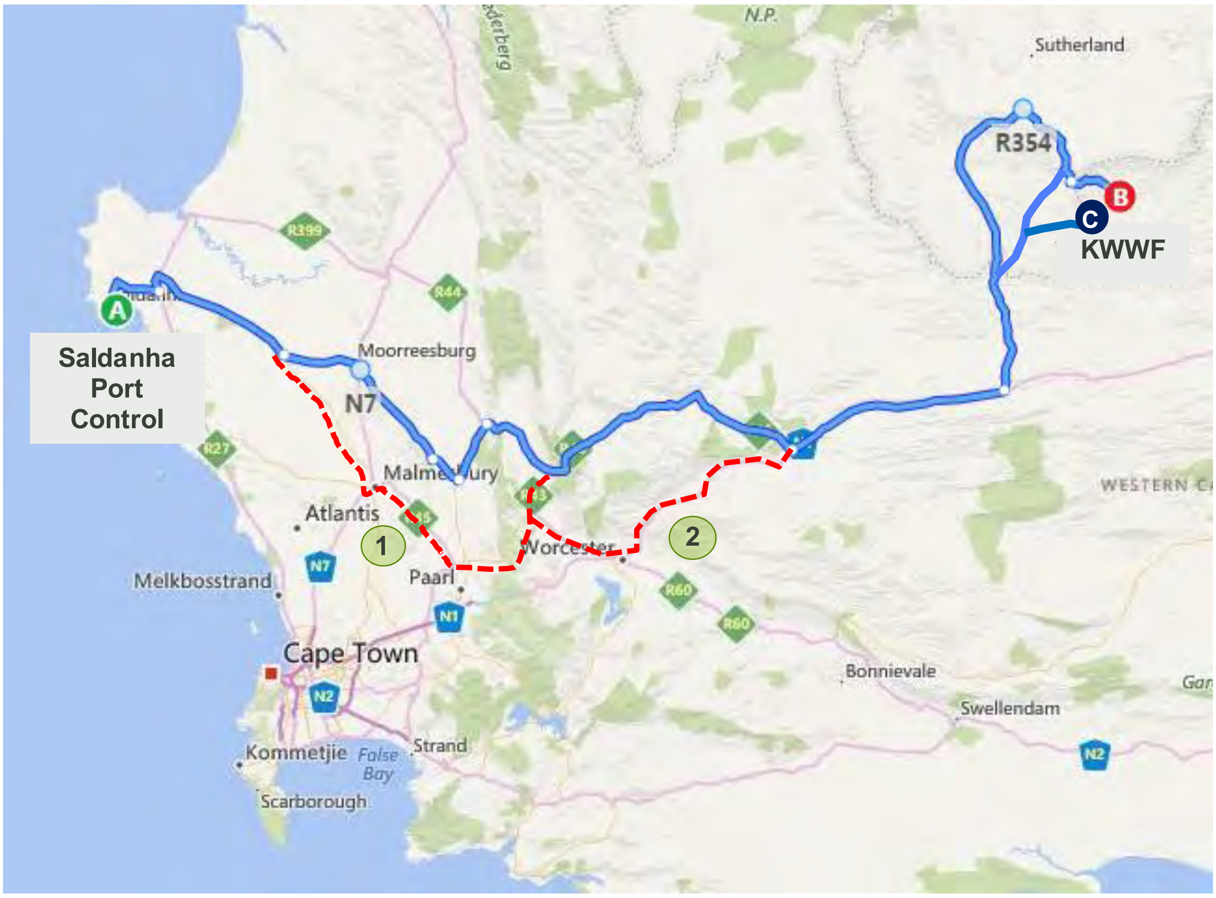


Figure 6: Alternative freight routes from Saldanha Port

The following is noted regarding deviations from the preferred route:

1. This alternative passes through the town of Malmesbury, where an urban intersection limits the maximum turning radius. This alternative will be restricted for abnormal loads that require a large turning radius (eg vehicles transporting wind turbine blades).
2. This alternative passes through Worcester and De Doorns, along the N1. However, one of the bridges over the N1, between Worcester and De Doorns, is of concern. It is estimated that the bridge is lower than 5m, limiting the maximum height of freight that can be transported along this route.

The alternatives shown in Figure 6 are presented for the cases where the preferred route of travel is unavailable due to maintenance, or any other reason. The alternatives that are presented have certain constraints (as mentioned) and may not be able to accommodate all of the abnormal loads. An alternative of accessing the site from Laingsburg was not considered, due to the excessive length of gravel roads along the route.

It is suggested that the transporting contractor executes a more detailed study before transporting any of the components, to confirm the preferred and alternative routes for each type of load configuration. Should any of the preferred sections be unavailable for any reason, a combination of routes should also be considered.

3.3.3 Route for Construction Materials

Material sources for road building and concrete works are available in Worcester and all material will most likely be transported from this town on the N1 and the R354. As stated earlier, to reduce traffic on the access roads, consideration could be given to sourcing material for road building and concrete aggregate from new quarries/sources in the vicinity of the site, provided that it is feasible with respect to the target implementation programme. It is noted that the approval period for such quarries/sources is typically 12 to 18 months. The possible siting of quarries and/or borrow pits will be confirmed prior to construction, once a geotechnical investigation has been conducted.

The closest manufacturing centre will most likely be Cape Town, which is situated 326km from the site. For the largest part of the route from Cape Town, the N1 (which is surfaced) will be used. There are, however, toll fees present on this specific route, which can be avoided by use of alternatives.

3.3.4 Authority and Permit Requirements

The following is noted:

a) No toll fees are required on the routes from the Saldanha Port. On the routes from the other manufacturing centres, certain portions of the National Roads are tolled, but the related fees can be avoided by use of alternatives.

b) Abnormal permits will be required for the transport of the transformer and the turbine elements by the logistics contractor. The estimated permit value will be a function of the actual vehicle configuration, but is estimated at R9000 – R15000 per trip (dependent on the weight of the load and escorting requirements by Provincial Traffic). In extreme cases, permits could cost as much as R50 000 per trip. The abnormal application process would take approximately one month to complete and should be applied for, by the logistics contractor, once the project is awarded preferred bidder status.

3.3.5 Route Limitations of the Preferred Route from the Port

The identified route has possible limitations that will necessitate more detailed investigations to determine the level of upgrading that will be required (if any) to accommodate the abnormal loads. All the possible limitations (apart from the capacity of the bridges on the R354, discussed in Section 3.3.6) will potentially be encountered on the gravel roads from the R354 intersection to the prospective site. Possible limitations, other than capacity of the bridges on the R354, that require investigation may include: motor grid gates with loading constraints, overhead power and telecommunication lines with an insufficient ground clearance, substandard geometry of roads and bridges, and drainage issues.

3.3.6 Capacity of Bridges

The section of the preferred route along the R354 between Matjiesfontein (N1) and Sutherland does not form part of a heavy freight route. Several bridges exist along this road that will have to be crossed by abnormal loads. Elevation and approach views of a typical bridge on the R354 are shown in Figure 7 and Figure 8.

Figure 7: Elevation view of typical bridge on R354

Figure 8: Approach view of typical bridge on R354

A high order investigation was performed to identify limitations on the loading capacity of the existing bridges along this section of road. Aurecon believes it is unlikely that there would be any problems with the loading capacity of these bridges with regards to the delivery of abnormal loads (provided the requirements of the Bridge Formula are met). However, a detailed investigation should be undertaken by the transport contractor, to confirm that the vehicle configuration is suited to the maximum axle loading for the bridges.

3.3.7 Site Access Road

Two equally viable alternatives for the final section of the route to the site exist. These to the proposed site access point(s) are shown in Figure 9.

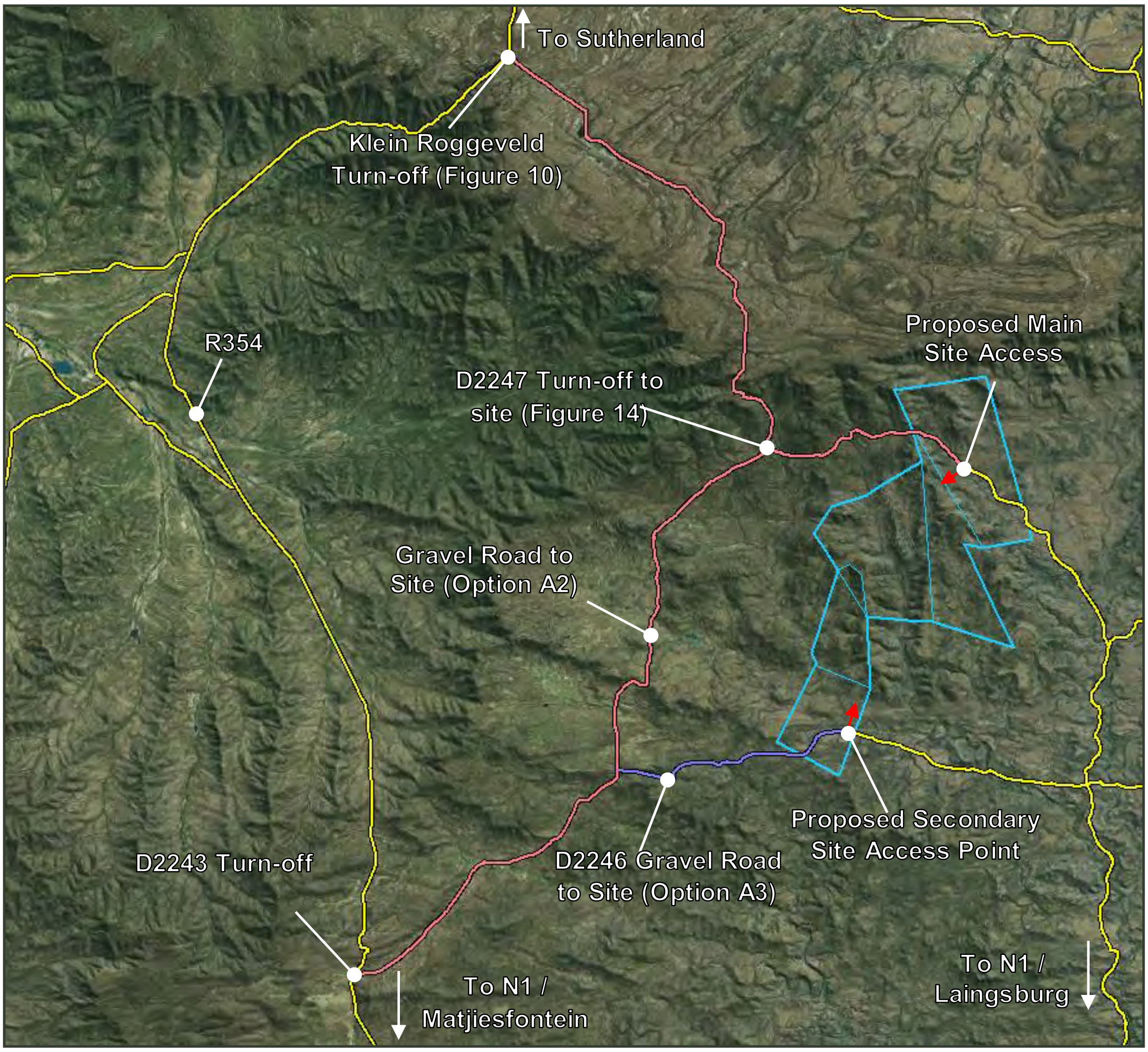


Figure 9: Access position to KWWF

The proposed site access position is situated roughly 11km south-east of the border between the Northern Cape and Western Cape and is to be approved by the Western Cape Provincial Government. The sufficiency of the sight distances (stopping and shoulder) at the proposed site entrance are to be reviewed and approved by the local authority. The two alternative routes from the R354 are discussed in the subsequent sections.

3.3.7.1 Road to Site Access Point (Option A1)

For this option, the proposed access position for the site is located approximately 40km from the R354 turn-off to Klein Roggeveld. Figure 10 shows the Klein Roggeveld turn-off from the R354. The remainder of the route to site from this point consists of gravel roads.

Figure 10: Klein Roggeveld turn-off

Prior to the final turn-off to site, the road goes down Komsberg Pass. The road is in a good condition, but navigation down the pass will present some difficulties and falling rocks may result in unwanted issues (Figure 11). The safety for using the pass road will have to be confirmed prior to the transport of loads. Potential removal of unstable material could improve safety.

Figure 11: Falling rocks at Komsberg Pass

3.3.7.2 Road to Site Access Point (Option A2)

For this option, the site access point is located approximately 51km from the R354 turn-off on to D2243, shown in Figure 12. Following this turn-off, the road is surfaced for about 130m, after which the remainder of the route to site consists of gravel roads.

Figure 12: D2243 Turn-off to Komsberg

Even though this alternative results in a shorter overall route length from port than Option A1, upgrades in the form of a bridge widening, addressing drainage issues and the widening of cattle grid gates are required. The potential bridge widening is shown in Figure 13.

Figure 13: Possible bridge widening for Route Option A2

The distance to be travelled on gravel roads for this alternative is also 11km longer than for Option A1. Furthermore, this route passes some farm homesteads and farm owners will have to be consulted before this route is deemed a viable option. Dust suppression and consultation will be required in certain cases.

The majority of these constraints should however be eliminated when this route is upgraded as part of the other proposed wind farm projects in the area whose construction precedes that of KEWF, in 2016 and 2017. The final 7.7km until the final turnoff of the route will however not be upgraded as part of a preceding wind farm construction. It is therefore recommended that the final choice between Options A1 and A2 be made closer to the time of construction, with a possibility to use both routes.

3.3.7.3 Route from Final Turn-off

A final turn-off on to D2247 (shown in Figure 14) is located approximately 28km from the Klein Roggeveld turn-off (and about 39km from the D2243 turn-off), at the location where Options A1 and A2 converge. The turning radius appears to be adequate, however further investigation into the width adequacy of the cattle grid and farm gate is to be undertaken. The site is located approximately 12km after the final turn-off.

Figure 14: D2247 Final turn-off to KWWF

Existing roads will be utilised as far as possible, with upgrades to be performed where necessary. Due to the relatively long section of gravel roads from the R354 to the site, the likelihood of upgrade requirements is increased, especially on the last 12km section. The possible need of an additional wearing course on certain sections of the road exists to improve riding quality, along with the potential widening or strengthening of cattle grid gates, as mentioned earlier. A typical farm gate on the preferred route is shown in Figure 15.

Figure 15: Farm gate

Drainage issues also need to be addressed along certain sections of the road. It is proposed that a hydraulic structure such as a causeway is constructed at the river crossing situated within approximately 1km of the site's entrance (Figure 16) to ensure crossing during flooding. Else regular maintenance would be required to remove debris from the roadway.

Figure 16: River crossing before KWWF

3.3.7.4 Road to Site Access Point (Option A3)

For this option, the secondary site access point is located approximately 14 km from the D2243 turn-off on to D2246, shown in Figure 17. Existing roads will be utilised as far as possible, with upgrades to be performed where necessary. The possible need of an additional wearing course on certain sections of the road exists to improve riding quality, along with the potential widening or strengthening of cattle grid gates, as mentioned earlier. There are three significant stream crossings on the proposed access road, where low-level Bridges or causeways are to be constructed at these crossings.

Figure 17: Secondary Site Access (South) via D2246

3.3.7.5 Road from Site Access Point to Site

The proposed access road to the site is approximately 2.7km in length and has to be newly constructed. Allowance for adequate turning radii are to be made, along with sufficient sight distances. The road was deliberately positioned in such a way that it does not interfere with the closest farmer's view, seeing that it is some distance away from his farm house as well as large streams. The location of the proposed access road is shown in Figure 18.

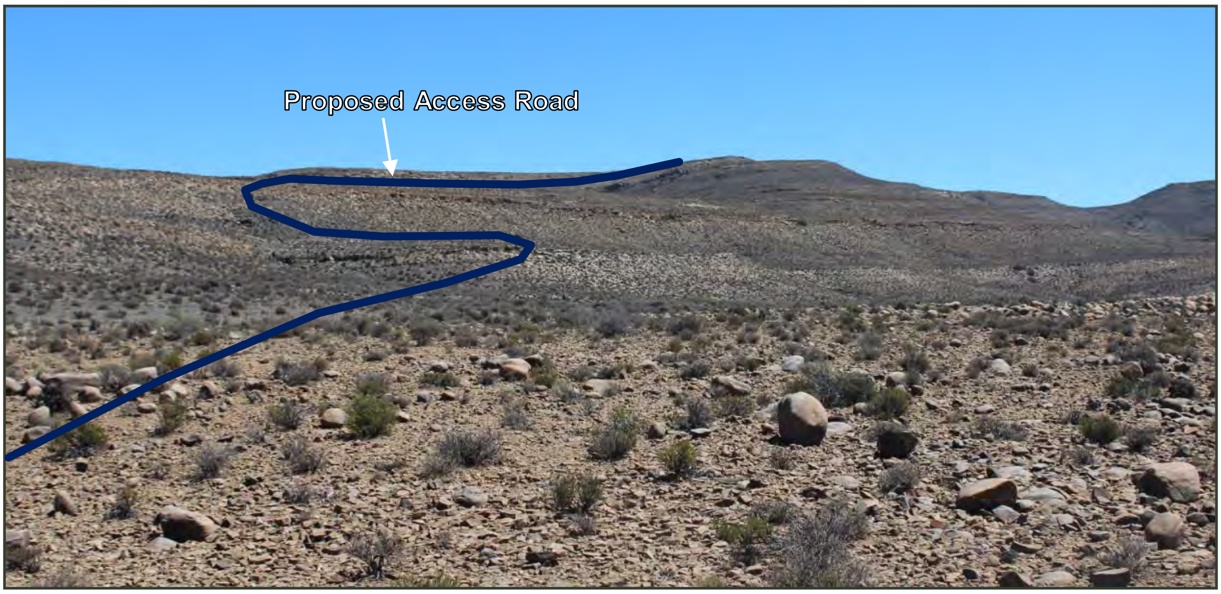


Figure 18: KWWF access road to site

Access roads between the turbines will be required for construction, and later for maintenance purposes. The internal access roads will be confirmed once the final positioning of the wind turbines are available and a more detailed design is required.

3.3.8 Accommodation of Traffic during Construction

SANRAL and Provincial Authority may require upgrading of the access intersection to the site from National or Provincial Roads. During upgrading of the access, traffic will have to be accommodated, as per SADC Road Traffic Signs Manual requirements. The typical minimum signage requirements, shown in Figure 19, will have to be implemented to ensure safety, should the closure of the road be required during construction.

The accommodation of traffic on the proposed access road, from the gravel road leading to the site, would require consultation with the farm users. As only one-way traffic is likely to be possible on this road, it will likely have to be closed to local traffic at times.

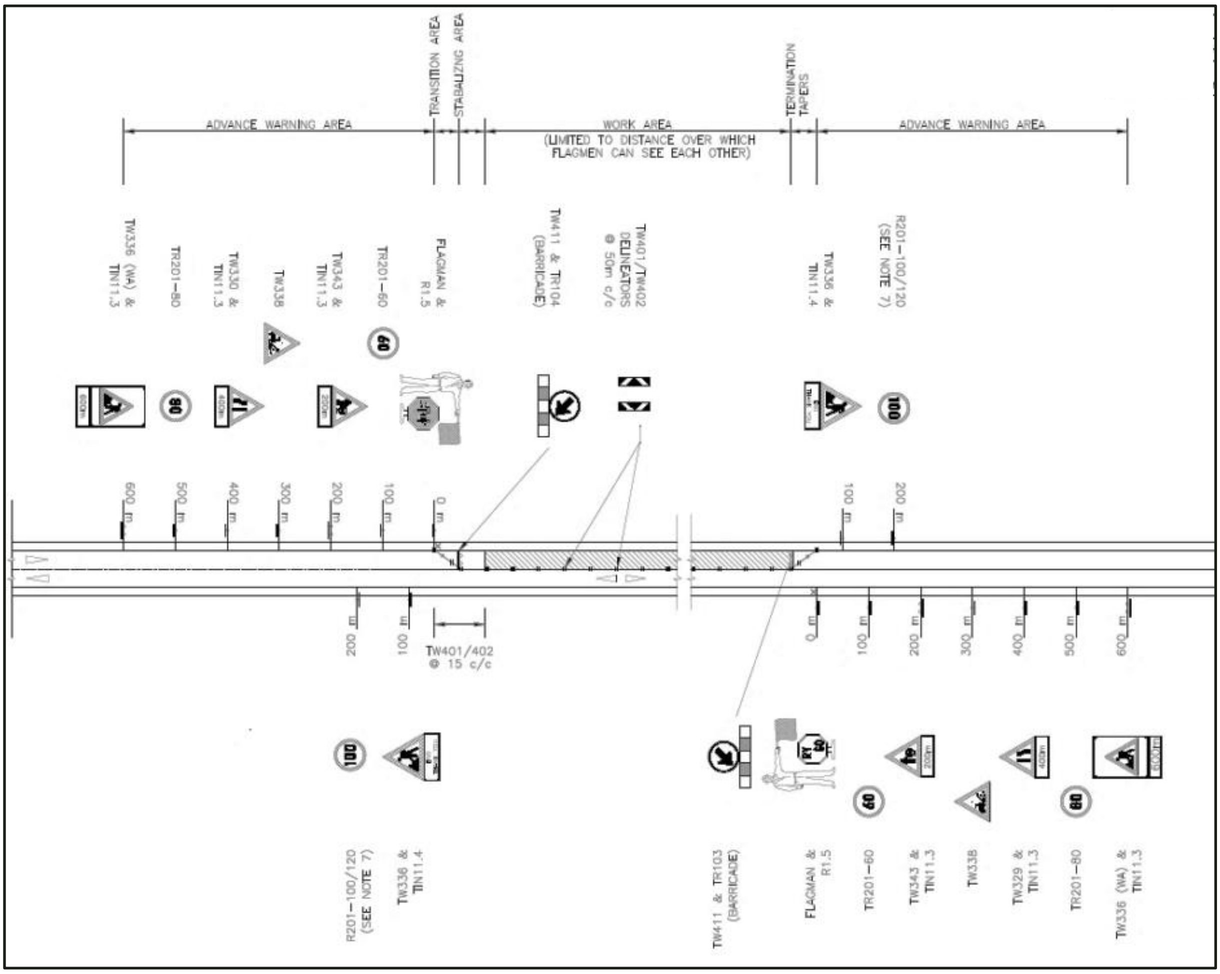


Figure 19: Accommodation of traffic - typical layout

4 CONCLUSION

The transport needs for the proposed Komsberg West Wind Farm, located on the border between the Western Cape and Northern Cape Provinces, on the farms Taayboschkraal (12/2), Vlak Kloof (11/0), Welgemoed (268/3 and 4), Schalkwykskraal (204/2) and De Plaat (205/1), was investigated to identify potential access routes, including site access, for the development of the facility. The general freight for the wind farm will comprise building materials, blades, nacelles, towers, hubs, cables and transformers.

The imported freight will preferably be transported from Saldanha Port to the site. The preferred freight route from Saldanha Port, via Moorreesburg (a distance of 458km), comprises surfaced roads for the majority of the way (the final 40km or 51km – depending on the final route chosen - to the site entrance from the R354 consists of gravel roads). This route is predominantly on National or Provincial Roads, with suitable conditions for the transport of normal freight, or abnormal loads with permits. No toll fees are required on this route, however, abnormal permits will be required for the transport of the transformers and turbine components, irrespective of the final route determined by the logistics contractor.

Building materials will most likely be transported from Worcester, while certain elements will be transported from various manufacturing centres in South Africa - most likely Cape Town for tower sections and Johannesburg for transformers. The transport of elements from these manufacturing centres will be predominantly on National and Provincial roads, which presents no limitations for normal freight.

Due to the distance from Worcester to site (approximately 218km), significant reductions in heavy vehicle trips could be achieved by sourcing road building materials and concrete aggregate from new quarries or borrow pits in proximity to the site, provided that it is a feasible with respect to the target implementation programme. The possible siting of quarries and/or borrow pits will be confirmed prior to construction, once a geotechnical investigation has been conducted.

There is a limited risk of delays to the various deliveries required for the construction of the facility, due to potential routine maintenance works (such as repairs and reseals). The impact of such activities is dependent on the scheduling of deliveries and of roads contracts, and may be mitigated by the use of the alternative routes proposed in this report.

In general, no obvious problems were identified associated with the transport of freight along the proposed routes to the site, nor for the accesses required for the construction and maintenance of the facility. It will, however, be necessary to confirm certain aspects such as clearances, bridge capacities, etc., by the logistics contractor as part of their preparation as this will be dependent on the actual vehicles configuration used.

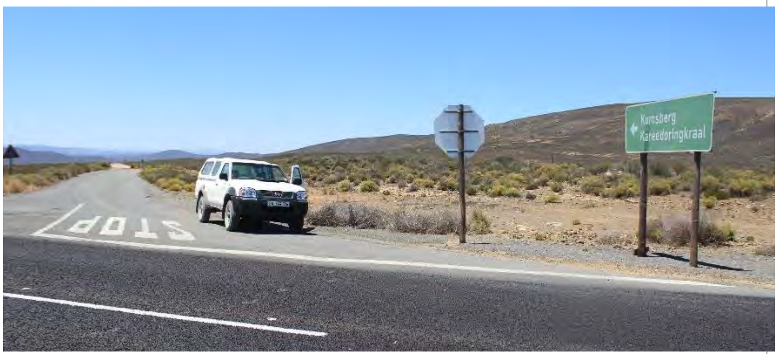
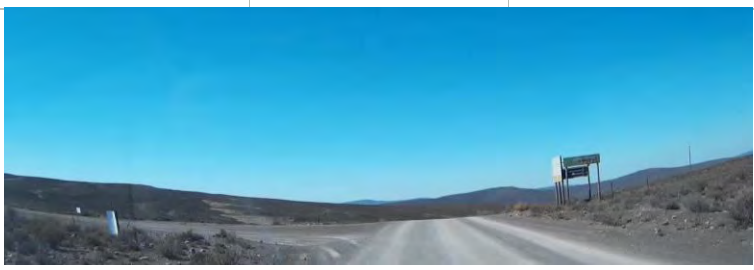
Appendix A: Elements of Preferred Route

Table 3: Elements of preferred route

Element	Route Name	From	To	Distance [km]	Type
1	R45	Saldanha	Moorreesburg	84.9	Surfaced Provincial Road
				The R45 is a single carriageway, two lane road with surfaced shoulders.	
2	R311	Moorreesburg	Riebeeck Kasteel	35.4	Surfaced Provincial Road
				The R311 is a single carriageway, two lane road with surfaced shoulders.	
3	R46	Riebeeck Kasteel	Hermon	9.9	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders.	

Element	Route Name	From	To	Distance [km]	Type
4	R46	Hermon	Wolseley	42.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders. There are mountain passes along this section of the route.	
5	R46	Wolseley	Ceres	16.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with surfaced shoulders. There are mountain passes along this section of the route.	
6	R46	Ceres	Touwsrivier	80.6	Surfaced Provincial Road
				The R46 is a single carriageway, two lane road with gravel shoulders. There are mountain passes along this section of the route.	

Element	Route Name	From	To	Distance [km]	Type
7	N1	Touwsrivier	Matjiesfontein	56.7	Surfaced National Road
				The N1 is a single carriageway, two lane road with surfaced shoulders.	
8	R354	Matjiesfontein	D2243 (North) Klein Roggeveld Turn-Off	95	Surfaced Provincial Road
			D2243 (South) Turn-off	33.3	
				The R354 is a single carriageway, two lane road with gravel shoulders (surfaced shoulders in places). There are mountain passes along this section of the route.	
9A	D2243	D2243 (North) Klein Roggeveld Turn-Off	D2247 Turn-Off	28	Gravel Road
				Provincial gravel road potentially requiring minor upgrades (improvement of vertical alignment, drainage, gate widenings, etc.) and routine maintenance.	

Element	Route Name	From	To	Distance [km]	Type
9B	D2243	D2243 (South) Turn-off	D2247 Turn-off	39	Gravel Road
				Provincial gravel road potentially requiring significant upgrades (bridge widening, road improvements, drainage, gate widenings, etc.) and routine maintenance.	
10	D2247	D2247 Turn-Off	Main Site Access Point	12	Gravel Road
				Provincial gravel road potentially requiring minor upgrades (widening of bridges and cattle grids) and routine maintenance	
11	D2246	D2243 Turn-Off	Secondary Site Access Point	14	Gravel Road
				Provincial gravel road potentially requiring minor upgrades (widening of bridges and cattle grids) and routine maintenance	

Appendix B: Urban sections along the preferred route

Table 4: Urban sections on preferred route

<table>
<tr><th>Element</th><th>Route Name</th><th>Town</th><th>Type</th></tr>
<tr><td>2</td><td>R311</td><td>Moorreesburg</td><td>Surfaced Provincial Road</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td>3</td><td>R46</td><td>Riebeeck Kasteel</td><td>Surfaced Provincial Road</td></tr>
<tr><td></td><td colspan="3"></td></tr>
</table>

Element	Route Name	Town	Type
6	R46	Ceres	Surfaced Provincial Road
	 		

Aurecon South Africa (Pty) Ltd
Aurecon Centre
1 Century City Drive
Waterford Precinct
Century City, Cape Town, 7441
T +27 21 526 9400
F +27 21 526 9500
E capetown@aurecongroup.com
W www.aurecongroup.com

Aurecon offices are located in:
Angola, Australia, Botswana, China, Ethiopia, Ghana, Hong Kong, Indonesia, Lesotho, Libya, Malawi, Mozambique, Namibia, New Zealand, Nigeria, Philippines, Qatar, Singapore, South Africa, Swaziland, Tanzania, Thailand, Uganda, United Arab Emirates, Vietnam.