Environmental Impact Assessment for the proposed Banna Ba Pifhu Wind Energy Project near Humansdorp, Eastern Cape: Final Environmental Impact Assessment Report

Chapter 9:

Noise Impacts

Contents

9.1 INTRODUCTION & METHODOLOGY 3

9.1.1 Methodology 3
9.1.2 Terms of Reference 5
9.1.3 Declaration of independence 6

9.2 DESCRIPTION OF THE NOISE IMPACTS 7

9.2.1 Mechanical Sounds 7
9.2.2 Aerodynamic Sound 8
9.2.3 Ambient Sound & Wind Speed 8
9.2.4 Low Frequency Noise and Infrasound 9

9.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT 11

9.3.1 Site Location 12
9.3.2 Noise Sensitive Areas 14
9.3.3 Ambient Noise at Proposed Site 14

9.4 IDENTIFICATION OF ISSUES AND IMPACTS 16

9.5 APPLICABLE LEGISLATION AND STANDARDS 16

9.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS 18

9.6.1 Predicted noise levels for the Construction Phase 18
9.6.1.1 Construction Equipment 18
9.6.2 Low frequency noise concerns 20
9.6.3 Predicted noise levels for the Wind Turbines Generators 20
9.6.4 Assessment of Noise Impacts 25
9.6.4.1 Assessment and mitigation for Construction Phase 25
9.6.4.2 Assessment and mitigation for Operational Phase 25
9.6.5 Reversibility and Irreplaceability of Noise Impacts: 27
9.6.6 Recommendations 27
9.6.6.1 Construction Activities 28
9.6.6.2 Operational Activities 28
9.6.7 Assessment of impacts of Preferred Alternative (30.6 M) and Alternative 1 (50 MW) 28

9.7 IMPACT ASSESSMENT RATING TABLE 29

9.8 MONITORING ACTIONS 31

9.9 CONCLUSIONS 31

9.10 REFERENCES 32

Appendices

APPENDIX 9.1:	AIA APPROVAL CERTIFICATE	33
APPENDIX 9.2:	CALIBRATION CERTIFICATE	34
APPENDIX 9.3:	TYPICAL SOUND POWER AND SOUND PRESSURE LEVELS	35
APPENDIX 9.4:	LETTER FROM LANDOWNER	36

Tables

Table 9.1:	Wind Turbine Generator Technical Data	4
Table 9.2:	Wind Turbine Location Co-ordinates	12
Table 9.3:	Noise Sensitive Areas (NSA)	14
Table 9.4:	Ambient Noise Results during the day – 09th November 2011	15
Table 9.5:	Ambient Noise Results during the night – 09th November 2011	15
Table 9.6:	Typical rating levels for noise in various types of districts	17
Table 9.7:	Categories of environmental community / group response (SANS 10103:2008)	17
Table 9.8:	Typical Construction Noise	18
Table 9.9:	Combining Different Construction Noise Sources – High Impacts (Worst Case)	19
Table 9.10:	Combining Different Construction Noise Sources – Low Impacts (at approximately 3m).	19
Table 9.11:	Attenuation by distance from a noise of 117 dB for the construction phase (worst case)	19
Table 9.12:	Preferred Alternative (30.6 MW) - Table of Results of the Noise Impacts at the Noise Sensitive Areas (NSA's)	20
Table 9.13:	Preferred Alternative (30.6 MW) - Summary of Noise Impacts (Vestas V100 – 1.8MW)	26
Table 9.14:	Preferred Alternative (30.6 MW)- Summary of distances from NSA to the nearest WTG	26
Table 9.15:	Table of impact assessment rating (Preferred Alternative of 30.6 MW)	29
Table 9.16:	Table of impact assessment rating (Alternative 1 of 50 MW)	30
Table 9.17:	Table of monitoring actions (Construction)	31
Table 9.18:	Table of monitoring actions (Operation)	31

Figures

Figure 9.1:	Typical Sound Power Levels of a 2 MW Turbine	7
Figure 9.2:	Sources of Aerodynamic Noise	8
Figure 9.3:	Low frequency Hearing Threshold Levels	10
Figure 9.4:	Noise Sensitive Areas (NSA's) and Wind Turbine Locations (Vestas V100)	13
Figure 9.5:	Alternative 1 (50 MW) - Raster Image of Noise Isopleths & Noise Sensitive Areas (28 WTG Vestas V90 at 8 m/s)	24

9.1 INTRODUCTION & METHODOLOGY

This Chapter presents the Noise Specialist Study conducted by Safetrain CC (trading as Safetech) under the leadership of Mr Brett Williams, as input to the EIA being conducted by CSIR for the proposed WKN Windcurrent Banna Ba Pifhu Wind Energy Project. The Technical Review was conducted by Mr Andrew Wade of Sound Research Laboratories South Africa.

9.1.1 Methodology

The methodology used in the study consisted of three approaches to determine the noise impact from the proposed project and associated infrastructure:

- A desktop study to model the likely noise emissions from the site;
- Field measurements of the existing ambient noise at different locations in the vicinity of the project; and
- The identification of potential noise sensitive areas.

The desktop study was done using the available literature on noise impacts from wind turbines as well as numerical calculations of the possible noise emissions. The computer noise modelling program, EMD WindPro Software Version 2.7 was used and is specifically developed for wind turbine noise assessment. This program is used extensively worldwide and has been developed and validated in Denmark. The method described in SANS 10357:2004 version 2.1 (The calculation of sound propagation by the Concawe method) was used as reference for further calculations where required.

WindPro uses the methods described in ISO 9613-2 (Acoustics – Attenuation of sound during propagation outdoors. Part 2 – General method of calculation). This method is very comparable to SANS 10357:2004 and is used worldwide for modelling noise from various sources including wind turbine generators (Wind turbines). Where a tonal character is identified in the noise emitted from the turbines, a 5 dB(A) penalty is included in the modelling result.

The numerical results were then used to produce "noise maps" that visually indicates the extent of the noise emissions from the site. The noise emissions were modelled for various wind speeds from 4 m/s to 12 m/s. The direction of the wind is not taken into consideration as the wind could blow from any direction at the speeds that were modelled. The modelling is thus for worst case scenarios and takes the topography around the turbine and noise sensitive area (NSA) into account. The site elevation data was sourced from NASA and imported into WindPro. A comparison was done using the digital elevation data and the contour heights from a 1:50 000 topographical map. The comparison showed that the digital data and the map corresponded well. Furthermore, the digital data provided a better resolution.

The WTG technical data used in the modelling includes the following:

Table 9.1: Wind Turbine Generator Technical Data

Wind Speed m/s	Vestas V100 1.8MW 95.0 m Hub – Level "0" as contained in WindPro Sound Power (dB)
3	93.8
4	96.4
5	100.7
6	104.4
7	105.0
8	105.0
9	105.0
10	105.0
1	105.0
12	105.0

WindPro settings:

- Noise Calculation Model: ISO 9631-2 (General option)
- Ground Attenuation: Alternative
- Meteorological Co-efficient set to 0dB(A)

Field Study

A number of measurements were taken by placing the noise meter on a tripod and ensuring that it was at least 1.2 m from floor level and 3.5 m from any large flat reflecting surface.

All measurements were conducted over at least 10 minutes, except where indicated. The noise meter was calibrated before and after the survey. At no time was the difference more than one decibel (If the difference is more than 1 decibel the meter is not calibrated properly and the measurement is discarded). The weighting used was on the A scale. No tonal correction was added to the data. Measurements were taken during the day and at night. The meter was fitted with a windscreen, which is supplied by the manufacturer. The screen is designed so as to reduce wind noise around the microphone and not bias the measurements.

The test environment contained the following noise sources:

- Vehicular traffic that included trucks and cars;
- Birds and insects;
- Farm animals;
- Wind noise; and
- Noise from the chicken houses fans.

The instrumentation that was used to conduct the study is as follows:

- Rion Precision Sound Level Meter (NL32) with 1/3 Octave Band Analyzer
- Serial No. 00151075;

- Microphone (UC-53A) Serial No. 307806; and
- Preamplifier (NH-21) Serial No. 13814.

All equipment was calibrated in October 2011 (see Appendix 9.2)

9.1.2 Terms of Reference

The Terms of Reference provided by CSIR for this noise study included the following:

Objectives of the noise study:

- Describe the affected environment covered by the scope of the noise specialist study, drawing on existing information, professional experience and limited field work;
- Contribute to the scoping process by identifying issues and concerns that need to be addressed in the specialist study, based on the experience of the specialist;
- Identify relevant protocols, legal and permit requirements (if any); and
- Assess the potential impacts of the project, and provide management actions to avoid/reduce negative impacts or enhance benefits, as well as associated monitoring requirements.

The scope of work of the noise study includes the following:

- Conduct a desktop study of available information that can support and inform the specialist noise study;
- Identify issues and potential impacts, as well as possible cumulative impacts related to the noise aspects of the project;
- Measure the existing ambient noise at the proposed site, during both the day and night time;
- Identify the components of the project that could generate significant noise levels;
- Identify the sensitive noise receptors in the vicinity of the proposed project;
- Conduct a noise study of the predicted (future) noise impacts during construction and operation of the proposed wind farm;
- Assess the potential impacts associated with the proposed project for the construction, operation and decommissioning phases; and
- Identify management and mitigation actions to enhance positive impacts and avoid/reduce negative impacts respectively.

The required EIA end-product from the noise assessment is to provide a Noise Impact Assessment (NIA) that presents and evaluates the noise impact of the wind turbines under different operating conditions. The specialists are required to assess impacts for the preferred layout (30.6 MW) .and an alternative 1 layout (50 MW).

9.1.3 Declaration of independence

The declaration of independence by the noise specialist is provided in Box 9.1 below:

BOX 9.1: DECLARATION OF INDEPENDENCE FOR NOISE IMPACT ASSESSMENT

I, Brett Williams, declare that I am an independent consultant and have no business, financial, personal or other interest in the proposed Wind Current Banna Ba Pifhu Wind Energy Project, application or appeal in respect of which I was appointed, other than fair remuneration for work performed in connection with the activity, application or appeal. There are no circumstances that compromise the objectivity of my performing such work.

Brett Williams (Author)

Andrew Wade (Technical Reviewer)

9.2 DESCRIPTION OF THE NOISE IMPACTS

The sources of sounds emitted from operating wind turbines can be divided into two categories, firstly mechanical sounds, from the interaction of turbine components, and secondly aerodynamic sounds, produced by the flow of air over the blades.

9.2.1 Mechanical Sounds

Mechanical sounds originate from the relative motion of mechanical components and the dynamic response among them. Sources of such sounds include the:

- Gearbox;
- Generator;
- Yaw Drives;
- Cooling Fans; and
- Auxiliary Equipment (e.g., hydraulics).

Since the emitted sound is associated with the rotation of mechanical and electrical equipment, it tends to be tonal (of a common frequency), although it may have a broadband component. For example, pure tones can be emitted at the rotational frequencies of shafts and generators, and the meshing frequencies of the gears.

In addition, the hub, rotor, and tower may act as loudspeakers, transmitting the mechanical sound and radiating it. The transmission path of the sound can be airborne or structure-borne. Airborne means that the sound is directly propagated from the component surface or interior into the air. Structure-borne sound is transmitted along other structural components before it is radiated into the air.

The type of transmission path and the sound power levels for the individual components for a 2 MW wind turbine is shown in Figure 9.1.

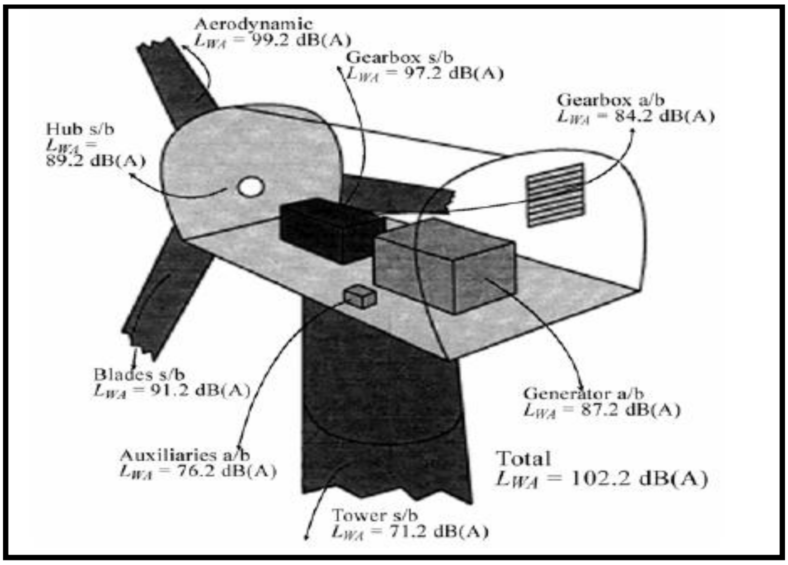

Figure 9.1: Typical Sound Power Levels of a 2 MW Turbine

9.2.2 Aerodynamic Sound

Aerodynamic broadband sound is typically the largest component of wind turbine acoustic emissions. It originates from the flow of air around the blades. As shown in Figure 9.2, a large number of complex flow phenomena occur, each of which might generate some sound. Aerodynamic sound generally increases with rotor speed. The various aerodynamic sound generation mechanisms that have to be considered are divided into three groups:

- *Low Frequency Sound:* Sound in the low frequency part of the sound spectrum is generated when the rotating blade encounters localized flow deficiencies due to the flow around a tower, wind speed changes, or wakes shed from other blades;
- *Inflow Turbulence Sound:* Depends on the amount of atmospheric turbulence. The atmospheric turbulence results in local force or local pressure fluctuations around the blade; and
- *Airfoil Self Noise:* This group includes the sound generated by the air flow right along the surface of the airfoil. This type of sound is typically of a broadband nature, but tonal components may occur due to blunt trailing edges, or flow over slits and holes.

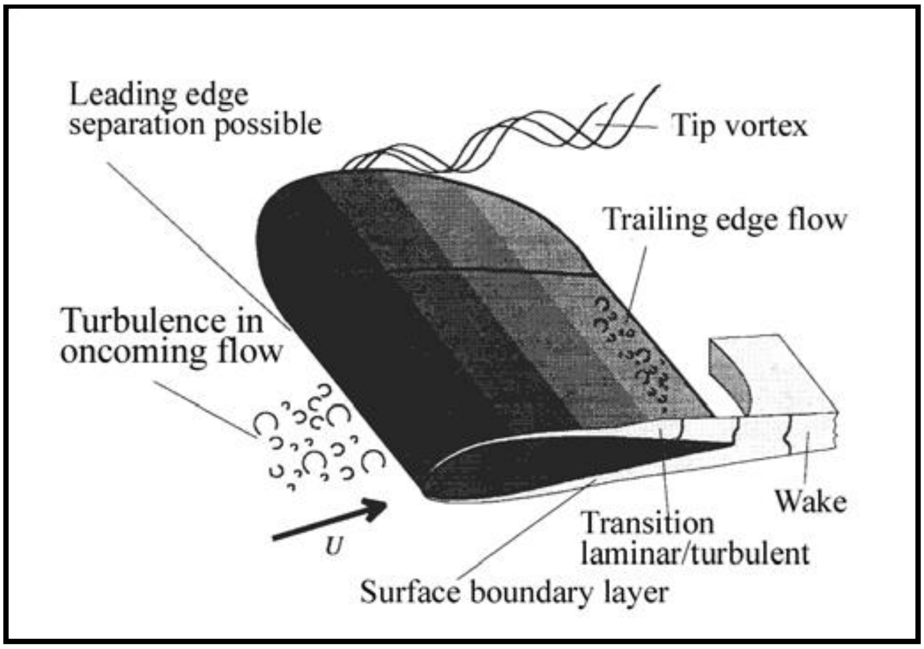

Figure 9.2: Sources of Aerodynamic Noise

Modern airfoil design takes all of the above factors into account and is generally much quieter than the first generation of blade design.

9.2.3 Ambient Sound & Wind Speed

The ability to hear a wind turbine in a given installation depends on the ambient sound level. When the background sounds and wind turbine sounds are of the same magnitude, the wind turbine sound gets lost in the background. Both the wind turbine sound power level and the ambient sound pressure level will be functions of wind speed. Thus whether a wind turbine exceeds the background sound level will depend on how each of these varies with wind speed.

The most likely sources of wind-generated sounds are interactions between wind and vegetation. A number of factors affect the sound generated by wind flowing over vegetation. For example, the total magnitude of wind-generated sound depends more on the size of the windward surface of the vegetation than the foliage density or volume.

The sound level and frequency content of wind generated sound also depends on the type of vegetation. For example, sounds from deciduous trees tend to be slightly lower and more broadband than that from conifers, which generate more sounds at specific frequencies. The equivalent A-weighted broadband sound pressure generated by wind in foliage has been shown to be approximately proportional to the base 10 logarithm of the wind speed.

Sound levels from large modern wind turbines during constant speed operation tend to increase more slowly with increasing wind speed than ambient wind generated sound. As a result, wind turbine noise is more commonly a concern at lower wind speeds and it is often difficult to measure sound from modern wind turbines above wind speeds of 8 m/s because the background wind-generated sound masks the wind turbine sound above 8 m/s.

It should be remembered that average sound pressure measurements might not indicate when a sound is detectable by a listener. Just as a dog's barking can be heard through other sounds, sounds with particular frequencies or an identifiable pattern may be heard through background sounds that is otherwise loud enough to mask those sounds. Sound emissions from wind turbines will also vary as the turbulence in the wind through the rotor changes. Turbulence in the ground level winds will also affect a listener's ability to hear other sounds. Because fluctuations in ground level wind speeds will not correlate exactly with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient sound.

9.2.4 Low Frequency Noise and Infrasound

Infrasound was a characteristic of some types of wind turbine that has been attributed to early designs in which turbine blades were downwind of the main tower. The effect was generated as the blades cut through the turbulence generated around the downwind side of the tower. Modern designs generally have the blades upwind of the tower. Wind conditions around the blades and improved blade design minimise the generation of the effect.

Low frequency pressure vibrations are typically categorized as low frequency sound when they can be heard near the bottom of human perception (10-200 Hz), and infrasound when they are below the common limit of human perception. Sound below 20 Hz is generally considered to be infrasound, even though there may be some human perception in that range. Because these ranges overlap in these, it is important to understand how the terms are intended in a given context.

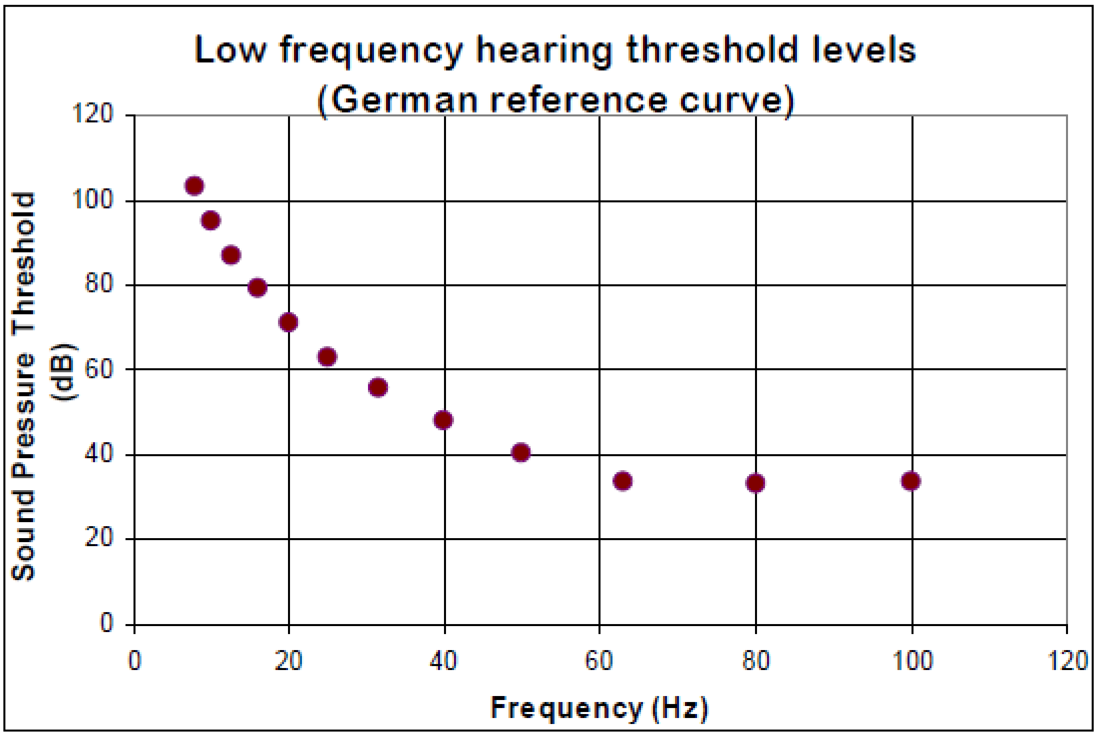

Figure 9.3: Low frequency Hearing Threshold Levels

Infrasound is always present in the environment and stems from many sources including ambient air turbulence, ventilation units, waves on the seashore, distant explosions, traffic, aircraft, and other machinery. Infrasound propagates farther (i.e. with lower levels of dissipation) than higher frequencies. To place infrasound in perspective, when a child is swinging high on a swing, the pressure change on its ears, from top to bottom of the swing, is nearly 120 dB at a frequency of around 1 Hz.

Some characteristics of the human perception of infrasound and low frequency sound are:

- Low frequency sound and infrasound (2-100 Hz) are perceived as a mixture of auditory and tactile sensations;
- Lower frequencies must be of a higher magnitude (dB) to be perceived, e.g. the threshold of hearing at 10 Hz is around 100 dB (see Figure 9.3 above);
- Tonality cannot be perceived below around 18 Hz; and
- Infrasound may not appear to be coming from a specific location, because of its long wavelengths.

The primary human response to perceived infrasound is annoyance, with resulting secondary effects. Annoyance levels typically depend on other characteristics of the infrasound, including intensity, variations with time, such as impulses, loudest sound, periodicity, etc. Infrasound has three annoyance mechanisms:

- A feeling of static pressure;
- Periodic masking effects in medium and higher frequencies; and
- Rattling of doors, windows, etc. from strong low frequency components.

Human effects vary by the intensity of the perceived infrasound, which can be grouped into these approximate ranges:

- 90 dB and below: No evidence of adverse effects;
- 115 dB: Fatigue, apathy, abdominal symptoms, hypertension in some humans;
- 120 dB: Approximate threshold of pain at 10 Hz; and
- 120 – 130 dB and above: Exposure for 24 hours causes physiological damage.

There is no reliable evidence that infrasound below the perception threshold produces physiological or psychological effects.

The typical range of sound power level for wind turbine generators is in the range of 100 to 105 dBA – a much lower sound power level (10 dB or more) than the majority of construction machinery such as dozers. In order for infrasound to be audible even to a person with the most sensitive hearing at a distance of, say, 300 m would require a sound power level of at least 140 dB at 10 Hz and even higher emission levels than this at lower frequencies and at greater distances. There is no information available to indicate that wind turbine generators emit infrasound anywhere near this intensity (Bellhouse 2004).

Several studies have confirmed that there are no physiological effects from low frequency or infrasound from wind turbines (Bellhouse 2004; Leventhall. 2003; Mackenzie. 2006; Rogers *et al* 2006; Pedersen 2003).

9.3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

The proposed Banna Ba Pifhu wind energy project is to be constructed on farmland in an area adjacent to the R330 near Humansdorp located in the Eastern Cape Province of South Africa. The project is planned to consider two alternatives, namely

- **Preferred Alternative (30.6 MW)** - The maximum number of turbines that was modelled for Alternative 1 are 17 turbines. The size of the turbine is a 1.8MW unit.

- **Alternative 1 (50 MW)** - The maximum number of turbines that was modelled for Alternative 1 are 28 turbines. The sizes of the turbines modelled include a Vestas V90 (2 MW), Nordex N80 (2.5 MW) and the Vestas V112 (3.0 MW). A further option was modelled using 25 or 28 turbines of each type. The modelling and actual assessment of the 50 MW alternative 1 was done in a separate noise study and is included in the Draft EIA Report (CSIR 2012).

An assessment summary table of the preferred Alternative (30.6 MW) and Alternative 1 (50 MW) are provided in Tables 9.15 and 9.16 respectively. The actual assessment and modelling of the 50 MW alternative is included in the Draft EIA Report (CSIR 2012). This report is based on the preferred alternative of 30.6 MW.

WKN Windcurrent has agreed to undertake additional noise monitoring once the final tubine type has been selected (should this turbine type differ from the ones that were modelled).

The topography surrounding the site is characterised by undulating hills.

9.3.1 Site Location

The location and position of the wind turbines are contained in the Table 9.2 below.

Table 9.2: Wind Turbine Location Co-ordinates

WTG Name	East	South
1	24°44'40.19"	34°04'30.92"
2	24°45'05.62"	34°04'37.00"
3	24°44'58.88"	34°04'10.29"
4	24°45'21.51"	34°04'20.25"
5	24°45'22.79"	34°04'01.15"
6	24°45'41.71"	34°03'46.47"
7	24°45'53.43"	34°04'09.27"
8	24°46'22.61"	34°04'12.01"
9	24°46'40.03"	34°03'54.73"
10	24°46'48.18"	34°04'14.39"
11	24°47'09.53"	34°03'57.28"
12	24°47'17.22"	34°04'16.28"
13	24°46'59.24"	34°04'32.73"
14	24°47'34.89"	34°03'58.48"
15	24°47'44.19"	34°04'17.41"
16	24°47'25.70"	34°04'42.88"
17	24°47'29.34"	34°05'02.07"

The positions of the turbines are shown in Figures 9.4 below.

Figure 9.4: Noise Sensitive Areas (NSA's) and Wind Turbine Locations (Vestas V100)

The potential sensitive receptors are discussed below. The main noise sensitive receptors that could be impacted by noise pollution are the terrestrial fauna, the avifauna and human receptors.

9.3.2 Noise Sensitive Areas

Human Sensitive Receptors

The site is situated in a farming community. Several homesteads are located on the properties where the turbines will be erected as well as on neighbouring farms. The sensitive noise receptors have been recorded in Table 9.3 below.

Table 9.3: Noise Sensitive Areas (NSA)

Label	Location Description	X	Y
NSA 1	House	24°46'28.76"	34°03'32.23"
NSA 2	House	24°46'53.37"	34°03'02.29"
NSA 3	House	24°45'55.27"	34°03'09.84"
NSA 4	House	24°45'44.06"	34°03'28.21"
NSA 5	House	24°45'00.16"	34°03'21.95"
NSA 6	House	24°44'18.87"	34°03'53.94"
NSA 7	House	24°44'52.26"	34°05'33.62"
NSA 8	House	24°46'55.19"	34°05'25.08"
NSA 9	House	24°47'54.78"	34°03'55.43"
NSA 10	House	24°47'49.44"	34°03'53.78"
NSA 11	House	24°48'14.70"	34°03'42.25"

Natural Environment Receptors

The vegetation around the site is characterised by grassy fynbos with thicket in areas of richer soil. The fauna includes bats, birds, commercial livestock and a variety of buck.

9.3.3 Ambient Noise at Proposed Site

The ambient noise was measured at two locations as described in the methodology and results thereof are contained in Table 9.4 below. The author is confident that this represents the ambient noise at the project site.

Table 9.4: Ambient Noise Results during the day – 09th November 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments
Point 1 (NSA 1)	11:50	10	8.9	22.1	51.2	• Wind noise • One vehicle passing • Tractor passing in distance
Point 2 (NSA 9)	12:50	10	8.0	23.4	52.1	• Numerous vehicles on R330 • Wind noise

*Author measurements of wind speed and temperature at microphone height (1.2 m).

Table 9.5: Ambient Noise Results during the night – 09th November 2011

Location	Start Time	Duration (minutes)	Wind (m/s) *(At Microphone)	Temperature (° Celsius) *(At Microphone)	$L_{Req.T}$ dB(A)	Comments
Point 1 (NSA 1)	22:00	10	2.9	14.6	41.3	
Point 2 (NSA 9)	22:45	10	2.8	14.7	43.1	• Vehicles on R330

*Author measurements of wind speed and temperature at microphone height (1.2 m).

The general ambient noise at each location varies substantially as the ambient sound is influenced by human activities, vehicles, wind noise and animal sounds.

9.4 IDENTIFICATION OF ISSUES AND IMPACTS

The key issues regarding the noise impact are:

- What is the current noise ambient noise in the vicinity of the proposed project?;
- What is the likely noise impact during construction and operation of the site and associated infrastructure?;
- Where are local sensitive human receptors located and how is the noise going to affect them?; and
- Could low frequency sound and infra sound pose a problem?

9.5 APPLICABLE LEGISLATION AND STANDARDS

South Africa has noise legislation or standards that could be applied to the project. The draft scoping report has identified that the applicable environmental legislation places a general onus on the developer to ensure that the environment is not affected negatively by the development.

The following legislation and standards have been used to aid the study and guide the decision making process with regards noise pollution:

- South Africa - GNR.154 of January 1992: Noise control regulations in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989);
- South Africa - GNR.155 of 10 January 1992: Application of noise control regulations made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989);
- South Africa - SANS 10103:2008 Version 6 - The measurement and rating of environmental noise with respect to annoyance and to speech communication;
- South Africa - SANS 10210:2004 Edition 2.2 – Calculating and predicting road traffic noise;
- South Africa - SANS 10357:2004 Version 2.1 - The calculation of sound propagation by the Concawe method; and
- International Finance Corporation – 2007 General EHS Guidelines: Environmental Noise.

SANS 10103:2008 provides typical rating levels for noise in various types of districts, as described in the table 9.6 below. The project is being proposed for a rural district, therefore this is the typical rating level chosen as per the SANS standard.

Table 9.6: Typical rating levels for noise in various types of districts

Type of District	Equivalent Continuous Rating Level, LReq.T for Noise					
	Outdoors (dB(A))			Indoors, with open windows (dB(A))		
	Day-night	Daytime	Night-time	Day-night	Daytime	Night-time
Rural Districts	45	45	35	35	35	25
Suburban districts with little road traffic	50	50	40	40	40	30
Urban districts	55	55	45	45	45	35
Urban districts with one or more of the following: Workshops; business premises and main roads	60	60	50	50	50	40
Central business districts	65	65	55	55	55	45
Industrial districts	70	70	60	60	60	50

SANS 10103:2008 defines Daytime as 06:00 to 22:00 hours and night time as 22:00 to 06:00 hours (Table 9.6). The rating levels in the table above indicate that in rural districts the ambient noise should not exceed 35 dB(A) at night and 45 dB(A) during the day or a combination of 45 dB(A) for day/night. These levels can thus be seen as the target levels for any noise pollution sources.

Furthermore the South African noise control regulations describe a disturbing noise as **any** noise that exceeds the ambient noise by more than 7 dB. This difference is usually measured at the complainants location should a noise complaint arise. Therefore, if a new noise source is introduced into the environment, irrespective of the current noise levels, and the new source is louder than the existing ambient environmental noise by more than 7 dB, the complainant will have a legitimate complaint.

SANS 10103: 2004 also provides a guideline for expected community responses to excess environmental noise above the ambient noise. These are reflected in Table 9.7 below.

Table 9.7: Categories of environmental community / group response (SANS 10103:2008)

EXCESS Lr dB (A)	ESTIMATED COMMUNITY/GROUP RESPONSE	
	CATEGORY	DESCRIPTION
0 - 10	Little	Sporadic complaints
5 - 15	Medium	Widespread complaints
10 - 20	Strong	Threats of community / group action
> 15	Very Strong	Vigorous community / group action

International Standards

There are various international criteria levels for ambient sound from wind turbines. These are listed below:

- New Zealand – 40 dB(A);
- Denmark – 40 dB(A); and
- United Kingdom (L_{A90}) 35 – 40 dB(A).

Australia has set the following limits that wind turbine noise should not exceed:

- 35 dB(A) at relevant receivers in localities which are primarily intended for rural living, or
- 40 dB(A) at relevant receivers in localities in other zones, or
- the background noise (L_{A90}) by more than 5 dB(A).

Germany has set the following standards:

- Purely residential areas with no commercial developments 50 dBA (day) and 35 dBA (night); and
- Areas with hospitals, health resorts, etc. 45 dBA (day) 35 dBA (night)

The rationale behind the criteria levels is that the design limit should be 5 dB below the natural ambient limit. This corresponds well with the South African guideline limit of 45 dB for rural districts.

9.6 ASSESSMENT OF IMPACTS AND IDENTIFICATION OF MANAGEMENT ACTIONS

9.6.1 Predicted noise levels for the Construction Phase

9.6.1.1 Construction Equipment

The construction noise at the various sites will have a local impact. Safetech has conducted noise tests at various sites in South Africa and has recorded the noise emissions of various pieces of construction equipment. The results are presented in Table 9.8 below.

Table 9.8: Typical Construction Noise

Type of Equipment	$L_{Req.T}$ dB(A)
CAT 320D Excavator measured at approximately 50 m.	67.9
Mobile crane measured at approximately 70 m	69.6
Drilling rig measured at approximately 70 m	72.6

The impact of the construction noise that can be expected at the proposed site can be extrapolated from the tables above. As an example, if a number of pieces of equipment are used simultaneously, the noise levels can be added logarithmically and then calculated at various distances from the site to determine the distance at which the ambient level will be reached (refer to *Tables 9.9 - 9.10*).

Table 9.9: Combining Different Construction Noise Sources – High Impacts (Worst Case)

Description	Typical Sound Power Level (dB)
Overhead and mobile cranes	109
Front end loaders	100
Excavators	108
Bull Dozer	111
Piling machine (mobile)	115
Total*	**117**

*The total is a logarithmic total and not a sum of the values (at approximately 3m).

Table 9.10: Combining Different Construction Noise Sources – Low Impacts (at approximately 3m).

Description	Typical Sound Power Level (dB)
Front end loaders	100
Excavators	108
Truck	95
Total	**111**

The information in Tables 9.9 and 9.10 above can be used to calculate the attenuation by distance. Noise will also be attenuated by topography and atmospheric conditions such as temperature, humidity, wind speed and direction etc. but this is ignored for this purpose. Therefore, the distance calculated below would be representative of maximum distances to reach ambient noise levels.

An illustration of attenuation by distance from a noise of 117 dB measured from the source is presented in Table 9.11.

Table 9.11: Attenuation by distance from a noise of 117 dB for the construction phase (worst case)

Distance from noise source (metres)	Sound Pressure Level dB(A)
10	89
20	83
40	77
80	71
160	65
320	59
640	53
1280	47

What can be inferred from Table 9.11 is that if the ambient noise level is at 45 dB(A), the construction noise will be similar to the ambient level at approximately 1280 m from the noise source, if the noise characteristics are similar. Beyond this distance, the noise level will be below the ambient noise and will therefore have little impact. The above only applies to the construction noise and light wind conditions.

In all likelihood, the construction noise will have little impact on the surrounding community as it will most likely occur during the day when the ambient noise is louder and there are unstable atmospheric conditions.

9.6.2 Low frequency noise concerns

The effects of low frequency noise include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the plant and the nearest communities. Sources of low frequency noise also include wind, train movements and vehicular traffic.

9.6.3 Predicted noise levels for the Wind Turbines Generators

Table 9.12 and Figure 9.5 below indicate the isopleths for the noise generated by the turbines at wind speeds from 4 m/s to 12 m/s. The modelling was conducted for one turbine size, namely:

Preferred Alternative (30.6 MW) - Vestas V100 (1.8 MW) using 17 turbines.

The results are contained in Table 9.12 below (maximum allowable = 45dB(A)):

Table 9.12: Preferred Alternative (30.6 MW) - Table of Results of the Noise Impacts at the Noise Sensitive Areas (NSA's)

Name	Wind speed [m/s]	Vestas V100 WTG dB(A)
NSA 1	4	30.7
	5	35.0
	6	38.7
	7	39.3
	8	39.3
	9	39.3
	10	39.3
	11	39.3
	12	39.3
NSA 2	4	24.4
	5	28.7
	6	32.4
	7	33.0
	8	33.0
	9	33.0
	10	33.0
	11	33.0
	12	33.0

Name	Wind speed [m/s]	Vestas V100 WTG dB(A)
NSA 3	4	26.2
	5	30.5
	6	34.2
	7	34.8
	8	34.8
	9	34.8
	10	34.8
	11	34.8
	12	34.8
NSA 4	4	31.4
	5	35.7
	6	39.4
	7	40.0
	8	40.0
	9	40.0
	10	40.0
	11	40.0
	12	40.0
NSA 5	4	26.2
	5	30.5
	6	34.2
	7	34.8
	8	34.8
	9	34.8
	10	34.8
	11	34.8
	12	34.8
NSA 6	4	26.5
	5	30.8
	6	34.5
	7	35.1
	8	35.1
	9	35.1
	10	35.1
	11	35.1
	12	35.1

Name	Wind speed [m/s]	Vestas V100 WTG dB(A)
NSA 7	4	21.6
	5	25.9
	6	29.6
	7	30.2
	8	30.2
	9	30.2
	10	30.2
	11	30.2
	12	30.2
NSA 8	4	26.2
	5	30.5
	6	34.2
	7	34.8
	8	34.8
	9	34.8
	10	34.8
	11	34.8
	12	34.8
NSA 9	4	33.8
	5	38.1
	6	41.8
	7	42.4
	8	42.4
	9	42.4
	10	42.4
	11	42.4
	12	42.4
NSA 10	4	36.0
	5	40.3
	6	44.0
	7	44.6
	8	44.6
	9	44.6
	10	44.6
	11	44.6
	12	44.6

Name	Wind speed	Vestas V100 WTG
	[m/s]	dB(A)
NSA 11	4	26.2
	5	30.5
	6	34.2
	7	34.8
	8	34.8
	9	34.8
	10	34.8
	11	34.8
	12	34.8

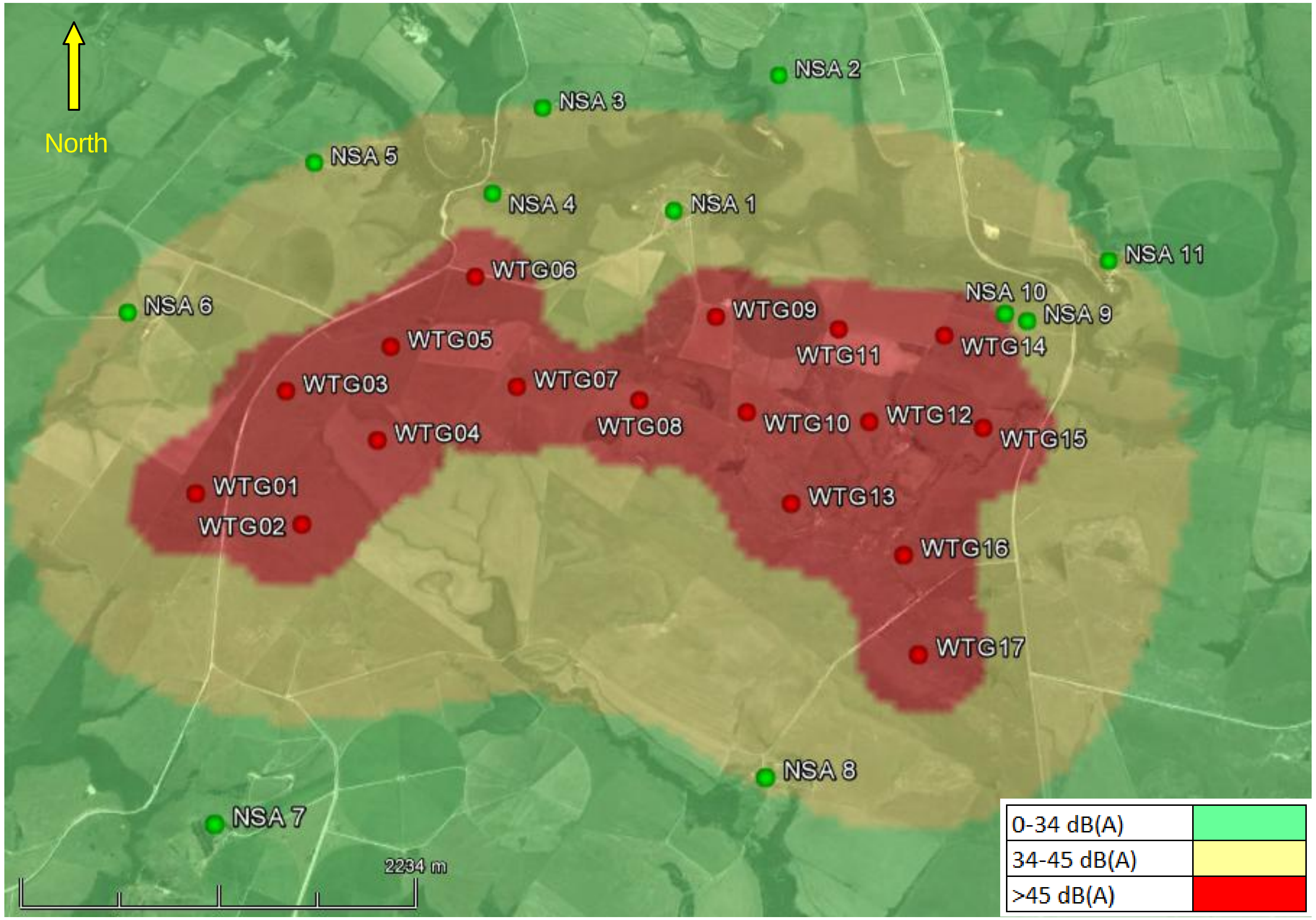

Figure 9.5: Alternative 1 (50 MW) - Raster Image of Noise Isopleths & Noise Sensitive Areas (28 WTG Vestas V90 at 8 m/s)

9.6.4 Assessment of Noise Impacts

The impact of the noise that can be expected to be generated on the site during the construction and operational phases is presented below. A summary of the noise impact assessment using the standard assessment criteria is provided in Tables 9.13.

9.6.4.1 Assessment and mitigation for Construction Phase

1) There will be an impact on the immediate surrounding environment from the construction activities, especially if pile driving is to be done. This, however, will only occur if the underlying geological structure requires piling;
2) The area surrounding the construction site will be affected for a short period of time in all directions by construction noise impacts, should several pieces of construction equipment be used simultaneously; and
3) The number of construction vehicles that will be used in the project will add to the existing ambient levels and will most likely cause a disturbing noise, albeit for a short period of time.

In conclusion, there will be a short term increase in noise in the vicinity of the site during the construction phase as the ambient noise level will be exceeded. The impact during the construction phase will be difficult to mitigate. The significance of the construction noise impact is predicted to be ***low*** (without mitigation).

The following **mitigation measures** are recommended for construction activities:

- All construction operations should only occur during daylight hours, if possible;
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions; and
- Construction staff should be given “noise sensitivity” training in order to mitigate the noise impacts caused during construction.
- Use temporary noise screens around noisy, static equipment and activities such as generators, piling, cutting and drilling to reduce the noise levels at the residential buildings

9.6.4.2 Assessment and mitigation for Operational Phase

The ambient noise increases as the wind speed increases. Under very stable atmospheric conditions, a temperature inversion or a light wind, the turbines will in all likelihood not be operational as the cut-in speed is 4 m/s. As the wind speed increases above the cut-in speed the ambient noise will also increase. If the atmospheric conditions are such that the wind is very light (<4 m/s) at ground level but exceeds the cut-in speed at hub height, it is feasible that little ambient noise masking will occur. As the wind speed increases, the ambient noise also increases and masks the wind turbine noise. The critical wind speeds are thus between 4-6 m/s when there is a possibility of little masking. Above 8 m/s the wind noise starts masking the wind turbine noise. The noise modelling indicates that, in general, noise from the turbines will be below the SANS 10103 limits for rural areas at a distance of approximately 500 m from the turbines.

The results indicate the following:

Table 9.13: Preferred Alternative (30.6 MW) - Summary of Noise Impacts (Vestas V100 – 1.8MW)

Wind Speed	NSA 1	NSA 2	NSA 3	NSA 4	NSA 5	NSA 6	NSA 7	NSA 8	NSA 9	NSA 10	NSA 11
4m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
12m/s	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

NSA = Noise Sensitive Area
✓ = Within Recommended Noise Limits
X = Exceeds 45 dB (A) Rural Recommended Limit

Table 9.14: Preferred Alternative (30.6 MW)- Summary of distances from NSA to the nearest WTG

Label	Distance to Nearest WTG in metres – Minimum 500 m	Notes
NSA 1	756	
NSA 2	1654	
NSA 3	1184	
NSA 4	577	
NSA 5	1309	
NSA 6	1148	
NSA 7	1783	
NSA 8	1131	
NSA 9	529	
NSA 10	413	WTG 14 is too close to NSA 10. This house will however not be occupied once construction commences. The resident will be relocated (See letter from landowner in Appendix 9.4)

Label	Distance to Nearest WTG in metres – Minimum 500 m	Notes
NSA 11	1144	

The results indicate the following:

Preferred Alternative (30.6 MW) – Noise Impact

The Vestas V100 – 1.8MW did not exceed the 45 dB(A) guideline at any of the identified noise sensitive sources for the 17 WTG's that were modelled.

Preferred Alternative (30.6 MW) – Setback Distance

All the turbine positions met the required 500 m setback distance except for WTG 14 that is too close to NSA 10 (i.e. 413 m). **This house will however be not be occupied once construction commences. The resident will be relocated (see letter from landowner in Appendix 9.4).**

9.6.5 Reversibility and Irreplaceability of Noise Impacts:

Reversibility:

The reversibility of noise impacts is considered to be **high**. The main noise impacts associated with the proposed project include the generation of noise and an increase in ambient noise levels during the construction phase of development, and during the operational phase as a result of the turbine itself. Once the project has reached the end of its life cycle, the wind turbines will be dismantled and the noise impact associated with the proposed project will be reversed. It should be noted that some noise impacts will be experienced during the project closure and dismantling, however once this has been completed there will be no noise impacts.

Irreplaceability:

The irreplaceability of resources likely to have been impacted upon by the proposed project is considered to be **replaceable**. The proposed project would impact on sensitive noise receptors through means of an increase in ambient noise levels. However the removal of the proposed project will restore the ambient noise levels (granted that ambient noise levels have not been significantly increased as a result of future developments within the Coega IDZ, in which case the ambient noise level will be permanently altered).

9.6.6 Recommendations

The results of the study indicate that the following conclusions can be drawn:

- There will be a short term increase in noise in the vicinity of the site during construction as the ambient level will be exceeded. The impact during construction will be difficult to mitigate although some mitigation measures are recommended;

- The impact of low frequency noise and infra sound will be negligible and there is no evidence to suggest that adverse health effects will occur as the sound power levels generated in the low frequency range are not high enough to cause physiological effects.
- The noise generated by the turbines will meet the 45dB(A) maximum demand for Alternative's 1.

The following is recommended:

9.6.6.1 Construction Activities

- All construction operations should only occur during daylight hours if possible.
- Use temporary noise screens around static, noisy equipment and activities, such as generators, piling, cutting and drilling to reduce the noise impact at the residential properties.
- No construction piling should occur at night. Piling should only occur during the hottest part of the day to take advantage of unstable atmospheric conditions. Ensure that the construction staff is given "noise sensitivity" training such as:
    - Potential sources of noise on construction sites;
    - Local noise sensitive areas;
    - Critical times of the day to minimise noise pollution; and
    - Actions to be taken to minimise noise pollution.

9.6.6.2 Operational Activities

- Ambient noise monitoring is recommended at all noise sensitive areas once the turbines are erected. This is to determine if the noise rating limits are being exceeded.

9.6.7 Assessment of impacts of Preferred Alternative (30.6 M) and Alternative 1 (50 MW)

Both alternative layouts were assessed with 30.6 MW being the Preferred Alternative with a maximum of 17 turbines (Table 9.15) and 50 MW being Alternative 1 with a maximum of 28 turbines (Table 9.16). The actual assessment and modelling of the 50 MW wind farm was done in a separate noise study and is included in the Draft EIA Report (CSIR, 2012).

The overall impact ratings for the two alternatives will remain the same.

9.7 IMPACT ASSESSMENT RATING TABLE

Table 9.15: Table of impact assessment rating (Preferred Alternative of 30.6 MW)

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Construction Phase									
1.1 Impact of the construction noise on the Noise Sensitive Areas (NSAs)	Negative	**Local**, given impact is limited to one NSA at a time.	**Short**, only for the duration of the construction (approx 22 months**)**	**Low** no change in the environment is expected	**Improbable,** based on calculations	**Low**	Staff to receive noise sensitivity training; Temporary noise screens around noisy, static equipment and activities such as generators, piling, cutting and drilling Monitoring of noise; Limit high noise activities to daytime operations when possible, noting that operational requirements might not allow this due to various factors e.g. Crane use optimization, weather conditions etc.	**Low**	**High**, since based on actual measurements
Operational Phase									
1.1 Impact of the operational noise on the Noise Sensitive Areas (NSAs) using the Vestas V100 WTG	Negative	**Local**, given impact is limited to a one NSA at a time.	**Long Term**	**Low** – no change in the environment is not expected	**Probable**, based on calculations	**Low**	Ensure that noise monitoring is conducted during the commissioning phase to determine the actual noise impact during operation.	**Low**	**High**, since based on modelling and ambient measurements

Table 9.16: Table of impact assessment rating (Alternative 1 of 50 MW)

Nature of impact	Status (Negative or positive)	Extent	Duration	Intensity	Probability	Significance (no mitigation)	Mitigation/Management Actions	Significance (with mitigation)	Confidence level
Construction Phase									
1.1 Impact of the construction noise on the Noise Sensitive Areas (NSAs)	Negative	**Local**, given impact is limited to one NSA at a time.	**Short**, only for the duration of the construction (approx 22 months**)**	**Low** no change in the environment is expected	**Improbable,** based on calculations	**Low**	Staff to receive noise sensitivity training; Monitoring of noise; Limit high noise activities to daytime operations when possible, noting that operational requirements might not allow this due to various factors e.g. Crane use optimization, weather conditions etc.	**Low**	**High**, since based on actual measurements
Operational Phase									
1.1 Impact of the operational noise on the Noise Sensitive Areas (NSAs) using the Vestas V90, Vestas V112, Nordex N80.	Negative	**Local**, given impact is limited to a one NSA at a time.	**Long Term**	**Low** – no change in the environment is not expected	**Probable**, based on calculations	**Low**	Ensure that noise monitoring is conducted during the commissioning phase to determine the actual noise impact during operation.	**Low**	**High**, since based on modelling and ambient measurements

9.8 MONITORING ACTIONS

Table 9.17: Table of monitoring actions (Construction)

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
Reduce construction noise	Conduct noise sensitivity training for all construction staff	Training	Before construction commences	Contractor
	Temporary noise screens around noisy activities	Temporary noise screens	During construction	Contractor
Monitor construction noise	Ambient noise monitoring to be conducted at the 11 NSAs as well as any other areas the specialist bird study will identify.	As per the requirements of SANS 10103	Four times during the construction phase	Specialist noise consultant

Table 9.18: Table of monitoring actions (Operation)

Impact	Mitigation/Management action	Monitoring		
		Methodology	*Frequency*	*Responsibility*
Reduce operational noise	Ambient noise monitoring to be conducted at the 11 NSAs when operations commence to verify the noise emissions meet the noise rating limit.	As per the requirements of SANS 10103	During project commissioning	Specialist noise consultant
Reduce operational noise	Confirm the noise impact by conducting annual monitoring.	As per the requirements of SANS 10103	Annually for the first 3 years of the operational phase.	Specialist noise consultant

9.9 CONCLUSIONS

Provided that the mitigation measures presented in the noise specialist study are implemented effectively, the noise from the turbines at the identified noise sensitive areas is predicted to be less than the 45 dB(A) limit for rural areas presented in SANS 10103:2008. The overall noise impact with recommended mitigation is expected to be negative and of **Low** significance.

9.10 REFERENCES

1)	Australia Environmental Protect Agency - **Wind farms - environmental noise guidelines**. July 2009.
2)	Bell Acoustic Consulting. **Low frequency noise and infrasound from Wind turbine generators: A literature review.** George Bellhouse. June 2004.
3)	CSIR 2011: **Scoping Report: Proposed Banna Ba Pifhu Wind Energy Project**, Stellenbosch.
4)	DEFRA – United Kingdom **A Review of Published Research on Low Frequency Noise and its Effects.** Geoff Leventhall. 2003
5)	DTI – United Kingdom **The measurement of low frequency noise at 3 UK Wind Farms**. Hayes Mackenzie. 2006
6)	Gold Coast Desalination Alliance (GCDA) – **2006 Environmental Impact Assessment Queensland Desalination Plant** (Chapter 11).
7)	Infrasound Toxicological Summary November 2001- **Infrasound - Brief Review of Toxicological Literature**
8)	International Finance Corporation – 2007 **General EHS Guidelines: Environmental Noise.**
9)	ISO 9613-2 - **Acoustics – Attenuation of sound during propagation outdoors**. Part 2 – General method of calculation.
10)	Renewable Energy Research Laboratory - Department of Mechanical and Industrial Engineering. University of Massachusetts at Amherst. **A White Paper on Wind Turbine Acoustic Noise.** Authors: Anthony L. Rogers, Ph.D. James F. Manwell, Ph.D. Sally Wright. Amended January 2006
11)	South Africa - GNR.154 of January 1992: **Noise control regulations** in terms of section 25 of the Environment Conservation Act (ECA), 1989 (Act No. 73 of 1989)
12)	South Africa - GNR.155 of 10 January 1992: **Application of noise control regulations** made under section 25 of the Environment Conservation Act, 1989 (Act No. 73 of 1989)
13)	South Africa - SANS 10210:2004 Edition 2.2 – **Calculating and predicting road traffic noise**
14)	South Africa - SANS 10357:2004 Version 2.1 - **The calculation of sound propagation by the Concawe method**
15)	South Africa - SANS 10103:2008 Version 6 - **The measurement and rating of environmental noise with respect to annoyance and to speech communication**.
16)	Swedish Environmental Protection Agency – **Noise Annoyance from Wind Turbines – a Review.** Authors: Eja Pedersen, Högskolan i Halmstad. August 2003.
17)	University of Groningen - **11th International Meeting on Low Frequency Noise and Vibration and its Control. Do wind turbines produce significant low frequency sound levels?** GP. van den Berg. September 2003.
18)	World Health Organization – **Guidelines for Community Noise**. 1999

APPENDIX 9.1: AIA APPROVAL CERTIFICATE

DEPARTMENT
OF LABOUR

Certificate

This is to certify that

SAFETRAIN CC
TRADING AS T\A SAFETECH

has been approved as an

APPROVED INSPECTION AUTHORITY

in terms of the Occupational Health and Safety Act, 1993,
for the monitoring of

Physical Stress Factors and Chemical Stress Factors (including Lead and Asbestos, Ergonomic hazards and Ventilation Installation) and Biological Factors

2009-08-27
DATE

CI 049 OH
CERTIFICATE NUMBER

CHIEF INSPECTOR

APPENDIX 9.2: CALIBRATION CERTIFICATE

sanas Calibration Laboratory
148 1302

M AND N ACOUSTIC SERVICES CC
VAT NO: 4300255876
P.O. Box 61713
Pierre van Ryneveld
0045
Co. Reg. No: 2009/079193/23
Tel: 012 689 2007/8
Fax: 086 211 4698
E-mail: calservice@mweb.co.za

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	2011-1507
ORGANISATION	SAFETRAIN trading as SAFETECH
ORGANISATION ADDRESS	P.O. BOX 27697, GREENACRES, 6057
CALIBRATION OF	INTEGRATING SOUND LEVEL METER, ½" MICROPHONE and ⅓- OCTAVE/OCTAVE FILTER CARD
CALIBRATED BY	M. NAUDÉ
MANUFACTURER	RION
MODEL NUMBERS	NL-32, UC-53 and NX-22RT
SERIAL NUMBERS	00151075, 12930 and 00150957 V2.2
DATE OF CALIBRATION	1 NOVEMBER 2011
RECOMMENDED DUE DATE	NOVEMBER 2012
PAGE NUMBER	PAGE 1 OF 4

This certificate is issued in accordance with the conditions of approval granted by the South African National Accreditation System (SANAS). This Certificate may not be reproduced without the written approval of SANAS and M and N Acoustic Services.

Calibrations performed by this laboratory are in terms of standards, the accuracies of which are traceable to national measuring standards as maintained by NMISA

The measurement results recorded in this certificate were correct at the time of calibration. The subsequent accuracy will depend on factors such as care, handling, frequency of use and the amount of different users. It is recommended that re-calibration should be performed at an interval, which will ensure that the instrument remains within the desired limits and/or manufacturer's specifications.

The South African National Accreditation System (SANAS) is member of the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). This arrangement allows for mutual recognition of technical test and calibration data by member accreditation bodies worldwide. For more information on the arrangement please consult www.ilac.org

M and N Acoustic Services physical address:
Ryneveld Corner, c/o Fouché & Van Ryneveld Streets, Pierre van Ryneveld, 0045

M.W. DE BEER (SANAS TECHNICAL SIGNATORY) — 4 November 2011 **DATE OF ISSUE**

Only Member : Marianka Naudé

APPENDIX 9.3: TYPICAL SOUND POWER AND SOUND PRESSURE LEVELS

Acoustic Power	Degree		Pressure Level	Source
32 GW	Deafening		225 dB	12" Cannon @ 12ft in front and below
25 to 40 MW			195 dB	Saturn Rocket
100 Kw			170 dB	Turbojet engine with afterburner
10 Kw			160 dB	Turbojet engine, 7000lb thrust
1 kW			150 dB	4 Propeller Airliner
100 W			140 dB	Artillery Fire
10 W	Threshold of pain		130 dB	Pneumatic Rock Drill
				130 dB causes immediate ear damage
3 W			125 dB	Small aircraft engine
1.0 W			120 dB	Thunder
100 Mw			110 dB	Close to train
10 mW	Very Loud		100 dB	Home lawn mower
1 mW			90 dB	Symphony or a Band
				85 dB regularly can cause ear damage
100 uW	Loud		80 dB	Police whistle
10 uW			70 dB	Average radio
1 uW	Moderate		60 dB	Normal conversational voice
100 nW			50 dB	Quiet stream
10 nW	Faint		40 dB	Quiet conversation
1 nW			30 dB	Very soft whisper
100 pW	Very faint		20 dB	Ticking of a watch
10 pW	Threshold of hearing		10 dB	
1 pW			0 dB	Absolute silence

Sound Perception

Change in Sound Level	Perception
3 dB	Barely perceptible
5 dB	Clearly perceptible
10 dB	Twice as loud

APPENDIX 9.4: LETTER FROM LANDOWNER

DAVID MASTERSON FAMILY TRUST

FARM: BROADLANDS

P.O. BOX 162, HUMANSDORP. 6300

TEL. NO: 042-2952052 FAX: 0865240776

To Whom It May Concern

I hereby confirm that I am the owner of the Broadlands Farm upon which the dwelling referred to as NSA10 (co-ordinates X 296700 Y 6228454) in the Final Environmental Impact Report, is situated.

I recognise that the SANS noise limit at this dwelling is predicted to be exceeded by the closest turbine (WTG 14).

The current occupant of the dwelling is retiring by the end of 2013 and will be moving to alternative accommodation in town. Thereafter, the dwelling will remain unoccupied.

Sincerely

....

David Masterson

Date: 26 September 2012