ENVIRONMENT
HEALTH
SAFETY

ENVIRONMENTAL IMPACT ASSESSMENT

for the proposed

KOUGA WIND ENERGY PROJECT

SPECIALIST STUDY ON NOISE IMPACTS

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Amendment History

Version 1	Original	26/10/2010
Version 2	Two NSA's added and modelling re-done	13/11/2010
Version 3	Figure showing West NSA's updated and Impact scoring table updated	09/12/2010
Version 4	Impact rating table changed to enable correct interpretation	10/12/2010
Version 5	Executive summary and Section 7.2 (a) amended	17/01/2011

INFORMATION PAGE

CLIENT NAME	Arcus Gibb - Environmental Services
PROJECT	Kouga Wind Energy Project
CONTACT PERSON	Mr. J Jegels
TYPE OF SURVEY	Noise Specialist Study as part of the Environmental Impact Assessment
DATE OF SITE SURVEY	30th August and 25th – 26th October 2010
REPORT PREPARED BY	Brett Williams

This report only pertains to the conditions found at the above site at the time of the survey. This report may not be copied electronically, physically or otherwise, except in its entirety. If sections of the report are to be copied the approval of the author, in writing, is required.

....

B WILLIAMS (Author)

HW592PA0600140

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DECLARATION OF INDEPENDENCE	
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 Redcap Kouga 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. **SIGNATURE:**

EXECUTIVE SUMMARY

Safetech were appointed to conduct a specialist study for an environmental impact assessment for the construction of the Kouga Wind Energy Project situated in the Kouga Municipal area. The project will generate electricity and will be operated by Red Cap Investments (PTY) LTD.

The study considered the site location as described in the Draft Scoping Report. A literature review and desktop modelling was conducted. Baseline monitoring was done of the ambient noise levels at selected noise sensitive areas.

The results for of the modelling were found to exceed the day/night limit of 45 dB(A) at six Noise Sensitive Areas in the Central and Western clusterse when the wind speed is at 8m/s. The noise impact at this speed would result in a noise level exceeding 45 dB(A), which is regarded as the recommended limt.

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 the construction phase as the ambient level will be exceeded. The impact during the construction phase will difficult to mitigate.
- The impact of low frequency noise and infra sound will be negligible as 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 (i.e. are well below 90 dB) to cause physiological effects.

It is recommended that ambient noise monitoring be done during the construction phase to ensure that there is as little as possible impact on the Noise Sensitive Areas.

The following recommendations are made for the operational phase:

a) All wind turbines should be located at a setback distance of 500m from any homestead and a **day/night** noise criteria level at the nearest residents of 45 dB(A) should be used to locate the turbines. The 500m setback distance can be relaxed if local factors; such as high ground between the noise source and the receiver, indicates that a noise disturbance will not occur.

b) If the Nordex or similar turbines are used, they should be operated in a low noise mode in the 4-6m/s wind speed range, where onsite measurements (after construction) at the West cluster NSA West Ext 1 & 2 and the Central cluster NSA 7,8,9 & Ext1 show the noise emissions exceed the recommended limits.

c) Ambient noise monitoring is recommended at all the NSA’s once the WTG’s are erected. This is to determine the exact power mode settings needed to comply with the guideline limit in the 45 dB(A) range.

Brett Williams

GLOSSARY OF TERMS & DEFINITIONS	
Ambient noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far. **Note:** Ambient noise includes the noise from the noise source under investigation.
Annoyance	General negative reaction of the community or person to a condition creating displeasure or interference with specific activities
A-weighted sound pressure level (L_{pA} and $L_{Aeq,T}$)	A-weighted sound level L_{pA} which is the sound pressure level at specific frequencies and is given using the following equation: $L_{pA} = 10\text{Log}\left(\frac{P_A}{P_O}\right)^2$ **Where:** *PA* = is the root-mean-square sound pressure, using the frequency weighting network A *PO* = is the reference sound pressure (*PO* = 20 μPa). A-weighted sound pressure level is expressed in decibels dBA **Note:** For clarity in this study L_{pA} shall equal $L_{Aeq,T}$
dBA	The decibel is the unit used to measure sound pressure levels. The human ear does not perceive all sound pressures equally at all frequencies. The "A" weighted scale adjusts the measurement to approximate a human ear response.
Equivalent continuous day/night rating level ($L_{R,dn}$)	Equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$) during a reference time interval of 24 h, plus specified adjustments for tonal character, impulsiveness of the sound and the time of day; and derived from the following equation: $L_{R,dn} = 10Log\left[\left(\frac{d}{24}\right)10^{\frac{L_{Req,d}}{10}} + \left(\frac{24-d}{24}\right)10^{\frac{L_{Req,n}+K_n}{10}}\right]$ dB **Where:** $L_{R,dn}$ is the equivalent continuous day/night rating level; *d* is the number of daytime hours; $L_{Req,d}$ is the rating level for daytime; $L_{Req,n}$ is the rating level for night-time; K_n is the adjustment of 10 dB added to the night-time rating level.

GLOSSARY OF TERMS & DEFINITIONS	
High-energy impulsive sound	Sound from one of the following categories of sound sources: quarry and mining explosions, sonic booms, demolition and industrial processes that use high explosives, explosive industrial circuit breakers, military ordnance (e.g. armour, artillery, mortar fire, bombs, explosive ignition of rockets and missiles), or any other explosive source where the equivalent mass of TNT exceeds 25 g, or a sound with comparable characteristics and degree of intrusiveness
Highly impulsive sound	sound from one of the following categories of sound sources: small arms fire, metal hammering, wood hammering, drop-hammer pile driver, drop forging, pneumatic hammering, pavement breaking, or metal impacts of rail yard shunting operations, or sound with comparable characteristics and degree of intrusiveness
Infra sound	Sound which predominantly contains sound energy at frequencies below 10 Hz
Low frequency noise	Sound which predominantly contains sound energy at frequencies below 100 Hz
m/s	Metres per second
MW	Mega Watt of electricity (1000 kilowatts)
NSA	Noise Sensitive Area
Reference time interval	Representative duration of time periods that are regarded as typical for sound exposure of the community within a period of 24 h: – Daytime: 06:00 to 22:00 – Night-time: 22:00 to 06:00
Residual noise	Totally encompassing sound in a given situation at a given time, and usually composed of sound from many sources, both near and far, excluding the noise under investigation
Specific noise	Component of the ambient noise which can be specifically identified by acoustical means and which may be associated with a specific source **Note:** Complaints about noise usually arise as a result of one or more specific noises.
WTG	Wind Turbine Generator

1.0 INTRODUCTION AND METHODOLOGY

1.1 Introduction

Red Cap Investments (PTY) LTD is proposing the construction of a wind energy facility between St Francis Bay and Thyspunt in the Kouga Municipal area of the Eastern Cape Province. The proposed project, referred to as the Kouga Wind Energy Project, comprises an electricity generation facility utilising 121 wind turbine generators (WTG's).

This study only addresses the noise impact from the proposed site. The study was requested by Arcus Gibb as part of the overall Environmental Impact Assessment for the project.

1.2 Methodology

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

- A desktop study to model the likely noise emissions from the operation of the turbines;
- Field measurements of the existing ambient noise at different locations in the vicinity of the proposed turbines.

The initial modelling indicated that the envisaged 131 WTG's was not suitable at low wind speeds as the impact at the Noise Sensitive Areas (NSA"s) would have exceeded the guidelines at 4-6m/s, at the Central site. It was decided in conjunction with the client, to reduce the turbine number to 121 units to decrease the impact on the NSA's at the Central Site.

1.2.1 Desktop study methodology

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. A Danish modelling program, EMD WindPro Software Version 2.7 was used and is specifically developed for wind turbine noise. 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 a 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 (WTG's).

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 4m/s to 12m/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.

1.2.2 Field Study – Proposed Site

A field study to the proposed site was conducted on 30th August. This was in the initial stages of the project. A further field study was conducted on the 25th – 26th October 2010 when seven ambient monitoring points were chosen based on their proximity to noise sensitive receptors as well as the location of the proposed wind turbines. The access to some of the proposed locations was hampered as there are no access roads at present. This also influenced where the ambient monitoring occurred.

The location of the ambient measurement positions are as follows:

Table I - Measurement Point Positions

Description	Site Location	Measurement Position	
NSA 1: Lambardin/ Chattam Intersection	Eastern site	34°05’14.99 S	24°51’29.34 E
NSA 5: St Francis College	Eastern site	34°7’12.26 S	24°48’1.24 E
NSA 6: Buffelsbos Farmhouse	Central site	34°9’2.72 S	24°44’36.26 E
NSA 8: Penny Sands Farmhouse	Central site	34°9’13.26 S	24°42’57.63 E
NSA 9: Welgelegen Farmhouse	Central site	34°9’25.44 S	24°41’21.20 E
NSA 11: Brandkop Farmhouse	Western site	34°7’16.84 S	24°33’50.90 E
NSA 14: Rosenhoff Farmhouse	Western site	34°6’11.91 S	24°32’26.08 E

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 measurement periods were at least over 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 and the meter placed on impulse correction, which is the preferred method as per Section 5 of SANS 10103:2008. No tonal correction was added to the data. Measurements were taken during the day and night-time. 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

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
- Preamplifier (NH-21) Serial No. 13814

All equipment was calibrated in January 2010 (see Appendix B)

1.3 Introduction to Noise Measurement

1.3.1 Sound Propagation

Noise is defined as any unwanted sound and is measured in decibels. Sounds are characterized by their magnitude (loudness) and frequency. There can be loud low frequency sounds, soft high frequency sounds and loud sounds that include a range of frequencies. The human ear can detect a very wide range of both sound levels and frequencies, but it is more sensitive to some frequencies than others.

Sound frequency denotes the “pitch” of the sound and, in many cases, corresponds to notes on the musical scale (Middle C is 262 Hz). An octave is a frequency range between a sound with one frequency and one with twice that frequency, a concept often used to define ranges of sound frequency values. The frequency range of human hearing is quite wide, generally ranging from about 20 to 20 kHz (about 10 octaves). Sounds experienced in daily life are usually not a single frequency, but are formed from a mixture of numerous frequencies, from numerous sources (See Appendix C).

Concerns about environmental noise depend on:

- the level of intensity, frequency, frequency distribution and patterns of the noise source;
- background sound levels;
- the terrain between the emitter and receptor
- the nature of the receptor; and
- the attitude of the receptor about the emitter.

In general, the effects of noise on people can be classified into three general categories:

- Subjective effects including annoyance, nuisance, dissatisfaction,
- Interference with activities such as speech, sleep, and learning,
- Physiological effects such as anxiety, tinnitus, or hearing loss.

It is important to distinguish between the various measures of the magnitude of sounds, namely sound **power** level and sound **pressure** level. Sound power level is the power per unit area of the sound pressure wave; it is a property of the source of the sound and it gives the total acoustic power or energy emitted by the source. Sound pressure is a property of sound at a given observer location and can be measured there by a microphone. In simple terms sound **power** level is the energy the noise source produces and sound **pressure** level is the amount of energy that arrives at the receptor.

In order to predict the sound pressure level at a distance from a source with a known power level, one must determine how the sound waves propagate. In general, as sound propagates without obstruction from a point source, the sound pressure level decreases. The initial energy in the sound is distributed over a larger and larger area as the distance from the source increases. Thus, assuming spherical propagation, the same energy that is distributed over a square meter at a distance of one meter from a source is distributed over 10,000 m^2 at a distance of 100 meters away from the source. With spherical propagation, the sound pressure level is reduced by 6 dB per doubling of distance.

This simple model of spherical propagation must be modified in the presence of reflective surfaces and other disruptive effects. For example, if the source is on a perfectly flat and reflecting surface, then hemispherical spreading has to be assumed, which also leads to a 6 dB reduction per doubling of distance, but the sound level would be 3 dB higher at a given distance than with spherical spreading.

Sound propagation is generally influenced by the following factors:

- Source characteristics (e.g., directivity, emission height, etc.)
- Distance of the source from the observer
- Air absorption, which depends on frequency, temperature and humidity
- Ground effects (i.e., reflection and absorption of sound on the ground, dependent on source height, terrain cover, ground properties, frequency, etc.)
- Blocking of sound by obstructions and uneven terrain
- Weather effects (i.e., wind speed, change of wind speed or temperature with height). The prevailing wind direction can cause differences in sound pressure levels between upwind and downwind positions.
- Shape of the land; certain land forms can also focus sound

1.3.2 Sources of Wind Turbine Noise

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.

Mechanical Sounds

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

- Gearbox
- Generator
- Yaw Drives
- Cooling Fans
- 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. An example is that 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 thus be air-borne or structure-borne. Air-borne 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.

Figure 2 shows the type of transmission path and the sound power levels for the individual components for a typical 2 MW wind turbine.

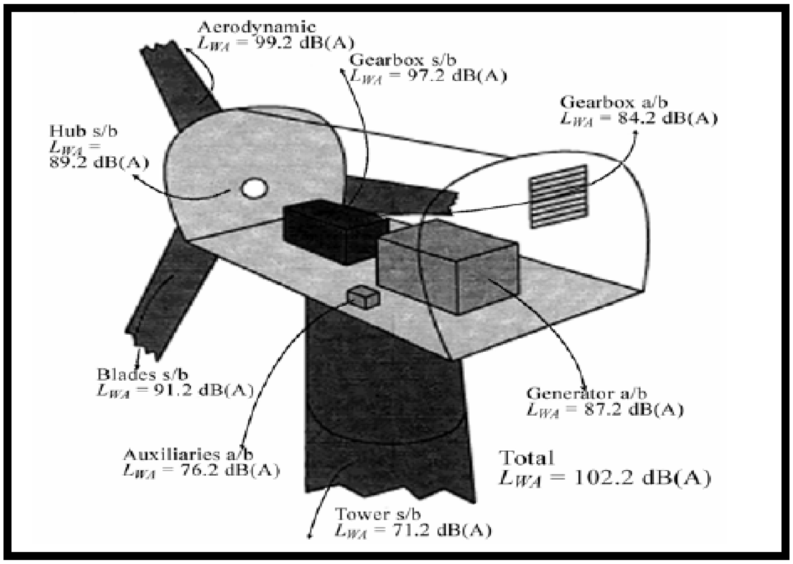

Figure 1 - Typical Sound Power Levels of a 2MW Turbine

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 3, 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.
- *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.

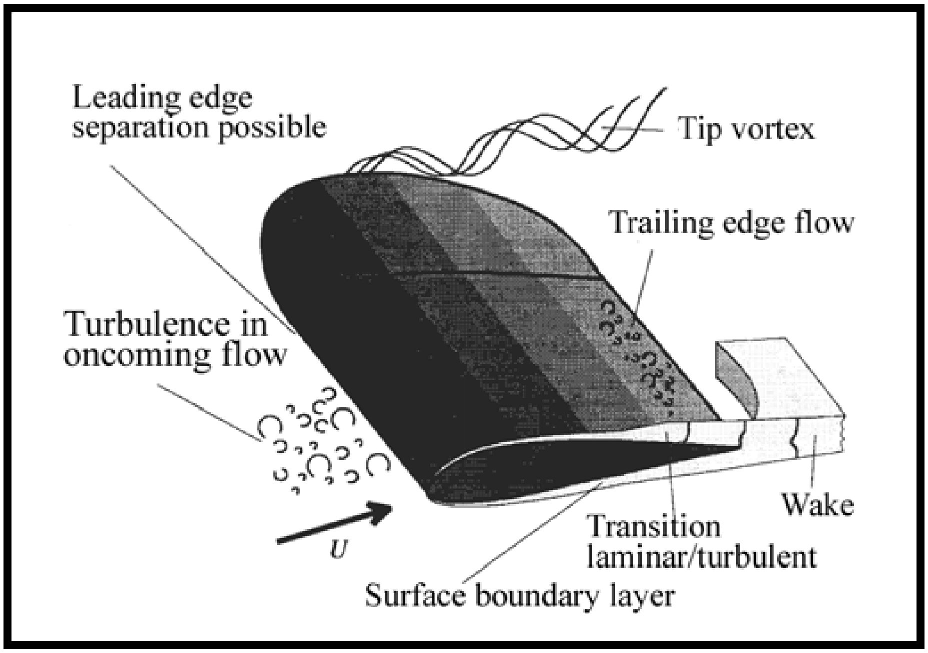

Figure 2 - Sources of Aerodynamic Noise

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

1.3.3 Ambient Sound & Wind Speed

The ability to hear a wind turbine in a given situation 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 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 exactly correlate with those at the height of the turbine, a listener might find moments when the wind turbine could be heard over the ambient sound.

1.3.4 Low Frequency Noise and Infrasound

Infrasound was a characteristic of some wind turbine models 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 infrasound, even though there may be some human perception in that range. Because these ranges overlap, it is important to understand how the terms are intended in a given context.

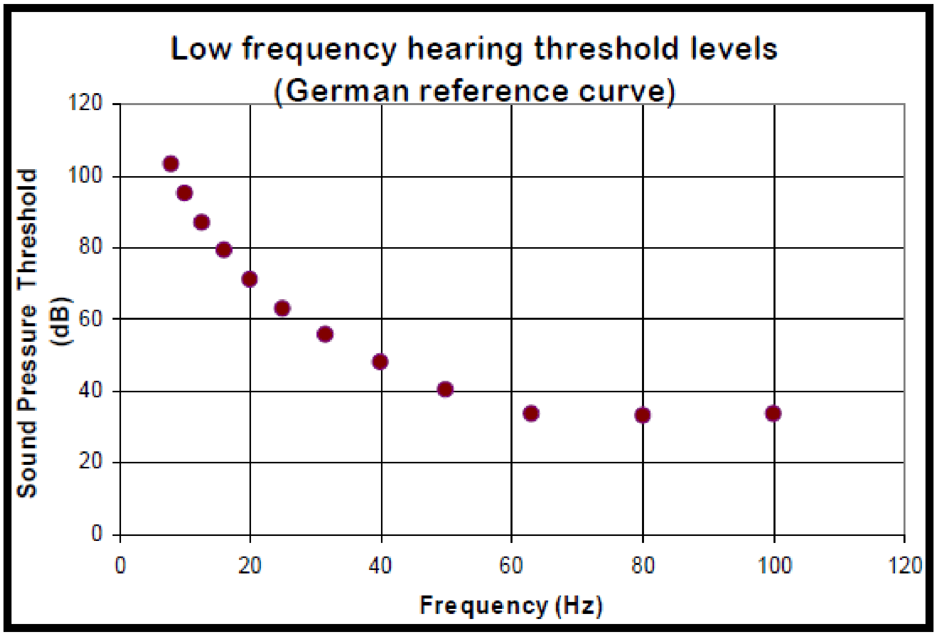

Figure 3 - Low frequency Hearing Threshold Levels

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 4 above.
- Tonality cannot be perceived below approximately 18 Hz
- 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
- 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
- 120 – 130 dB and above: Exposure for 24 hours or more causes physiological damage

(Source: Infrasound Toxicological Summary Pages 5,6)

There is no reliable evidence in the literature that was reviewed 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 105dBA – a much lower sound power level (10dB or more) than the majority of construction machinery such as bulldozers. In order for infrasound to be audible, even to a person with the most sensitive hearing at a distance of, say, 300m would require a sound power level of at least 140dB at 10Hz 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[2].

Several studies have confirmed that there are no physiological effects below 90dB from low frequency or infrasound from wind turbines [(2),(4),(5),(9),(15),(16),(17)].

2.0 PROJECT DESCRIPTION

The proposed wind energy project is to be constructed across several farms between St Francis Bay and Thyspunt. The intention is to install 121 WTG's, each with a nominal power output ranging between 2.3 Megawatts (MW) and 3 MW's. The final number of turbines will depend on the findings of this and other specialist reports. The electricity produced will be sold to Eskom to be used in the national grid. The topography surrounding the site is characterised by hills and valleys, sand dunes and wetland areas.

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2.1 Site Location

The location and position of the various wind turbines are contained in the table and figures below.

Table II –Wind Turbine Location Co-ordinates

WTG Number	East	South	Site	WTG Number	East	South	Site
1	24°49'26.17"	34°05'43.46"	East	21	24°51'17.62"	34°05'58.08"	East
2	24°49'04.02"	34°06'05.82"	East	22	24°51'45.99"	34°05'56.43"	East
3	24°50'10.55"	34°06'05.47"	East	23	24°48'46.52"	34°06'33.84"	East
4	24°50'28.45"	34°06'15.33"	East	24	24°49'47.06"	34°05'53.50"	East
5	24°50'49.80"	34°06'27.32"	East	25	24°49'50.44"	34°06'23.13"	East
6	24°51'09.46"	34°06'38.51"	East	26	24°49'12.77"	34°06'28.01"	East
7	24°50'08.76"	34°06'33.06"	East	27	24°49'29.64"	34°06'12.47"	East
8	24°50'13.79"	34°06'49.83"	East	28	24°40'04.01"	34°09'42.87"	Central
9	24°50'39.82"	34°06'45.46"	East	29	24°42'36.18"	34°07'12.11"	Central
10	24°50'22.58"	34°07'04.82"	East	30	24°41'07.66"	34°08'31.01"	Central
11	24°50'54.21"	34°06'57.91"	East	31	24°41'54.62"	34°08'08.13"	Central
12	24°50'40.84"	34°07'14.36"	East	32	24°41'19.49"	34°08'45.48"	Central
13	24°50'29.95"	34°07'31.34"	East	33	24°40'51.97"	34°09'49.78"	Central
14	24°50'11.49"	34°07'21.86"	East	34	Removed	Removed	-
15	24°49'26.91"	34°07'02.64"	East	35	24°43'12.66"	34°08'00.54"	Central
16	24°49'06.25"	34°06'49.39"	East	36	24°41'56.09"	34°09'43.68"	Central
17	24°51'33.31"	34°05'44.07"	East	37	24°42'03.35"	34°08'27.25"	Central
18	24°51'19.80"	34°05'32.02"	East	38	24°42'30.58"	34°08'16.31"	Central
19	24°51'54.80"	34°06'12.10"	East	39	Removed	Removed	-
20	24°49'49.04"	34°06'47.22"	East	40	24°43'37.10"	34°09'33.53"	Central

WTG Number	East	South	Site	WTG Number	East	South	Site
41	24°43'02.21"	34°09'40.12"	Central	61	24°42'55.93"	34°08'15.71"	Central
42	24°44'12.31"	34°08'03.13"	Central	62	Removed	Removed	-
43	24°44'48.50"	34°08'29.51"	Central	63	24°43'42.01"	34°08'22.50"	Central
44	24°44'37.83"	34°07'59.09"	Central	64	24°45'13.98"	34°08'38.44"	Central
45	24°45'12.59"	34°08'20.24"	Central	65	24°44'56.37"	34°08'09.17"	Central
46	Removed	Removed	-	66	24°41'38.20"	34°08'23.37"	Central
47	24°44'32.59"	34°08'18.53"	Central	67	24°41'21.90"	34°07'56.97"	Central
48	24°44'22.13"	34°09'20.01"	Central	68	24°40'53.56"	34°08'47.17"	Central
49	Removed	Removed	-	69	24°41'09.15"	34°08'13.61"	Central
50	24°44'20.73"	34°07'46.02"	Central	70	24°40'32.00"	34°08'30.30"	Central
51	24°42'56.86"	34°08'34.81"	Central	71	24°41'00.72"	34°07'50.86"	Central
52	Removed	Removed	-	72	24°40'41.35"	34°08'12.76"	Central
53	24°42'24.49"	34°08'33.95"	Central	73	Removed	Removed	-
54	24°44'07.27"	34°08'20.73"	Central	74	24°41'24.99"	34°07'06.69"	Central
55	24°40'23.76"	34°08'47.71"	Central	75	Removed	Removed	-
56	24°43'03.57"	34°07'45.63"	Central	76	24°41'54.77"	34°06'57.96"	Central
57	24°42'59.25"	34°07'16.14"	Central	77	Removed	Removed	-
58	24°42'15.38"	34°08'58.90"	Central	78	Removed	Removed	-
59	24°43'34.39"	34°08'06.88"	Central	79	24°34'24.11"	34°08'59.95"	West
60	24°42'05.10"	34°08'44.98"	Central	80	24°33'38.37"	34°08'16.01"	West

WTG Number	East	South	Site	WTG Number	East	South	Site
81	24°33'16.54"	34°08'49.95"	West	101	24°32'52.25"	34°09'07.80"	West
82	24°33'42.64"	34°08'46.57"	West	102	24°33'01.70"	34°09'22.82"	West
83	24°34'18.49"	34°09'17.37"	West	103	24°34'15.72"	34°08'44.70"	West
84	24°33'44.09"	34°09'14.94"	West	104	24°33'17.79"	34°08'07.94"	West
85	24°32'34.41"	34°09'22.80"	West	105	24°32'29.30"	34°08'01.81"	West
86	24°32'57.68"	34°06'43.19"	West	106	24°31'37.75"	34°08'20.12"	West
87	24°32'22.03"	34°09'04.08"	West	107	24°32'03.50"	34°08'15.32"	West
88	24°32'37.77"	34°08'53.13"	West	108	24°31'12.16"	34°08'22.23"	West
89	24°32'13.08"	34°08'50.82"	West	109	24°33'23.34"	34°08'32.17"	West
90	24°31'53.84"	34°09'10.88"	West	110	24°32'26.05"	34°08'21.09"	West
91	24°31'28.26"	34°09'11.11"	West	111	24°31'47.35"	34°08'55.01"	West
92	24°32'06.36"	34°08'34.94"	West	112	24°32'49.43"	34°08'10.20"	West
93	24°30'48.86"	34°08'46.23"	West	113	24°31'21.70"	34°08'55.17"	West
94	24°29'28.19"	34°09'04.16"	West	114	24°33'02.11"	34°08'24.12"	West
95	24°29'27.35"	34°08'33.18"	West	115	24°32'37.81"	34°08'35.38"	West
96	24°29'03.19"	34°08'56.83"	West	116	24°30'46.82"	34°08'29.09"	West
97	24°28'01.71"	34°08'02.86"	West	117	24°31'40.40"	34°08'39.03"	West
98	24°29'00.95"	34°08'34.98"	West	118	24°31'14.90"	34°08'42.09"	West
99	24°28'28.76"	34°08'37.17"	West	119	24°29'57.68"	34°08'47.66"	West
100	24°28'41.48"	34°08'50.48"	West	120	24°29'53.69"	34°09'05.17"	West

WTG Number	East	South	Site	WTG Number	East	South	Site
121	24°31'02.84"	34°09'11.44"	West	127	24°31'39.13"	34°08'02.43"	West
122	24°30'42.10"	34°09'03.85"	West	128	24°32'05.29"	34°07'57.95"	West
123	24°27'42.63"	34°08'30.22"	West	129	24°29'31.53"	34°08'48.88"	West
124	24°28'03.73"	34°08'36.07"	West	139	24°27'29.46"	34°07'47.69"	West
125	24°31'33.49"	34°07'25.51"	West	131	24°27'31.70"	34°07'21.15"	West
126	24°31'46.78"	34°07'44.73"	West				

2.2. Potential Noise Sources - Construction Phase

Noise pollution will be generated during the construction phase as well as the operational phase. A brief description of construction noise is discussed in the section below.

2.2.1 Potential Noise Sources (General Equipment and Vehicles)

The construction phase could generate noise during different activities such as:

- Site preparation and earthworks to gain access using bulldozers, trucks etc.
- Foundation construction using mobile equipment, cranes, concrete mixing and pile driving equipment (if needed).
- Heavy vehicle use to deliver construction material and the turbines.

The number and frequency of use of the various types of vehicles has not been determined but an indication of the type and level of noise generated is presented below.

Table III – Typical types of vehicles and equipment to be used on site (Construction Phase)

Type	Description	Typical Sound Power Level (dB)
Passenger Vehicle	Passenger vehicle or light delivery vehicle such as bakkies	85
Trucks	10 ton capacity	95
Cranes	Overhead and mobile	109
Mobile Construction Vehicles	Front end loaders	100
Mobile Construction Vehicles	Excavators	108
Mobile Construction Vehicles	Bull Dozer	111
Mobile Construction Vehicles	Dump Truck	107
Mobile Construction Vehicles	Grader	98
Mobile Construction Vehicles	Water Tanker	95
Stationary Construction Equipment	Concrete mixers	110
Compressor	Air compressor	100
Compactor	Vibratory compactor	110
Pile Driver	Piling machine (mobile)	115

Source: GCDA 2006

2.3 Potential Noise Sources – Operational Phase

The project will install 121 wind turbine generators. The manufacturer will be chosen by tender. The Vestas V90 3MW and Nordex N90 2500 HS 2.5MW WTG's was used for the modelling. The general characteristics of the model are as follows:

The WTG is a pitch regulated upwind wind turbine with active yaw and three blade rotor. The turbine consists of three main parts:

Rotor

- 3 blades and hub, electrical pitch control

Integrated power unit

- roller bearing, planetary gear and variable speed
- generator with permanent magnets

Nacelle

- frequency converter, transformer and accessories

The technical specifications are contained in the table below.

Table IV - WTG Technical Specifications – Vestas V90

Type	3 blades, up-wind
Power control	Pitch, variable speed
Rated power	3 MW (grid side)
Rotor diameter	90m
Cut-in wind speed	4 m/s
Rated Rotor speed	16.1 rpm
Frequency converter	Located in nacelle
Transformer	Transformer located in nacelle
Hub heights	90m

Table V - WTG Technical Specifications – Nordex N90

Type	3 blades, up-wind
Power control	Pitch, variable speed
Rated power	2.5MW (grid side)
Rotor diameter	90m
Cut-in wind speed	4 m/s
Rated Rotor speed	16.9 rpm
Frequency converter	Located in nacelle
Transformer	Transformer located in nacelle
Hub heights	90m

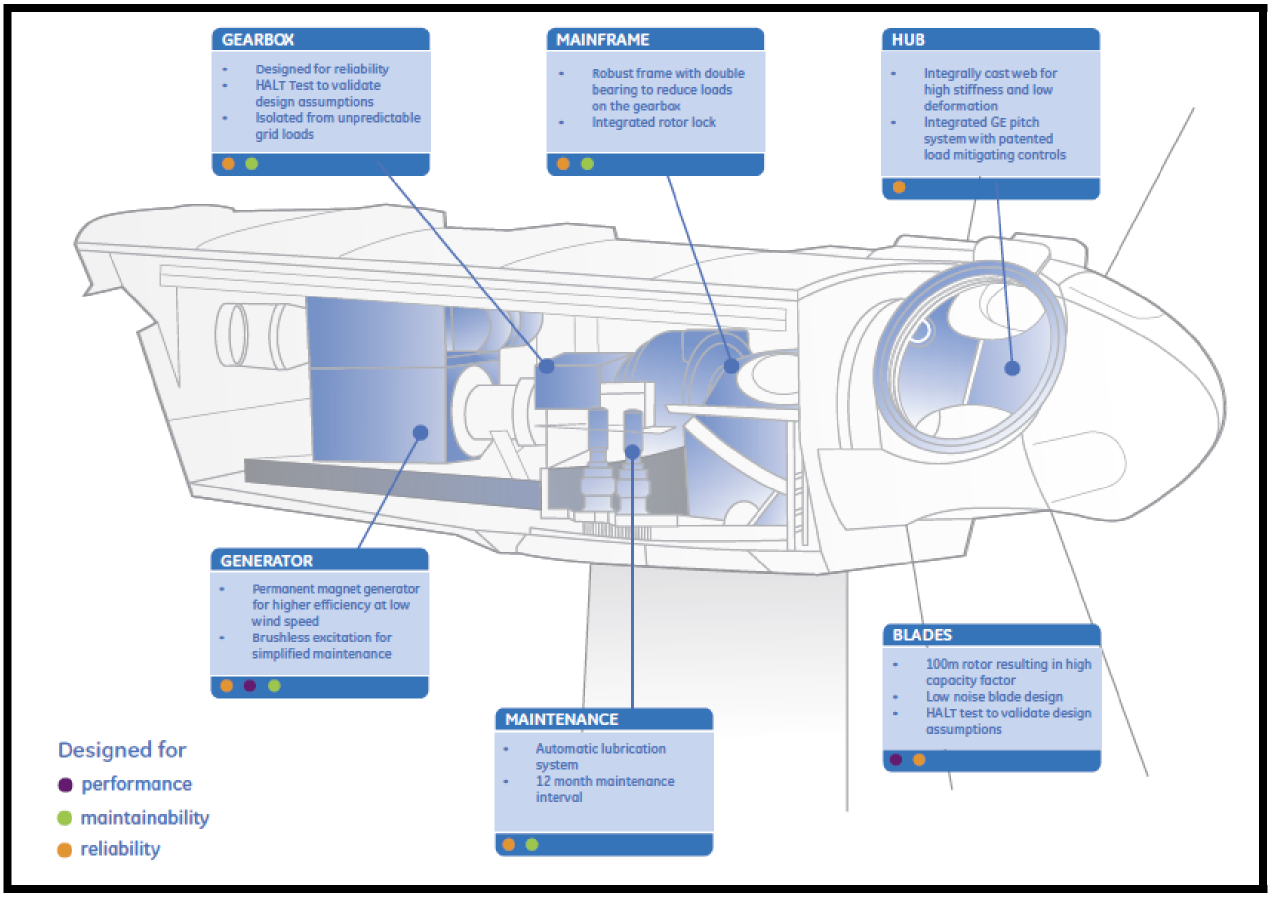


Figure 4- Nacelle details

3.0 DESCRIPTION OF THE AFFECTED ENVIRONMENT

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.

3.1 Sensitive Noise Receptors

3.1.1 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 the Table below.

Table VI - Noise Sensitive Areas (NSA's)

Label	Location Description	Site Description	Position	
NSA 1	Chattam Farmhouse	Eastern Site	34°5'15.26 S	24°51'36.83 E
NSA 2	Lambardin Farmhouse	Eastern Site	34°5'15.83 S	24°51'3.66 E
NSA 3	Paradise Marina	Eastern Site	34°6'49.35 S	24°52'15.06 E
NSA 4	Kromriviermond	Eastern Site	34°8'6.18 S	24°50'1.74 E
NSA 5	St Francis College	Eastern Site	34°7'12.26 S	24°48'1.24 E
NSA 6	Buffelbos Farmhouse	Central Site	34°9'2.72 S	24°44'36.26 E
NSA 7	Lappie-Aadre Farmhouse	Central Site	34°9'0.06 S	24°43'24.45 E
NSA 8	Penny Sands Farmhouse	Central Site	34°9'13.26 S	24°42'57.63 E
NSA 9	Welgelegen Farmhouse	Central Site	34°9'25.44 S	24°41'21.20 E
NSA 10	Township	Central Site	34°9'58.89 S	24°39'48.51 E
NSA 11	Brandkop Farmhouse	Western Site	34°7'16.84 S	24°33'50.90 E
NSA 12	Langfontein Farmhouse	Western Site	34°6'57.52 S	24°33'38.77 E
NSA 13	Ou Werf Farmhouse	Western Site	34°7'30.46 S	24°32'38.40 E

Label	Location Description	Site Description	Position	
NSA 14	Rosenhof Farmhouse	Western Site	34°6'11.91 S	24°32'26.08 E
NSA 15	Driefontein Farmhouse	Western Site	34°7'51.15 S	24°28'21.14 E
NSA 16	Homestead	Central Site	24°41'28.59"	34°09'18.34"
NSA 17	Homestead	Central Site	24°46'29.21"	34°08'20.50"
NSA 18	Homestead	Central Site	24°46'39.37"	34°08'30.65"
NSA 19	Homestead	Western Site	24°32'41.49"	34°07'27.78"
NSA 20	Homestead	Western Site	24°33'30.82"	34°06'40.21"
NSA 21	Homestead	Western Site	24°33'50.45"	34°07'16.86"
NSA 22	Homestead	Western Site	24°28'21.45"	34°07'48.79"
NSA 23	Homestead	Western Site	24°28'47.41"	34°07'34.23"
NSA 24	Homestead	Western Site	24°29'01.47"	34°07'23.36"
NSA 25	Homestead	Western Site	24°28'18.00"	34°07'19.25"
NSA 26	Homestead	Western Site	24°28'15.92"	34°07'11.94"
NSA 27	Homestead	Western Site	24°28'08.84"	34°07'03.35"
NSA 28	Homestead	Western Site	24°29'28.52"	34°07'40.40"
NSA 29	Homestead	Western Site	24°33'54.67"	34°07'09.70"
NSA 30	Homestead	Western Site	24°33'34.48"	34°07'15.60"
NSA West Ext 1	Homestead	Western Site	24°33'23.77"	34°09'06.00"

Label	Location Description	Site Description	Position	
NSA West Ext 2	Homestead	Western Site	24°34'00.66"	34°08'57.93"
NSA Ext 1	Homestead	Central Site	24°42'12.43"	34°07'38.29"
NSA Ext 2	Homestead	Central Site	24°41'42.04"	34°06'23.51"
NSA Ext 3	Homestead	Central Site	24°43'42.55"	34°07'00.82"
NSA Ext 4	Homestead	Central Site	24°44'17.43"	34°06'58.47"
NSA Ext 5	Homestead	Central Site	24°44'24.87"	34°07'10.49"
NSA Ext 6	Homestead	Central Site	24°44'39.10"	34°07'06.66"
NSA Ext 7	Homestead	Central Site	24°44'40.90"	34°07'11.14"
NSA Ext 9	Homestead	Central Site	24°41'42.04"	34°06'23.51"
NSA Ext 10	Homestead	Central Site	24°43'42.55"	34°07'00.82"
NSA Ext 11	Homestead	Central Site	24°44'17.43"	34°06'58.47"
NSA Ext 12	Homestead	Central Site	24°44'24.87"	34°07'10.49"
NSA Ext 13	Homestead	Central Site	24°44'39.10"	34°07'06.66"
NSA Ext 14	Homestead	Central Site	24°44'40.90"	34°07'11.14"

The locations of the various human sensitive receptors are indicated in the figures below.

Figure 5 – Sensitive human receptors in Eastern site.

Figure 6 – Sensitive human receptors in Central site

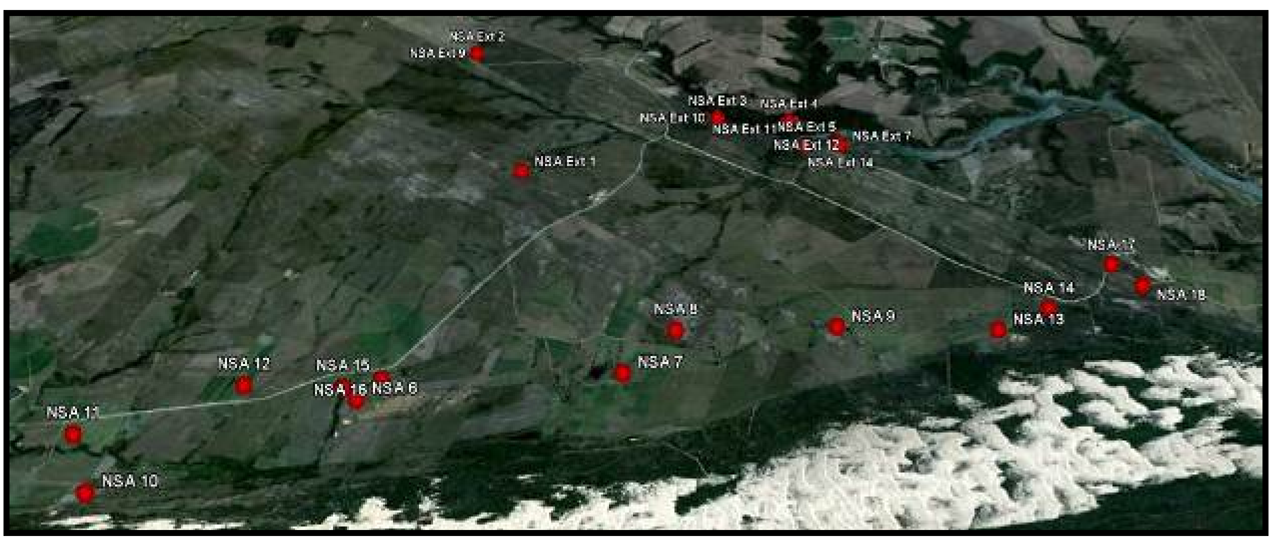


Figure 7 – Sensitive human receptors in Western site.

3.1.2 Natural Environment Receptors

The vegetation around the site is characterised by thicket and grasslands. The fauna includes bats, birds, commercial livestock and a variety of buck. The impacts on the faun and avifauna are dealt with in separate studies.

3.2 Results of the Field Study

3.2.1 Ambient Noise at Proposed Site

The ambient noise was measured at four locations as described in the above methodology (Section 1.2) and results thereof are contained in the table below.

Table VII - Ambient Noise Results

	NSA 1 & 2 – T-junction between Chattan and Lambardin Farmhouses		Comments
Date	26 October 2010	26 October 2010	• Traffic on farm road
Time	09:50 – 10:10	00:00 – 00:20	• Wind in trees
Wind Speed	1.9m/s	1.1m/s	• Dogs barking
Temp	20.6°C	13.9°C	• Birds & Insects
Humidity	53.5%	81.6%	• Aeroplane overhead
Lmin dB(A)	24.1	27.4	• Frogs
Lmax dB(A)	77.4	45.2	• Sea noise
Leq dB(A)	52.6	31.9	
L90 dB(A)	26.7	29.6	

	NSA 5 – St Francis College		Comments
Date	30 August 2010	26 October 2010	• Traffic on R330
Time	12:05 – 12:25	00:25 – 00:45	• Voices
Wind Speed	4.8m/s	0.7m/s	• Rooster
Temp	22.7°C	13.9°C	• Banging in office
Humidity	65.4%	76.4%	• Sea noise
Lmin dB(A)	21.0	24.9	• Dogs barking
Lmax dB(A)	45.6	63.6	• Birds & Insects
Leq dB(A)	31.1	42.3	
L90 dB(A)	25.4	27.1	

	NSA 6 – Buffelbos Farmhouse	Comments
Date	30 August 2010	• Wind noise
Time	12:50 – 13:10	• Birds
Wind Speed	4.9m/s	• Cows
Temp	23.2°C	• Generator
Humidity	69.1%	
Lmin dB(A)	30.5	
Lmax dB(A)	62.5	
Leq dB(A)	39.0	
L90 dB(A)	33.3	

	NSA - 8 Penny Sands Farmhouse		Comments
Date	26 October 2010	25 October 2010	• Traffic on farm road
Time	10:45 – 11:05	23:00 – 23:20	• Wind noise
Wind Speed	3.3m/s	2.4m/s	• Cows
Temp	19.1°C	14.9°C	• Birds & Insects
Humidity	63.8%	58.1%	• Chain Saw
Lmin dB(A)	23.7	25.9	• Water noise at pump
Lmax dB(A)	63.5	51.0	
Leq dB(A)	40.9	31.2	
L90 dB(A)	28.2	28.3	

	NSA 9 - Welgelegen Farmhouse		Comments
Date	30 August 2010	25 October 2010	• Traffic on farm road
Time	13:25 – 13:45	22:25 – 22:45	• Voices
Wind Speed	7.4m/s	1.3m/s	• Wind noise
Temp	24.1°C	16.1°C	• Birds & Insects
Humidity	58.8%	58.6%	• Cows
Lmin dB(A)	23.6	29.7	• Frogs
Lmax dB(A)	60.2	60.8	
Leq dB(A)	40.7	35.7	
L90 dB(A)	28.0	32.1	

	NSA 11 – Brandkop Farmhouse	Comments
Date	26 October 2010	• Tractor
Time	12:25 – 12:45	• Voices
Wind Speed	4.7m/s	• Cows
Temp	17.0°C	• Traffic on farm road
Humidity	67.4%	• Birds
Lmin dB(A)	33.6	• Dog barking
Lmax dB(A)	71.9	
Leq dB(A)	53.6	
L90 dB(A)	39.4	

	NSA 14 – Rosenhoff Farmhouse	Comments
Date	26 October 2010	• Tractor
Time	12:00 – 12:20	• Wind noise
Wind Speed	6.5m/s	
Temp	18.4°C	
Humidity	61.6%	
Lmin	38.8	
Lmax	71.7	
Leq	47.3	
L90	42.6	

*Author measurements of wind speed and temperature at microphone height.

The ambient noise at each location varies substantially as the ambient sound is influenced by wind speed, human activities as well as vehicles and animal sounds. It is thus extremely difficult to isolate just the wind component.

3.2.2 Noise Study at InnoVent France

A field trip was undertaken to France in November 2009 by the author. The field study was done to specifically measure firsthand the noise at different frequencies from various sizes of turbines. The results are presented below. The red bar on each graph indicates the total energy for all frequencies measured.

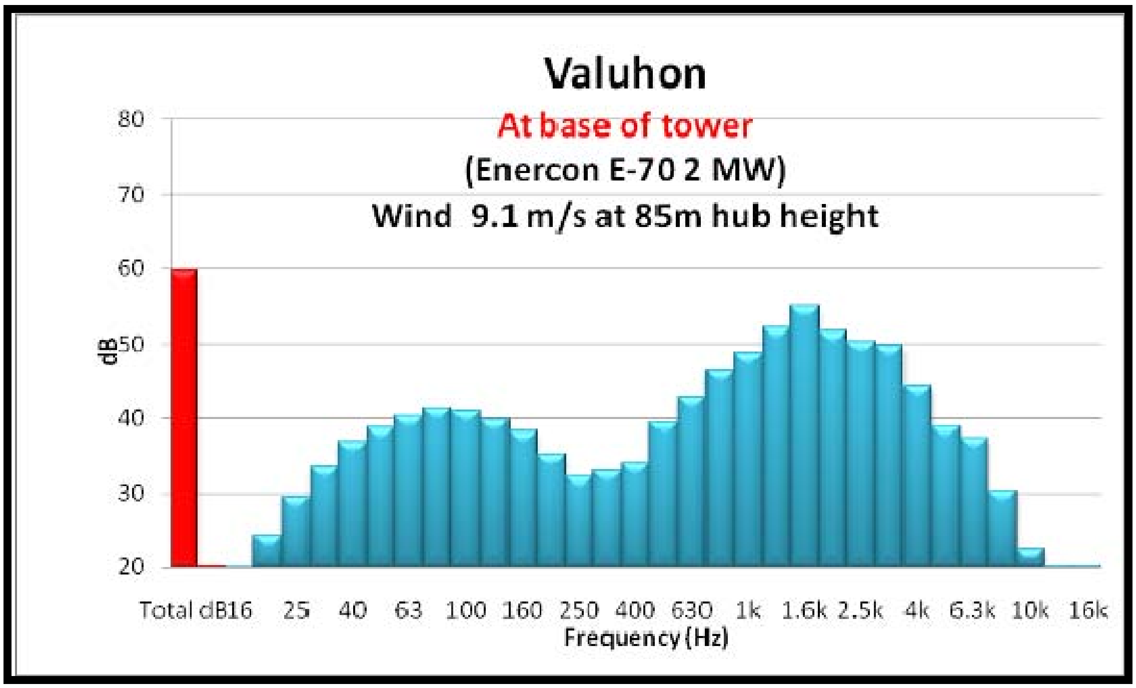


Figure 8 - Frequency analysis 2MW WTG - At base of tower

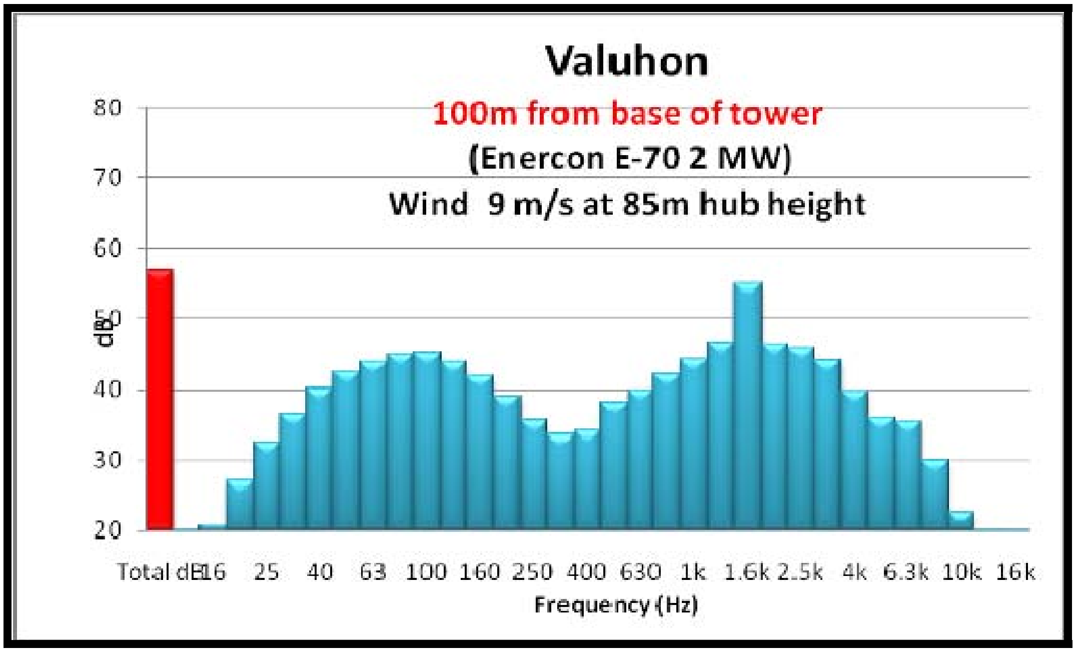


Figure 9- Frequency analysis 2MW WTG – 100m from tower

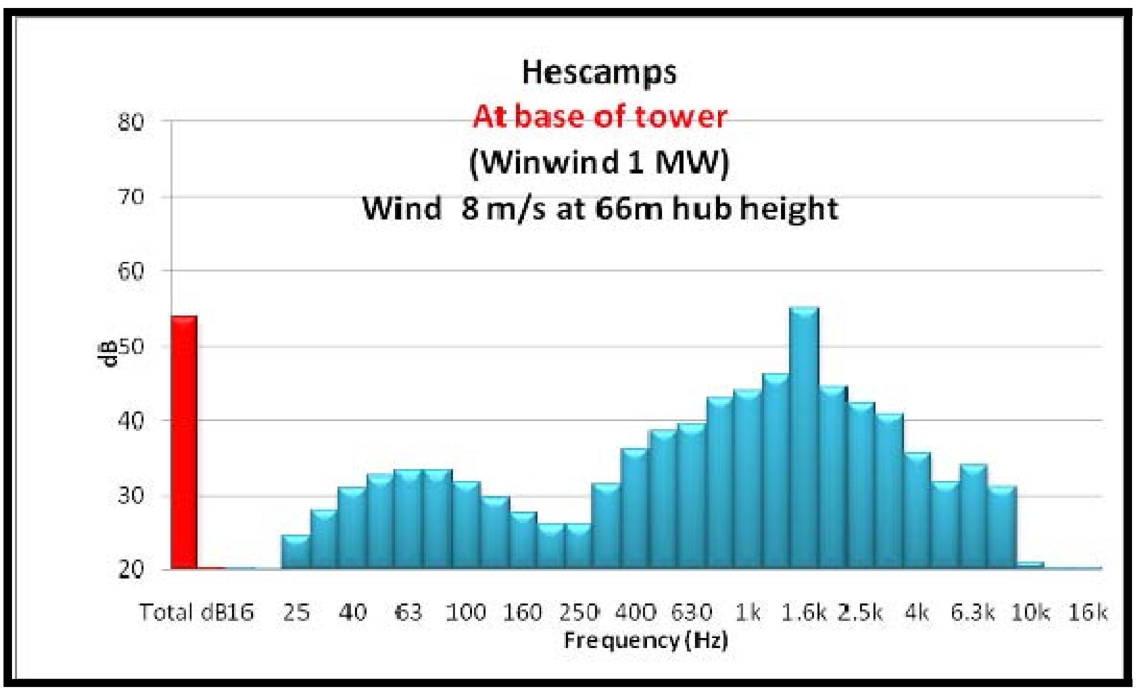


Figure 10- Frequency analysis 1MW WTG – At base of tower

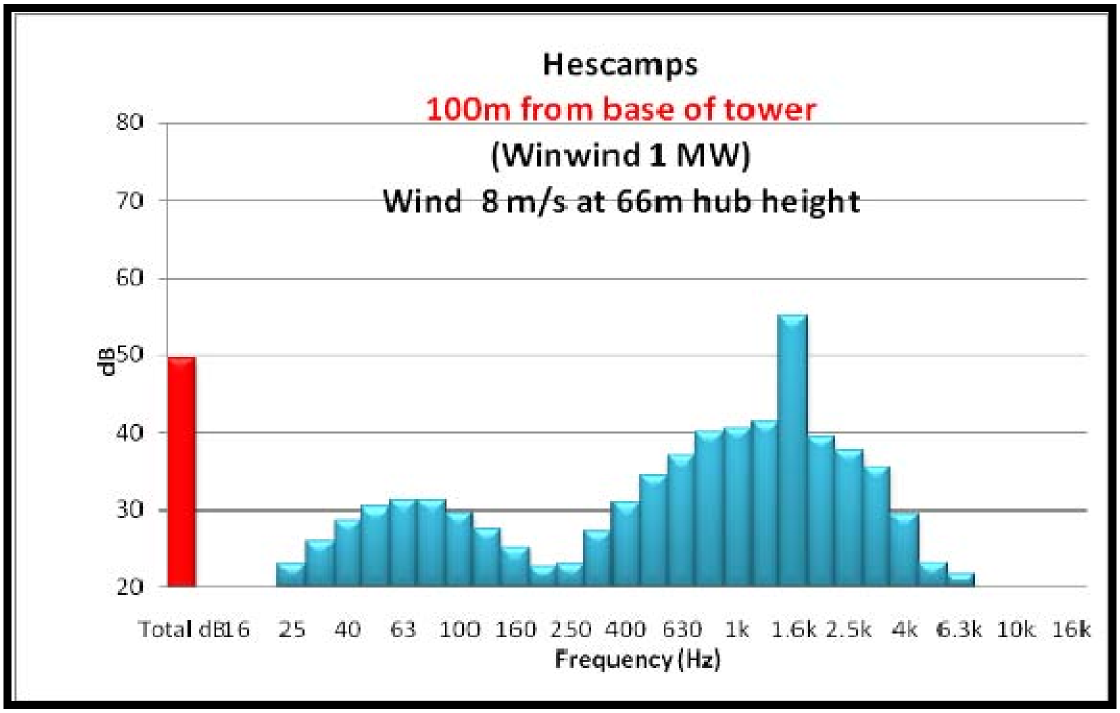


Figure 11 - Frequency analysis 1MW WTG – 100m from tower

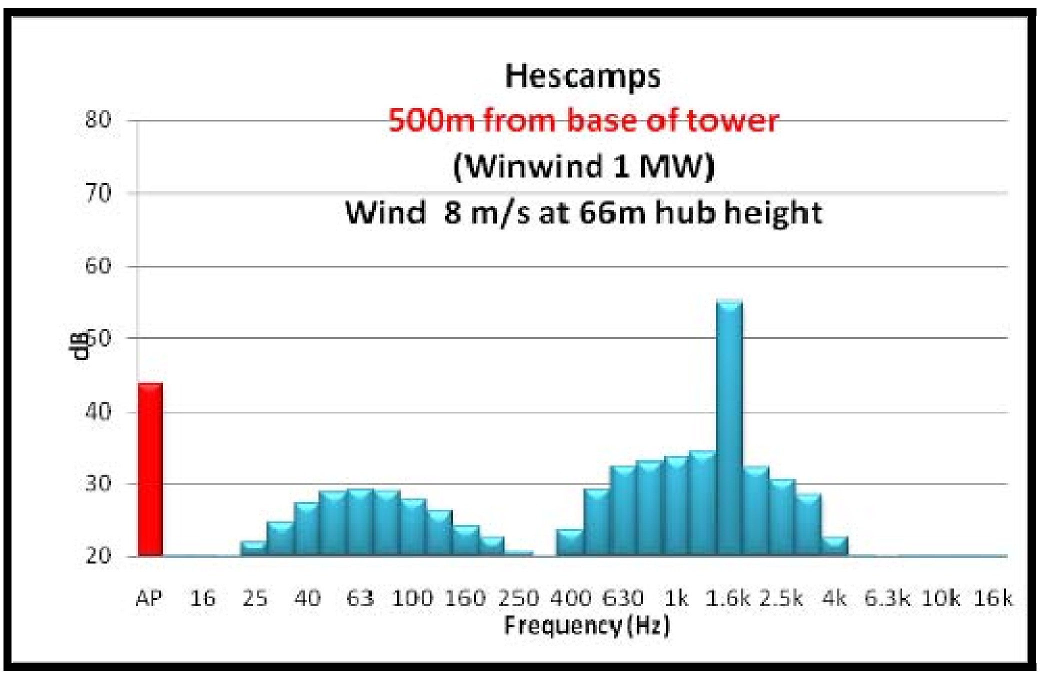


Figure 12 - Frequency analysis 1MW WTG – 500m from tower

The author did note that the Winwind 1 MW unit made a distinct sound when the blade passed the nacelle as the static and lightning discharge coupling made contact. The author was informed that on subsequent models this design has been revised. These units will not be installed in South Africa.

The results of the field study showed that at no time did the sound level below 20 hertz exceed 25 decibels. This correlates well with the literature review as there are no proven health effects from infrasound below 90dB.

The total noise measured at 500m was approximately 45dB. This level included the ambient noise and the turbine noise, which was intermittently barely audible. It is not anticipated that the turbines will be heard indoors. This level would correspond to the SANS 10103 recommended ambient limit for rural areas. The sound above the infrasound range does not indicate specific tonal qualities except at 1600hertz, but this is explained above as a turbine design flaw.

4.0 IDENTIFICATION OF KEY ISSUES

The key issues regarding the noise impact are as follows:

- 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?
- Will low frequency sound and infra sound pose an unacceptable impact?

5.0 APPLICABLE LEGISLATION & STANDARDS

South Africa has applicable 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.
- 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 below.

Table VIII - 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. 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. 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 7dB. 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 7dB, 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 below.

Table IX - 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 maximum ambient sound levels from wind turbines. These are listed below:

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

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

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

Germany has set the following standards:

- Purely residential areas with no commercial developments 50 dBA (Day) and 35 dBA (Night)
- 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(A) for rural districts during the day. A guideline limit of 45 dB(A) (day/night) is thus chosen as the design limit for the wind turbine noise at sensitive noise receptors.

There are no legislated setback distance guidelines for wind turbines in South Africa. A 500m setback distance is recommended as this is approximately the distance that the author noted in France that the wind turbines could not be heard. This distance is chosen subjectively, but in the absence of legislated requirements, it could be considered as a reasonable option.

6.0 NOISE IMPACT ASSESSMENT

6.1. Predicted Noise Levels for the Construction Phase

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 Southern Africa and have recorded the noise emissions of various pieces of construction equipment. The results are presented in the Table below.

Table X – 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 Table 3. 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 distance the ambient level will be reached.

Table XI - 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.

Table XII - Combining Different Construction Noise Sources – Low Impacts

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

The information in the tables 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.

The table below gives an illustration of attenuation by distance from a noise of 117dB measured from the source.

Table XIII – Attenuation by distance 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 the above table is that if the ambient noise level is at 45dB(A), the construction noise will be similar to the ambient level at approximately 1300m 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. The construction noise will be transient in nature and in all likelihood not constant for extended periods as the construction team will move from site to site.

6.2. Predicted noise levels for the Operational Phase

The effects of low frequency noise could include sleep disturbance, nausea, vertigo etc. These effects are unlikely to impact upon residents due to the distance between the turbines and the nearest communities as the sound power levels from the turbines are low. Sources of low frequency noise other than the turbines include wind noise, train movements (at very infrequent times) and vehicular traffic.

6.2.1 Predicted noise levels for the Wind Turbines Generators

The tables and figures below indicate the isopleths for the noise generated by the turbines at wind speeds from 4m/s to 12m/s. The areas shaded red in the tables indicate where the 45dB(A) recommended limit is exceeded.

Table XIV - Results of the modeling for the various NSA's (Eastern Site)

NSA 1 - (East)				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1695m from WTG 23	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	28.8	28.3	Yes
6	45	35.3	34.8	Yes
8	45	37.8	36.3	Yes
10	45	36.2	36.3	Yes
12	45	36.1	36.3	Yes

NSA 2				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 680m from WTG 18	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.6	35.1	Yes
6	45	42.1	41.6	Yes
8	45	44.6	43.1	Yes
10	45	43.0	43.1	Yes
12	45	42.9	43.1	Yes

NSA 3				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 657m from WTG 18	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.5	35.0	Yes
6	45	42.0	41.5	Yes
8	45	44.5	43.0	Yes
10	45	42.9	43.0	Yes
12	45	42.8	43.0	Yes

NSA 4				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1266m from WTG 19	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.1	30.6	Yes
6	45	37.6	37.1	Yes
8	45	40.1	38.6	Yes
10	45	38.5	38.6	Yes
12	45	38.4	38.6	Yes

NSA 5				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1563m from WTG 15	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.8	30.3	Yes
6	45	37.3	36.8	Yes
8	45	39.8	38.3	Yes
10	45	38.2	38.3	Yes
12	45	38.1	38.3	Yes

Table XV - Results of the modeling for the various NSA's (Central Site)

NSA 6 (Central)				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1039m from WTG 33	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.3	34.8	Yes
6	45	41.8	41.3	Yes
8	45	44.3	42.8	Yes
10	45	42.7	42.8	Yes
12	45	42.6	42.8	Yes

NSA 7				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 710m from WTG 41	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	36.4	35.9	Yes
6	45	42.9	42.4	Yes
8	45	45.4	43.9	No
10	45	43.8	43.9	Yes
12	45	43.7	43.9	Yes

NSA 8				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1253m from WTG 63	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	36.1	35.6	Yes
6	45	42.6	42.1	Yes
8	45	45.1	43.6	No
10	45	43.5	43.6	Yes
12	45	43.4	43.6	Yes

NSA 9				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 816m from WTG 48	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	36.8	36.3	Yes
6	45	43.3	42.8	Yes
8	45	45.8	44.3	No
10	45	44.2	44.3	Yes
12	45	44.1	44.3	Yes

NSA 10				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1682m from WTG 33	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	33.7	33.2	Yes
6	45	40.2	39.7	Yes
8	45	42.7	41.2	Yes
10	45	41.1	41.2	Yes
12	45	41.0	41.2	Yes

NSA 11				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1961m from WTG 55	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.9	31.4	Yes
6	45	38.4	37.9	Yes
8	45	40.9	39.4	Yes
10	45	39.3	39.4	Yes
12	45	39.2	39.4	Yes

NSA 12				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1026m from WTG 55	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.5	35.0	Yes
6	45	42.0	41.5	Yes
8	45	44.5	43.0	Yes
10	45	42.9	43.0	Yes
12	45	42.8	43.0	Yes

NSA 13				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 689m from WTG 64	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	34.9	34.4	Yes
6	45	41.4	40.9	Yes
8	45	43.9	42.4	Yes
10	45	42.3	42.4	Yes
12	45	42.2	42.4	Yes

NSA 14				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1336m from WTG 45	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.6	31.1	Yes
6	45	38.1	37.6	Yes
8	45	40.6	39.1	Yes
10	45	39.0	39.1	Yes
12	45	38.9	39.1	Yes

NSA 15				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1052m from WTG 33	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.6	35.1	Yes
6	45	42.1	41.6	Yes
8	45	44.6	43.1	Yes
10	45	43.0	43.1	Yes
12	45	42.9	43.1	Yes

NSA 16				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1046m from WTG 32	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.9	35.4	Yes
6	45	42.4	41.9	Yes
8	45	44.9	43.4	Yes
10	45	43.3	43.4	Yes
12	45	43.2	43.4	Yes

NSA 17				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1967m from WTG 45	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	27.0	26.5	Yes
6	45	33.5	33.0	Yes
8	45	36.0	34.5	Yes
10	45	34.4	34.5	Yes
12	45	34.3	34.5	Yes

NSA 18				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 2204m from WTG 64	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	25.7	25.2	Yes
6	45	32.2	31.7	Yes
8	45	34.7	33.2	Yes
10	45	33.1	33.2	Yes
12	45	33.0	33.2	Yes

NSA Ext 1				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1012m from WTG 29	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	36.9	36.4	Yes
6	45	43.4	42.9	Yes
8	45	45.9	44.4	No
10	45	44.3	44.4	Yes
12	45	44.2	44.4	Yes

NSA Ext 2				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1113m from WTG 76	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.9	30.4	Yes
6	45	37.4	36.9	Yes
8	45	39.9	38.4	Yes
10	45	38.3	38.4	Yes
12	45	38.2	38.4	Yes

NSA Ext 3				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1211m from WTG 57	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.5	32.0	Yes
6	45	39.0	38.5	Yes
8	45	41.5	40.0	Yes
10	45	39.9	40.0	Yes
12	45	39.8	40.0	Yes

NSA Ext 4				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1943m from WTG 44	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.9	30.4	Yes
6	45	37.4	36.9	Yes
8	45	39.9	38.4	Yes
10	45	38.3	38.4	Yes
12	45	38.2	38.4	Yes

NSA Ext 5				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1109m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.7	32.2	Yes
6	45	39.2	38.7	Yes
8	45	41.7	40.2	Yes
10	45	40.1	40.2	Yes
12	45	40.0	40.2	Yes

NSA Ext 6				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1309m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.4	30.9	Yes
6	45	37.9	37.4	Yes
8	45	40.4	38.9	Yes
10	45	38.8	38.9	Yes
12	45	38.7	38.9	Yes

NSA Ext 7				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1199m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.2	31.7	Yes
6	45	38.7	38.2	Yes
8	45	41.2	39.7	Yes
10	45	39.6	39.7	Yes
12	45	39.5	39.7	Yes

NSA Ext 9				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1113m from WTG 76	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.9	30.4	Yes
6	45	37.4	36.9	Yes
8	45	39.9	38.4	Yes
10	45	38.3	38.4	Yes
12	45	38.2	38.4	Yes

NSA Ext 10				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1211m from WTG 57	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.5	32.0	Yes
6	45	39.0	38.5	Yes
8	45	41.5	40.0	Yes
10	45	39.9	40.0	Yes
12	45	39.8	40.0	Yes

NSA Ext 11				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1472m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.9	30.4	Yes
6	45	37.4	36.9	Yes
8	45	39.9	38.4	Yes
10	45	38.3	38.4	Yes
12	45	38.2	38.4	Yes

NSA Ext 12				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1109m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.7	32.2	Yes
6	45	39.2	38.7	Yes
8	45	41.7	40.2	Yes
10	45	40.1	40.2	Yes
12	45	40.0	40.2	Yes

NSA Ext 13				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1309m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.4	30.9	Yes
6	45	37.9	37.4	Yes
8	45	40.4	38.9	Yes
10	45	38.8	38.9	Yes
12	45	38.7	38.9	Yes

NSA Ext 14				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1199m from WTG 50	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	32.2	31.7	Yes
6	45	38.7	38.2	Yes
8	45	41.2	39.7	Yes
10	45	39.6	39.7	Yes
12	45	39.5	39.7	Yes

Table XVI - Results of the modeling for the various NSA's (Western Site)

NSA 19 - West				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1100m from WTG 105	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.5	35.5	Yes
6	45	42.0	36.7	Yes
8	45	44.5	38.7	Yes
10	45	42.9	42.5	Yes
12	45	42.8	43.5	Yes

NSA 20				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 862m from WTG 86	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.4	31.4	Yes
6	45	37.9	32.5	Yes
8	45	40.4	34.5	Yes
10	45	38.8	38.4	Yes
12	45	38.7	39.4	Yes

NSA 21				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1708m from WTG 86	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.7	30.6	Yes
6	45	37.2	32.3	Yes
8	45	39.7	34.2	Yes
10	45	38.1	37.7	Yes
12	45	38.0	38.6	Yes

NSA 22				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 672m from WTG 97	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	35.4	35.4	Yes
6	45	41.9	36.4	Yes
8	45	44.4	38.4	Yes
10	45	42.8	42.4	Yes
12	45	42.7	43.4	Yes

NSA 23				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1470m from WTG 97	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.1	31.1	Yes
6	45	37.6	32.2	Yes
8	45	40.1	34.2	Yes
10	45	38.5	38.1	Yes
12	45	38.4	39.1	Yes

NSA 24				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1959m from WTG 97	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	29.5	29.5	Yes
6	45	36.0	30.5	Yes
8	45	38.5	32.5	Yes
10	45	36.9	36.5	Yes
12	45	36.8	37.5	Yes

NSA 25				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1193m from WTG 131	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.3	31.3	Yes
6	45	37.8	32.4	Yes
8	45	40.3	34.4	Yes
10	45	38.7	38.3	Yes
12	45	38.6	39.3	Yes

NSA 26				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1614m from WTG 97	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.7	30.7	Yes
6	45	37.2	31.7	Yes
8	45	39.7	33.7	Yes
10	45	38.1	37.7	Yes
12	45	38.0	38.7	Yes

NSA 27				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1105m from WTG 131	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	30.3	30.3	Yes
6	45	36.8	31.3	Yes
8	45	39.3	33.3	Yes
10	45	37.7	37.3	Yes
12	45	37.6	38.3	Yes

NSA 28				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1632m from WTG 95	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.2	31.2	Yes
6	45	37.7	32.3	Yes
8	45	40.2	34.3	Yes
10	45	38.6	38.2	Yes
12	45	38.5	39.2	Yes

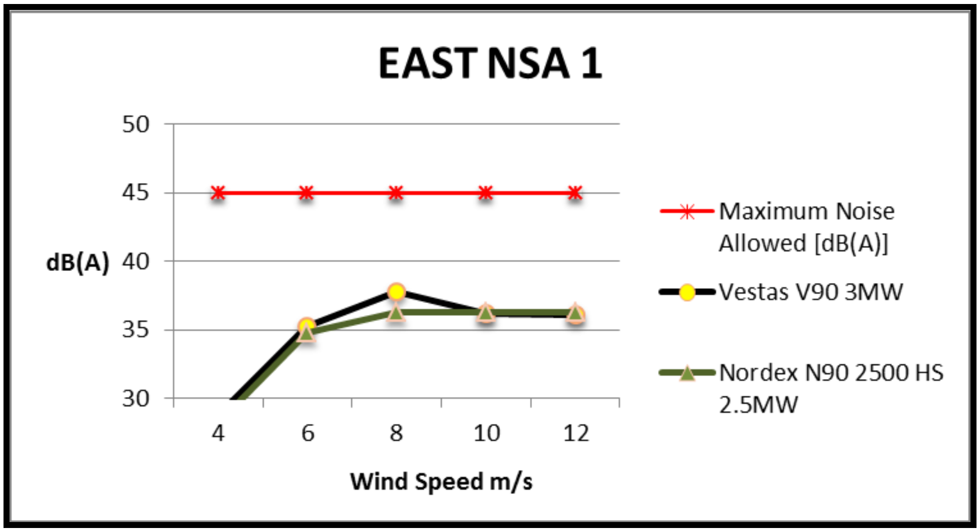
NSA 29				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1677m from WTG 86	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	29.7	29.7	Yes
6	45	36.2	31.3	Yes
8	45	38.7	33.2	Yes
10	45	37.1	36.8	Yes
12	45	37.0	37.7	Yes

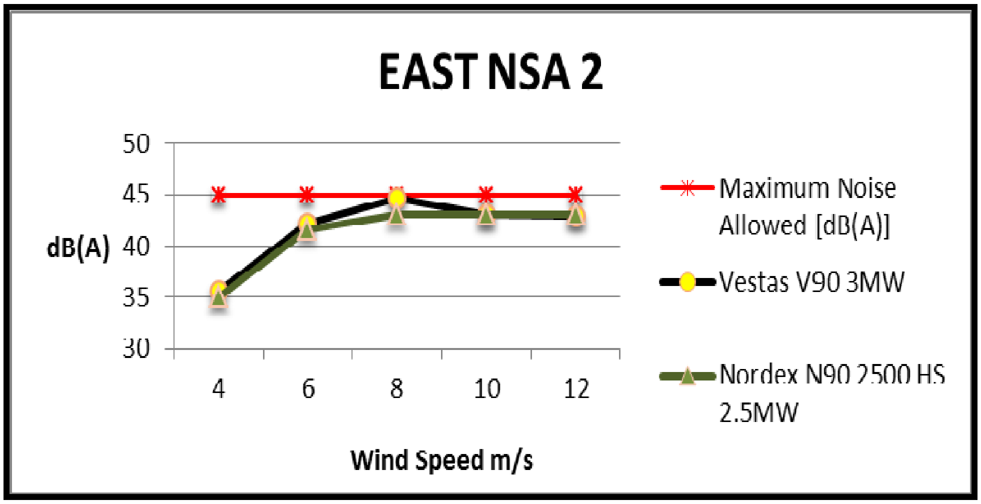
NSA 30				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 1380m from WTG 86	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	31.7	31.7	Yes
6	45	38.2	33.2	Yes
8	45	40.7	35.1	Yes
10	45	39.1	38.7	Yes
12	45	39.0	39.7	Yes

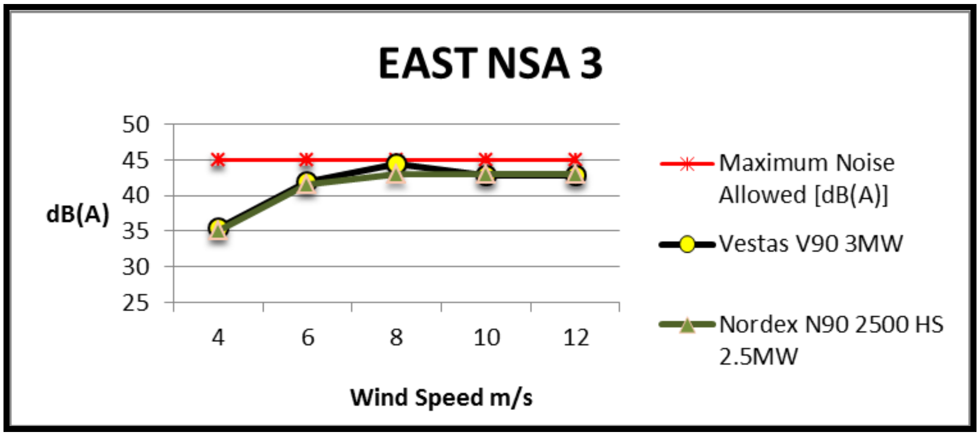
NSA West Ext 1				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 536m from WTG 81	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	40.9	40.7	Yes
6	45	47.4	44.8	No
8	45	49.9	46.4	No
10	45	48.3	48.1	No
12	45	48.2	48.7	No

NSA West Ext 2				
Distance to Nearest WTG[m] - min 500m			Nearest WTG 568m from WTG 82	
Wind Speed [m/s]	Maximum Noise Allowed [dB(A)]	Vestas V90 3MW	Nordex N90 2500 HS 2.5MW	Noise Demand Fulfilled?
4	45	40.8	40.5	Yes
6	45	47.3	44.7	No
8	45	49.8	46.4	No
10	45	48.2	48.0	No
12	45	48.1	48.5	No

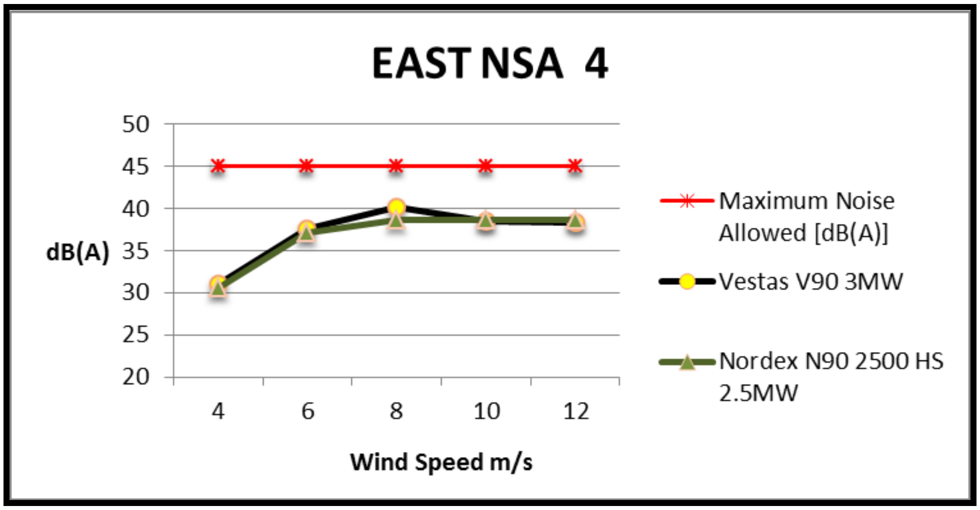
Figure 13 - Graphs of Noise Levels at NSA's



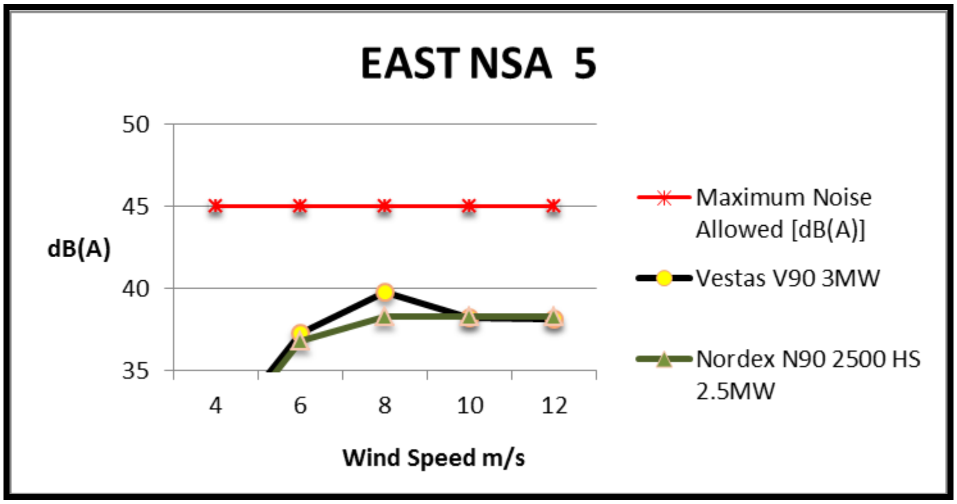




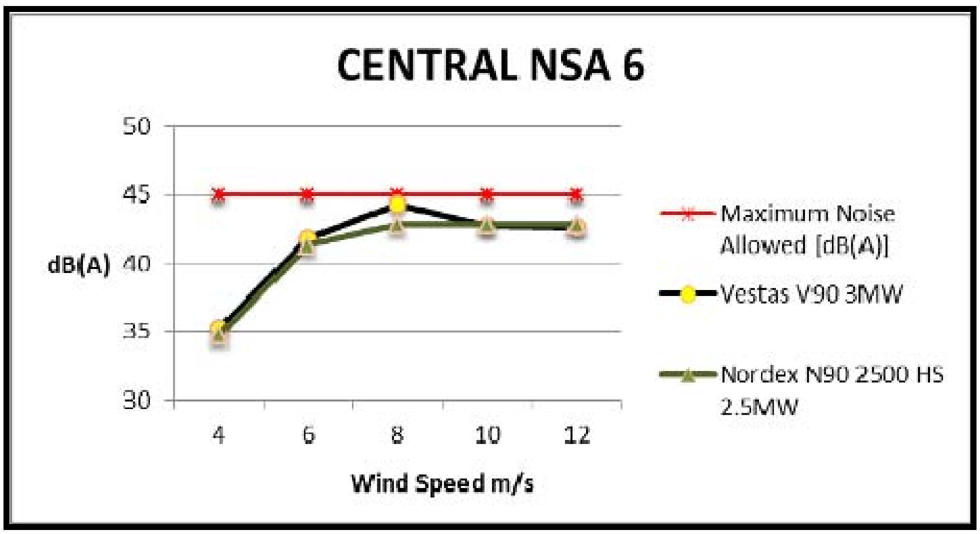
EAST NSA 3
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



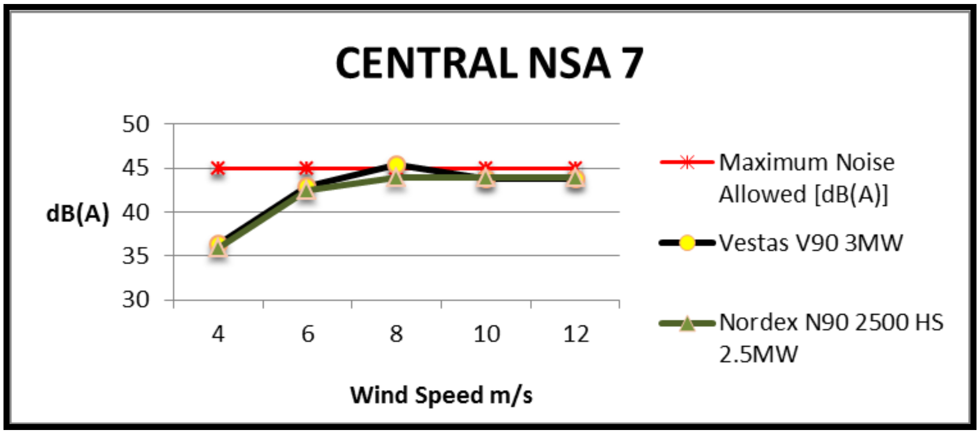
EAST NSA 4
50
45
40
35
30
25
20
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



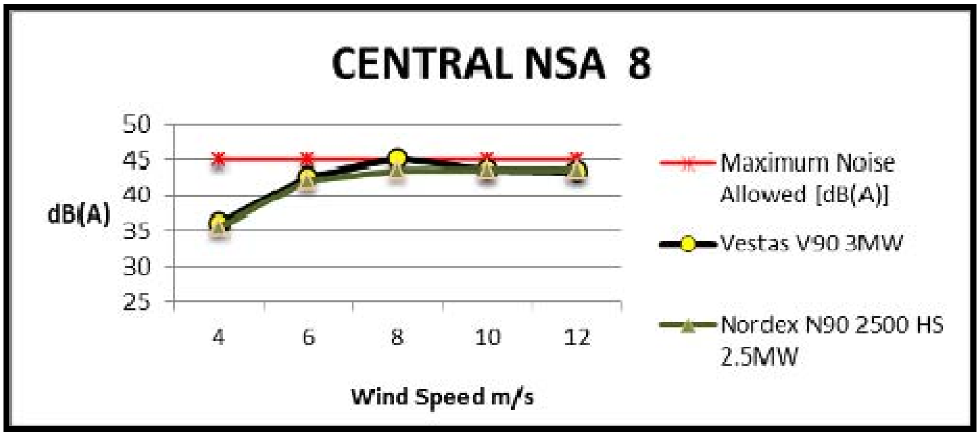
EAST NSA 5
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



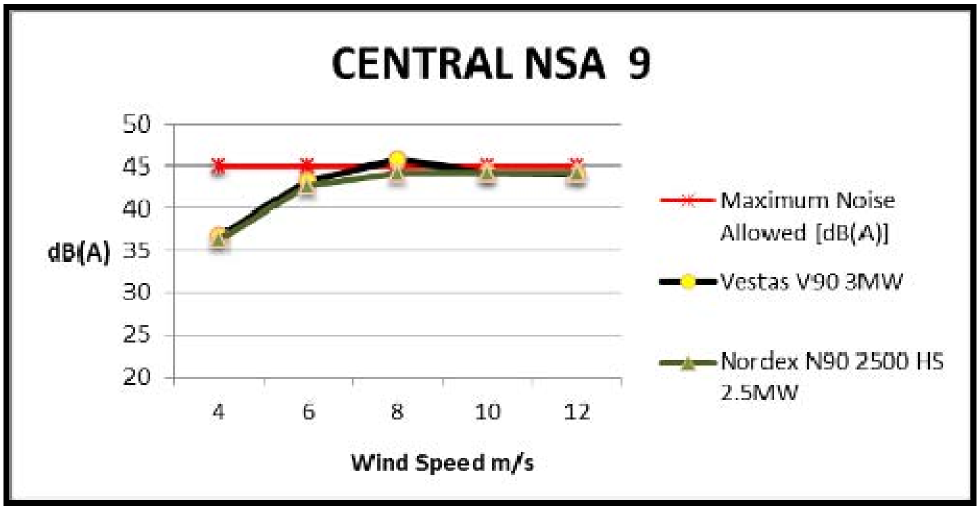
CENTRAL NSA 6
50
45
40
35
30
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



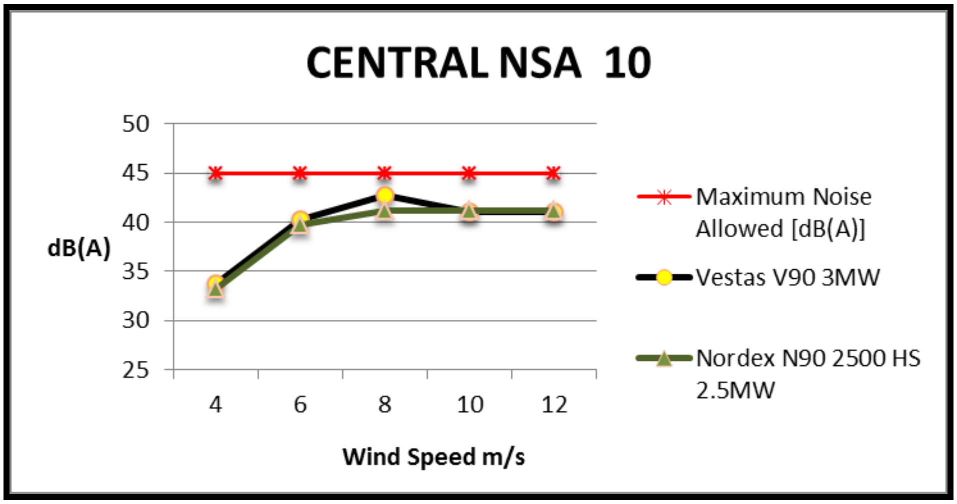
CENTRAL NSA 7
dB(A)
50
45
40
35
30
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



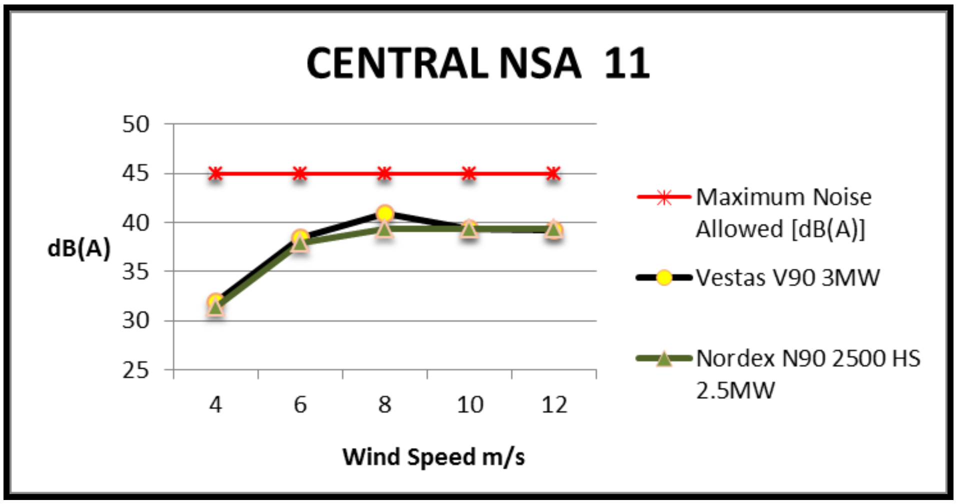
CENTRAL NSA 8
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



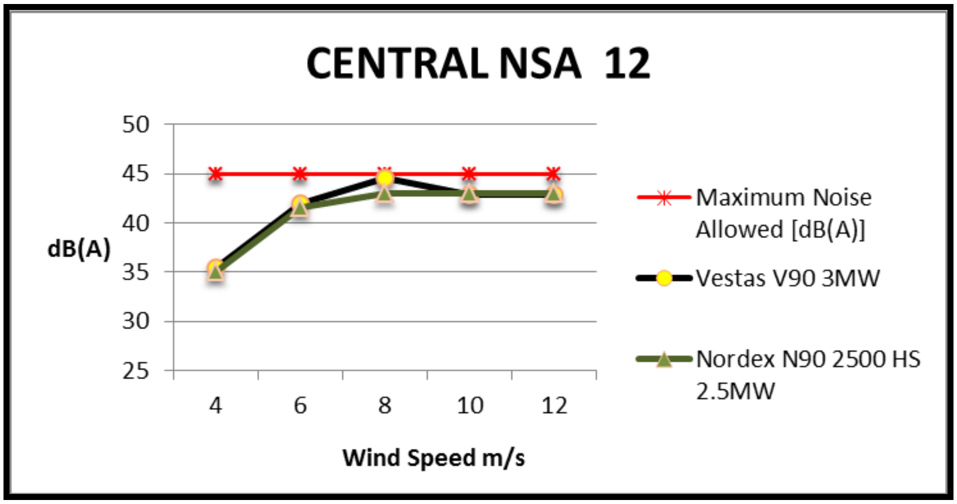
CENTRAL NSA 9
dB(A)
50
45
40
35
30
25
20
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



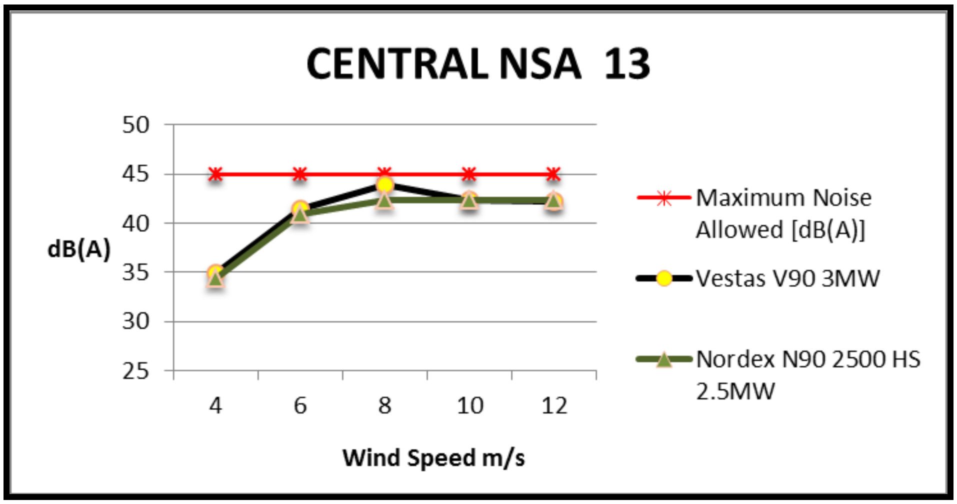
CENTRAL NSA 10
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



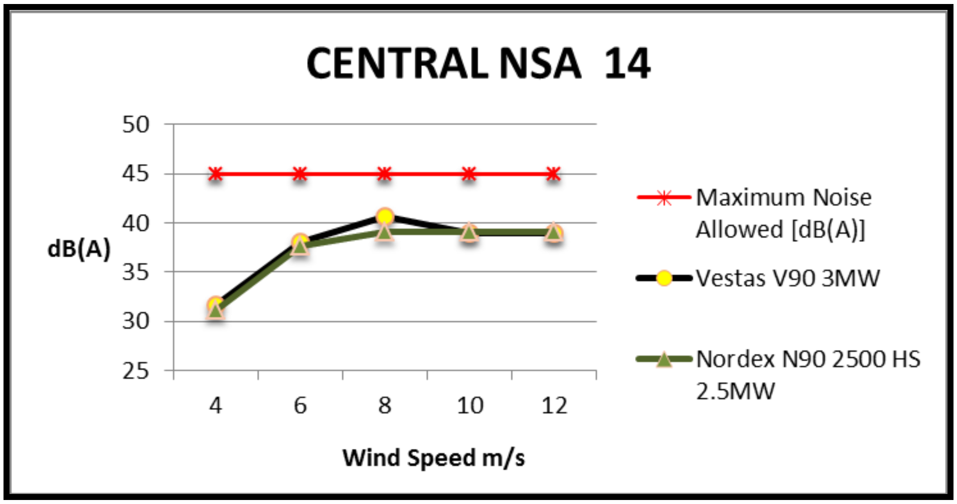
CENTRAL NSA 11
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



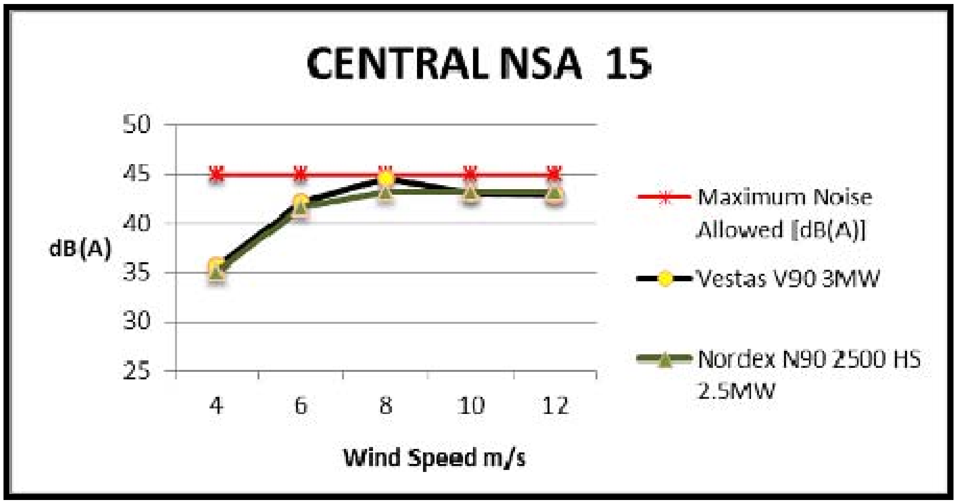
CENTRAL NSA 12
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



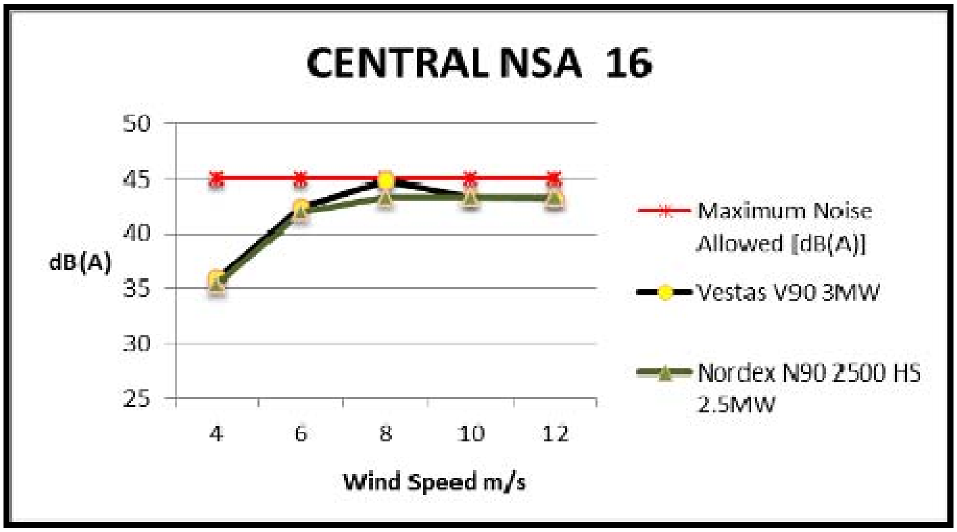
CENTRAL NSA 13
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



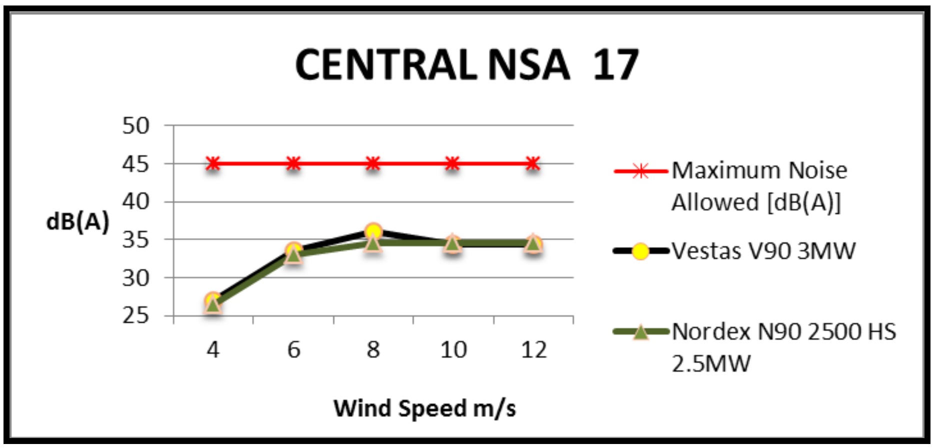
CENTRAL NSA 14
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



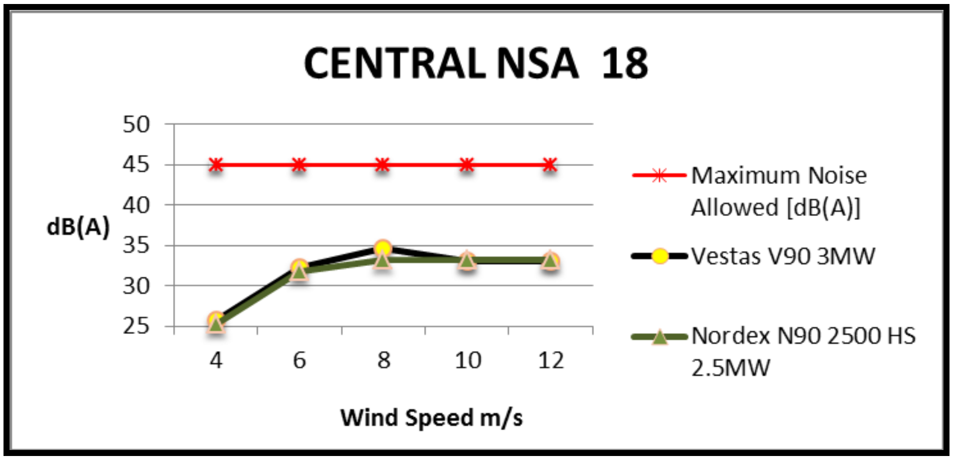
CENTRAL NSA 15
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



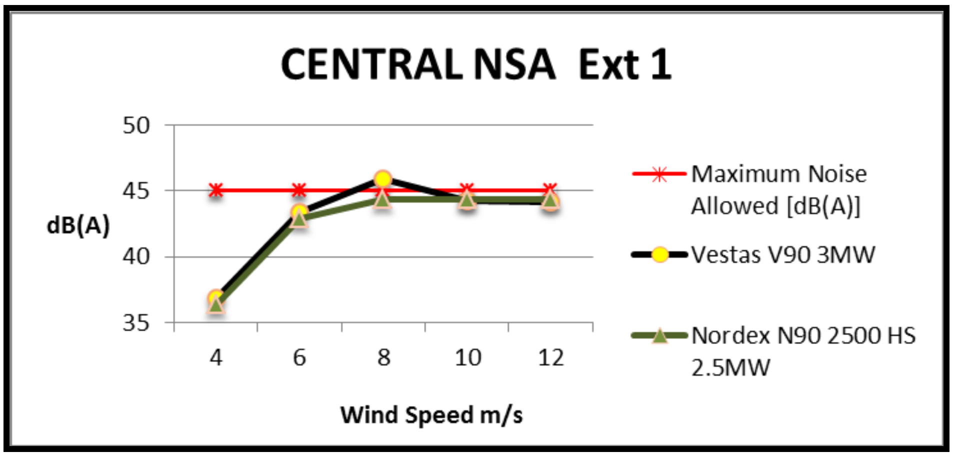
CENTRAL NSA 16
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



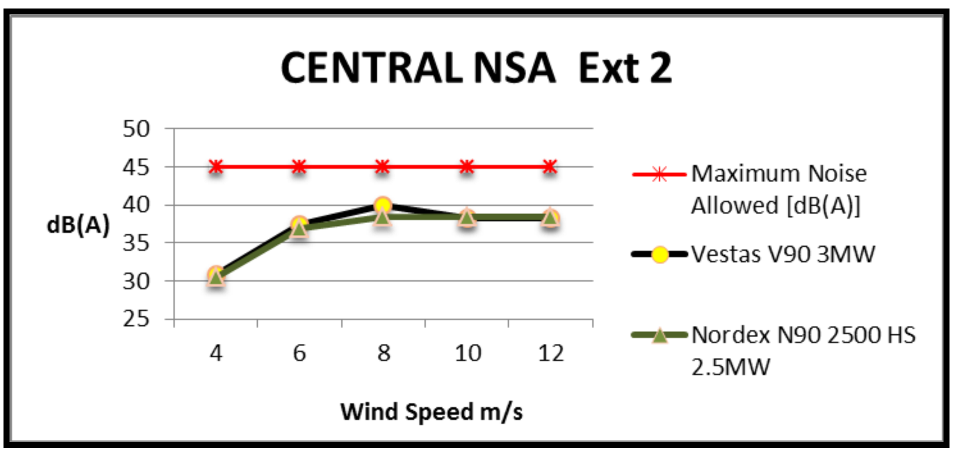
CENTRAL NSA 17
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



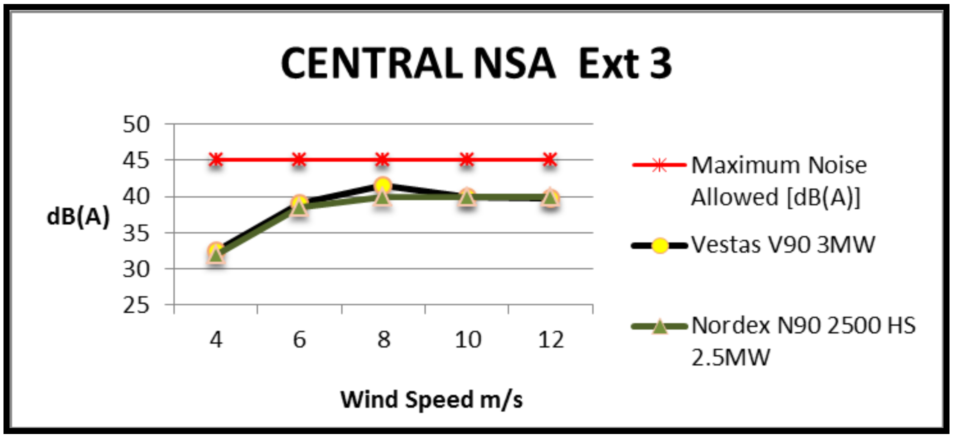
CENTRAL NSA 18
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



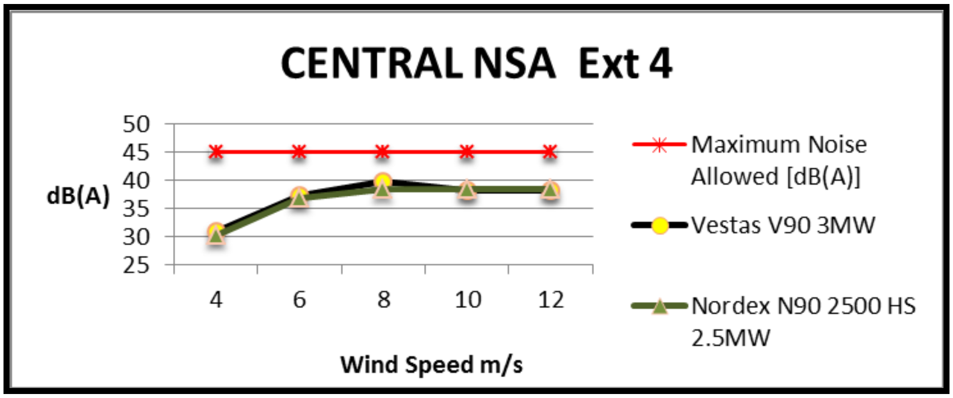
CENTRAL NSA Ext 1
dB(A)
50
45
40
35
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



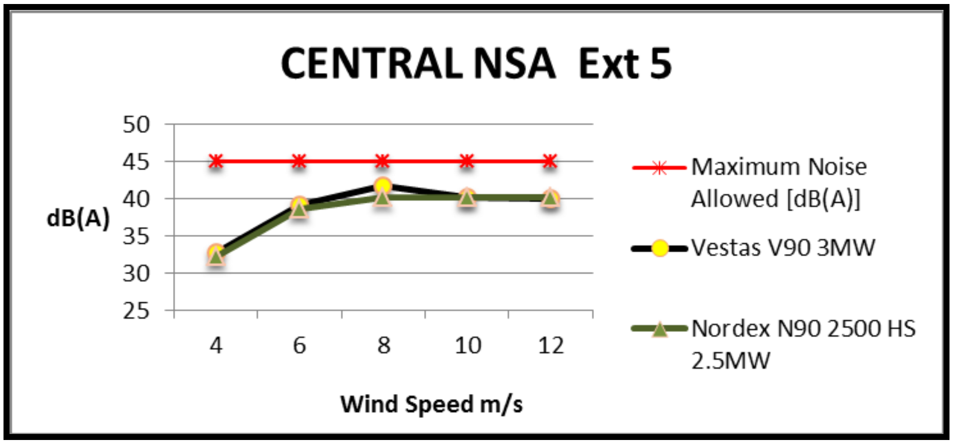
CENTRAL NSA Ext 2
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



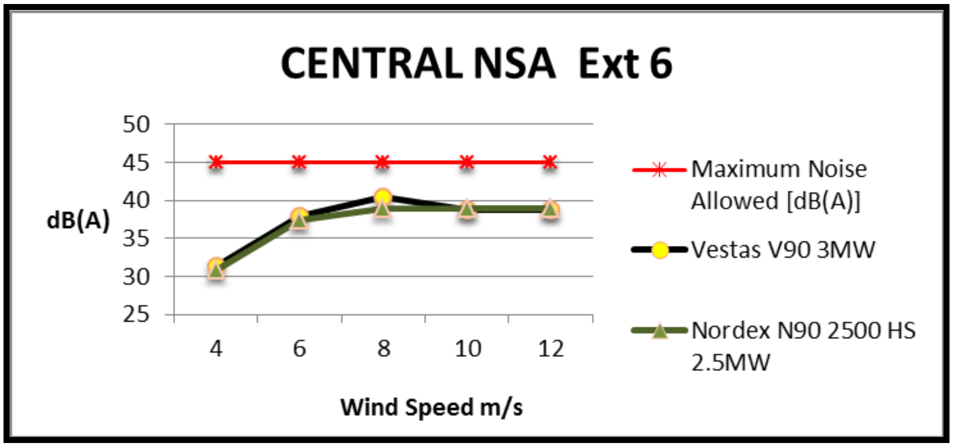
CENTRAL NSA Ext 3
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



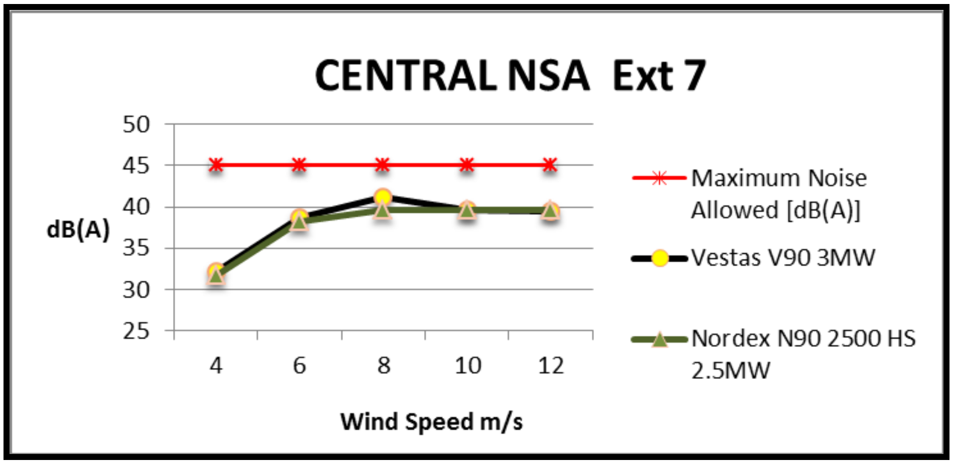
CENTRAL NSA Ext 4
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



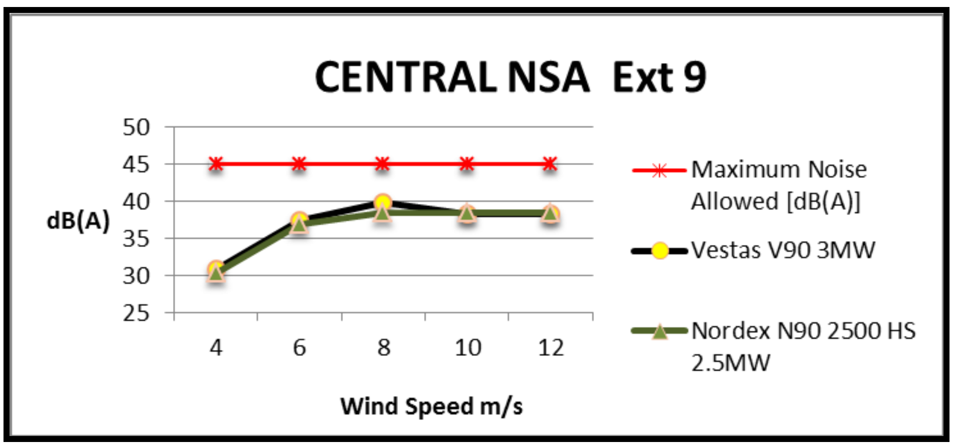
CENTRAL NSA Ext 5
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



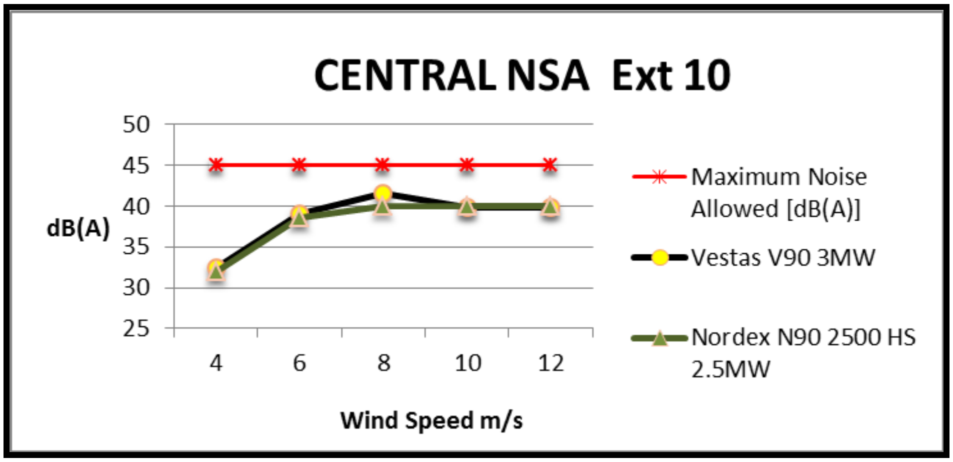
CENTRAL NSA Ext 6
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



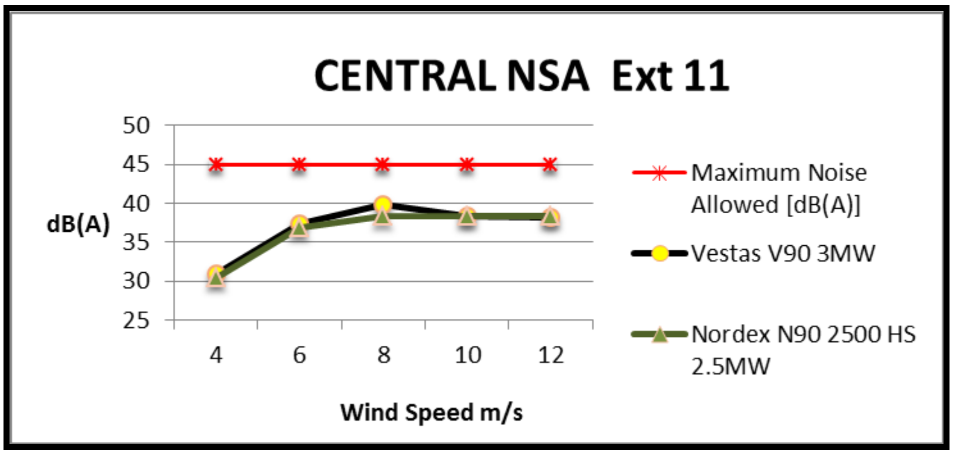
CENTRAL NSA Ext 7
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



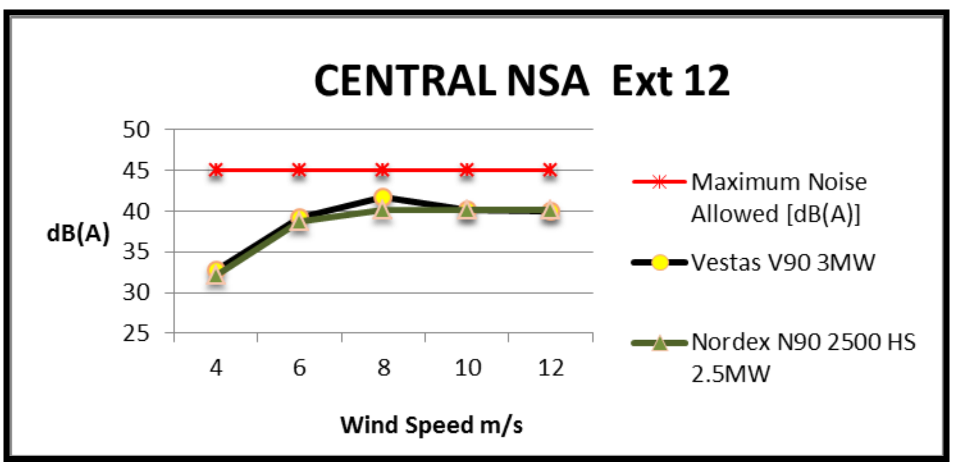
CENTRAL NSA Ext 9
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



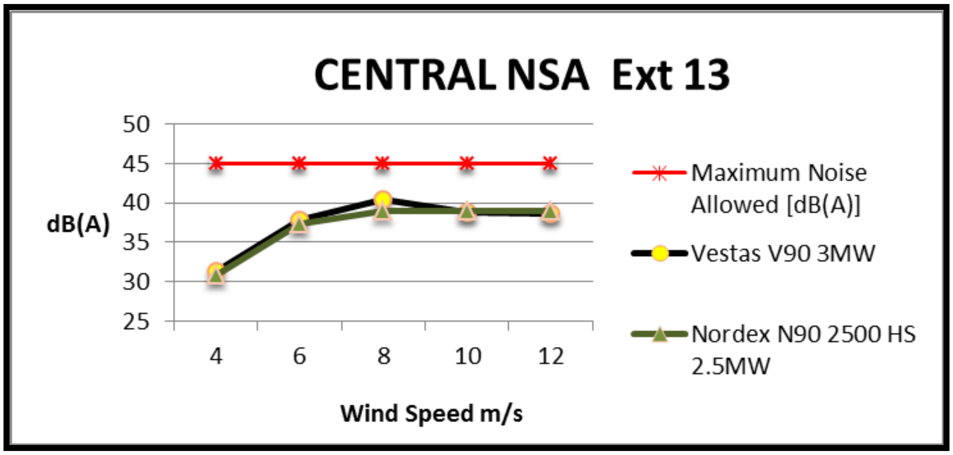
CENTRAL NSA Ext 10
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



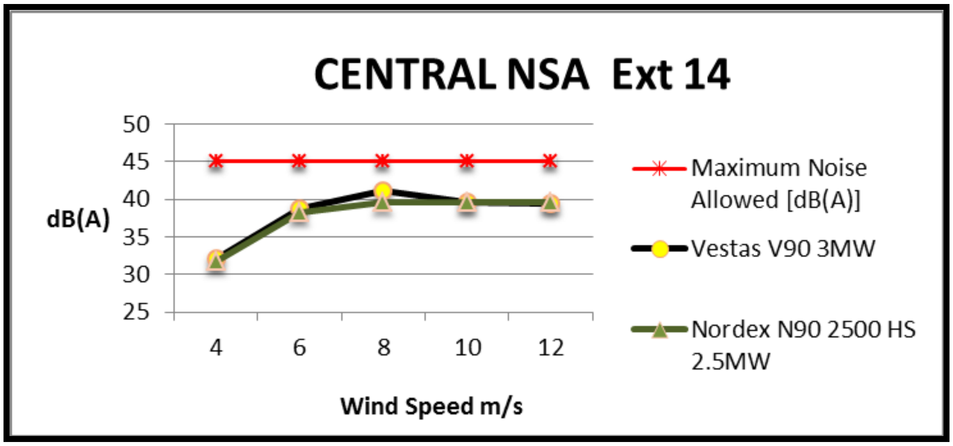
CENTRAL NSA Ext 11
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



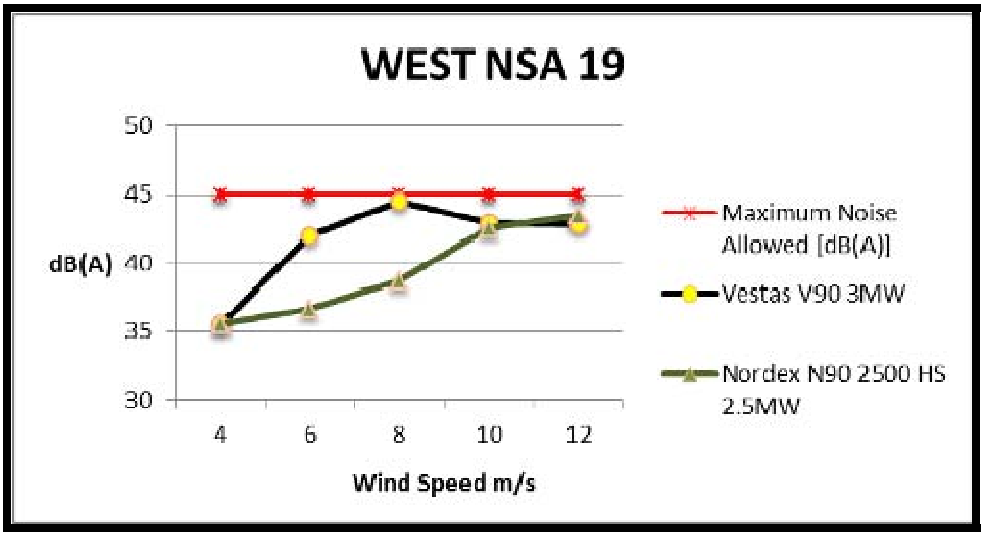
CENTRAL NSA Ext 12
dB(A)
50
45
40
35
30
25
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



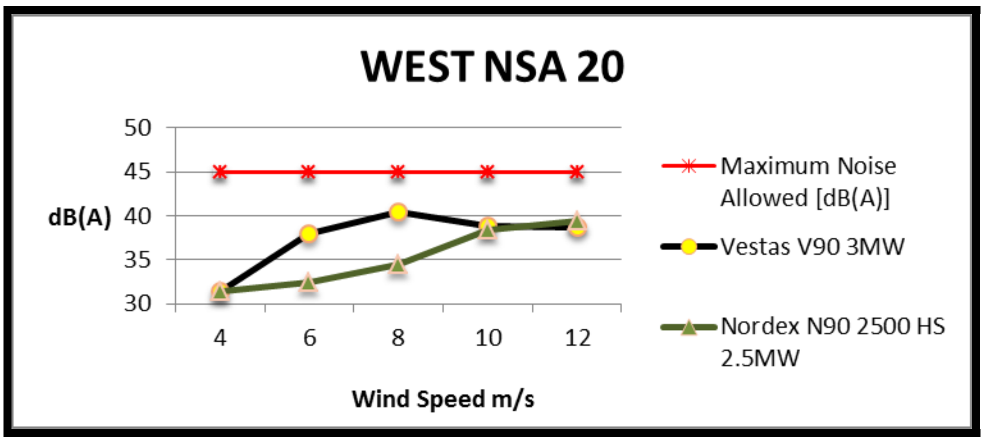
CENTRAL NSA Ext 13
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



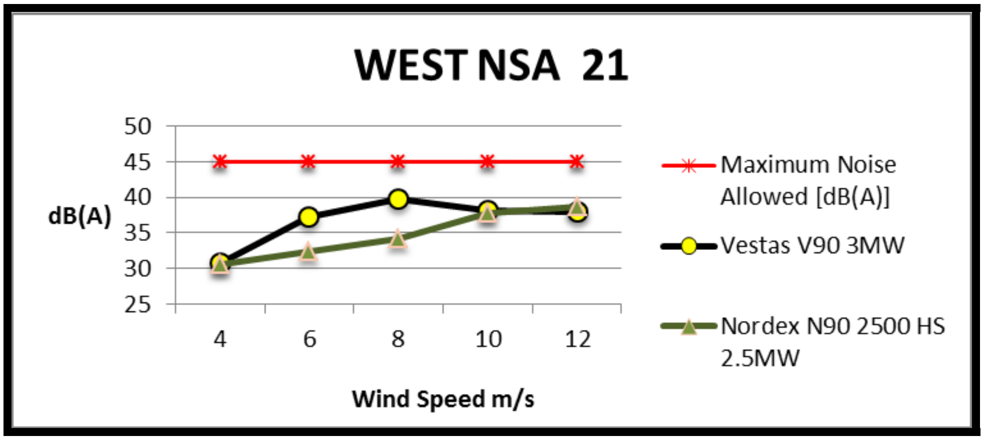
CENTRAL NSA Ext 14
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



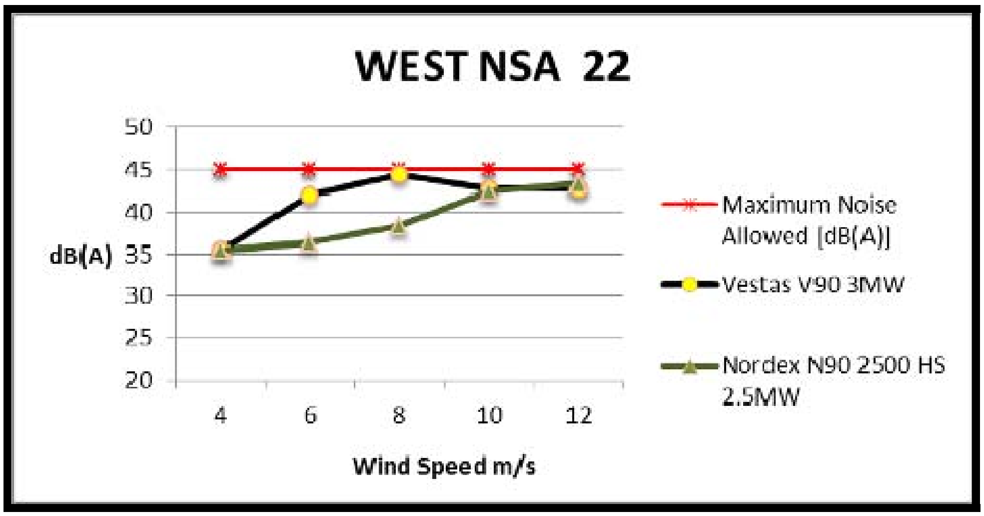
WEST NSA 19
50
45
dB(A) 40
35
30
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



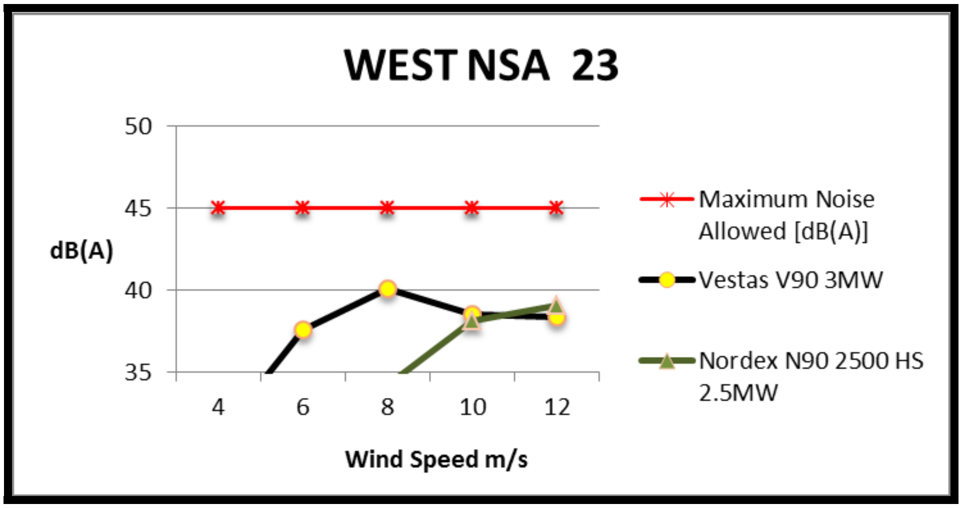
WEST NSA 20
50
45
dB(A) 40
35
30
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



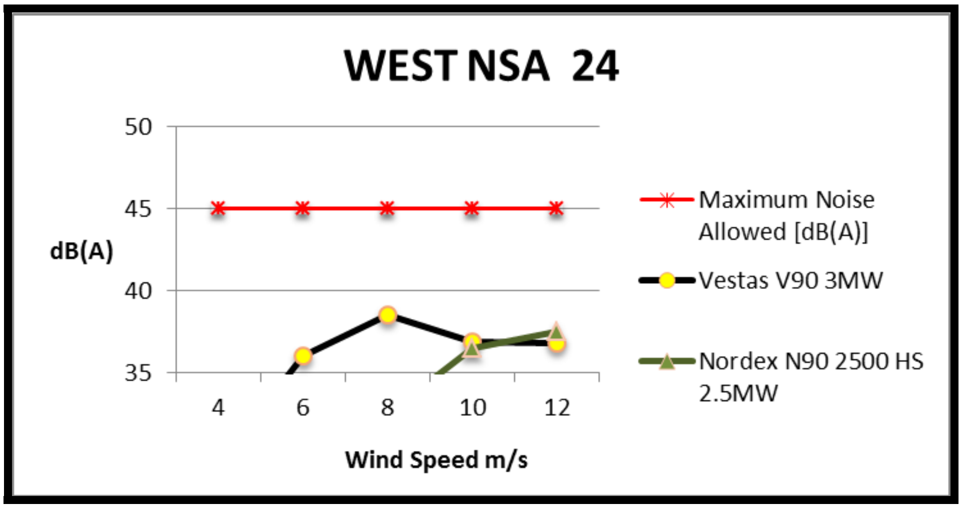
WEST NSA 21
50
45
40
35
30
25
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



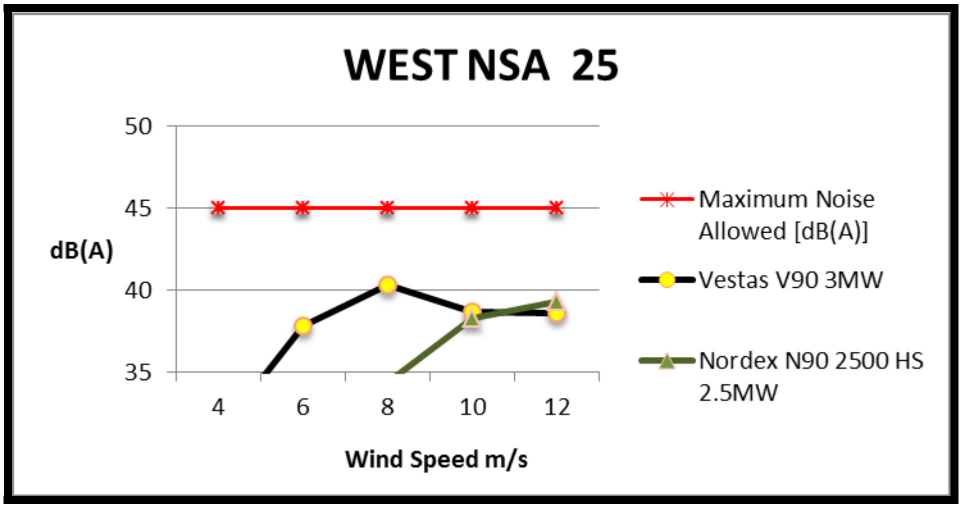
WEST NSA 22
50
45
40
35
30
25
20
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



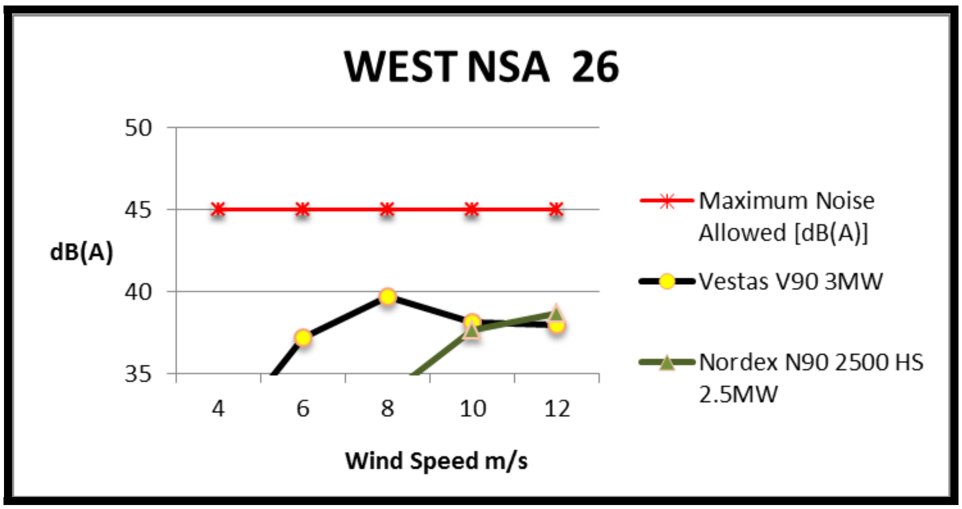
WEST NSA 23
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



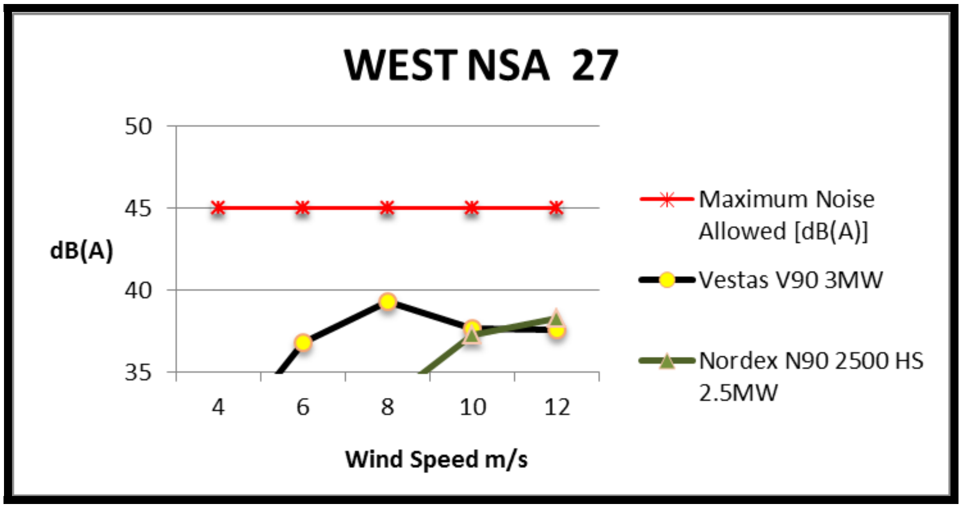
WEST NSA 24
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



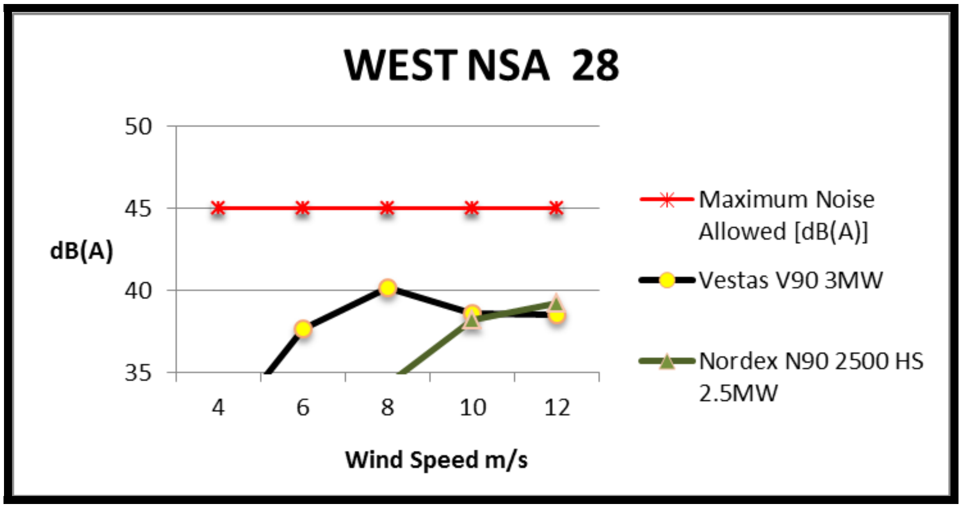
WEST NSA 25
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



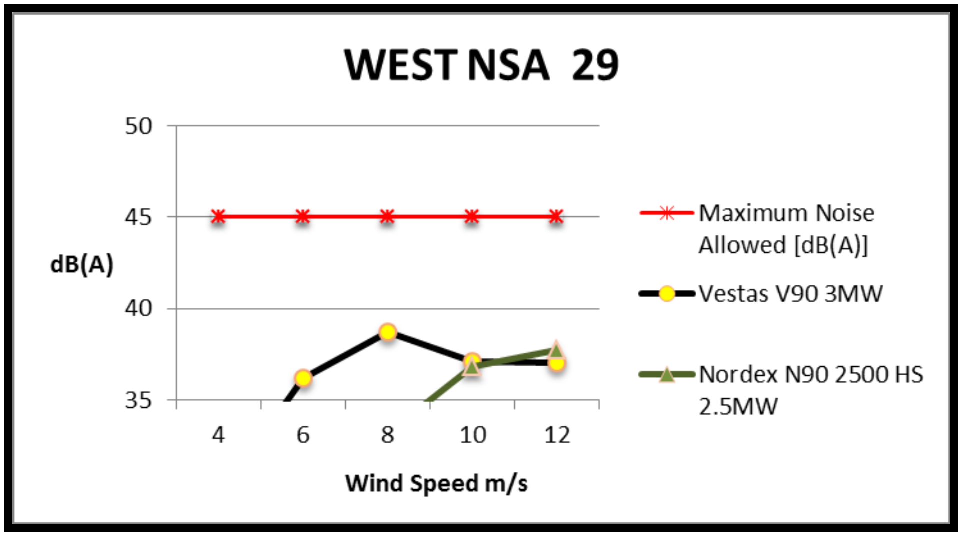
WEST NSA 26
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



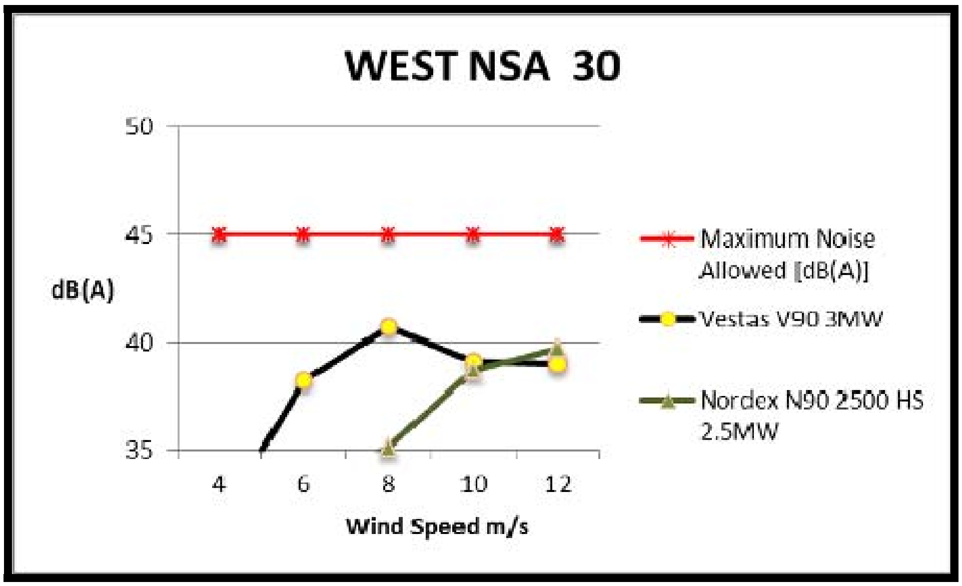
WEST NSA 27
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



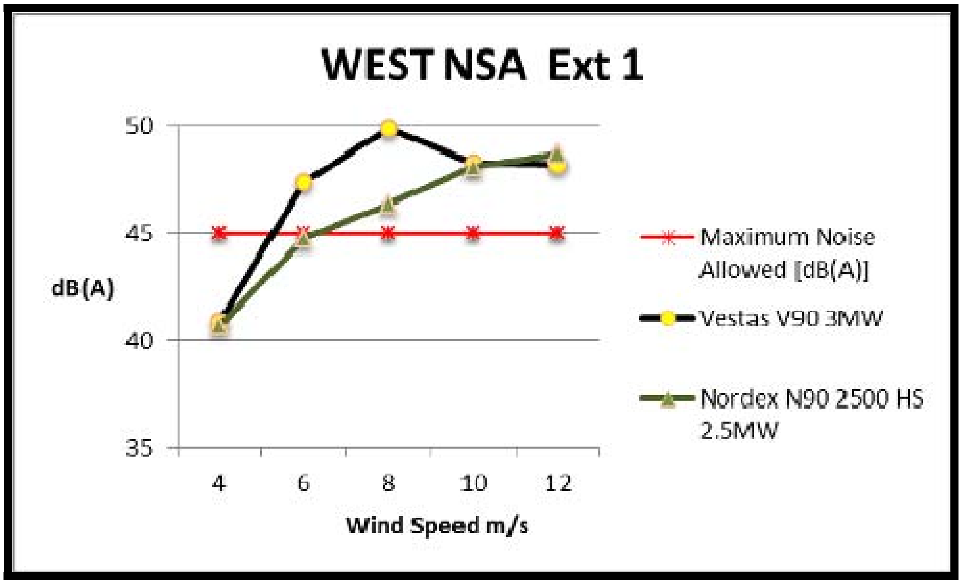
WEST NSA 28
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



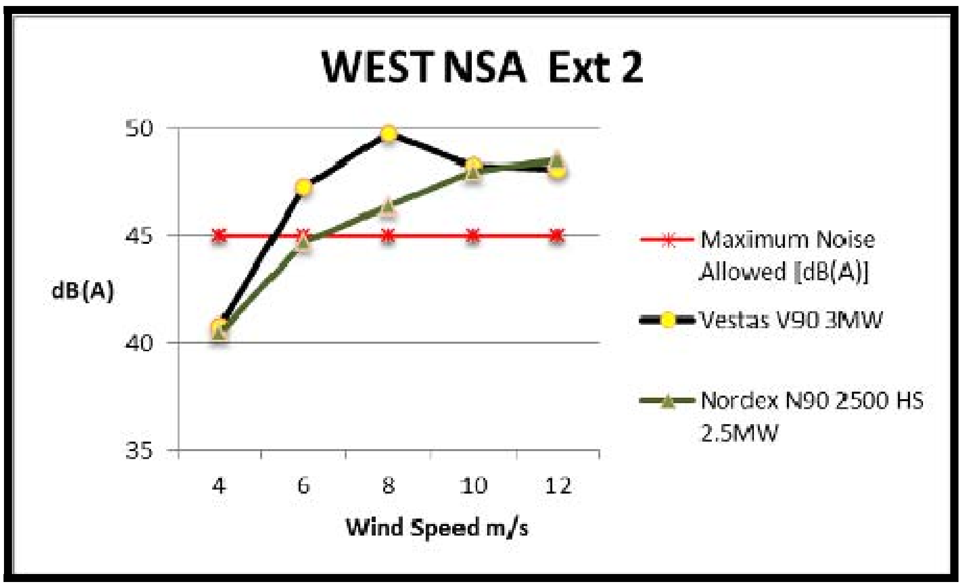
WEST NSA 29
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



WEST NSA 30
50
45
40
35
dB(A)
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



WEST NSA Ext 1
dB(A)
50
45
40
35
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW



WEST NSA Ext 2
dB(A)
50
45
40
35
4
6
8
10
12
Wind Speed m/s
Maximum Noise Allowed [dB(A)]
Vestas V90 3MW
Nordex N90 2500 HS 2.5MW

Figure 14 - Raster Image of Eastern Site Isopleths & NSA's (Nordex N90 -Wind speed 4m/s)

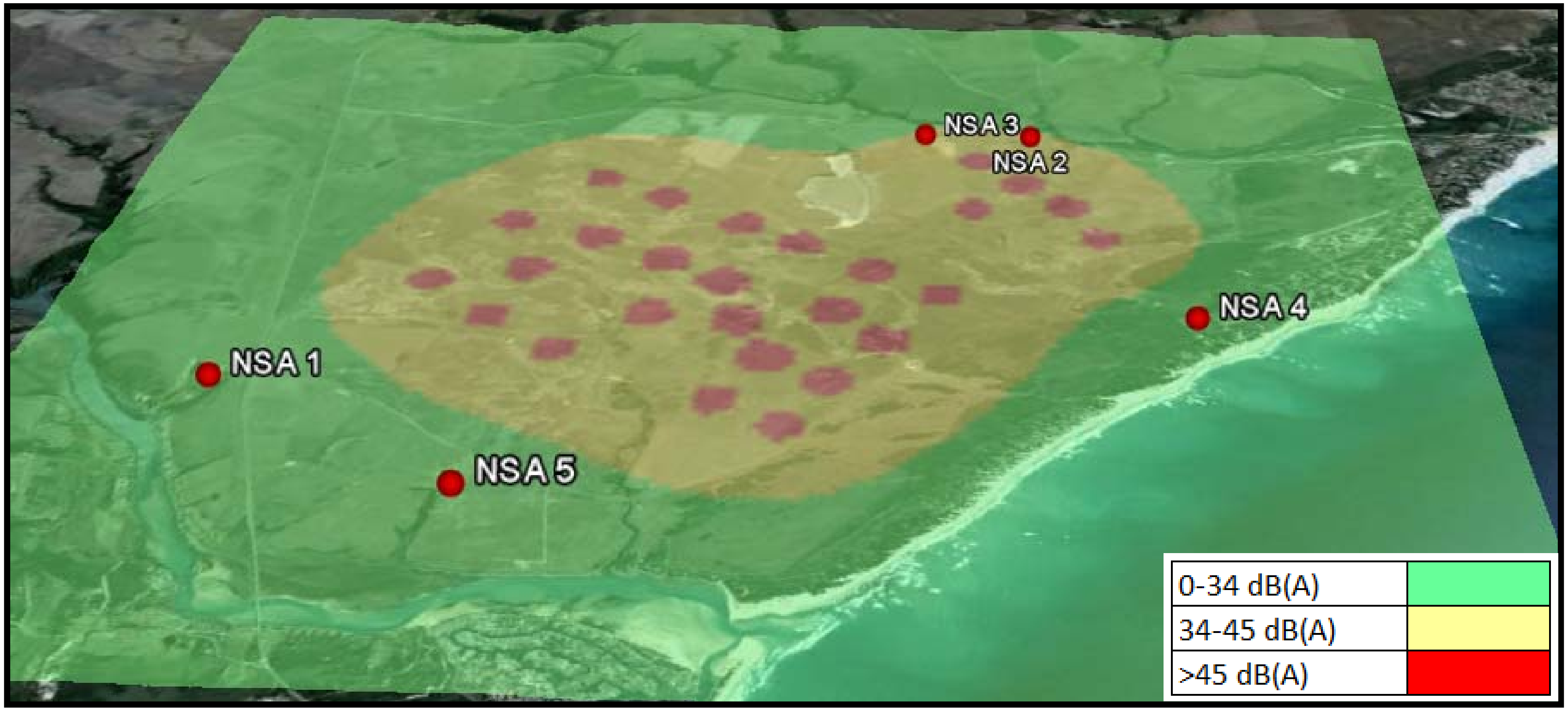


Figure 15 - Raster Image of Eastern Site Isopleths & NSA's (Nordex N90 -Wind speed 8m/s)

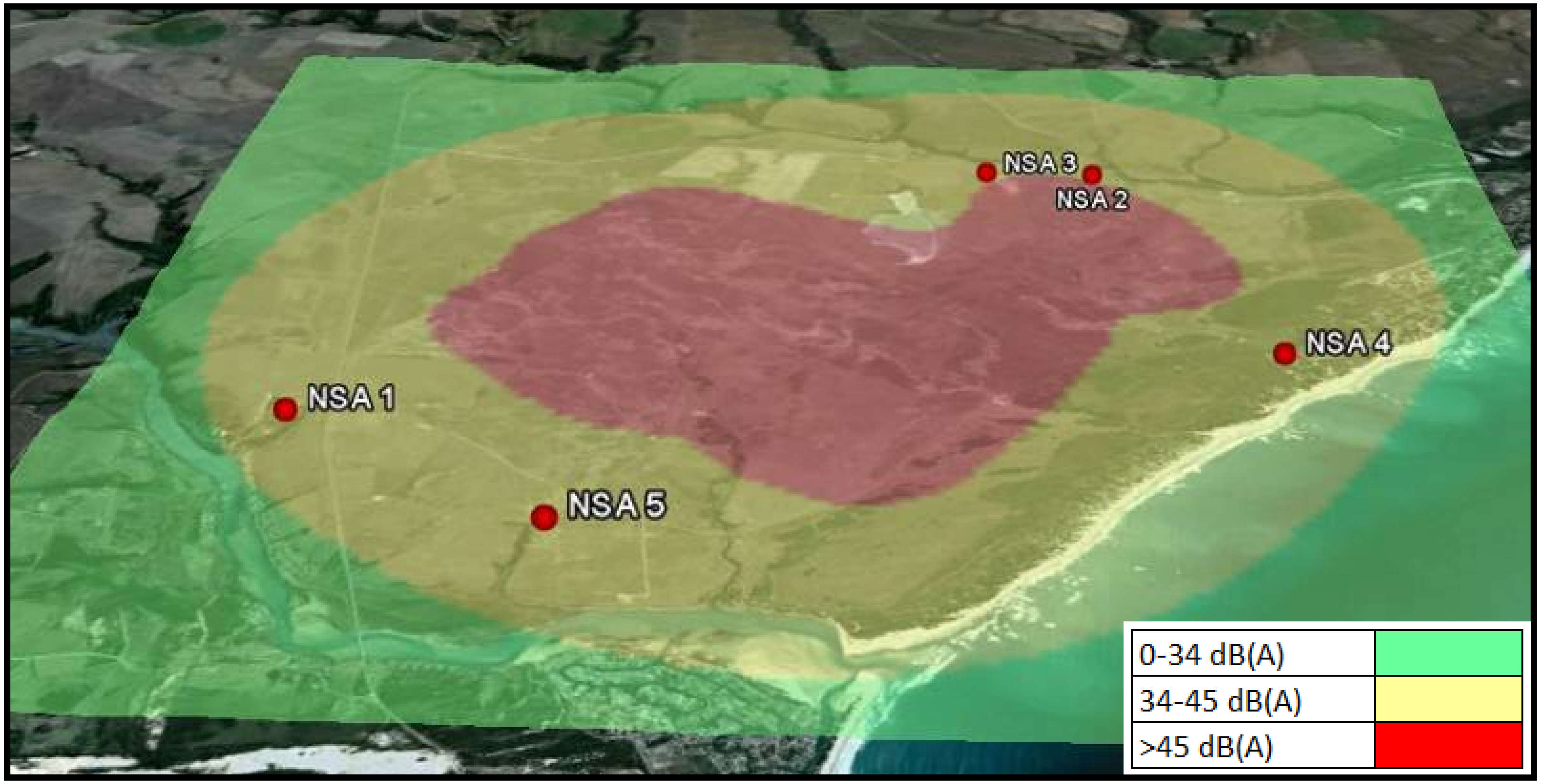


Figure 16 - Raster Image of Central Site Isopleths & NSA's (Nordex N90 -Wind speed 4m/s)

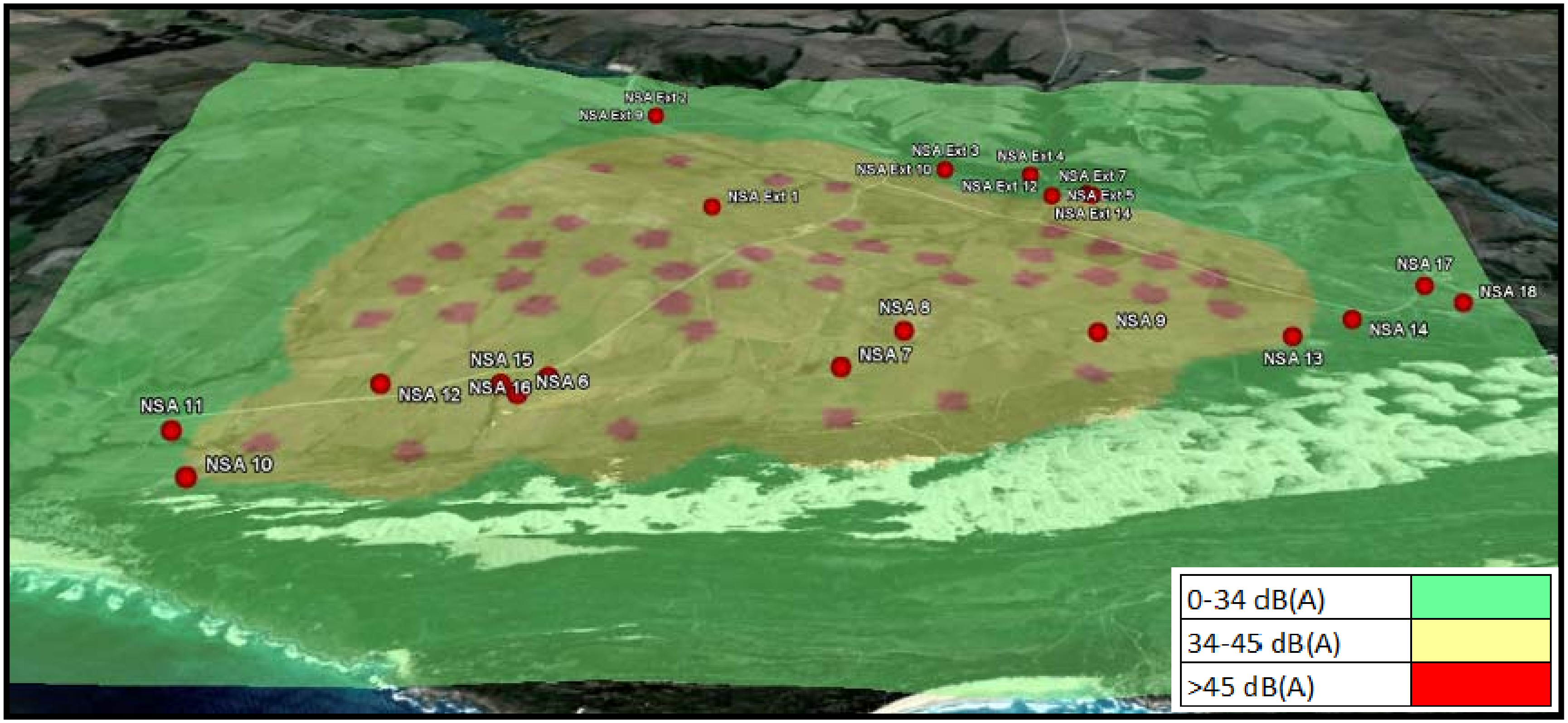


Figure 17 - Raster Image of Central Site Isopleths & NSA's (Nordex N90 -Wind speed 8m/s)

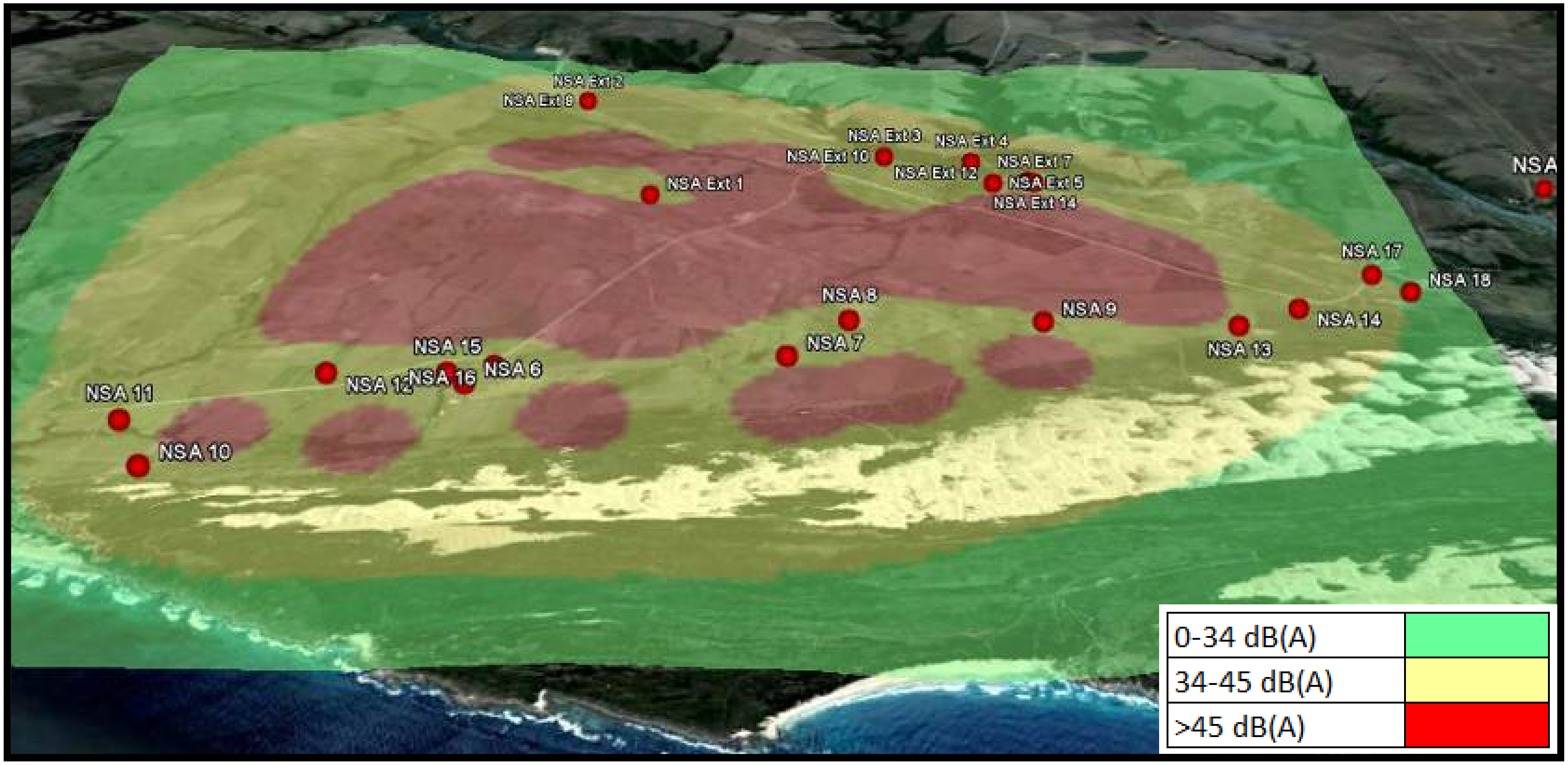


Figure 18 - Raster Image of Western Site Isopleths & NSA's (Nordex N90 -Wind speed 4m/s)

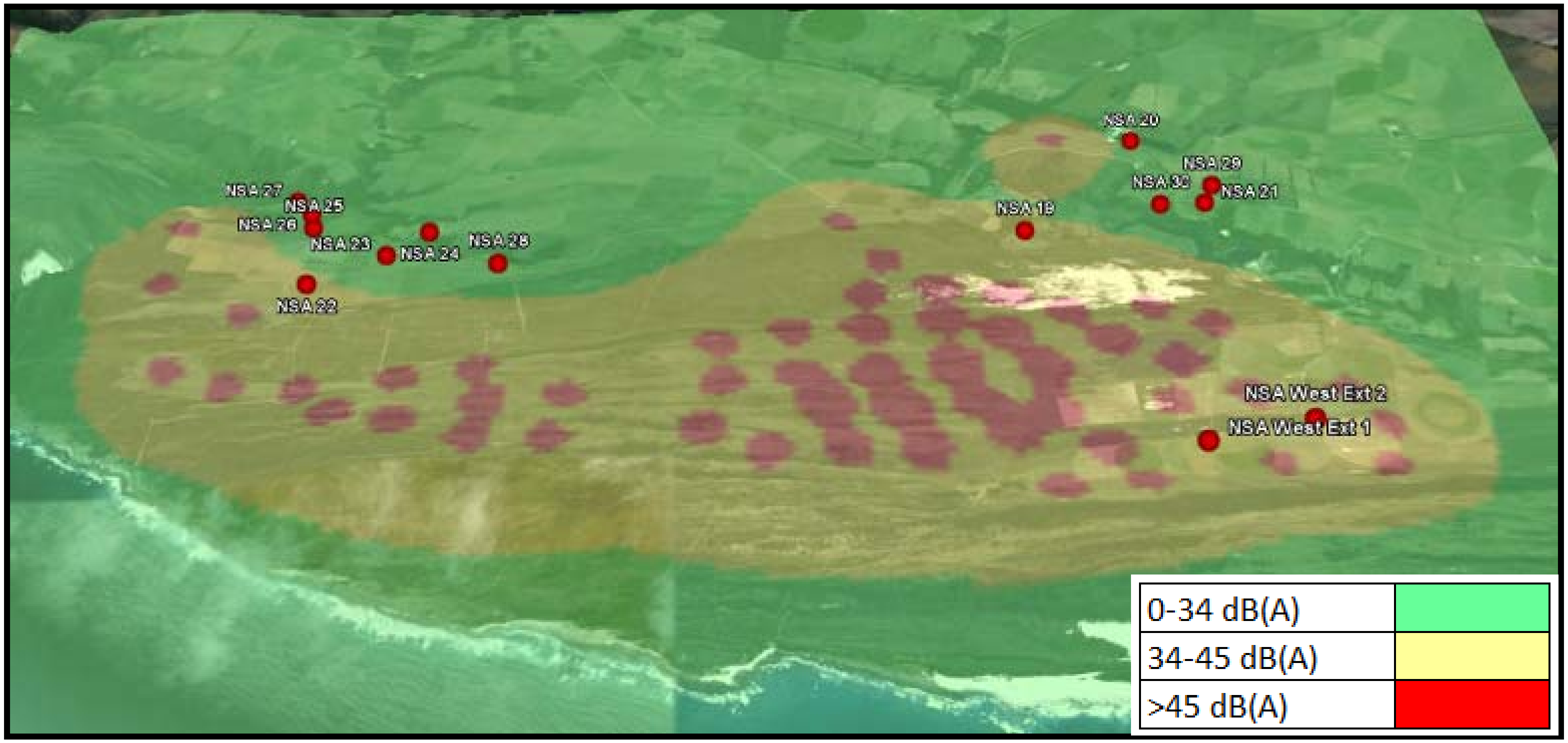


Figure 19 - Raster Image of Western Site Isopleths & NSA's (Nordex N90 -Wind speed 8m/s)

6.3 Impact Assessment Summary

The impact of the noise pollution that can be expected from the site during the construction and operational phase will largely depend on the climatic conditions at the site. The ambient noise increases as the wind speed increases.

The results indicate the following:

Operational Phase

Table XVII – Summary of Noise Impacts on Various Receptors (Vestas V90)

NSA = Noise Sensitive Area

✓ = Within Recommended Noise Limit

X* = Exceeds 45dB (A) Recommended Limit (* = Nordex N90 2.5 MW WTG)

X **= Exceeds 45dB (A) Recommended Limit (** = Vestas V90 MW WTG)

NSA	4m/s	6m/s	8m/s	10m/s	12m/s	Site
NSA 1	✓	✓	✓	✓	✓	East
NSA 2	✓	✓	✓	✓	✓	East
NSA 3	✓	✓	✓	✓	✓	East
NSA 4	✓	✓	✓	✓	✓	East
NSA 5	✓	✓	✓	✓	✓	East
NSA 6	✓	✓	✓	✓	✓	Central
NSA 7	✓	✓	X**	✓	✓	Central
NSA 8	✓	✓	X**	✓	✓	Central
NSA 9	✓	✓	X**	✓	✓	Central
NSA 10	✓	✓	✓	✓	✓	Central

NSA	4m/s	6m/s	8m/s	10m/s	12m/s	Site
NSA 11	✓	✓	✓	✓	✓	Central
NSA 12	✓	✓	✓	✓	✓	Central
NSA 13	✓	✓	✓	✓	✓	Central
NSA 14	✓	✓	✓	✓	✓	Central
NSA 15	✓	✓	✓	✓	✓	Central
NSA 16	✓	✓	✓	✓	✓	Central
NSA 17	✓	✓	✓	✓	✓	Central
NSA 18	✓	✓	✓	✓	✓	Central
NSA Ext 1	✓	✓	X**	✓	✓	Central
NSA Ext 2	✓	✓	✓	✓	✓	Central
NSA Ext 3	✓	✓	✓	✓	✓	Central
NSA Ext 4	✓	✓	✓	✓	✓	Central
NSA Ext 5	✓	✓	✓	✓	✓	Central
NSA Ext 6	✓	✓	✓	✓	✓	Central
NSA Ext 7	✓	✓	✓	✓	✓	Central
NSA Ext 9	✓	✓	✓	✓	✓	Central
NSA Ext 10	✓	✓	✓	✓	✓	Central
NSA Ext 11	✓	✓	✓	✓	✓	Central
NSA Ext 12	✓	✓	✓	✓	✓	Central
NSA Ext 13	✓	✓	✓	✓	✓	Central

NSA	4m/s	6m/s	8m/s	10m/s	12m/s	Site
NSA Ext 14	✓	✓	✓	✓	✓	Central
NSA 19	✓	✓	✓	✓	✓	West
NSA 20	✓	✓	✓	✓	✓	West
NSA 21	✓	✓	✓	✓	✓	West
NSA 22	✓	✓	✓	✓	✓	West
NSA 23	✓	✓	✓	✓	✓	West
NSA 24	✓	✓	✓	✓	✓	West
NSA 25	✓	✓	✓	✓	✓	West
NSA 26	✓	✓	✓	✓	✓	West
NSA 27	✓	✓	✓	✓	✓	West
NSA 28	✓	✓	✓	✓	✓	West
NSA 29	✓	✓	✓	✓	✓	West
NSA 30	✓	✓	✓	✓	✓	West
NSA West Ext 1	✓	✓X**	X**+	X**+	X**+	West
NSA West Ext 2	✓	✓X**	X**+	X**+	X**+	West

NSA = Noise Sensitive Area

✓ = Within Recommended Noise Limit

X* = Exceeds 45dB (A) Recommended Limit (Nordex N90 2.5 MW WTG)

X** = Exceeds 45dB (A) Recommended Limit (Vestas V90 MW WTG)

X**+ = Exceeds 45dB (A) Recommended Limit (Nordex N90 2.5 MW WTG & Vestas V90 MW WTG)

The results indicate that all the WTG's are further than the recommended 500m setback distance.

The results for of the modelling were found to exceed the recommended day/night limit of 45dB(A) at six of Noise Sensitive Areas. The affected areas are :

- Central Cluster - NSA's 7,8,9 & NSA Ext 1 when modelled using the Vestas V90 Turbine. All NSA's were below the 45dB(A) limit when modelled using the Nordex N90 WTG in low noise mode. This mode has a lower power output at 4-6m/s wind speed.
- Western Cluster – NSA West Ext 1 & 2 when modeled using the Vestas V90 and Nordex N90. The Nordex unit was marginally better when WTG's 79, 81, 83 and 84 were modeled using the low noise mode. The recommended limit was exceeded above 6m/s for both turbine types.

If the atmospheric conditions are such that the wind is very light (<4m/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 mask the wind turbine noise. The critical wind speeds are thus between 4-6m/s when there is a possibility of little masking.

Construction Phase

d) 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 this.
e) The area surrounding the construction site will be affected for a short periods of time in all directions, should several pieces of construction equipment be used simultaneously.
f) 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.

The noise impact assessment tables are presented below.

Table XVIII- Noise impact rating table

Nature of impact	Extent	Duration	Intensity	Probability	Significance without mitigation	Significance with mitigation	Status	Confidence level
Impact of the construction noise on the NSAs	Local	Short term	Low	Probable	Low	Low	Low	High
Impact of the operational noise on the NSAs (except NSA 7, 8, 9, Ext 1, west Ext 1 and west Ext 2	Local	Long term	Low	Probable	Low	Low	Low	High
Impact of the operational noise on NSA 7, 8, 9, Ext 1, west Ext 1 and west Ext 2	Local	Long term	Low	Probable	High	Low	Low	High

7.0 RECOMMENDATIONS AND CONCLUSION

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 the construction phase as the ambient level will be exceeded. The impact during the construction phase will difficult to mitigate.
- The noise level at six noise sensitive areas during the operational phase exceeds the recommended limit when the wind is at 8m/s.
- The impact of low frequency noise and infra sound will be negligible as 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 (i.e. are well below 90 dB) to cause physiological effects.

The following mitigation measures are recommended:

7.1 Construction Activities

a) All construction operations should only occur during daylight hours if possible.
b) No construction piling should occur at night. Piling operations should only occur during the day to take advantage of unstable atmospheric conditions. Technical requirements such as concrete curing temperatures may have to take precedence, but a final decision on piling should consider the noise impact.
c) Construction staff should be given “noise sensitivity” training in order to mitigate the noise impacts caused during construction.
d) Ambient noise monitoring should be done during the construction phase to ensure that there is as little as possible impact on the Noise Sensitive Areas.

7.2 Operational Phase

The following recommendations are made for the operational phase:

a) All wind turbines should be located at a setback distance of 500m from any homestead and a **day/night** noise criteria level at the nearest residents of 45 dB(A) should be used to locate the turbines. The 500m setback distance can be relaxed if local factors; such as high ground between the noise source and the receiver, indicates that a noise disturbance will not occur.

b) If the Nordex or similar turbines are used, they should be operated in a low noise mode in the 4-6m/s wind speed range, where onsite measurements (after construction) at the West cluster NSA West Ext 1 & 2 and the Central cluster NSA 7,8,9 & Ext1 show the noise emissions exceed the recommended limits.

c) Ambient noise monitoring is recommended at all NSA's once the WTG's are erected. This is to determine the exact power mode settings needed to comply with the guideline limit in the 45 dB(A) range.

7.3 No-Go Option

The no-go option of *not* proceeding with the project is not recommended for the following reasons:

- The impacts associated with the project can be mitigated by applying set back distances as well as relocating turbines.
- There are a number of the farm owners whose property the turbines are on and who are enthusiastic about contributing to the environment in a positive way.
- The economic and environmental benefits of the project outweigh the cost of mitigation measure that are needed to ensure that the sensitive noise receptors are not adversely affected.

Brett Williams

8.0 REFERENCES

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2)	Bell Acoustic Consulting. **Low frequency noise and infrasound from Wind turbine generators: A literature review.** George Bellhouse. June 2004.
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7)	Infrasound Toxicological Summary November 2001- **Infrasound - Brief Review of Toxicological Literature**
8)	International Finance Corporation – 2007 **General EHS Guidelines: Environmental Noise.**
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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)
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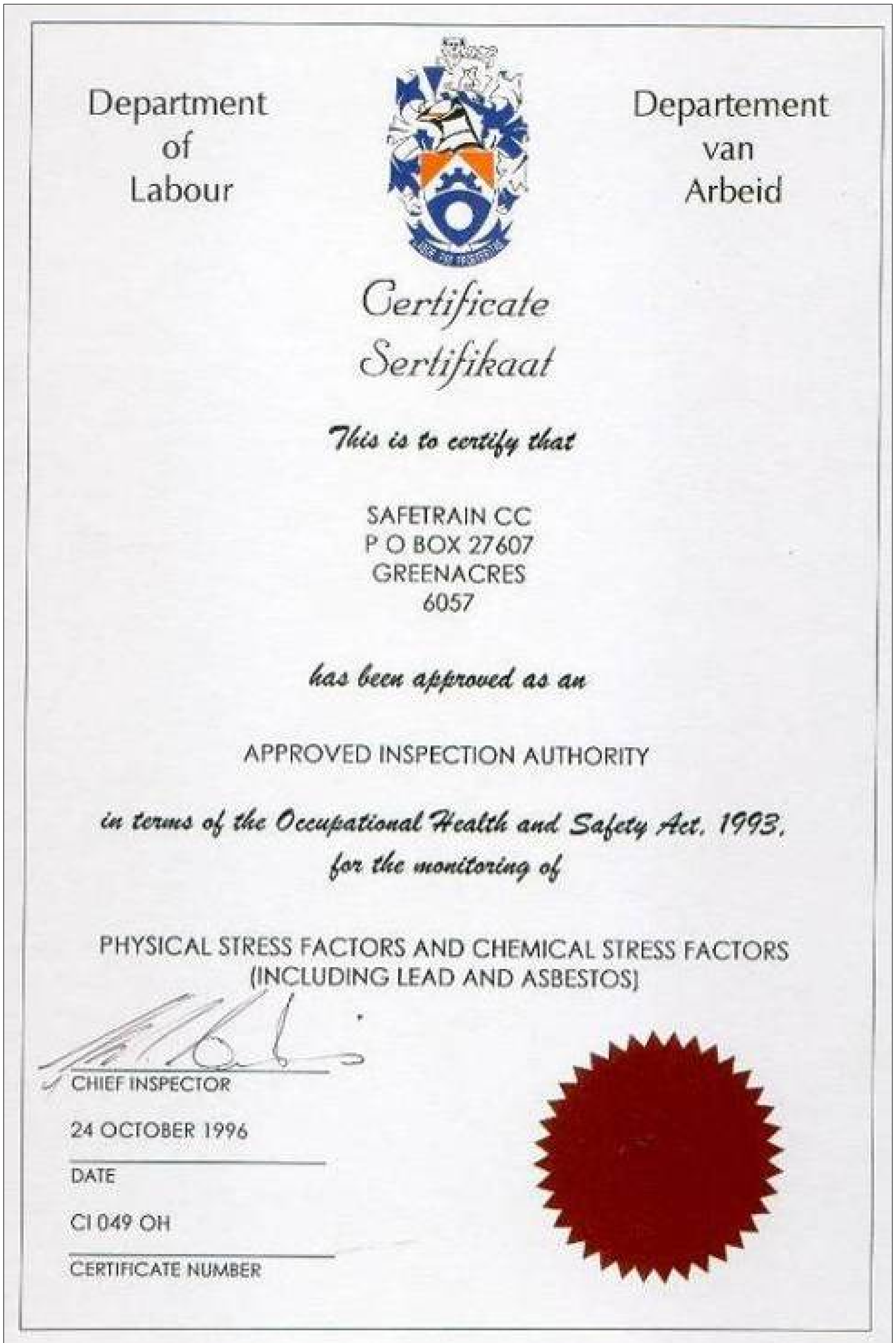
APPENDIX A - AIA Certificate



Department of Labour

Departement van Arbeid

Certificate

Sertifikaat

This is to certify that

SAFETRAIN CC
P O BOX 27607
GREENACRES
6057

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)

CHIEF INSPECTOR

24 OCTOBER 1996

DATE

CI 049 OH

CERTIFICATE NUMBER

APPENDIX B - Calibration Certificate

sanas Calibration Laboratory

148 1302

M AND N ACOUSTIC SERVICES CC

P.O. Box 61715
Pierre van Ryneveld
0045
Co. Reg. No: 2009/079193/23
Tel: 012 689 2007/8
Cell: 072 215 2481
E-mail: calservice@mweb.co.za

CERTIFICATE OF CALIBRATION

CERTIFICATE NUMBER	*2010-0098*
ORGANISATION	*SAFETECH, PORT ELIZABETH*
ORGANISAION ADDRESS	*78 LUCAS STREET, NEWTON PARK, 6045*
CALIBRATION OF	*INTEGRATING SOUND LEVEL METER, ½" MICROPHONE and ⅓-OCTAVE/OCTAVE FILTER CARD*
CALIBRATED BY	*M.W. DE BEER*
MANUFACTURER	*RION*
MODEL NUMBERS	*NL-32, UC-53A and NX-22RT*
SERIAL NUMBERS	*00151075, 316747 and 00150957 V2.2*
DATE OF CALIBRATION	*13 JANUARY 2010*
RECOMMENDED DUE DATE	*JANUARY 2011*
PAGE NUMBER	*PAGE 1 OF 4*

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

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M.W. DE BEER (SANAS TECHNICAL SIGNATORY)

Only Member : Marianka Naude

14 January 2010

DATE OF ISSUE

APPENDIX C – 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