ENVIRONMENTAL ACOUSTIC IMPACT ASSESSMENT - MARALLA WEST WIND ENERGY FACILITY

BIOTHERM ENERGY (PTY) LTD

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WSP | PARSONS BRINCKERHOFF

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GLOSSARY OF TERMS

Sound Sound is small fluctuations in air pressure, measured in Newtons per square meter (N/m^2) or Pascals (Pa) that are transmitted as vibrational energy via a medium (air) from the source to the receiver. The human ear is a pressure transducer, which converts these small fluctuations in air pressure into electrical signals, which the brain then interprets as sound.

Noise Noise is generally defined as unwanted sound.

Sound or noise level A sound or noise level is a sound measurement that is expressed in decibels (dB or dB(A)).

dB or dB(A) The human ear is a sensitive instrument that can detect fluctuations in air pressure over a wide range of amplitudes. This limits the usefulness of sound quantities in absolute terms. For this reason, a sound measurement is expressed as ten times the logarithm of the ratio of the sound measurement to a reference value, 20 micro (millionth) Pa. This process converts a scale of constant increases to a scale of constant ratios and considerably simplifies the handling of sound measurement quantities. The attached 'A' indicates that the sound measurement has been A-weighted.

dB(Z) Historically sound levels were read off a hand held meter and the noise levels were noted in dB, after the development of different weighting curves sound levels were noted as Z-weighting or dB(Z) to reduce the confusion with different type of weighting applied noise levels. dB(Z) refers to linear noise levels.

A-weighting The human ear is not equally sensitive to sound of all frequencies, i.e. it is less sensitive to low pitched (or 'bass') than high pitched (or 'treble') sounds. In order to compensate when making sound measurements, the measured value is passed through a filter that simulates the human hearing characteristic. Internationally this is an accepted procedure when working with measurements that relate to human responses to sound/noise.

Ambient sound level Ambient noise will be defined as the totally encompassing sound in a given situation at a given time, and is usually composed of sound from many sources, both near and far.

Annoyance General negative reaction of the community or person to a condition creating displeasure or interference with specific activities**.**

Sound pressure Sound pressure is the force of sound exerted on a surface area perpendicular to the direction of the sound and is measured in N/m^2 or Pa. The human ear perceives sound pressure as loudness and can also be expressed as the number of air pressure fluctuations that a noise source creates.

Sound pressure level The sound pressure level is a relative quantity as it is a ratio between the actual sound pressure and a fixed reference pressure. The reference pressure is usually the threshold of hearing, namely 20 microPascals (µPa).

Sound power Sound power is the rate of sound energy transferred from a noise source per unit of time in Joules per second (J/s) or Watts (W).

Sound power level The sound power level is a relative quantity as it relates the sound power of a source to the threshold of human hearing (10^{-12} W). Sound power levels are expressed in dB(A), as they are referenced to sound detected by the human ear (A-weighted).

Noise nuisance Noise nuisance means any sound which disturbs or impairs or may disturb or impair the convenience or peace of any person.

Octave bands The octave bands refer to the frequency groups that make a sound. The sound is generally divided in to nine groups (octave bands) ranging from 32 Hertz (Hz) to 8,000 Hz. The lower frequency ranges of a sound have a vibrating character where the higher frequency of sound has the character of high pitched sound. In viewing the total octave bands scale from 32 Hz to 8000 Hz the character of the sound can be described.

ACRONYMS AND ABBREVIATIONS

dB	Decibel
dB(A)	A-weighted sound measurement
dB(C)	C-weighted sound measurement
dB(Z)	Z-weighted sound measurement
EA	Environmental authorisation
ECA	Environmental Conservation Act 73 of 1989
EIA	Environmental Impact Assessment
ha	Hectare
Hz	Hertz
L_{Aeq}	Equivalent continuous sound pressure level
$L_{R,dn}$	Equivalent continuous day/night rating level
$L_{Req,d}$	Equivalent continuous rating level for day-time
$L_{Req,n}$	Equivalent continuous rating level for night-time
$L_{Req,T}$	Typical noise rating levels
m/s	Meters per second
NEMA	National Environmental Management Act
NEMAQA	National Environmental Management: Air Quality Act 39 of 2004
REDZ	Renewable Energy Development Zone
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
S&EIR	Scoping and Environmental Impact Reporting
SABS	South African Bureau of Standards
SANS	South African National Standards
WHO	World Health Organisation

EXECUTIVE SUMMARY

BioTherm Energy (Pty) Ltd (BioTherm) plan to construct the Maralla West wind energy facility facility, near Sutherland, in the Northern Cape Province. In order for the project to proceed, an Environmental Impact Assessment (EIA) for the proposed facility is required to determine the impacts that the proposed development may have on the surrounding environment. Wind turbines have the potential to generate noise and as such a specialist Environmental Acoustic Impact Assessment is required as part of the EIA process. This report presents the findings of the Environmental Acoustic Impact Assessment performed for the Maralla West wind energy facility.

Baseline acoustic monitoring was performed at three nearby receptor locations (farmhouses) in order to obtain representative ambient noise levels in the vicinity of the Proposed Project. The acoustic impacts of the Proposed Project were evaluated through the use of attenuation-over-distance calculations (construction phase) and the CadnaA acoustic modelling software (operational phase). Changes in noise levels at the receptor locations as a result of the construction and operation of the Proposed Project were assessed and related community responses evaluated.

CONSTRUCTION PHASE

During the construction phase noise levels in the immediate vicinity of the construction activities were predicted to be high, decreasing as distance from the source increases. The change in noise levels associated with the construction of the proposed wind energy facility will result in “little” estimated community response at two of the three receptor locations (FH 2 and FH 3). Noise levels are anticipated to increase by between 0.3 and 0.6 dB(A) at these farmhouse receptors. Such increases in noise levels are anticipated to be negligible, resulting in sporadic complaints and are deemed to go unnoticed during the noisier day-time hours. At the third receptor (FH 1), the change in current noise levels with the introduction of construction activities will result in “medium” estimated community response, with an increase of 11.5 dB(A) predicted. This receptor is located in close proximity to the wind turbines (500 m).

The South African Noise Control Regulations state that a noise is considered disturbing when noise levels from a new source exceed the ambient sound level by 7 dB(A). Increases in noise levels at all FH 2 and FH 3 are below 7 dB(A) and as such are not considered as disturbing, having little impact on these receptors. At FH 1, however, changes in noise levels exceed 7 dB(A) and as such are considered as disturbing. It must be noted that this represents a worst-case scenario with all construction equipment operational simultaneously, which will not occur in reality.

During a blasting event, noise levels at two of the three receptors (FH 2 and FH 3) were predicted to increase slightly, resulting in “little” community response. Noise levels are anticipated to increase by between 3.1 and 5.0 dB(A) at these farmhouse receptors. According to the Noise Control Regulations, such increases are not considered to be disturbing. At FH 1, however, noise levels during a blasting event are predicted to increase by 22.6 dB(A), resulting in “very strong” community response. Due to the immediate location of this farmhouse to the wind turbines, it is advised that no blasting take place at this location or alternatively new locations for the turbines in the immediate vicinity of this receptor be considered. It must also be noted that in addition to the noise impacts of a blasting event, air over pressure and ground-borne vibration impacts may also be noted. Such impacts were beyond the scope of this Environmental Acoustic Impact Assessment and as such were not assessed here.

Noise associated with construction traffic at the proposed site was calculated based on the South African National Standards (SANS) 10210 methodology. Noise levels in the immediate vicinity of the roads will be elevated, with noise levels dropping considerably from 400 m, with predicted noise levels below the SANS rural guideline level from 600 m onwards.

OPERATIONAL PHASE

Since noise from wind turbines changes with changing wind speeds, three operational phase scenarios were considered, with winds (at 10 m height) blowing at: 6 m/s, 8 m/s and 10 m/s. At all three wind speeds, predicted day-time noise levels at all receiver locations were low with noise associated with the operation of the proposed wind energy facility only perceived at one receiver location. This farmhouse is located 500 m from the nearest wind turbine. The increase in noise at this location is only predicted to increase by between 1.6 and 1.9 dB(A), resulting in "little" impact and community response. Such an increase is also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

At night, at all three wind speeds, noise levels are expected to increase at one receptor location (FH 1). Such an increase is deemed to have "medium" to "strong" impact on this receptor location with an increase of between 14.8 and 15.7 dB(A) predicted. Such an increase exceeds the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. It must be noted that the night-time scenario represents a worst-case, using the lowest monitored background levels in the area. Should the ambient noise levels be higher than this in reality, the expected increases will diminish. Additionally, it is understood that the farmhouse belongs to one of the landowners who is in support of the Proposed Project and it is deemed that the annoyance created for this receptor would be lower than a normal residential receptor.

The acoustic impacts of the proposed wind energy facility were evaluated using a risk matrix which assessed the nature, significance, extent, duration and probability of potentially significant impacts. Based on this rating system, it was calculated that the acoustic impacts of the Proposed Project on the surrounding receptors during both the construction and operational phases are "medium" with no mitigation in place and "low" with the implementation of mitigation measures.

Cumulatively, considering impacts from all other surrounding proposed wind energy projects in the area, construction phase impacts were deemed to remain as having a "medium" impact on the surrounding receptors. Since construction is temporary and not all sites may be constructed simultaneously, as well as the fact that construction activities can be mitigated to a certain degree, the cumulative construction impacts are not deemed to be significant. During the operational phase, cumulative impacts are envisaged to remain "medium", dropping to "low", with implementation of mitigation measures. Additionally, the acoustic impacts are very site specific, with each wind energy project having its own set of sensitive receptors based on locality to the site. Acoustic impacts on receptors at great distances from a source are not considered as noise attenuates over distance with no impacts on receptors located many kilometres away.

Based on the findings of this Environmental Acoustic Impact Assessment, it is advised that the Proposed Project can be authorised. The greatest impact is on the nearest sensitive receptor, namely FH 1 (located 500 m from the nearest turbine). This farmhouse is, however, a landowner's farm who is in support of the Proposed Project and may not be inhabited all of the time. Additionally, due to the remoteness of the site, with very limited sensitive receptors in the vicinity of the Proposed Project and the predominantly "low" impact on receptors during the ± 20-year lifespan of the project; negative, irreversible impacts are not envisaged.

It must also be noted that after completion of the EIA reports for the Biodiversity, Avifauna and Bats specialist studies, the sensitivity maps changed. As a result, the placement of the turbines was revisited and subsequently the number of proposed turbines was reduced from 70 to 56. Such changes will reduce the overall acoustic impacts from the Proposed Project. The turbines located in closest proximity to the FH 1 receptor will be removed, with the closest turbine being located 900 m from this receptor. This relocation will aid in improving the acoustic impacts on this receptor. The acoustic impacts of the operation of the proposed wind energy facility will, however, remain "medium".

1 INTRODUCTION

BioTherm Energy (Pty) Ltd (BioTherm) plan to construct the Maralla West wind energy facility, near Sutherland, in the Northern Cape Province. In order for the project to proceed, an Environmental Impact Assessment (EIA) for the proposed facility is required to determine the impacts that the proposed development may have on the surrounding environment. Wind turbines have the potential to generate noise and as such a specialist Environmental Acoustic Impact Assessment is required as part of the EIA process. This report presents the findings of the Environmental Acoustic Impact Assessment performed for the Maralla West wind energy facility.

1.1 SCOPE OF WORK

The scope of work for the Environmental Acoustic Impact Assessment, as conducted in accordance with the South African National Standards (SANS) 10328 (*Methods for Environmental Noise Impact Assessments*) includes the following:

- Baseline (day and night) acoustic monitoring at sensitive receptor locations surrounding the proposed wind project;
- Development of a comprehensive acoustic inventory to account for all noise sources during both the construction and operational phases of the project;
- Determination of the propagation of noise from the wind power generation facility through the use of acoustic modelling software;
- Assessment of the modelled results to determine any impacts on neighbouring receptors; and
- Provision of mitigation measures should this be deemed necessary.

1.2 OBJECTIVES OF THE REPORT

The objective of this report is to present the findings of the Environmental Acoustic Impact Assessment performed for the proposed Maralla West wind energy facility. Since wind energy facilities of this nature have the potential to generate significant noise, such a study is required as part of the EIA process. This report presents the current monitored noise levels in the vicinity of the proposed site in order to establish the current baseline noise climate; the noise levels predicted due to the Proposed Project; assessment of the changes in noise levels; as well as assessment of the resultant impacts and potential mitigation options.

1.3 LEGISLATIVE FRAMEWORK

SOUTH AFRICAN NOISE CONTROL REGULATIONS

In South Africa, environmental noise control has been in place for three decades, beginning in the 1980s with codes of practice issued by the South African National Standards (formerly the South African Bureau of Standards, SABS) to address noise pollution in various sectors of the country. Under the previous generation of environmental legislation, specifically the Environmental Conservation Act 73 of 1989 (ECA), provisions were made to control noise from a National level in the form of the Noise Control Regulations (GNR 154 of January 1992). In later years, the ECA was replaced by the National Environmental Management Act 107 of 1998 (NEMA) as amended. The National Environmental Management: Air Quality Act 39 of 2004 (NEMAQA) was published in line with NEMA and contains noise control provisions under Section 34:

> *"(1) The minister may prescribe essential national standards –*
> *(a) for the control of noise, either in general or by specific machinery or activities or in specified places or areas; or*

(b) for determining –

(i) a definition of noise; and

(ii) the maximum levels of noise.

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

Under NEMAQA, the Noise Control Regulations were updated and are to be applied to all provinces in South Africa. The Noise Control Regulations give all the responsibilities of enforcement to the Local Provincial Authority, where location specific by-laws can be created and applied to the locations with approval of Provincial Government. Where province-specific regulations have not been promulgated, acoustic impact assessments must follow the Noise Control Regulations. These regulations define the following:

→ **Ambient Sound Level:** the reading on an integrating impulse sound level meter taken at a measuring point in the absence of any alleged disturbing noise at the end of a total period of at least 10 minutes, after such meter had been put into operation;

→ **Zone Sound Level**: a derived dB(A) value determined indirectly by means of a series of measurements, calculations or table readings and designated by a local authority for an area; and

→ **Disturbing Noise**: a noise level which exceeds the zone sound level or, if no zone sound level has been designated, a noise level which exceeds the ambient sound level at the same measuring point by 7 dB(A) or more.

With the above definitions in mind, regulation 4 of the Noise Control Regulations stipulate that no person shall make, produce or cause a disturbing noise, or allow it to be made, produced or caused by any person, machine, device or apparatus or any combination thereof.

Furthermore, NEMAQA prescribes that the Minister must publish maximum allowable noise levels for different districts and national noise standards. These have not yet been accomplished and as a result all monitoring and assessments are done in accordance with the SANS 10103:2008 and 10328:2008 as discussed in the sections that follow.

SOUTH AFRICAN NATIONAL STANDARDS (SANS)

The SANS 10328:2008 (*Methods for Environmental Noise Impact Assessment*s) presently inform environmental acoustic impact assessment in South Africa. This standard defines that the purpose of an Environmental Acoustic Impact Assessment is to determine and quantify the acoustical impact of, or on, a proposed development. It also stipulates the methods used to assess impacts as well as the minimum requirements to be investigated and included in the Environmental Acoustic Impact Assessment report as part of the EIA. These minimum requirements include:

1) the purpose of the investigation;

2) a brief description of the planned development or the changes that are being considered;

3) a brief description of the existing environment including, where relevant, the topography, surface conditions and meteorological conditions during measurements;

4) the identified noise sources together with their respective sound pressure levels or sound power levels (or both) and, where applicable, the operating cycles, the nature of sound emission, the spectral composition and the directional characteristics;

5) the identified noise sources that were not taken into account and the reasons as to why they were not investigated;

6) the identified noise-sensitive developments and the noise impact on them;

7) where applicable, any assumptions, with references, made with regard to any calculations or determination of source and propagation characteristics;

8) an explanation, either by a brief description or by reference, of all measuring and calculation procedures that were followed, as well as any possible adjustments to existing measuring methods that had to be made, together with the results of calculations;

9) an explanation, either by description or by reference, of all measuring or calculation methods (or both) that were used to determine existing and predicted rating levels, as well as other relevant information, including a statement of how the data were obtained and applied to determine the rating level for the area in question;

10) the location of measuring or calculating points in a sketch or on a map;

11) quantification of the noise impact with, where relevant, reference to the literature consulted and the assumptions made;

12) alternatives that were considered and the results of those that were investigated;

13) a list of all the interested or affected parties that offered any comments with respect to the environmental noise impact investigation;

14) a detailed summary of all the comments received from interested or affected parties as well as the procedures and discussions followed to deal with them;

15) conclusions that were reached;

16) proposed recommendations;

17) if remedial measures will provide an acceptable solution which would prevent a significant impact, these remedial measures should be outlined in detail and included in the final record of decision if the approval is obtained from the relevant authority. If the remedial measures deteriorate after time and a follow-up auditing or maintenance programme (or both) is instituted, this programme should be included in the final recommendations and accepted in the record of decision if the approval is obtained from the relevant authority; and

18) any follow-up investigation which should be conducted at completion of the project as well as at regular intervals after the commissioning of the project so as to ensure that the recommendations of this report will be maintained in the future.

The SANS 10103:2008 document (*The measurement and rating of environmental noise with respect to speech communication*) provides methods and guidelines to assess working and living environments with respect to acoustic comfort as well as respect to possible annoyance by noise. As applicable to this assessment, SANS 10103 provides guideline typical rating levels for noise in different districts. These rating levels are presented in **Table 1**.

Table 1: Typical rating levels for noise in districts (adapted from SANS 10103:2008)

Type of District	Classification	Equivalent Continuous Rating level for Noise ($L_{Req,T}$) (dB(A)) Outdoors	
		Day-time ($L_{Req,d}$)	Night-time ($L_{Req,n}$)
a) Rural	A	45	35
b) Suburban (with little road traffic)	B	50	40
c) Urban	C	55	45
d) Urban (with one or more of the following: workshops, business premises and main roads)	D	60	50
e) Central Business Districts	E	65	55
f) Industrial District	F	70	60
Guidelines in red are applicable to this Environmental Acoustic Impact Assessment			

As stipulated in SANS 10103:2008, noise can pose as an annoyance to a community if the increase in average noise levels exceeds the ambient noise by a certain degree. These specified increases together with the relevant estimated community responses are presented in **Table 2**. Such changes in ambient (residual) noise levels are assessed in this report with the resultant community response determined.

Table 2: Categories of community/group response (Adapted from SANS 10103:2008)

Excess ($\Delta L_{Req,T}$)[a] dB(A)	Estimated Community or Group Response	
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

Overlapping ranges for the excess values are given because a spread in the community reaction might be anticipated.
[a] $\Delta L_{Req,T}$ should be calculated from the appropriate of the following:
1) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS $L_{Req,T}$ of the residual noise (determined in the absence of the specific noise under investigation);
2) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the maximum rating level of the ambient noise given in Table 1 of the code;
3) $L_{Req,T}$ = $L_{Req,T}$ of ambient noise under investigation MINUS the typical rating level for the applicable district as determined from Table 2 of the code; or
4) $L_{Req,T}$ = Expected increase in $L_{Req,T}$ of ambient noise in the area because of the proposed development under investigation.

The SANS 10210 (*Calculating and predicting road traffic noise*) covers a procedure for calculating and predicting road traffic noise under typical South African traffic and sound propagation conditions, in terms of a one-hour L_{Aeq} for any chosen interval (in multiples of one hour). The procedure relates both to traffic operating on uninterrupted roads and to stop-start conditions on interrupted roads. The procedure involves the following:

- Calculation of the basic noise level for a set of standard conditions at a reference distance of 10 m from the source line.
- Calculation of the primary correction factors, namely:
  - Speed and percentage of heavy vehicles;
  - Gradient; and
  - Road surface texture.

- Calculation of secondary correction factors (where necessary), namely:
  - Propagation and screening;
  - Site layout; and
  - Angle of view.
- Application of the corrections to the basic noise level to obtain the predicted noise level at the receiver.

INTERNATIONAL GUIDELINES

WORLD HEALTH ORGANISATION GUIDELINES FOR COMMUNITY NOISE

The World Health Organisation (WHO) together with the Organisation for Economic Co-operation and Development (OECD) are the main international bodies that have collected data and developed assessments on the effects of exposure to environmental noise. This has provided the following summary of thresholds for noise nuisance in terms of the outdoor day-time equivalent continuous A-weighted sound pressure level (L_{Aeq}) in residential districts:

- At 55 - 60 dB(A) noise creates annoyance.
- At 60 - 65 dB(A) annoyance increases considerably.
- Above 65 dB(A) constrained behaviour patterns, symptomatic of serious damage caused by noise

The World Health Organisation recommends a maximum outdoor day-time L_{Aeq} of 55 dB(A) in residential areas and schools in order to prevent significant interference with normal activities. It further recommends a maximum night-time L_{Aeq} of 45 dB(A) outside dwellings. No distinction is made as to whether the noise originates from road traffic, from industry, or any other noise source.

The WHO guideline for industrial noise is set at 70 dB(A) over a period of 24 hours. Anything above this level would cause hearing impairment, however, a peak noise level of 110 dB(A) is allowable on a fast response measurement.

THE ASSESSMENT AND RATING OF NOISE FROM WIND FARMS (ETSU)

The ETSU-R-97 report describes the framework for the measurement of noise associated with wind farms and provides indicative noise levels that offer a reasonable degree of protection to communities surrounding wind farm developments, without placing unreasonable restrictions on the wind farm developers. The assessment was developed by a Working Group on Wind Turbine Noise, facilitated by the United Kingdom Department of Trade and Industry. The key findings identified in the assessment include:

- Absolute noise limits applied at all wind speeds are not suited to wind farms. Limits set relative to background noise are more appropriate;
- The L_{A90} descriptor is much more accurate when monitoring and assessing wind turbine noise;
- Limits should be set on noise over a range of wind speeds up to 12 m/s when measured at 10 m height;
- The effects of other wind energy facilities in a specific area should be added to the effect of the proposed wind energy facility in order to determine the cumulative effect;
- Increases in noise levels as a result of a wind energy facility should be restricted to 5 dB(A) above the current ambient noise level at a specified receptor location;
- Noise from wind farms should be limited to a range between 35 and 40 dB(A) (daytime) in a low noise environment. A fixed limit of 43 dB(A) should be implemented during night time. This

should increase to 45 dB(A) (day and night) if the potential receptors have financial investments in the facility; and

- For turbines spaced further apart, if noise is limited to an L_{A90} of 35 d(B)A at wind speeds up to 10 m/s at 10 m height, then this condition alone offers sufficient protection of amenity and background noise surveys would not be necessary.

1.4 ACOUSTIC FUNDAMENTALS

PRINCIPLES

Sound is defined as any pressure variation (in air, water or other medium) that the human ear can detect. Noise is defined as "unwanted sound". Noise can lead to health impacts and can negatively affect people's quality of life. Hearing impairment is typically defined as a decrease in the threshold of hearing. Severe hearing deficits may be accompanied by tinnitus (ringing in the ears). Noise-induced hearing impairment occurs predominantly in the higher frequency range of 3,000 to 6,000 Hertz (Hz), with the largest effect at 4,000 Hz. With increasing $L_{Aeq,8h}$ and increasing exposure time, noise-induced hearing impairment occurs even at frequencies as low as 2,000 Hz. However, hearing impairment is not expected to occur at $L_{Aeq,8h}$ levels of 75 dB(A) or below, even for prolonged occupational noise exposure.

Speech intelligibility is adversely affected by noise. Most of the acoustical energy of speech is in the frequency range of 100 to 6,000 Hz, with the most important cue-bearing energy being between 300 and 3,000 Hz. Speech interference is basically a masking process in which simultaneous interfering noise renders speech incapable of being understood. Environmental noise may also mask other acoustical signals that are important for daily life such as doorbells, telephone signals, alarm clocks, music, fire alarms and other warning signals.

Sleep disturbance is a major effect of environmental noise. It may cause primary effects during sleep and secondary effects that can be assessed the day after night-time noise exposure. Uninterrupted sleep is a prerequisite for good physiological and mental functioning and the primary effects of sleep disturbance are: (a) difficulty in falling asleep; and (b) awakenings and alterations of sleep stages or depth. The difference between the sound levels of a noise event and background sound levels, rather than the absolute noise level, may determine the reaction probability.

The annoyance due to a given noise source is subjective from person to person, and is also dependent upon many non-acoustic factors such as the prominence of the source, its importance to the listener's economy (wellbeing), and his or her personal opinion of the source. The result of increased exposure to noise on individuals can have negative effects, both physiological (influence on communication, productivity and even impaired hearing) and psychological effects (stress, frustration and disturbed sleep). As such, noise impacts need to be understood to mean one or a combination of negative physical, physiological or psychological responses experienced by individuals, whether consciously or unconsciously, caused by exposure to noise.

More technically, noise impacts are defined as the capacity of noise to induce annoyance depending upon its physical characteristics including the sound pressure level, spectral characteristics and variations of these properties with time. During day-time, individuals may be annoyed at L_{Aeq} levels below 55 dB(A), while very few individuals are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5 to 10 dB(A) lower than during the day (World Health Organisation, 1999).

Table 3: Typical noise levels

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130	threshold of pain	intolerable
120 **110**	heavy rock concert grinding on steel	extremely noisy
100 **90**	loud car horn at 3m construction site with pneumatic hammering	very noisy
80 **70**	kerbside of busy street loud radio or television	loud
60 **50**	department store general office	moderate to quiet
40 **30**	inside private office inside bedroom	quiet to very quiet
20	unoccupied recording studio	almost silent

NOISE PROPAGATION

Sound is a pressure wave that diminishes with distance from source. Depending on the nature of the noise source, sound propagates at different rates. The three most common categories of noise are point sources (specified single point of noise generation), line sources (multiple linear noise generating points, such as a road) and area sources (specified single area of noise generation). The most important factors affecting noise propagation are:

- The type of source (point, line or area);
- Obstacles such as barriers and buildings;
- Distance from source;
- Atmospheric absorption;
- Ground absorption; and
- Reflections.

Research has shown that doubling the distance from a noise source results in a proportional decline in noise level. Sound propagation in air can be compared to ripples on a pond. The ripples spread out uniformly in all directions, decreasing in amplitude as they move further from the source. An acoustically hard site exists where sound travels away from the source over a generally flat, hard surface such as water, concrete, or hard-packed soil. These are examples of reflective ground, where the ground cover provides little or no attenuation. The standard attenuation rate for hard site conditions is 6 dB(A) per doubling of distance for point sources. Thus, if you are at a position one meter from the source and move one meter further away from the source, the sound pressure level will drop by 6 dB(A), moving to 4 meters, the drop will be a further 6 dB(A), and so on. When ground cover or normal unpacked earth (i.e. a soft site) exists between the source and receptor, the ground becomes absorptive to sound energy. Absorptive ground results in an additional noise reduction of approximately 1.5 dB(A) per doubling of distance.

This methodology is only applicable when there are no reflecting or screening objects in the sound path. When an obstacle is in the sound path, part of the sound may be reflected and part absorbed and the remainder may be transmitted through the object. How much sound is reflected, absorbed and/or transmitted depends on many factors, including the properties of the object. When receptor locations are not in the line of sight of the noise source, there may be up to 20 dB(A) attenuation for broadband noise, with a further 10 to 15 dB(A) attenuation when inside the average residence and the windows are open.

CHARACTERISTICS OF NOISE

The human ear simultaneously receives sound (normal un-weighted sound or Z-weighting dB(Z)) at many frequencies (octave bands) at different amplitudes. The ear then adjusts its sensitivity based on the amplitude of the sound observed. This focuses the sound and makes it audible by adjusting the amplitude of the low, middle and high frequencies. To measure how a person experiences sound, an electronic weighting adjusted to the Z-weighted sound was developed, including three different weighting curves, namely:

- **A-weighting** - This measurement is often noted as dB(A) and this weighting curve attempts to make the noise level meter respond closely to the characteristics of a human ear. It adjusts the frequencies at low and high frequencies. Various national and international standards relate to measurements recorded in the A-weighting of sound pressure levels;
- **B-weighting** - is similar to A-weighting but with less attenuation. The B-weighting is very seldom, if ever, used. The B-weighting follows the C-weighted trend;
- **C-weighting** - is intended to represent how the ear perceives sound at high decibel levels. C-weighted measurements are reported as dB(C); and
- **Z-weighting** - this refers to linear, un-weighted noise levels.

The weighting is employed by arithmetically adding a table of values **(Table 4)**, listed by octave bands, to the measured linear sound pressure levels for each specific octave band. The resulting octave band measurements are logarithmically added to provide a single weighted value describing the sound, based on the applied weighting curve (**Figure 1**). Thus, if the A-weighted curve was applied to the sound, the noise level is noted as dB(A).

Table 4: Frequency weighting table for the different weighting curves

Frequency (Hz)	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0	1.2	1	1.1
B-weighting	-17.1	-9.3	-4.2	-1.3	-0.3	0	-0.1	-0.7	-2.9
C-weighting	-3	-0.8	-0.2	0	0	0	-0.2	-0.8	-3
Z-weighting	0	0	0	0	0	0	0	0	0

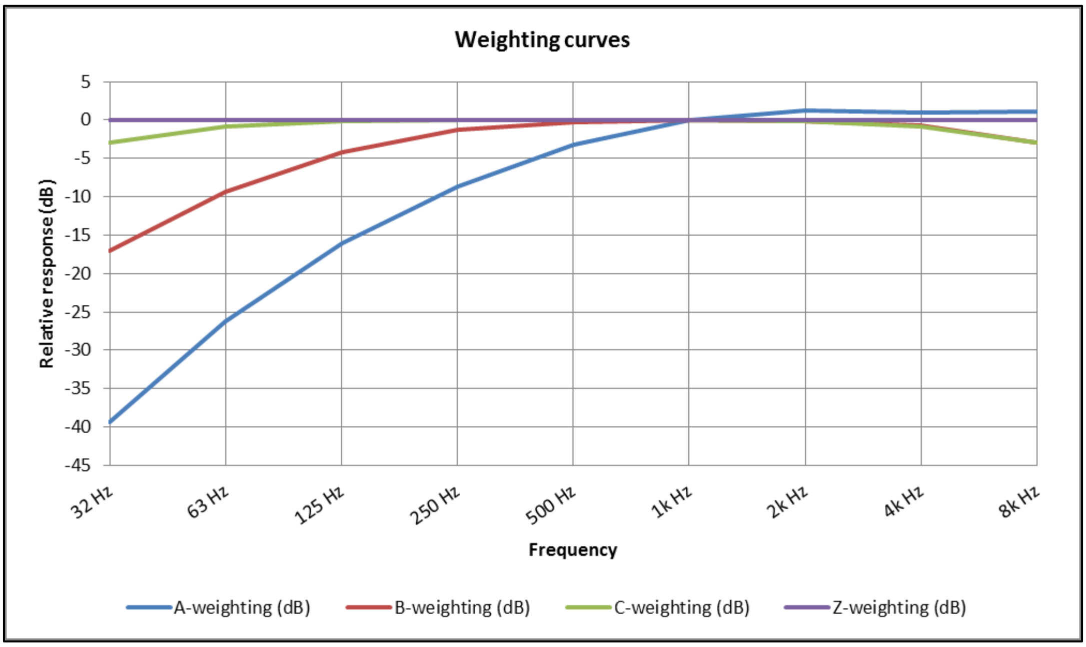

Figure 1: Weighting curves

1.5 WIND TURBINES AND NOISE

Noise from wind turbines can be classified into two categories, namely mechanical noise generated from the turbine's mechanical components and aerodynamic noise, produced by flow of air over the turbine blades.

MECHANICAL NOISE

The mechanical noise generated by a wind turbine is predominantly tonal (dominated by a narrow range of frequencies), but may also be broadband in character, displaying a wide range of frequencies (Council of Canadian Academics, 2015). Such noise is produced by the physical movement of the following components:

- Gearbox;
- Generator;
- Yaw drives;
- Cooling fans; and
- Auxiliary equipment.

Over time, appropriate design and manufacturing have reduced the mechanical noise produced from wind turbines. As such, the aerodynamic noise from the blades has become the dominant source of noise for modern turbines, however, low frequency tones associated with mechanical sources are audible for some turbines (Hau, 2006; Manwell *et al.*, 2009; Oerlemans,2011).

AERODYNAMIC NOISE

Aerodynamic noise is typically broadband in nature and is generated by the interaction between air flow and different parts of the turbine blades. These interactions depend on the speed and turbulence of the wind; the shape of the blade; the angle between the blade and relative wind velocity flowing over the blade; and the distance from the hub. The noise levels produced are relative to the velocity of the air flow, with higher rotor speeds resulting in higher noise levels. Specifically, parts of the blade closer to the tips move faster than those closer to the hub, resulting in faster relative air velocities and create higher aerodynamic noise levels. As such, most of the aerodynamic noise is produced near (but not at) the blade tips. This is partly why turbines with longer blades have a higher sound power level (Oerlemans, 2011).

Aerodynamic noise from wind turbines also has a strong directional component, projecting primarily downward, upward, or even perpendicular depending on the dominant mechanism (Oerlemans, 2011). As such, noise levels measured at a particular location can vary depending on the direction, speed and turbulence of the prevailing wind. Furthermore, as the rotor turns, the orientation of each blade changes in relation to a stationary receiver. As such, the noise levels at the receiver will vary as the blades rotate, resulting in periodic regular changes in noise levels over time (Renewable UK, 2013).

As wind speed increases, the aerodynamic noise of the turbines also increases. At low speeds the noise created is generally low and increases to a maximum at a certain speed (around 10 m/s) where it either remains constant, or can even slightly decrease.

LOW FREQUENCY NOISE AND INFRASOUND

In addition to the noise discussed above, wind turbines also produce some steady, deep, low frequency sounds (between 1 – 100 Hz), particularly under turbulent wind conditions. Sound waves below 20 Hz are called infrasound. These infrasound levels are only audible at very high sound pressure levels. Older wind turbines that had downwind rotors created noticeable amounts of infrasound. Levels produced by modern-day, up-wind style turbines are below the hearing threshold for most people (Jakobsen, 2005).

The human ear is substantially less sensitive to sound at very low or very high frequencies. For most people, a very low pitch sound (20 Hz) must have a sound pressure level of 70 dB to be audible. Levels of infrasound near modern commercial wind turbines are far below this level and are generally not perceptible to people (Leventhall, (2006)).

Low frequency sound, like all other sound, decreases as it travels away from the source. Siting wind turbines further away from sensitive receptors will therefore decrease the risk of infrasound. It is, however, important to note that in flat terrain, low frequency sound can travel more effectively than high frequency sound. Most environmental sound measurements and noise regulations are based on the A-weighed decibel scale (dB(A)), which under-weights low frequency sounds in order to mimic the human ear. Thus, noise limits based on the dB(A) levels do not fully regulate infrasound. The dB(C) scale offers an alternative of measuring sound that provides more weight to lower frequencies (Jakobsen, 2005; Bolin *et al*., 2011).

SANS 10103 proposes a methodology to identify whether low frequency noise could be an issue. The method suggests that if the difference between L_{Aeq} and L_{Ceq} is greater than 10 dB, then a predominant low frequency component may be present. However, in all cases the existing acoustic energy in low frequencies associated with wind must be considered.

SUBSTATION AND TRANSFORMER NOISE

In addition to the noise from wind turbines, wind farms require a substation and transformers, which produce a characteristic "hum" or "crackle" noise. Utility companies such as Eskom have experience with building and siting such sources to minimise their impact. Substation-related noise is relatively easy to mitigate should this be required, based on the use of acoustic shielding and careful planning regarding placement away from sensitive receptors. The specific location of the substation at Maralla West has not been decided upon yet, but based on the two possible alternatives, the substation will be located between 2,500 and 6,800 m from the nearest receptor and as such noise associated with this source will not impact on the surrounding receptors. As such, noise associated with this source is not considered in this assessment.

1.6 STUDY APPROACH AND METHODOLOGY

In order to assess the environmental acoustic impacts of the proposed Maralla West wind energy facility both baseline (monitored) and proposed (modelled) noise levels were assessed. Comparisons of the existing and proposed noise levels at various specified sensitive receptors (noise receivers) enabled an assessment of changes in noise levels at these locations as a result of the proposed wind energy facility. Such changes were then assessed against the SANS community or group responses (**Table 2**) in order to assess the anticipated impacts/responses as a result of such increases. It must be noted, that as per International guidance the L_{A90} levels are a better indication for noise associated with wind turbines. In the South African context, however, there are no guideline rating levels associated with the L_{A90} parameter. The SANS 10103 guidelines apply to L_{Aeq} levels and resultant changes in these levels. As such, in this assessment the L_{Aeq} levels have been utilised to assess changes and compliance with the relevant guideline levels.

ENVIRONMENTAL ACOUSTIC MONITORING

Ambient sound level measurements were undertaken during the week of 11 – 14 April 2016 at three receptor locations (**Table 5** and **Figure 2**). All receptor sound level measurements were free-field measurements (i.e. at least 3.5 m away from any vertical reflecting surfaces). Measurement procedures were undertaken according to the relevant South African Code of Practice SANS 10103:2008. This guides the selection of monitoring locations, microphone positioning and equipment specifications. Sound level measurements were taken with a SABS-calibrated Type 1

Integrating Sound Level Meter. The make and model as well as serial number and calibration validity of the sound level meter and calibrator are presented in **Table 6**.

Table 5: Location of receptors in relation to the Maralla West Wind Energy Facility

Receptor	Latitude (˚S)	Longitude (˚E)	Distance from nearest wind turbine (m)
Farmhouse 1	32.742466	20.736788	500
Farmhouse 2	32.692916	20.781019	4,150
Farmhouse 3	32.707112	20.779426	3,200

Table 6: Sound level meter and calibrator specifications

Sound level meter	Calibrator
Make & model: CEL 63X	**Make & model:** CEL-120/1
Serial number: 3134723	**Serial number:** 3939145
Date calibrated: October 2015	**Date calibrated:** October 2015
Calibration due date: October 2016	**Calibration due date:** October 2016

The Maralla West site is very remotely located with limited sources of noise and anthropogenic influences. As such, in order to get a good representation of baseline sound levels in the region, hourly measurements were conducted three times throughout the day and once at night, at each of the receptor locations. Since there are no regulations governing assessments of noise from wind energy facilities in South Africa, such a methodology is in-line with the SANS 10103 methodology and provides an adequate representation of current baseline conditions. The monitoring was conducted during the relevant timeframes for day (06:00 to 22:00) in accordance with the SANS methodology. The SANS prescribed night-time monitoring period is from 22:00 to 06:00. Due to the remoteness of the Maralla West site and safety concerns at night, sound level monitoring at two of the three receptors was performed before this prescribed time. As such, in order to present a worst-case assessment, the lowest L_{Aeq} value monitored during the night time will be applied as the current baseline level to all receptor locations when assessing changes in noise as a result of the Maralla West wind energy facility. The sound level meter was calibrated before and after measurements were conducted and no significant drifts (differences greater than 0.5 dB(A)) were found to occur.

The noise parameters recorded included:

- L_{Aeq} - The equivalent continuous sound pressure level, normally measured (A-weighted);
- L_{Amax} - The maximum sound pressure level of a noise event measured (A-weighted);
- L_{Amin} - The minimum sound pressure level of a noise event measured (A-weighted); and
- L_{A90} - The average noise level the receptor is exposed to for 90% of the monitoring period.

Meteorological conditions during each monitoring period were noted. Meteorological data from BioTherm's Maralla West meteorological mast (coordinates: 32.720484°S and 20.729768°) (**Figure 2**) was also obtained in order to correlate monitored results with prevailing ambient atmospheric conditions.

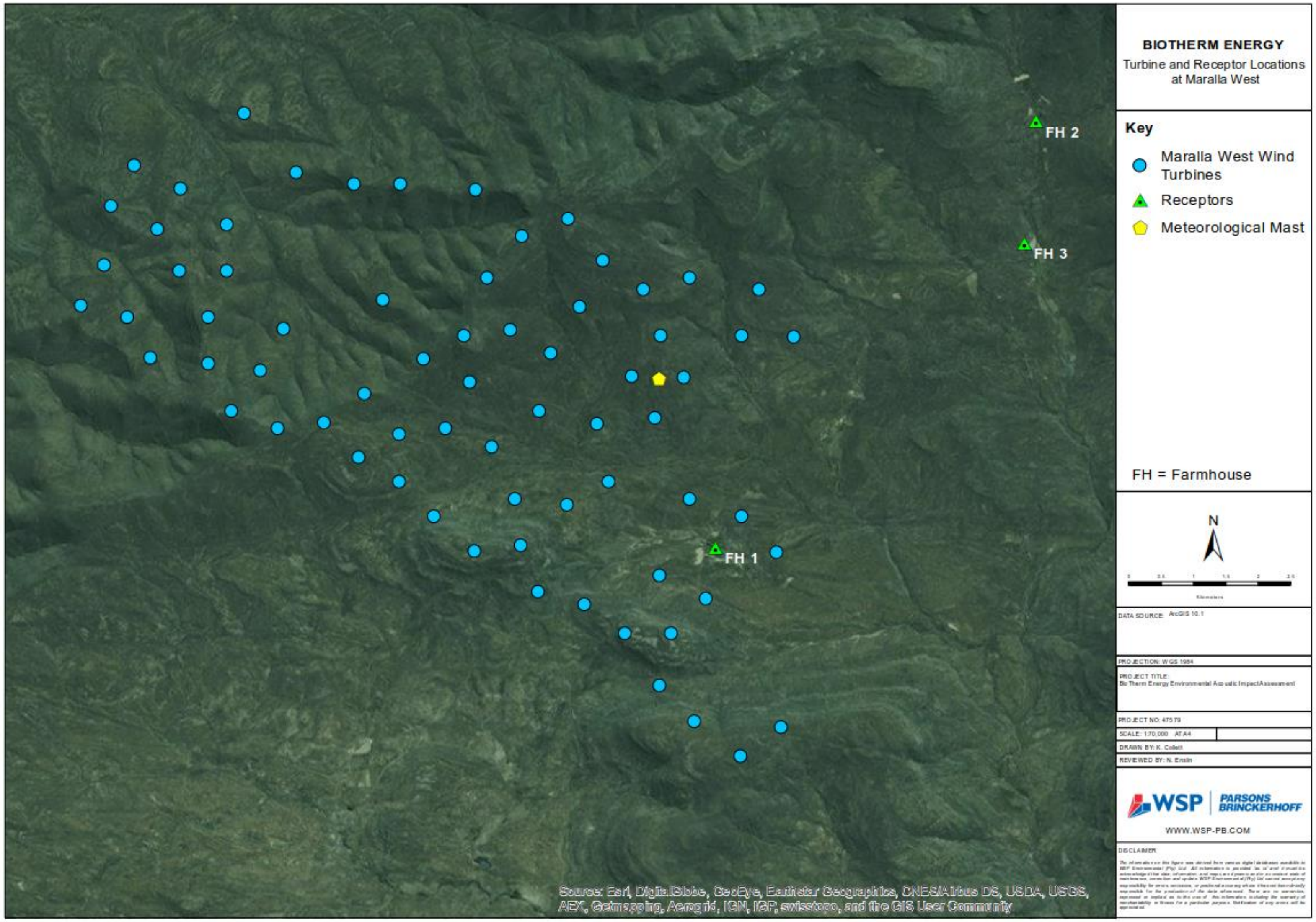

Figure 2: Location of receptors (monitoring locations) surrounding the proposed Maralla West wind energy facility

CONSTRUCTION PHASE ASSESSMENT

Table 7 presents a list of potential construction equipment that will be utilised during the construction of the wind energy facility as well as the sound power level (PWL) specifications of the equipment (BSI, 2009). At this stage of the project, detailed construction plans are not available. As such in order to present a worst-case noise scenario, the sum (logarithmic) of the PWLs from all noise sources was utilised to calculate resultant noise levels at specified distances from the facility. Such resultant receptor noise levels were calculated using attenuation-over-distance acoustic calculations. The construction phase is envisaged to endure for up to 2.5 years.

In addition to utilising the equipment listed below, in some cases where shallow rock may exist, limited shallow blasting for foundations may be required. Since blasting is instantaneous, such impacts would be short lived. As such, two scenarios are considered during the construction phase of this assessment, namely construction phase (no blasting) and construction phase during a blasting event. During the second scenario a PWL of 128 dB(A) (BHP Billiton, 2010) is applied and relative noise levels expected at the receptor locations are calculated.

Table 7: Construction phase equipment and sound power level ratings

Equipment	Number in operation	Sound Power Level (dB(A))
30 Ton Excavator	2	103.0
Grader	2	111.0
Hauler	6	107.0
Wheeled Crane	3	106.0
Tracked Crane	3	99.0
20 Ton Roller Compactor	2	108.0
Concrete Trucks	15 -25	108.0
Logarithmic Total		**116.9**

In addition to general construction activities at each wind turbine site, an increase in road traffic along main and inter-leading roads is also envisaged. Such traffic may have implications on the exiting noise climate at each receptor location. As such, noise emissions from construction traffic is calculated using the sound propagation model as described in SANS 10210, with corrections for the following factors considered:

- Distance of receptor from road;
- Average speed of travel;
- Percentage of heavy vehicles in operation;
- Road construction material; and
- Ground acoustical conditions.

OPERATIONAL PHASE ASSESSMENT

Acoustic modelling was used to calculate noise contours indicating the spatial extent of projected sound levels from the proposed wind energy facility within a specified grid area (15 km x 15 km) as well as the noise levels at specific receivers (sensitive receptors). The acoustic modelling software used in this study is the internationally recognised package, CadnaA (Computer Aided Noise Abatement). The CadnaA software provides an integrated environment for noise predictions under varying scenarios and calculates the cumulative effects of various sources. The model uses ground elevations in the calculation of the noise levels in a grid and uses standard meteorological parameters that have an effect on the propagation of noise. CadnaA has been utilised in many countries across the globe for the modelling of environmental noise and town planning. It is comprehensive software for three-dimensional calculations, presentation, assessment and prediction of environmental noise emitted from industrial plants, parking lots, roads, railway schemes or entire towns and urbanized areas.

Since noise from wind turbines change with changing wind speeds, three operational phase scenarios were considered, with winds (at 10 m height) blowing at:

- 6 m/s;
- 8 m/s; and
- 10 m/s.

The sound power levels for the turbines as applied in this assessment are presented in **Table 8**. These specifications were provided by BioTherm and represent the Acciona Windpower AW125/3000 turbine (Acciona Windpower, 2014). Since this assessment is a worst-case representation of noise associated with the proposed facility, wind speeds lower than 6 m/s were not considered. The cut-in speed of such turbines is between 3 and 4 m/s, however, much lower sound levels would be produced at these speeds.

Table 8: Sound power level specifications of each wind turbine

Wind speed at 10 m height (m/s)	Wind Speed at 120 m height (m/s) [z_0 = 0.05 m*]	Sound Power Level (dB(A) (at 120 m height)
6	8.8	107.3
8	11.8	108.2
10	14.7	107.7

* Roughness length of 0.05 m is applied to the hub height wind speed extrapolation

IMPACT ASSESSMENT

All impacts of the Proposed Project were evaluated using a risk matrix, which is a semi-quantitative risk assessment methodology. This system derives an environmental impact level on the basis of the nature, severity, consequence, extent, duration and probability of potentially significant impacts. The overall risk level is determined using professional judgement based on a clear understanding of the nature of the impact, potential mitigatory measures that can be implemented and changes in risk profile as a result of implementation of these mitigatory measures. A full description of the risk rating methodology is presented in **Appendix B**.

SENSITIVE RECEPTORS

Sensitive receptors (noise receivers) are identified as areas that may be impacted negatively due to noise associated with the proposed Maralla West wind energy facility. Examples of receptors include, but are not limited to, schools, shopping centres, hospitals, residential areas, conservation areas and nature reserves.

HUMAN NOISE SENSITIVE AREAS

The Maralla West wind energy facility is predominantly surrounded by natural and agricultural land uses with no residential settlements evident within a 20 km radius of the proposed site. Only three scattered farmhouse receptors have been identified in the area (**Table 5** and **Figure 2)**. Such locations are used in this assessment to assess changes in noise levels as a result of the construction and operation of the wind energy facility.

NATURAL ENVIRONMENTAL RECEPTORS

The fauna on the site includes bats, birds, commercial livestock and a variety of reptiles and insects. The noise impacts on the natural environment receptors are dealt with in separate specialist studies.

PEER REVIEW

The Environmental Acoustic Specialist Reports for the Maralla West wind energy facility for both the Scoping Phase and EIA phase were peer reviewed by Mackenzie Hoy Consulting Acoustics Engineers. All comments/changes regarding the Scoping Phase acoustic report were addressed and included in this EIA phase report. All relevant changes/comments addressed in the EIA phase report have been updated in this report (see underlined sections). Responses and reasoning as to why certain changes were not made to this report based on comments from Mackenzie Hoy, are presented in **Appendix D**.

1.7 ASSUMPTIONS

In this Environmental Acoustic Impact Assessment, various assumptions were made that may impact on the results obtained. These assumptions include:

- The information provided regarding the construction and operational activities is assumed to be representative of what will occur in reality;
- During the construction phase, all equipment will be operational simultaneously;
- The daily number of light duty vehicles frequenting the site during the construction phase were assumed to be the same as the number of construction vehicles, as a worst-case scenario; and
- A speed of 40 km/h was assumed for all vehicles travelling during the construction phase.

1.8 LIMITATIONS OF THIS STUDY

The limitations of the Environmental Acoustic Impact Assessment include:

- Night-time monitoring performed outside of the SANS prescribed night-time timeframes due to safety constraints for personnel performing the on-site monitoring;
- Use of L_{Aeq} noise levels as opposed to internationally recognised L_{A90} noise levels for assessment of noise impacts from wind turbines due to the lack of South African guidelines using L_{A90} levels; and
- In addition to the noise impacts of a blasting event during the construction phase, air over pressure and ground-borne vibration impacts may also be noted. Such impacts were beyond the scope of this Environmental Acoustic Impact Assessment and as such were not assessed in this report.

1.9 DECLARATION OF INDEPENDENCE

Kirsten Collett is an air quality and acoustic consultant with a Master of Science (Atmospheric Sciences) degree obtained from the University of the Witwatersrand. She is currently employed by WSP and has worked on environmental acoustic impact assessments, monitoring and modelling for a variety of clients over the past four years. She has provided acoustic consulting support to various client industries including petrochemical, mining and production industries among others. She is also a registered Professional Natural Scientist (Pr. Nat. Sci.) with the South African Council for Natural Scientific Professions (SACNASP). Please see **Appendix A** for a short CV detailing project experience.

I hereby declare that I am fully aware of my responsibilities in terms of the National Environmental Management Act: Environmental Impact Assessment Regulations of 2014 and that I have no financial or other interest in the undertaking of the proposed activity other than the imbursement of consultants fees.

Name:	Kirsten Collett
Company:	WSP Environmental (Pty) Ltd
Contact Details:	+27 11 361 1372
	Kirsten.Collett@wspgroup.co.za
Signature:	

2 DESCRIPTION OF THE PROJECT

2.1 LOCATION

The proposed Maralla West wind energy facility will be located 34 km south of Sutherland in the Northern Cape province (**Figure 3**) and extends across four farms, namely Farm Drie Roode Heuvels 180, Farm Annex Drie Roode Heuvels 181, Farm Wolven Hoek 182 Portion 1 and Farm Wolven Hoek Portion 2. The facility falls within the Karoo Hoogland Local Municipality, under the jurisdiction of the Namakwa District Municipality.

The site is considered highly suitable for a wind energy project due to the following:

- Climatic conditions;
- Relief and aspect;
- Land availability; and
- Access to the National Grid through Eskom's Komsburg Substation located approximately 10 km from the site.

2.2 WIND ENERGY POWER GENERATION PROCESS

Wind power is the conversion of wind energy into a useful form of energy, such as electricity, using modern and highly reliable wind turbines. Wind power is non-dispatchable, meaning that for economic operation, all of the available output must be taken when it is available.

The main components of a modern utility-scale wind turbine are illustrated in **Figure 4**. When the wind blows around the blades, the shape of the blades creates aerodynamic lift and drag. These forces are used to generate torque, which causes the blades to spin the rotor on its axis, creating mechanical power that is converted into electricity in a generator housed in the nacelle (Council of Canadian Academics, 2015).

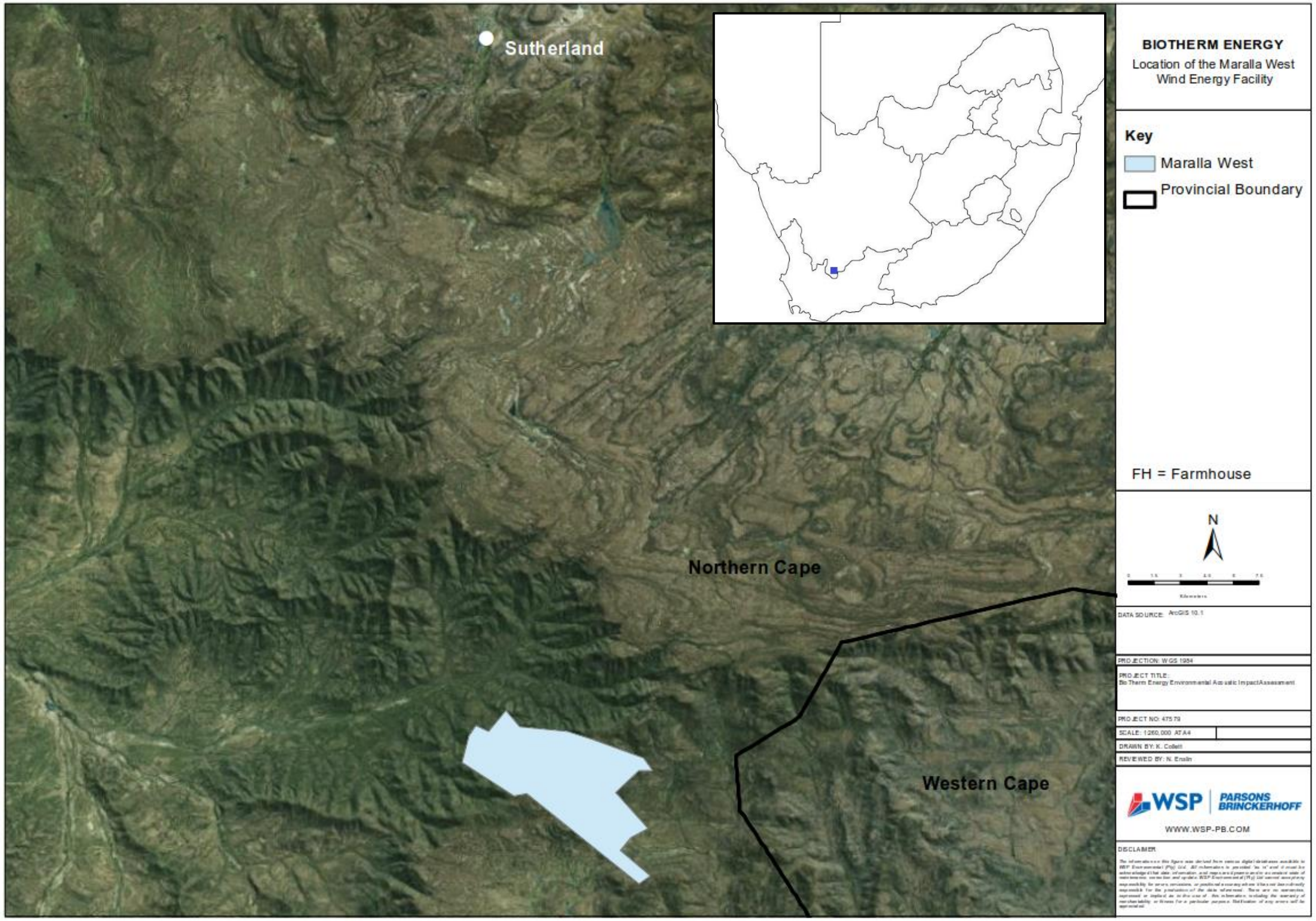

Figure 3: Location of the Maralla West wind energy facility

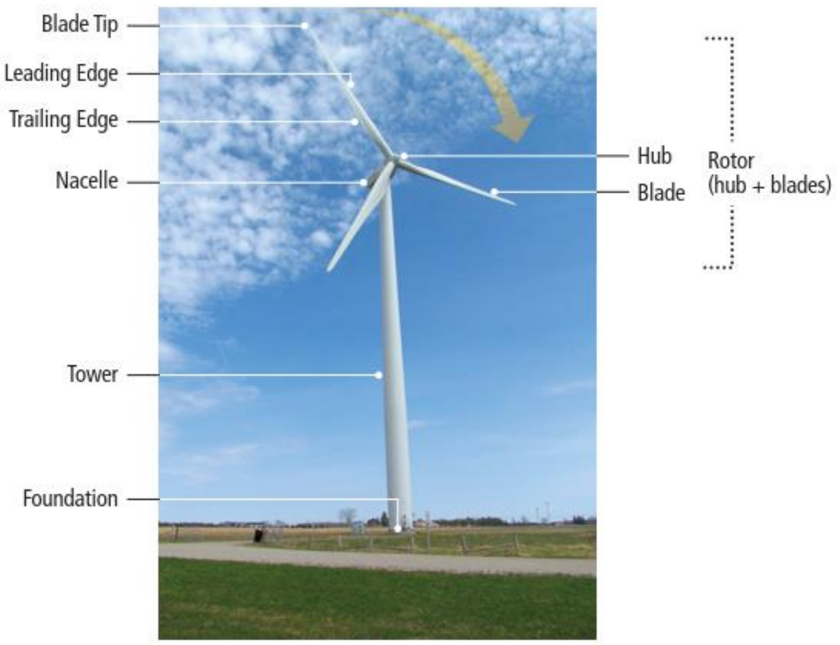

Figure 4: Components of a typical wind turbine (Council of Canadian Academics, 2015)

The electricity generated by the wind turbines is passed through a step-up transformer and then transmitted via either underground or overhead cables to a central substation, which connects the wind energy facility to a high voltage network. Wind turbines are designed to operate automatically with minimal maintenance for approximately 20-25 years.

2.3 PROJECT INFRASTRUCTURE

The Proposed Project is for the construction and operation of a wind energy facility of up to 250 MW. A technical summary of the facility and its associated infrastructure is included in **Table 9**.

Table 9: Details of the proposed wind energy facility and associated infrastructure

Generation capacity	up to 250 MW
Number of turbines	up to 70
Generation capacity per turbine	1.5 to 4 MW
Area of buildable area	Approximately 200 ha
Area occupied by each turbine	0.5 ha (85 m x 60 m)
Turbine hub height	up to 120 m
Rotor diameter	up to 150 m
Turbine foundation	20 m diameter x 3 m deep – 500 to 650 m^3 concrete. Excavation area approximately 1,000 m^2 in sandy soils due to access requirements and safe slope stability requirements.
Electrical turbine transformers	0.5 ha (85 m x 60 m)

Cement batching plant	Gravel and sand will be stored in separate heaps whilst the cement will be contained in a silo. The actual mixing of the concrete will take place in the concrete truck. The footprint of the plant will be in the order of 0.25 ha. The maximum height of the cement silo will be 20 m. This will be a temporary structure during construction.
Footprint of internal onsite substation	150 m x 150 m
On-site substation capacity	Up to 132 kV
Specifications of onsite switching stations, transformers, invertors, on-site cables etc.	The medium voltage collector system will comprise of cables (1kV up to and including 33 kV) that will be run underground, except where a technical assessment suggests that overhead lines are applicable, in the facility connecting the turbines to the onsite substation.
List of additional infrastructure to be built	Access roads and internal roads. Administration, control and warehouse buildings.

2.4 PHASES OF DEVELOPMENT

CONSTRUCTION PHASE

The main activities associated with the construction phase of the wind energy project will include the following:

- **Establishment of an access road to the site** – The site is already easily accessible via the tarred R354 national road, however, the regional gravel road connecting the site to the R354 will need to be upgraded.
- **Establishment of internal roads** – Internal road access will be constructed onsite. These roads will be between 4 and 6 m in width. The length of the internal road network is approximately 60 km.
- **Site preparation** – Site preparation includes the clearance of vegetation and any bulk earthworks (including blasting if required) within the footprint of each construction area that may be required in terms of the facility design.
- **Transport of components and equipment to site** – All construction material (i.e. masts, blades and associated infrastructure), machinery and equipment (i.e. graders, excavators, trucks, cement mixers etc.) will be transported to site utilising the national, regional and local road network.
- **Establishment of a laydown area on site** – Construction materials, machinery and equipment will be kept at relevant laydown and/or storage areas. A 1.1 ha laydown and storage area has been proposed for this project, with an additional 40,000 m^2 for concrete towers if required. The laydown area will limit potential environmental impacts associated with the construction phase by limiting the extent of the activities to one designated area. The location of the laydown area is not currently known and will be decided upon once the project has been identified as a preferred bidder.
- **Construction of foundations** – Concrete foundations will be constructed at each turbine location. Foundation holes will be mechanically excavated to a depth of 3 m, depending on the local geology. Concrete will be batched on site. The reinforced concrete foundation will have a footprint of approximately 550 m^2.

- **Construction of the turbine** – Large mobile lifting cranes (wheeled and tracked) will be brought onto site to lift each of the tower parts into place.
- **Construction of substation and invertors** – Invertors will be installed to facilitate the connection between the wind turbines and the Eskom Grid. The turbines will be connected to the substation via underground cabling (where possible). The substation will be constructed with a maximum footprint of approximately 150 m x 150 m.
- **Establishment of ancillary infrastructure** – Ancillary infrastructure will include a workshop, storage areas, office and a temporary laydown area for contractor's equipment.
- **Undertake site rehabilitation** – The site will be rehabilitated once the construction phase is complete and all construction equipment and machinery have been removed from site.

OPERATIONAL PHASE

The proposed wind facility is anticipated to have a minimum life of 20 years. The facility will operate 7 days a week. While the project is considered to be self-sufficient, maintenance and monitoring activities will be required.

DECOMMISSIONING PHASE

Following the initial 20-year operational period of the wind facility, the continued economic viability will be investigated. In the event that the facility is still deemed viable the life of the facility will be extended. The facility will only be decommissioned once it is no longer economically viable. In the event that a decision is made to completely decommission the facility all the components will be disassembled, reused and recycled or disposed. The site would be returned to its current use i.e. agricultural (grazing).

3 DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 EXISTING NOISE CLIMATE

The existing noise climate in the area surrounding the proposed wind energy project is typically rural with limited anthropogenic influences. Current sources of noise include livestock, farm equipment, birds, insects and motor vehicles travelling along nearby roads.

Ambient sound level monitoring was conducted at three receptor locations surrounding the proposed site during April 2016. Results from this monitoring are presented in **Table 10**, **Figure 5** and **Figure 6**. Average day-time (L_{Aeq}) sound levels are fairly similar to the SANS day-time rural rating level (45 dB(A)), with current ambient sound levels at two of the three receptors slightly above this guideline. At night, noise levels drop considerably, with current ambient sound levels at Farmhouse 2 and 3 well below the rural guideline level (35 dB(A)). At Farmhouse 1, activities at the farmhouse as well as noise from nearby livestock, contributed to the slightly elevated ambient levels recorded.

It must be noted that as a result of safety constraints at night due to the remoteness of the Maralla West site, sound level monitoring could not be undertaken during the night-time timeframe (22:00 – 06:00) as prescribed in SANS 10103 at all receptor locations. As such, in order to present a worst-case assessment, the lowest L_{Aeq} value (25.6 dB(A)) for night time was applied as the current baseline level to all receptor locations when assessing changes in noise as a result of the Maralla West wind energy facility.

Owing to the remoteness of the site, with limited impact from external sources, the day-time monitored levels are considered an accurate representation of ambient conditions. Similar noise levels were recorded during the three day-time periods at Farmhouse 1 and Farmhouse 3. Slight variations in the day-time monitored noise levels at Farmhouse 2 can be attributed to cars operating at the receptor during different times of the day.

Table 10: Sound level monitoring results at the three farmhouse receptor locations surrounding the Maralla West site

Farmhouse 1			
Date	**Time**	**(1-hour) L_{Aeq}**	**(1-hour) L_{A90}**
14 April 2016	08:09	44.3	34.5
13 April 2016	11:32	44.3	32.5
13 April 2016	17:28	42.6	37.5
Day-time Average		43.8	34.8
13 April 2016	22:09	42.0	21.0
Farmhouse 2			
Date	**Time**	**(1-hour) L_{Aeq}**	**(1-hour) L_{A90}**
14 April 2016	05:53	38.8	23.5
13 April 2016	12:50	50.7	35.0
13 April 2016	15:05	47.6	29.5
Day-time Average		47.8	29.3
13 April 2016	19:48	30.0	19.5
Farmhouse 3			
Date	**Time**	**(1-hour) L_{Aeq}**	**(1-hour) L_{A90}**
14 April 2016	06:58	40.0	20.0
13 April 2016	14:00	49.4	33.0
13 April 2016	16:10	47.0	31.5
Day-time Average		46.9	28.2
13 April 2016	20:53	25.6	18.5

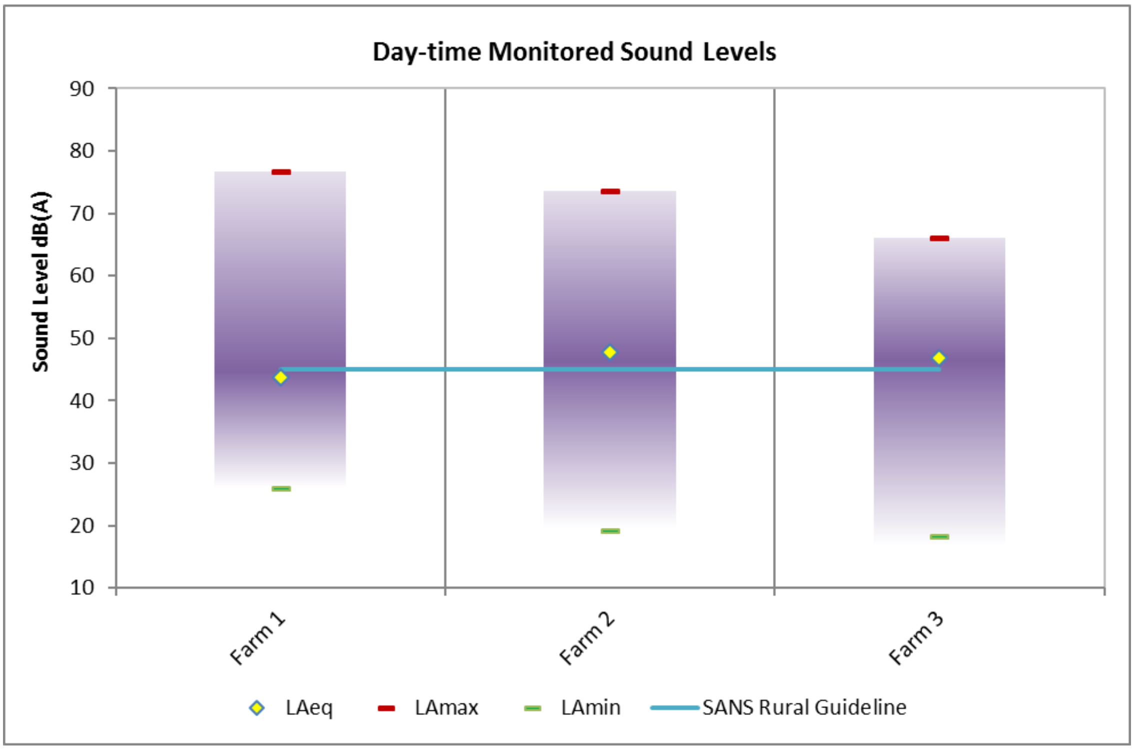

Figure 5: Day-time average sound levels in the vicinity of the Maralla West site. Note, L_{Aeq} is assessed against the SANS guideline.

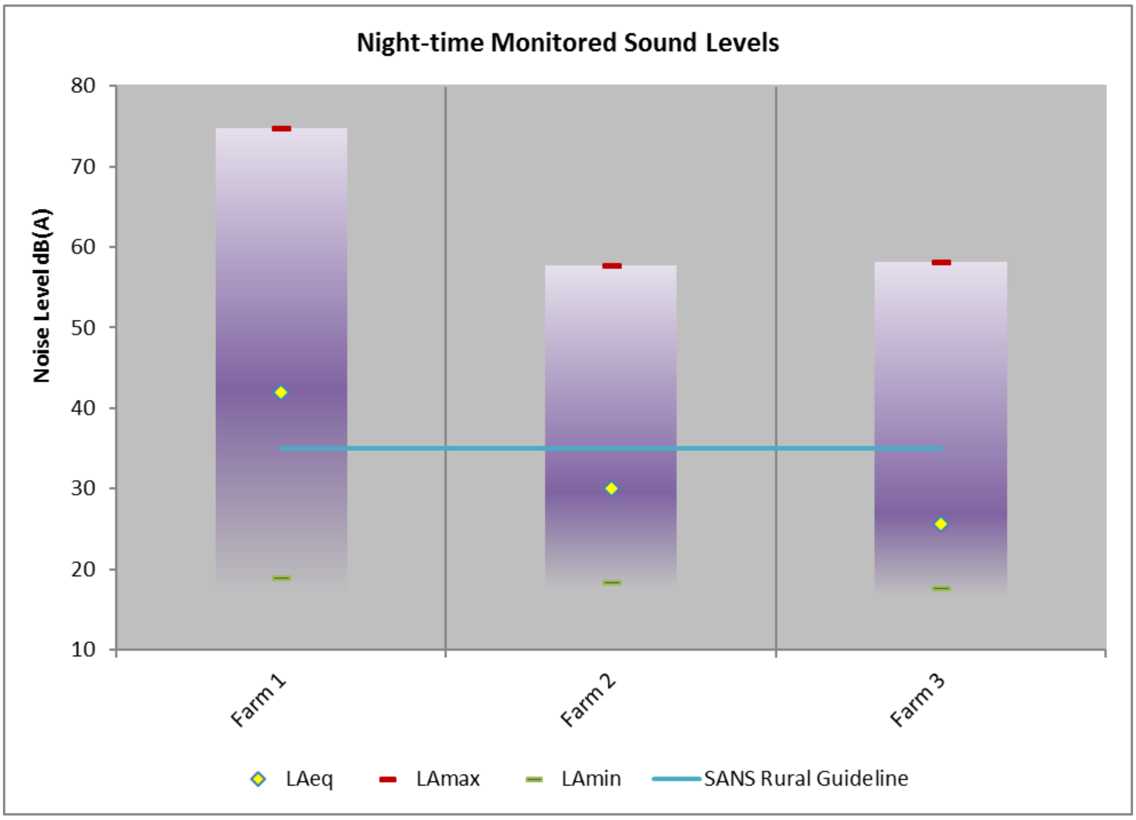

Figure 6: Night-time average sound levels in the vicinity of the Maralla West site. Note, L_{Aeq} is assessed against the SANS guideline.

3.2 CLIMATE AND METEOROLOGY

The climate of the region is arid to semi-arid. Rainfall is low and occurs throughout the year but predominantly in the autumn and winter months between March and September. The region experiences warm to hot summers with average temperatures reaching 27˚C. Winters are extremely cold with average temperatures dropping to -3˚C (World Weather Online, 2016).

Winds in the Maralla West region are moderate to strong, hence the development of a wind energy facility. Wind data was obtained from BioTherm's Maralla West meteorological mast for the period November 2015 (commencement of monitoring) until September 2016. The mast monitors wind conditions at three heights (39.9 m, 61.1 m and 80.4 m). **Figure 7** presents the wind rose plot from the 39.9 m dataset.

Wind roses are a useful tool in illustrating prevailing meteorological conditions for an area, indicating wind speeds and frequency of distribution. In the following wind roses, the colour of the bar indicates the wind speed whilst the length of the bar represents the frequency of winds *blowing from* a certain direction (as a percentage). Winds in the Maralla West area originate predominantly from the west-northwest, with smaller north-westerly and easterly components. The strongest winds originate from the west-north-westerly sector, with speeds as high as 24 m/s being recorded from this sector.

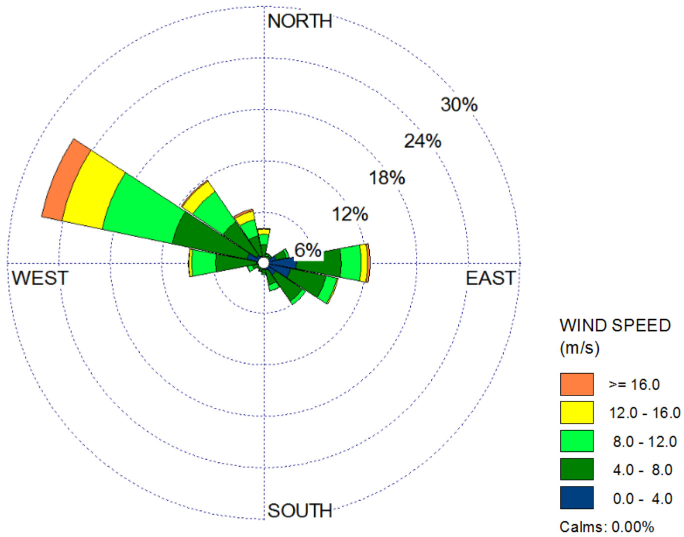

Figure 7: Wind rose plot for the Maralla West site (@ 39.9 m height)

Meteorology is an important aspect of an environmental acoustic assessment of this nature, as prevailing conditions determine how noise propagates from a source. Phenomena like temperature inversions cause sound energy to curve downwards and increase sound levels experienced at ground level below the inversion layer. On the other hand, normal mid-day type of temperature lapse conditions on clear, sunny days create a shadow zone around noise sources, usually below the noise source resulting in the majority of sound energy being directed in a more upward angle.

SANS 10103 makes reference to the ISO9613 standard (*Acoustics - Attenuation of sound during propagation outdoors*). ISO9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the L_{Aeq} under meteorological conditions favourable to propagation from sources of known sound emission. These conditions are for downwind propagation or equivalently propagation under well-developed moderate ground-based temperature inversion, commonly occurring at night.

In order to account for these meteorological conditions in this assessment, the ISO9613 parameters have been selected in the CadnaA acoustic model for determination of the worst-case operational phase noise levels from the wind turbines.

3.3 TOPOGRAPHY

The topography of the Maralla West site is relatively flat comprising open areas and mountainous slopes. In the mountainous area, the slope values average around 34.4 %, and 1.1 % on the floodplains of the main watercourses. The elevation of the Maralla West site ranges from 984 m to 1379 m and 1098 m to 1614 m, respectively (**Figure 8**). There are several natural gullies and watercourses, which drain the site in the direction of the slope, however, these are ephemeral in nature, and seldom have water present in the channels.

Since topography has an influence on the propagation and channelling of noise, terrain data was included in the acoustic models in order to account for such influences.

3.4 LAND COVER

The Department of Agriculture, Forestry and Fisheries (DAFF) define the land cover within the Maralla West site, predominantly as Scrubland and Low Fynbos, with minor pockets of Wetlands and Thicket, Bushlands, Bush Clumps, and High Fynbos (DAFF, 2012). Upon the site visit, the majority of the vegetation cover comprised of shrub-like vegetation and Fynbos, with minor areas of cultivated land and wetlands (i.e. “wetland flat” type). The land use throughout the site is dominated by sheep grazing. In addition, antelope were seen grazing on the farm, which may offer potential hunting activities. In general, the land use around the site, comprised of the following surface features:

- Three telecommunication masts installed on hilltops;
- District farm roads;
- Power lines;
- Earth-wall dams;
- Windmill-driven boreholes; and
- Reservoirs located on the farm property.

Land cover has an impact on the noise climate in an area, with soft, natural vegetation having more of an absorbing effect than hard flat man-made surfaces, which tend to reflect noise. With predominantly natural scrubland surrounding the Maralla West site, such effects were accounted for in the acoustic model.

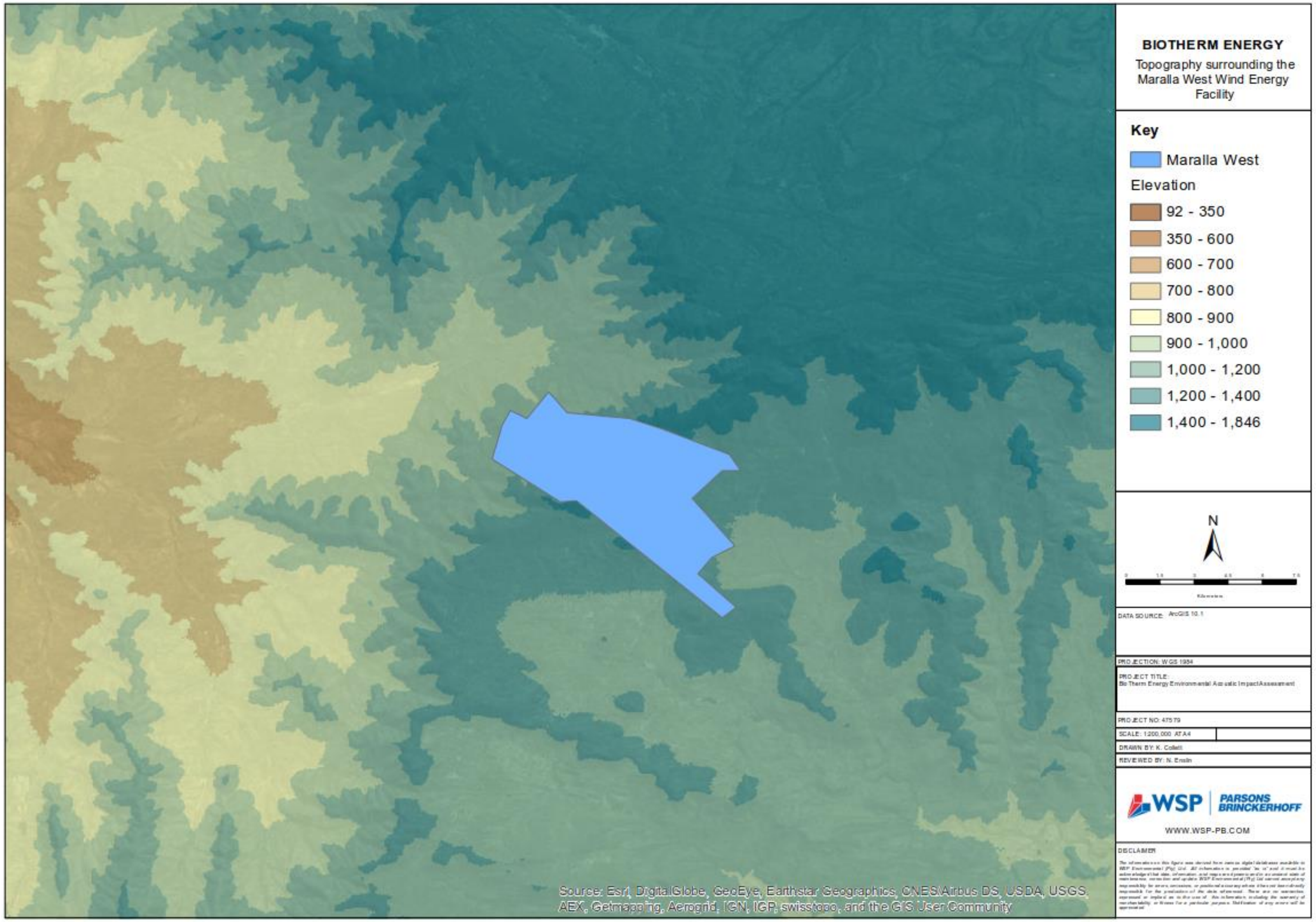

Figure 8: Topography of the area surrounding the Maralla West site

4 FINDINGS

4.1 CONSTRUCTION PHASE

Based on a worst-case cumulative PWL of 116.9 dB(A) stemming from the construction equipment located at an individual turbine, as outlined in **Table 7**, the resultant noise levels at specified distances from the source are presented in **Table 11**. Noise levels in the immediate vicinity of the construction activities are predicted to be high, as would be expected. From 500 m from the source, noise levels will reduce considerably, with noise levels at 1,483 m from the source dropping to below the SANS rural guideline level of 45 dB(A). It must be noted that these noise levels are purely associated with noise related to the construction of a proposed wind turbine and do not include baseline (existing) noise levels. It must also be noted that this is an absolute worst case scenario, with all construction equipment operational simultaneously which will not occur in reality. Such an approach was utilised as detailed construction plans are not yet available.

Table 11: Worst-case noise levels associated with the construction of a wind turbine at the Maralla West site

Distance from Wind Turbine Site (m)	Calculated Noise Level dB(A)
100	69
200	63
500	55
1,000	49
2,000	43
3,000	39
4,000	37
5,000	35

Resultant noise levels and predicted impacts at the receptor locations are presented in **Table 12**. This includes baseline (monitored) noise levels in order to assess changes in noise levels at each location. These changes are assessed using the classifications presented in **Table 2**. It must be noted that since sound levels are represented in logarithmic units, simple addition cannot be applied to obtain the cumulative sound levels, but rather logarithmic addition. Two scenarios are presented, namely construction phase and construction phase during a blasting event. Construction will only take place during day-time hours, so no night-time results are presented.

Table 12: Predicted day-time noise levels at the farmhouse receptors during the construction phase

Receiver	Noise level from construction activities dB(A)	Baseline Noise Level dB(A)	Cumulative Noise Level dB(A)	Change in Noise Level dB(A)	Estimated Community Response
FH 1	54.9	43.8	55.3	+11.5	Medium
FH 1 (during blast)	66.3	43.8	66.4	+22.6	Very Strong
FH 2	36.6	47.8	48.1	+0.3	Little
FH 2 (during blast)	48.0	47.8	50.9	+3.1	Little
FH 3	38.8	46.9	47.5	+0.6	Little
FH 3 (during blast)	50.2	46.9	51.9	+5.0	Little

The change in noise levels associated with the construction (without blasting) of the proposed wind energy facility will result in “little” estimated community response at two of the three receptor locations (FH 2 and FH 3). Noise levels are anticipated to increase by between 0.3 and 0.6 dB(A) at these farmhouse receptors. Such increases in noise levels are anticipated to be negligible, resulting in sporadic complaints and are deemed to go unnoticed during the noisier day-time hours. At FH 1, the change in current noise levels with the introduction of construction activities will result in “medium” estimated community response, with an increase of 11.5 dB(A) predicted.

Since all three receptors are located within the Northern Cape Province, assessment must also be made against the Noise Control Regulations as no province-specific regulations apply. As described in **Section 1.3**, a noise is considered disturbing when noise levels from a new source exceed the ambient sound level by 7 dB(A). Increases in noise levels at FH 2 and FH 3 are below 7 dB(A) and as such are not considered as disturbing, having little impact on these receptors. At FH 1, however, changes in noise levels exceed 7 dB(A) and as such are considered as disturbing. It must be noted that this represents a worst-case scenario with all construction equipment operational simultaneously, which will not occur in reality.

During a blasting event, noise levels at two of the three receptors (FH 2 and FH 3) are predicted to increase slightly, resulting in “little” community response. Noise levels are anticipated to increase by between 3.1 and 5.0 dB(A) at these farmhouse receptors. According to the Noise Control Regulations, such increases are not considered to be disturbing. At FH 1, however, noise levels during a blasting event are predicted to increase by 22.6 dB(A), resulting in “very strong” community response. Due to the immediate location of this farmhouse to the wind turbines, it is advised that no blasting take place at this location or alternatively new locations for the turbines in the immediate vicinity of this receptor be considered.

It must be noted that blasting is instantaneous and periodic and such impacts will only endure for as long as a blast occurs. Blasting may not even be necessary at many of the turbine sites, but this will be dependent on the underlying geology and will be decided at the time of construction. It must also be noted that in addition to the noise impacts of a blasting event, air over pressure and ground-borne vibration impacts may also be noted. Such impacts were beyond the scope of this Environmental Acoustic Impact Assessment and as such were not assessed here.

Figure 9 presents the projected construction road traffic noise levels over distance from the source as a result of the construction of the Maralla West wind energy facility. It must be noted that these noise levels are purely associated with noise related to construction traffic and do not include baseline (existing) noise levels. Calculations were based on the SANS 10210 methodology using the road traffic statistics as provided in the Traffic Impact Assessment (WSP, 2016), namely 50 construction vehicle trips (in and out combined) per day. From this, it was assumed that an equal number of light duty vehicles would also frequent each turbine site per day. Noise levels in the immediate vicinity of the roads will be elevated, with noise levels dropping considerably from 400 m, with predicted noise levels below the SANS rural guideline level from 600 m onwards.

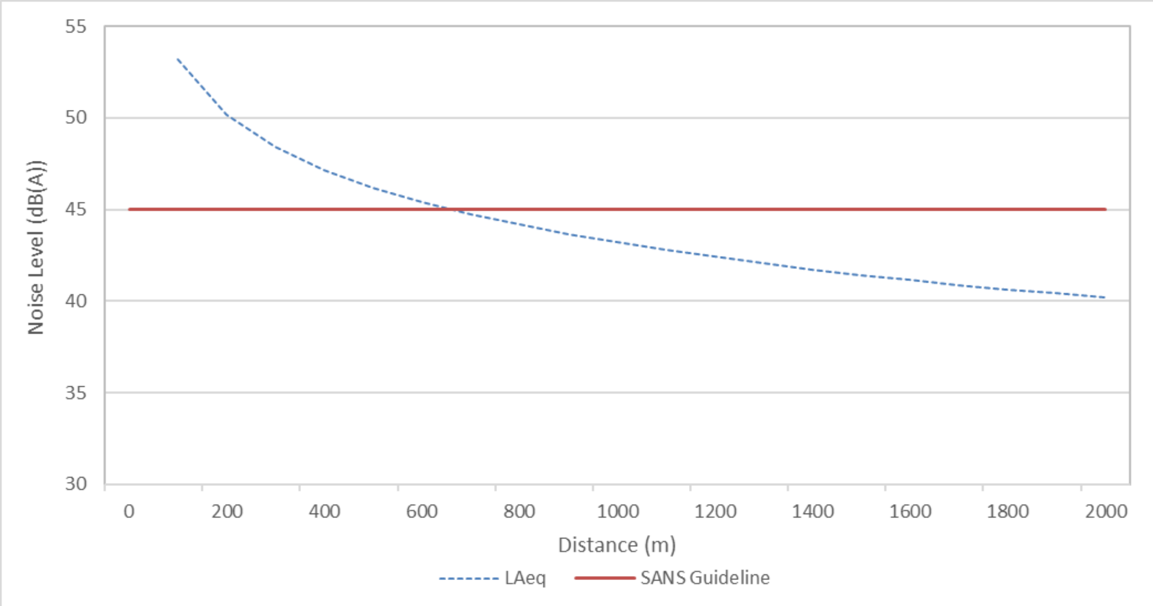

Figure 9: Construction phase projected road traffic noise levels as distance between roads and receivers increase

4.2 OPERATIONAL PHASE

Predicted noise levels from the operation of the wind turbines at the proposed Maralla West wind energy facility are presented in this section. The turbines will operate 24-hours a day depending on the prevailing wind conditions and as such only one output plot is presented for each wind class scenario. It must be noted that the visual outputs presented here are for the operation of the wind energy facility only and are not cumulative (i.e. taking the existing background sound levels into account). For each farmhouse receptor, the current ambient sound levels are evaluated against the predicted noise levels (modelled) to assess the change in sound levels as a result of the proposed wind energy facility. Cumulative sound levels (current and predicted) are also presented for each receiver, however, it must be noted that since sound levels are represented in logarithmic units, simple addition cannot be applied to obtain the cumulative sound levels, but rather logarithmic addition.

Table 13 and **Table 14** present the predicted day-time and night-time noise levels respectively at the three receiver locations during the operational phase of the proposed Maralla West wind energy facility when winds at a 10 m height are blowing at 6 m/s. Predicted noise levels were compared with the existing baseline noise levels to assess any changes in noise levels and the resultant community responses. A graphical output of the modelled results is presented in **Figure 10**.

Predicted day-time noise levels at all receiver locations are low with noise associated with the operation of the proposed wind energy facility only perceived at one receiver location (FH 1). This farmhouse is located 500 m from the nearest wind turbine. The increase in noise at this location is only predicted to be 1.6 dB(A), resulting in “little” impact and community response. Such an increase is also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

At night, noise levels are expected to increase at one receptor location (FH 1). Such an increase is deemed to have “medium” to “strong” impact on this receptor location with a 14.8 dB(A) increase. Such an increase exceeds the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. It must be noted that the night-time scenario represents a worst-case, using the lowest monitored background levels in the area. Should the ambient noise levels be higher than this in reality, the expected increases will diminish. Additionally, it is understood that the farmhouse belongs to one of the landowners who is in support of the Proposed Project.

Table 13: Day-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 6 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	40.3	43.8	45.4	+1.6	Little
FH 2	0.0	47.8	47.8	0.0	Little
FH 3	0.0	46.9	46.9	0.0	Little

Table 14: Night-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 6 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	40.3	25.6	40.4	+14.8	Medium to Strong
FH 2	0.0	25.6	25.6	0.0	Little
FH 3	0.0	25.6	25.6	0.0	Little

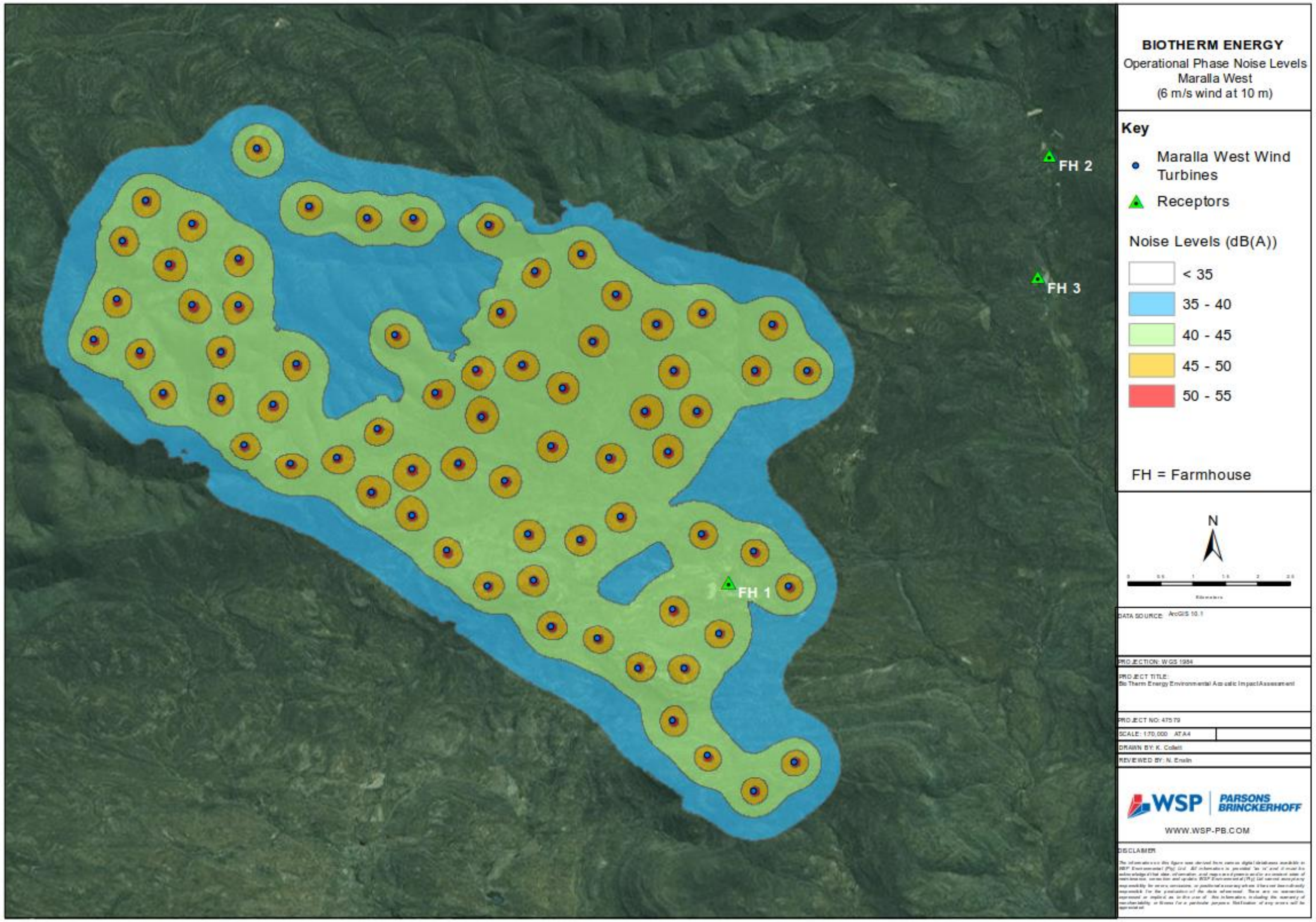

Figure 10: Predicted noise levels during the operational phase of the Maralla West wind energy facility when the wind at 10 m height is blowing at 6 m/s

Table 15 and **Table 16** present the predicted day-time and night-time noise levels respectively at the three receiver locations during the operational phase of the proposed Maralla West wind energy facility when winds at a 10 m height are blowing at 8 m/s. Predicted noise levels were compared with the existing baseline noise levels to assess any changes in noise levels and the resultant community responses. A graphical output of the modelled results is presented in **Figure 11**.

Predicted day-time noise levels at all receiver locations are low with noise associated with the operation of the proposed wind energy facility only perceived at one receiver location (FH 1). This farmhouse is located 500 m from the nearest wind turbine. The increase in noise at this location is only predicted to be 1.9 dB(A), resulting in “little” impact and community response. Such an increase is also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

At night, noise levels are expected to increase at one receptor location (FH 1). Such an increase is deemed to have “strong” impact on this receptor location with a 15.7 dB(A) increase. Such an increase exceeds the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. It must be noted that the night-time scenario represents a worst-case, using the lowest monitored background levels in the area. Should the ambient noise levels be higher than this in reality, the expected increases will diminish. Additionally, it is understood that the farmhouse belongs to one of the landowners who is in support of the Proposed Project.

Table 15: Day-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 8 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	41.2	43.8	45.7	+1.9	Little
FH 2	0.0	47.8	47.8	0.0	Little
FH 3	0.0	46.9	46.9	0.0	Little

Table 16: Night-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 8 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	41.2	25.6	41.3	+15.7	Strong
FH 2	0.0	25.6	25.6	0.0	Little
FH 3	0.0	25.6	30.3	0.0	Little

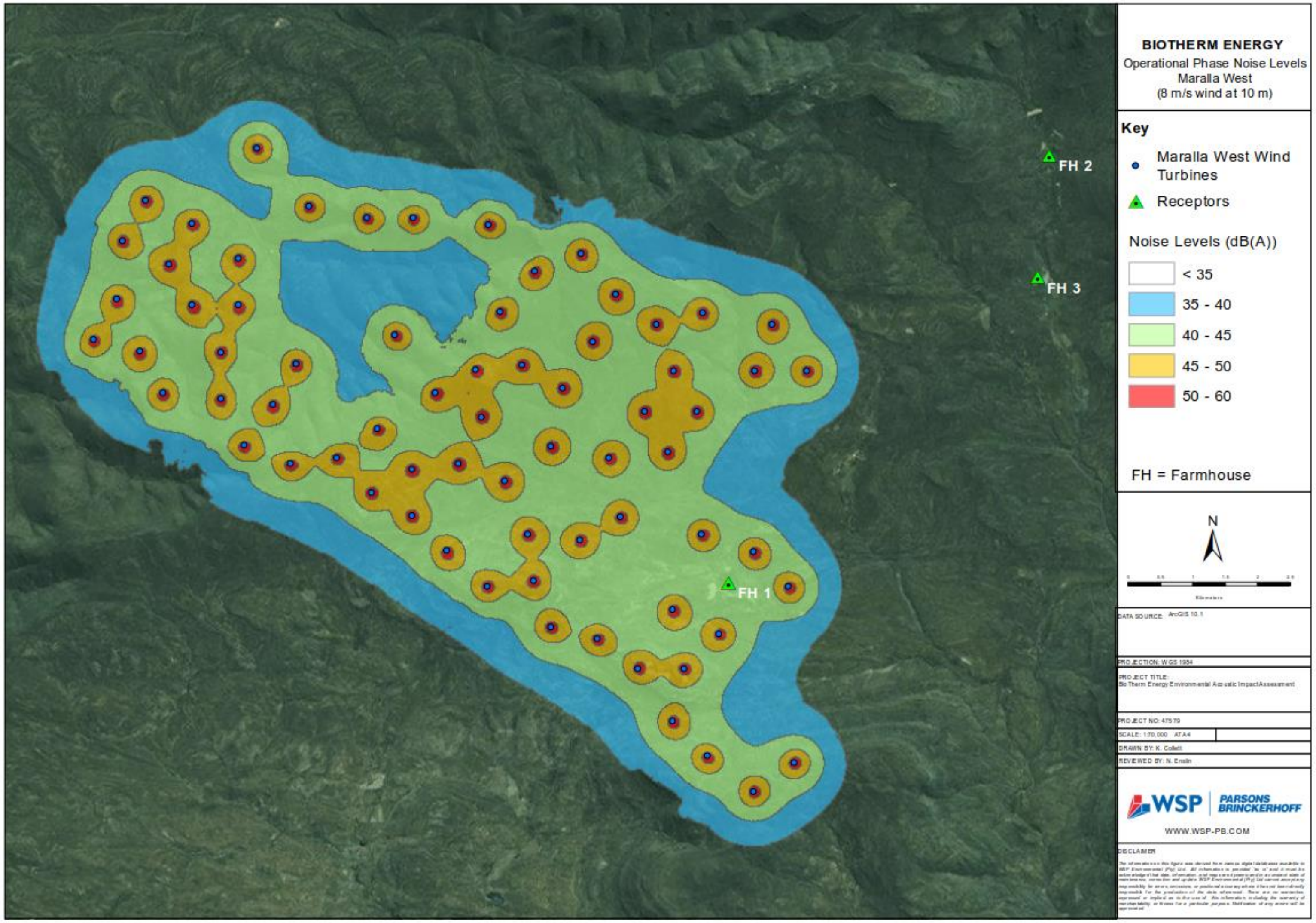

Figure 11: Predicted noise levels during the operational phase of the Maralla West wind energy facility when the wind at 10 m height is blowing at 8 m/s

Table 17 and **Table 18** present the predicted day-time and night-time noise levels respectively at the three receiver locations during the operational phase of the proposed Maralla West wind energy facility when winds at a 10 m height are blowing at 10 m/s. Predicted noise levels were compared with the existing baseline noise levels to assess any changes in noise levels and the resultant community responses. A graphical output of the modelled results is presented in **Figure 12**.

Predicted day-time noise levels at all receiver locations are low with noise associated with the operation of the proposed wind energy facility only perceived at one receiver location (FH 1). This farmhouse is located 500 m from the nearest wind turbine. The increase in noise at this location is only predicted to be 1.7 dB(A), resulting in "little" impact and community response. Such an increase is also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

At night, noise levels are expected to increase at one receptor location (FH 1). Such an increase is deemed to have "strong" impact on this receptor location with a 15.2 dB(A) increase. Such an increase exceeds the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. It must be noted that the night-time scenario represents a worst-case, using the lowest monitored background levels in the area. Should the ambient noise levels be higher than this in reality, the expected increases will diminish. Additionally, it is understood that the farmhouse belongs to one of the landowners who is in support of the Proposed Project.

Table 17: Day-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 10 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Day-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	40.7	43.8	45.5	+1.7	Little
FH 2	0.0	47.8	47.8	0.0	Little
FH 3	0.0	46.9	46.9	0.0	Little

Table 18: Night-time acoustic model results during the operational phase of the proposed Maralla West wind energy facility with winds at 10 m height blowing at 10 m/s

Receiver	Predicted Noise Level (dB(A))	Baseline Night-time Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Change in Noise Level (dB(A))	Estimated Community Response
FH 1	40.7	25.6	40.8	+15.2	Strong
FH 2	0.0	25.6	25.6	0.0	Little
FH 3	0.0	25.6	25.6	0.0	Little

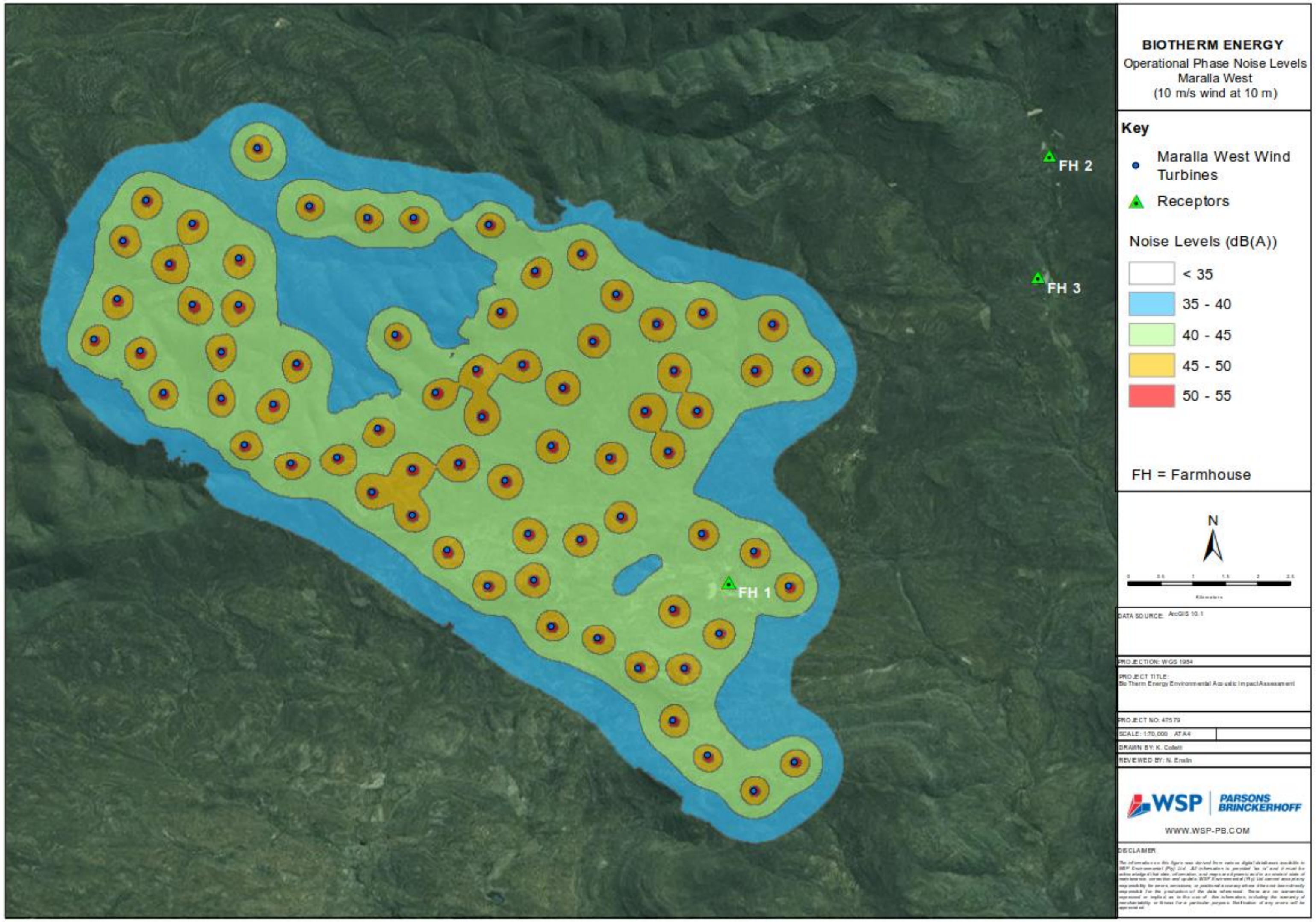

Figure 12: Predicted noise levels during the operational phase of the Maralla West wind energy facility when the wind at 10 m height is blowing at 10 m/s

4.3 DECOMMISSIONING PHASE

The noise impacts during the decommissioning phase are anticipated to be similar to those of the construction phase.

4.4 CUMULATIVE IMPACTS

There are a number of Environmental Authorisations (EA) (either issued or in process) in the area surrounding the Proposed Project site. It must be stressed that the fact that there are several approved EA surrounding the site does not equate to actual ‘development’. The surrounding projects, except for the Preferred Bidders, are still subject to the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) bidding process like the Maralla West project. Depending on the next bid window, Maralla West due to its competitive nature may actually be selected as the next Preferred Bidder and commence with construction prior to other facilities with existing EA approvals. Some of the other proposed Wind Energy facilities received their EA several years ago, but have not secured Preferred Bidder status. These EAs are illustrated in **Figure 13** and detailed in **Table 19**. The site is located within the Komsburg Renewable Energy Development Zone (REDZ) and is therefore considered to be located within the renewable energy hub that is developing in this focus area.

In addition to the above, the Proposed Project also forms part of a larger project plan proposed by the Applicant. BioTherm propose to develop two additional renewable wind energy projects in this area, namely:

- Maralla East - 1 x up to 140 MW Wind Facility and associated infrastructure
- Esizayo Wind- 1 x up to 140 MW Wind Facility and associated infrastructure

Table 19 also presents the resultant acoustic impacts (pre-mitigation) identified during the EIA phases of each of the projects. Overall, the impacts during the construction phase were identified as having a “medium” impact while the operational phase impacts of all other projects were deemed “low”.

Cumulatively, based on the number of hectares covered by all of the facilities, 40% of the total coverage area is deemed as having a “medium” impact and 60% a “low” impact during the construction phase. With the addition of the Maralla West facility, which will also have “medium” impact during the construction phase (see **Section 5** for full discussion), the cumulative impact is envisaged to remain the same. Since construction is temporary and not all sites may be constructed simultaneously, as well as the fact that construction activities can be mitigated to a certain degree, the cumulative construction impacts are not deemed to be significant. Additionally, the acoustic impacts are very site specific, with each Proposed Project having its own set of sensitive receptors based on their locality to the site. Acoustic impacts on receptors at great distances from a source are not considered as noise attenuates over distance with no impacts on receptors located many kilometres away.

Cumulatively, based on the number of hectares covered by all of the facilities, 93% of the total coverage area is deemed as having a “low” impact during the operational phase. With the addition of the Maralla West facility, which will have a “medium” impact during operational phase (see **Section 5** for full discussion), the cumulative impact is envisaged to remain the same. As noted above, acoustic impacts are very site specific, with each wind energy project having its own set of sensitive receptors based on locality to the site. Acoustic impacts on receptors at great distances from a source are not considered, as noise attenuates over distance with no impacts on receptors located many kilometres away.

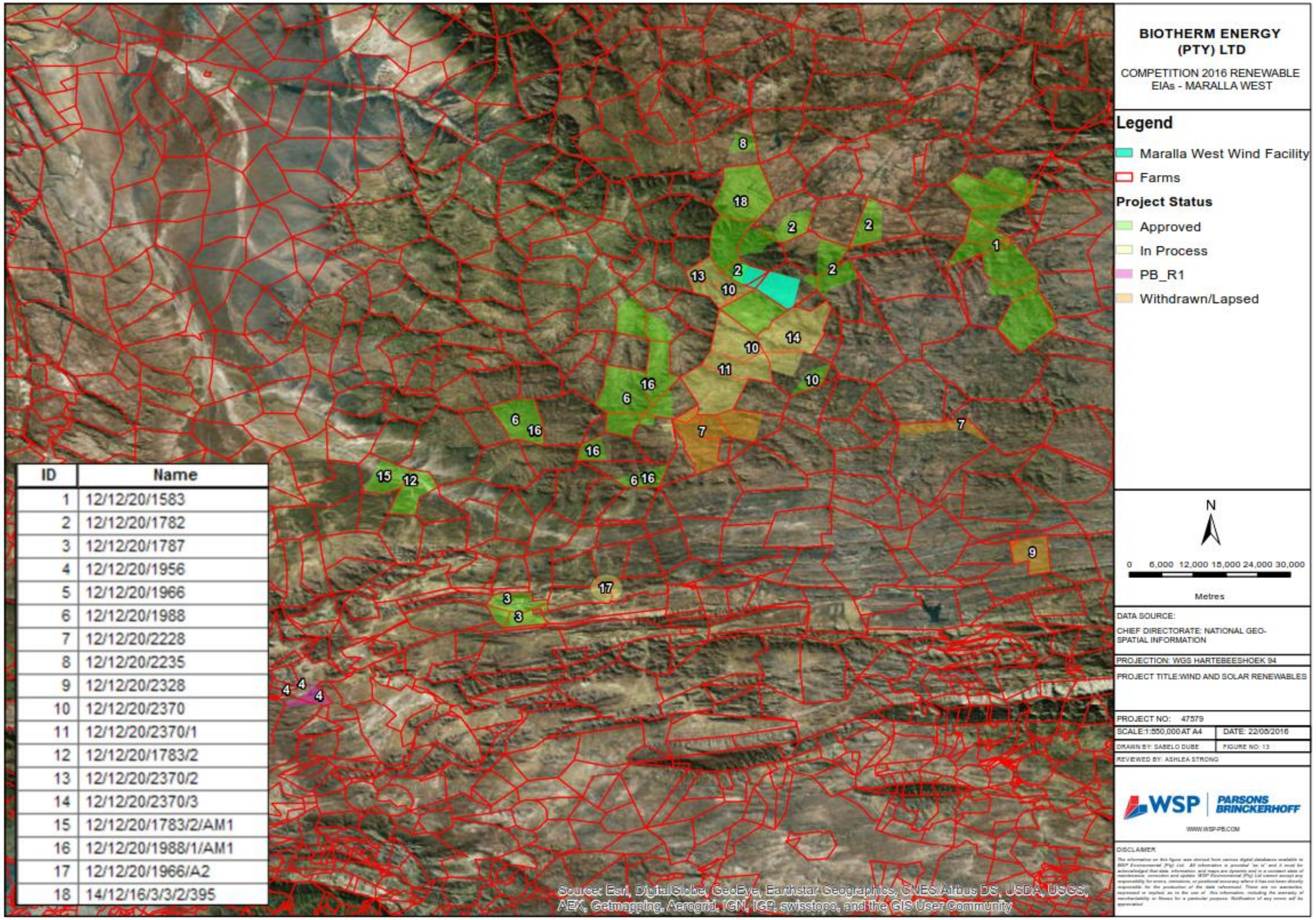

Figure 13: Location of the existing environmental authorisations in the area surrounding the proposed site

Table 19: Existing environmental authorisations and the resultant environmental acoustic impacts

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent (ha)	Proposed Capacity	Impacts			
						Construction	Operation		Decommissioning
						Construction Noise	Wind Turbine Noise at Boundary	Wind turbine Noise at Receptors	
Proposed 280 MW Gunstfontein Wind Energy Project	14/12/16/3/3/2/395	S&EIR	Networx Eolos Renewables (Pty) Ltd	12,000	280 MW	M	ND	L	ND
Proposed development of renewable energy facility at the Sutherland site, Western and Northern Cape.	12/12/20/1782/AM2	S&EIR	Mainstream Power Sutherland	9,530	650 MW	M	L	L	ND
Proposed Hidden Valley Wind Energy Facility, Northern Cape	12/12/20/2370/2	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	9,180	150 MW	L	ND	L	ND
Proposed Hidden Valley wind energy facility , Northern Cape	12/12/20/2370/3	S&EIR	Hidden Valley Wind- African Clean Energy Developments (Pty) Ltd	16,620	150 MW	L	ND	L	ND
Proposed Hidden Valley	12/12/20/2370/1	S&EIR	Hidden Valley Wind- African	26,529	150 MW	L	ND	L	ND

wind energy facility , Northern Cape			Clean Energy Developments (Pty) Ltd						
Proposed Construction Of The 140 MW Roggeveld Wind Farm Within The Karoo Hoogland Local Municipality Of The Northern Cape Province And Within The Laingsburg Local Municipality Of The Western Cape Province	12/12/20/1988/1/AM1	Amendment	G7 Renewable Energies (Pty) Ltd	2	140 MW	M	L	L	ND
Proposed establishment of the Suurplaat wind energy facility and associated infrastructure on a site near Sutherland, Western Cape and Northern Cape	12/12/20/1583	S&EIR	Moyeng Energy (Pty) Ltd		120 MW	Report not available			
Proposed establishment of the Witberg Bay wind energy facility, Laingsburg Local Municipality, Central Karoo District, Western Cape	12/12/20/1966/A2	Amendment	Witberg Wind Power (Pty) Ltd		Unknown	Report not available			

Proposed renewable energy facility at Konstabel	12/12/20/1787	S&EIR	South Africa Mainstream Renewable Power Development		170 MW	Report not available			
Proposed development of a renewable Energy facility at Perdekraal, Western Cape - Split 1	12/12/20/1783/2/AM1	Amendment	South Africa Mainstream Renewable Power Development	215	Unknown	Report not available			
Proposed Komsberg West Wind Energy Facility	14/12/16/3/3/2/856 (not shown on map)	S&EIR	Komsberg Wind Farms (Pty) Ltd	10,967	275 MW	Report not available			
Proposed Komsberg East Wind Energy Facility	14/12/16/3/3/2/857 (not shown on map)	S&EIR	Komsberg Wind Farms (Pty) Ltd	26,832	275 MW	Report not available			
Proposed Maralla East Wind Energy Facility near Sutherland, Northern Cape	14/12/16/3/3/2/962	S&EIR	BioTherm Energy	7,634	250 MW	M	ND	L	M
Proposed Esizayo Wind Energy Facility near Laingsburg, Western Cape	14/12/16/3/3/2/967	S&EIR	BioTherm Energy	6,061	250 MW	M	ND	M	M
				Total ha	**Total MW**				
				125,155	2,860				

Key:

ND = No Data; H = High; M = Medium; L = Low

Significance Totals per Impact	Significance Rating			Total Hectares per impact			
	High Significance						
	Medium Significance			35,227		6,061	13,695
	Low Significance			52,329	9,532	81,495	
	Positive Impacts						

The following EAs surrounding the wind developments have been either withdrawn or have lapsed and are therefore not been considered as part of the cumulative impact assessment:

Table 20: Withdrawn and lapsed environmental authorisation in the area surrounding the proposed site

Proposed Development Name	DEA Reference	Current EA Status	Proponent	Extent	Proposed Capacity
Proposed wind energy facility near Komsberg, Western Cape	12/12/20/2228	S&EIR	Inca Komsberg Wind (Pty) Ltd		300 MW
Proposed wind and solar project near Laingsburg, Western Cape	12/12/20/2328	S&EIR	Unknown		50 MW
Proposed development of renewable energy facility at the Sutherland site, Western and Northern Cape.	12/12/20/1782/AM1	S&EIR	Mainstream Power Sutherland	28 600	811 MW

5 ASSESSMENT OF IMPACTS

The purpose of this Environmental Acoustic Impact Assessment is to identify the potential impacts of the construction and operation of the proposed Maralla West wind energy facility on the noise climate of the area. The outcomes of the impact assessment provide a basis to make informed decisions to ensure that there is not unacceptable social or environmental impact of the proposed facility. The impact assessment was evaluated using a risk matrix. A detailed description of the impact assessment methodology is provided in **Appendix B**.

During the construction, operational and decommissioning phases, the resultant environmental acoustic impacts on the surrounding residential receptors are deemed “medium” with no mitigation in place and “low” with the implementation of the mitigation measures described in **Section 6**. The impacts of the cumulative assessment (operational phase) are considered “medium” during the unmitigated scenario and “low” during the mitigated scenario. Acoustic impacts of wind energy facilities are very site-specific and the impacts are directly assessed using noise level changes at nearby receptors. The different wind energy developments in the region (as identified in **Table 19**) are located in different areas with their own set of receptor locations. If the impacts on the receptors at the Maralla West site are low, then the impact from the other wind energy facilities on these receptors will be significantly lower based on distance from the source. For the detailed impact assessment results, please see **Appendix C**.

6 MITIGATION AND MANAGEMENT MEASURES

6.1 CONSTRUCTION PHASE

In order to minimise the acoustic impacts from the construction phase of the Proposed Project, various mitigation techniques can be employed. These options include both management and technical options:

- Planning construction activities in consultation with local communities so that activities with the greatest potential to generate noise are planned during periods of the day that will result in least disturbance. Information regarding construction activities should be provided to all local communities. Such information includes:
  - Proposed working times;
  - Anticipated duration of activities;
  - Explanations on activities to take place and reasons for activities; and
  - Contact details of a responsible person on site should complaints arise.
- When working near (within 500 m) a potential sensitive receptor, limit the number of simultaneous activities to a minimum as far as possible;
- Avoiding or minimizing project transportation through community areas;
- Using noise control devices, such as temporary noise barriers and deflectors for impact and blasting activities, and exhaust muffling devices for combustion engines;
- Selecting equipment with the lowest possible sound power levels; and
- Ensuring equipment is well-maintained to avoid additional noise generation.

In addition, should blasting activities be required, adequate blast management techniques should be employed. These include:

- Informing nearby residents as to when blasting will occur on a certain day at a given time;
- Displaying highly visible blast notices along the roadside within a certain vicinity of the site in order to notify any passing receptors;
- Not blasting after day-time hours; and
- Not allowing any blasting activities at the turbine locations surrounding the Farmhouse 1 receptor, which is located in close proximity (500 m) form the proposed turbines.

6.2 OPERATIONAL PHASE

The significance of the environmental acoustic impact of the operation of the wind energy facility is considered to be low at two of the three sensitive receptor locations and as such, further mitigation measures in these areas are not required. Noise levels around the Farmhouse 1 receptor are, however, elevated and re-location of the surrounding turbines should be considered or mitigation measures should be employed:

- Operating turbines in reduced noise mode should any complaints be received (IFC, 2015);
- Building walls/appropriate noise barriers around potentially affected buildings (IFC, 2015);

- Limiting turbine operations above the wind speed at which turbine noise becomes unacceptable in the project-specific circumstances (IFC, 2015);
- Ensuring a larger setback distance from potentially sensitive receptor locations; and
- Consideration of installing larger capacity wind turbines, limiting the number of turbines to be installed but having the same power generation potential.

6.3 DECOMMISSIONING PHASE

As the impacts during the decommissioning phase will be similar to those of the construction phase, the mitigation measures detailed in **Section 6.1**, also apply to the decommissioning phase.

7 STAKEHOLDER CONSULTATION

Public participation is a requirement of the Scoping and Environmental Impact Reporting (S&EIR) process. It consists of a series of inclusive and culturally appropriate interactions aimed at providing stakeholders with opportunities to express their views, so that these can be considered and incorporated into the S&EIR decision-making process. Effective public participation requires the prior disclosure of relevant and adequate project information to enable stakeholders to understand the risks, impacts, and opportunities of the Proposed Project.

A comprehensive stakeholder consultation process was undertaken during the Scoping Phase. Stakeholders were identified through existing databases, site notices, newspaper adverts and meetings. All stakeholders identified to date have been registered on the project database. All concerns, comments, viewpoints and questions (collectively referred to as 'issues') received to date have been documented and responded to in a Comment and Response Report.

There will be ongoing communication between WSP | Parsons Brinckerhoff and stakeholders throughout the S&EIR process.

7.1 STAKEHOLDER COMMENTS AND RESPONSE

The comments received regarding noise associated with the Proposed Project during the Scoping Phase stakeholder consultation process are presented in **Table 21**. Specialist responses to each comment are also provided.

Table 21: Stakeholder comments and responses regarding the Maralla West wind energy facility

Stakeholder Details	Comment	Specialist Response
Ms Mmamohale Kabasa (Department of Environmental Affairs) 12 October 2016 Formal Letter – Comments on DESR - Maralla West	Peer reviewer's details must be included in the final scoping report for the following specialist reports: Noise specialist study, traffic specialist study, social study, soil, land capability specialist study and wetland specialist study.	Mackenzie Hoy Consulting Acoustics Engineers has been identified as the peer reviewer for the environmental acoustic study. As with the Scoping Report, such details will be included in the EIA Report.
Mr J Venter (Laingsburg Local Municipality) 29 September 2016	What about noise and animals Impacts?	The impacts of noise from the wind energy facility on residential receptors is assessed in the Environmental Acoustic Impact Assessment Report (EIA Phase) – see **Section 4**. Impacts on animals is dealt with the in the Biodiversity study.
Mr M Kleinbooi (Laingsburg Local Municipality) 29 September 2016	What are the decibels associated with the wind farm?	The resultant noise levels associated with the wind energy facility are discussed thoroughly in the Environmental Acoustic Impact Assessment Report (EIA Phase) – see **Section 4**.

8 CONCLUSIONS

This Environmental Acoustic Impact Assessment investigated noise associated with the construction and operation of the proposed Maralla West wind energy facility, located near Sutherland in the Northern Cape province. Baseline acoustic monitoring was performed at three nearby receptor locations (farmhouses) in order to obtain representative ambient noise levels in the vicinity of the Proposed Project. The acoustic impacts of the Proposed Project were evaluated through the use of attenuation-over-distance calculations (construction phase) and the CadnaA acoustic modelling software (operational phase). Changes in noise levels at the receptor locations as a result of the construction and operation of the Proposed Project were then assessed and related community responses evaluated.

CONSTRUCTION PHASE

During the construction phase noise levels in the immediate vicinity of the construction activities were predicted to be high, decreasing as distance from the source increases. The change in noise levels associated with the construction of the proposed wind energy facility will result in “little” estimated community response at two of the three receptor locations (FH 2 and FH 3). Noise levels are anticipated to increase by between 0.3 and 0.6 dB(A) at these farmhouse receptors. Such increases in noise levels are anticipated to be negligible, resulting in sporadic complaints and are deemed to go unnoticed during the noisier day-time hours. At the third receptor (FH 1), the change in current noise levels with the introduction of construction activities will result in “medium” estimated community response, with an increase of 11.5 dB(A) predicted. This receptor is located in close proximity to the wind turbines (500 m).

The South African Noise Control Regulations state that a noise is considered disturbing when noise levels from a new source exceed the ambient sound level by 7 dB(A). Increases in noise levels at all FH 2 and FH 3 are below 7 dB(A) and as such are not considered as disturbing, having little impact on these receptors. At FH 1, however, changes in noise levels exceed 7 dB(A) and as such are considered as disturbing. It must be noted that this represents a worst-case scenario with all construction equipment operational simultaneously, which will not occur in reality.

During a blasting event, noise levels at two of the three receptors (FH 2 and FH 3) were predicted to increase slightly, resulting in “little” community response. Noise levels are anticipated to increase by between 3.1 and 5.0 dB(A) at these farmhouse receptors. According to the Noise Control Regulations, such increases are not considered to be disturbing. At FH 1, however, noise levels during a blasting event are predicted to increase by 22.6 dB(A), resulting in “very strong” community response. Due to the immediate location of this farmhouse to the wind turbines, it is advised that no blasting take place at this location or alternatively new locations for the turbines in the immediate vicinity of this receptor be considered. It must also be noted that in addition to the noise impacts of a blasting event, air over pressure and ground-borne vibration impacts may also be noted. Such impacts were beyond the scope of this Environmental Acoustic Impact Assessment and as such were not assessed here.

Noise associated with construction traffic at the proposed site was calculated based on the South African National Standards (SANS) 10210 methodology. Noise levels in the immediate vicinity of the roads will likely be elevated, with noise levels dropping considerably from 400 m, with predicted noise levels falling below the SANS rural guideline level from 600 m onwards.

OPERATIONAL PHASE

Since noise from wind turbines change with changing wind speeds, three operational phase scenarios were considered, with winds (at 10 m height) blowing at: 6 m/s, 8 m/s and 10 m/s. At all three wind speeds, predicted day-time noise levels at all receiver locations were low with noise associated with the operation of the proposed wind energy facility only perceived at one receiver location. This farmhouse is located 500 m from the nearest wind turbine. The increase in noise at this location is only predicted to increase by between 1.6 and 1.9 dB(A), resulting in "little" impact and community response. Such an increase is also well below the 7 dB(A) threshold for annoyance as per the Noise Control Regulations.

At night, at all three wind speeds, noise levels are expected to increase at one receptor location (FH 1). Such an increase is deemed to have "medium" to "strong" impact on this receptor location with an increase of between 14.8 and 15.7 dB(A) predicted. Such an increase exceeds the 7 dB(A) threshold for annoyance as per the Noise Control Regulations. It must be noted that the night-time scenario represents a worst-case, using the lowest monitored background levels in the area. Should the ambient noise levels be higher than this in reality, the expected increases will diminish. Additionally, it is understood that the farmhouse belongs to one of the landowners who is in support of the Proposed Project and it is deemed that the annoyance created for this receptor would be lower than a normal residential receptor.

The acoustic impacts of the proposed wind energy facility were evaluated using a risk matrix which assessed the nature, significance, extent, duration and probability of potentially significant impacts. Based on this rating system, it was calculated that the acoustic impacts of the Proposed Project on the surrounding receptors during both the construction and operational phases are "medium" with no mitigation in place and "low" with the implementation of mitigation measures.

Cumulatively, considering impacts from all other surrounding proposed wind energy projects in the area, construction phase impacts were deemed to remain as having a "medium" impact on the surrounding receptors. Since construction is temporary and not all sites may be constructed simultaneously, as well as the fact that construction activities can be mitigated to a certain degree, the cumulative construction impacts are not deemed to be significant. During the operational phase, cumulative impacts are envisaged to remain "medium", dropping to "low", with implementation of mitigation measures. Additionally, the acoustic impacts are very site specific, with each wind energy project having its own set of sensitive receptors based on locality to the site. Acoustic impacts on receptors at great distances from a source are not considered as noise attenuates over distance with no impacts on receptors located many kilometres away.

Based on the findings of this Environmental Acoustic Impact Assessment, it is advised that the Proposed Project can be authorised. The greatest impact is on the nearest sensitive receptor, namely FH 1 (located 500 m from the nearest turbine). This farmhouse is, however, a landowner's farm who is in support of the Proposed Project and may not be inhabited all of the time. Additionally, due to the remoteness of the site, with very limited sensitive receptors in the vicinity of the Proposed Project and the predominantly "low" impact on receptors during the ± 20-year lifespan of the project; negative, irreversible impacts are not envisaged.

It must also be noted that after completion of the EIA reports for the Biodiversity, Avifauna and Bats specialist studies, the sensitivity maps changed. As a result, the placement of the turbines was revisited and subsequently the number of proposed turbines was reduced from 70 to 56. Such changes will reduce the overall acoustic impacts from the Proposed Project. The turbines located in closest proximity to the FH 1 receptor will be removed, with the closest turbine being located 900 m from this receptor. This relocation will aid in improving the acoustic impacts on this receptor. The acoustic impacts of the operation of the proposed wind energy facility will, however, remain "medium".

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Appendix A

CURRICULUM VITAE

KIRSTEN COLLETT, M.Sc.

ENVIRONMENTAL CONSULTANT (AIR QUALITY SPECIALIST), ENVIRONMENT & ENERGY

YEARS WITH THE FIRM

5

YEARS TOTAL

7

AREAS OF PRACTICE

Air Quality Impact Assessments

Air Quality Management

Ambient Air Quality and Acoustic Monitoring

Environmental Acoustic Assessments

CAREER SUMMARY

Kirsten completed her BSc in Geography and Environmental Studies at the University of Witwatersrand in 2005. She then went on to complete her BSc honours and MSc degree in the field of Atmospheric Science. Kirsten worked at the Climatology Research Group at the University of Witwatersrand for 4 years and was involved in various air quality projects with both local and international associations. These projects involved the real time monitoring of atmospheric parameters, data analysis and reporting. She was also responsible for lecturing a variety of courses to undergraduate students and has presented much of her work at various local conferences. Kirsten is currently employed at the Johannesburg branch of WSP Environmental as an air quality and acoustic consultant and has worked on various air quality and acoustic impact assessments; air quality management plans; air quality and acoustic monitoring; and air quality and acoustic modelling for a variety of clients. She has provided consulting support to various client industries including petrochemical, mining, metallurgical, manufacturing and local government bodies.

EDUCATION

Master of Science, Atmospheric Sciences, University of Witwatersrand, Johannesburg, South Africa	2009
Bachelor of Science (Honours) Geography and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa	2006
Bachelor of Science, Geography and Environmental Studies, University of Witwatersrand, Johannesburg, South Africa	2005

PROFESSIONAL EXPERIENCE

Air Quality

- Air Quality Impact Assessment for a Chemical Manufacturer, New Germany, KwaZulu-Natal, South Africa (2015): Project Manager and Lead Consultant. WSP was appointed to conduct an Air Pollution Assessment for a proposed expansion to a chemical manufacturer in New Germany. The assessment consisted of the compilation of a comprehensive emissions inventory as well as dispersion modelling (AERMOD) to assess the impacts of emissions on the surrounding communities. Client: The Dow Chemical Company (Rohm and Haas) - Advanced Materials
- Air Quality Impact Assessment for a Smelter Decommissioning, Richards Bay, KwaZulu-Natal, South Africa (2014-2015): Lead Consultant. WSP was contracted to undertake a screening-level air quality impact assessment for the decommissioning of the Bayside Aluminium Smelter. The project included the development of a comprehensive emissions inventory; and determination of the impact of the proposed project using the AERSCREEN Tier 1 dispersion modelling software. Client: South32 Aluminium SA Limited
- Air Quality Impact Assessment for a Biodiesel Plant, Coega IDZ, Eastern Cape, South Africa (2011-2015): Lead Consultant. WSP was commissioned to conduct a specialist air quality impact assessment for a proposed biodiesel production plant. The project involved baseline meteorological and pollutant

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data analysis; emission inventory compilation; Tier 2 dispersion modelling; and atmospheric emission licence (AEL) compilation. Client: First in Spec Biofuels Ltd.

- Dust Fallout Monitoring for a Steel Facility, Mpumalanga, South Africa (2012-2015): Project Manager. WSP was commissioned to conduct dust fallout monitoring at the Evraz facility in Witbank. Monitoring has been performed on and off-site at the facility since 2012 on a monthly basis in accordance with the National Dust Control Regulations. Client: Evraz Highveld Steel & Vanadium Corporation Ltd.
- Dust Fallout Monitoring for Majuba Power Station, Volksrust, Mpumalanga, South Africa (2013-2015): Project Manager. WSP Environmental was commissioned to monitor dust fallout at the Majuba Power Station in Mpumalanga for a two year period. Kirsten was responsible for project management, data analysis and reporting for the project. Client: Eskom Holdings SOC Limited.
- Combined Air Quality Management Plan for the Greenside, Kleinkopje and Landau Collieries, Mpumalanga, South Africa (2013-2014): Lead Consultant. The combined AQMP was performed through a baseline assessment of activities at each colliery; identification of key emission sources; compilation of a detailed site specific emissions inventory for each colliery; Tier 3 (CALPUFF) dispersion modelling; and development of strategies to minimise any impacts of emissions going forward. Client: Anglo American Thermal Coal.
- Air Quality Impact Assessment for a Proposed Mine, Wakkerstroom, Mpumalanga, South Africa (2012-2014): Lead Consultant. WSP was commissioned to undertake an air quality impact assessment for a proposed underground coal mine. The assessment comprised on-site ambient air quality monitoring in order to assess the existing air quality in the region as well as dispersion modelling (using the ADMS (v5) software) to determine the predicted impacts that the proposed mine will have on the existing air quality. Client: Atha-Africa Ventures (Pty) Ltd.
- Fugitive Dust Suppression Plan for a Steel Producer, Middelburg, Mpumalanga, South Africa (2013): Lead Consultant. WSP was commissioned to compile a fugitive dust suppression plan in order to address fugitive dust concerns at a stainless steel plant in Middelburg. This comprised analysis of current and historical monitoring data; identification of key emission sources; and provision of mitigation and management measures in order to limit the impact of fugitive dust going forward. Client: Columbus Steel (Pty) Ltd.

Acoustics

- Environmental Acoustic Impact Assessment for a Proposed Paper Mill, Frankfort, Free State, South Africa (2013-2015): Lead Consultant. WSP was contracted to undertake an environmental acoustic impact assessment for a proposed paper mill in Frankfort in the Free State Province. This included baseline acoustic monitoring; development of a comprehensive noise source inventory; and determination of the impact of the proposed project on the surrounding communities using the CadnaA acoustic model. Client: Industrial Development Corporation of SA (Pty) Ltd.
- Environmental Acoustic Monitoring for a Gas Engine Power Plant, Ressano Garcia, Mozambique, Africa (2014-2015): Project Manager and Lead Consultant. WSP Environmental was commissioned to undertake acoustic monitoring at the Central Termica De Ressano Garcia gas engine power plant

site in order to assess the noise associated with the construction and operational phases of the plant. Client: Sasol New Energy Holding (Pty) Ltd.

- Environmental Acoustic Impact Assessment for a Proposed Mine, Wakkerstroom, Mpumalanga, South Africa (2012-2014): Lead Consultant. This assessment comprised on-site environmental noise monitoring as well as acoustic modelling to determine the predicted impacts that the proposed mine will have on the existing noise climate in the region. Client: Atha-Africa Ventures (Pty) Ltd.
- Environmental Acoustic Impact Assessment for SAPREF Cleaner Fuels Phase Two, Durban, KwaZulu-Natal, South Africa (2013): Lead Consultant. This assessment included on-site environmental noise monitoring as well as acoustic modelling to determine the impact of the proposed project on the surrounding communities through the use of the CadnaA acoustic model. Client: Shell and BP South Africa Petroleum Refineries (SAPREF).

Appendix B

IMPACT ASSESSMENT METHODOLOGY

The EIA uses a methodological framework developed by WSP | Parsons Brinckerhoff to meet the combined requirements of international best practice and NEMA, Environmental Impact Assessment Regulations, 2014 (GN No. 982) (the "EIA Regulations").

As required by the EIA Regulations (2014), the determination and assessment of impacts will be based on the following criteria:

- Nature of the Impact
- Significance of the Impact
- Consequence of the Impact
- Extent of the impact
- Duration of the Impact
- Probability if the impact
- Degree to which the impact:
  - can be reversed;
  - may cause irreplaceable loss of resources; and
  - can be avoided, managed or mitigated.

Following international best practice, additional criteria have been included to determine the significant effects. These include the consideration of the following:

- Magnitude: to what extent environmental resources are going to be affected;
- Sensitivity of the resource or receptor (rated as high, medium and low) by considering the importance of the receiving environment (international, national, regional, district and local), rarity of the receiving environment, benefits or services provided by the environmental resources and perception of the resource or receptor); and
- Severity of the impact, measured by the importance of the consequences of change (high, medium, low, negligible) by considering inter alia magnitude, duration, intensity, likelihood, frequency and reversibility of the change.

It should be noted that the definitions given are for guidance only, and not all the definitions will apply to all of the environmental receptors and resources being assessed. Impact significance was assessed with and without mitigation measures in place.

METHODOLOGY

Impacts are assessed in terms of the following criteria:

→ The **nature**, a description of what causes the effect, what will be affected and how it will be affected:

Nature or Type of Impact	Definition
Beneficial / Positive	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Adverse / Negative	An impact that is considered to represent an adverse change from the baseline, or introduces a new undesirable factor.
Direct	Impacts that arise directly from activities that form an integral part of the Project (e.g. new infrastructure).
Indirect	Impacts that arise indirectly from activities not explicitly forming part of the Project (e.g. noise changes due to changes in road or rail traffic resulting from the operation of Project).
Secondary	Secondary or induced impacts caused by a change in the Project environment (e.g. employment opportunities created by the supply chain requirements).
Cumulative	Impacts are those impacts arising from the combination of multiple impacts from existing projects, the Project and/or future projects.

→ The physical **extent**, wherein it is indicated whether:

Score	Description
1	the impact will be limited to the site;
2	the impact will be limited to the local area;
3	the impact will be limited to the region;
4	the impact will be national; or
5	the impact will be international;

→ The **duration**, wherein it is indicated whether the lifetime of the impact will be:

Score	Description
1	of a very short duration (0 to 1 years)
2	of a short duration (2 to 5 years)
3	medium term (5–15 years)
4	long term (> 15 years)
5	permanent

→ The **magnitude of impact on ecological processes**, quantified on a scale from 0-10, where a score is assigned:

Score	Description
0	small and will have no effect on the environment.
2	minor and will not result in an impact on processes.
4	low and will cause a slight impact on processes.
6	moderate and will result in processes continuing but in a modified way.
8	high (processes are altered to the extent that they temporarily cease).
10	very high and results in complete destruction of patterns and permanent cessation of processes.

- The **probability of occurrence**, which describes the likelihood of the impact actually occurring. Probability is estimated on a scale where:

Score	Description
1	very improbable (probably will not happen).
2	improbable (some possibility, but low likelihood).
3	probable (distinct possibility).
4	highly probable (most likely).
5	definite (impact will occur regardless of any prevention measures).

- the **significance**, which is determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high;
- the **status**, which is described as either positive, negative or neutral;
- the degree to which the impact can be reversed;
- the degree to which the impact may cause irreplaceable loss of resources; and
- the *degree* to which the impact can be mitigated.

The **significance** is determined by combining the criteria in the following formula:

$$S = (E+D+M)*P$$

S = Significance weighting

E = Extent

D = Duration

M = Magnitude

P = Probability

The **significance weightings** for each potential impact are as follows:

Overall Score	Significance Rating	Description
< 30 points	**Low**	where this impact would not have a direct influence on the decision to develop in the area
31-60 points	**Medium**	where the impact could influence the decision to develop in the area unless it is effectively mitigated
> 60 points	**High**	where the impact must have an influence on the decision process to develop in the area

The impact significance without mitigation measures will be assessed with the design controls in place. Impacts without mitigation measures in place are not representative of the Project's actual extent of impact, and are included to facilitate understanding of how and why mitigation measures were identified. The residual impact is what remains following the application of mitigation and management measures, and is thus the final level of impact associated with the development of the Project. Residual impacts also serve as the focus of management and monitoring activities during Project implementation to verify that actual impacts are the same as those predicted in this EIA Report.

Appendix C

IMPACT ASSESSMENT SIGNIFICANCE RATING TABLES

Construction Phase									
Maralla West									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on residential receptors	Nature of impact:	Direct							
	Without Mitigation	2	2	4	4	32	Medium	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	See Section 6.1							
	With Mitigation	2	2	4	3	24	Low	-	High

Operational Phase									
Maralla West									
Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on residential receptors	Nature of impact:	Direct							
	Without Mitigation	2	4	4	4	40	Medium	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	See Section 6.2							
	With Mitigation	2	4	2	2	16	Low	-	High

Decommissioning Phase

Maralla West

Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on residential receptors	**Nature of impact:**	Direct							
	Without Mitigation	2	2	4	4	**32**	**Medium**	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	See Section 6.3							
	With Mitigation	2	2	4	3	**24**	**Low**	-	High

Cumulative Impacts

Maralla West

Potential Impact		Extent (E)	Duration (D)	Magnitude (M)	Probability (P)	Significance (S=(E+D+M)*P)		Status (+ve or -ve)	Confidence
Acoustic impact on residential receptors	**Nature of impact:**	Direct							
	Without Mitigation	3	4	4	4	**44**	**Medium**	-	High
	degree to which impact can be reversed:	High							
	degree of impact on irreplaceable resources:	None							
	Mitigation Measures	See Section 6							
	With Mitigation	3	4	4	2	**22**	**Low**	-	High

Appendix D

PEER REVIEW RESPONSES

Responses to comments made in Section 2 ("Detailed Examination of Acoustic Impact Assessment Document") of Mackenzie Hoy's Peer Review Report for the Maralla West Wind Energy Facility: Acoustic Impact Assessment are outlined below:

Report Section No.	**Response**
2.a.	The reasons as to why hourly measurements conducted three times a day were selected rather than 24-hour measurements are adequately explained in this report in Section 1.6. The existing noise climate in the region is impacted on by very limited sources, so extended hours of monitoring is not warranted as significant changes in noise levels throughout the day would not occur at these remote sites. Such selection of time period is in line with SANS recommendations (see section that follows).
2.b.i.	• The time period of the measurements is discussed in the methodology in Section 1.6 • The selected hourly monitoring time period (three times a day) is adequately representative of the noise climate in the region due to the limited existing sources of noise and no clear periodicity of sources. This is in line with SANS recommendations which do not offer specific time periods for monitoring (i.e. the 24-hour timeframe as suggested by Mackenzie Hoy). SANS1013:2008 specifies the following regarding measurement time intervals: *"The measurement time intervals should be so chosen that the results are representative of the reference time interval, and that variations in the rating level owing to the variation of the emission at the source, and owing to weather influence on sound propagation, are adequately covered. The choice of the measurement time interval will depend on the method of data acquisition and on the time structure of the noise. If the noise displays a clear periodicity, the measurement time intervals should cover at least three periods, where possible. If continuous measurement over the period is not possible, the time intervals should be so chosen that each represents a part of the cycle and that together they represent a complete sample that is characteristic of the noise radiation being measured. If the sound pressure level varies stepwise, the measurement time intervals should be so selected that each represents a period within which the noise could have been considered to be approximately steady. If the noise is of a random nature, the measurement time intervals should be so chosen as to give sufficient independent samples to adequately characterize the noise radiation."* • It is correct to arithmetically average the L_{A90} levels. L_{A90} is a statistical parameter to determine the level exceeded for 90% of a given period, so are not determined logarithmically as indicated by Mackenzie Hoy.
2.b.ii.	SANS1013:2008 defines residual noise as *"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".* Such residual noise was determined in this assessment during the monitoring campaign and the L_{Aeq} levels presented in this report are an adequate representation of the ambient noise climate (residual noise) in the area. As such it was possible to proceed with the analysis and current and predicted noise levels could be assessed against the relevant SANS10103 rating levels.
2.b.iii	Based on the selection of the one-hour monitoring periods and the fact that more than one site was monitored each night, safety as a result of fatigue as well as driving in undulating terrain was definitely a warranted factor. The lack of a night-time/early morning dataset does not make this impact assessment inconceivable, as the wind energy facility is located in such a remote area, with very limited noise sources. It is not envisaged that the noise climate in such an area changes considerably over a 24-hour period. As such, the limited night-time dataset is representative of the noise climate at the site.

Report Section No.	Response
2.c.i.	The acoustic model was executed using ISO9613 parameters which represent a worst-case scenario with downwind propagation of noise in all directions. This is fully discussed in Section 3.2. As such, wind direction is not indicated on the model plots.
2.c.iii.	All comments raised in this section have been addressed in the responses above. Mitigation recommendations are provided in Section 6.