PROPOSED HIGHLANDS WIND ENERGY FACILITIES
EASTERN CAPE PROVINCE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

NOISE

SEPTEMBER 2018

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1 INTRODUCTION

WKN Windcurrent South Africa (Ltd) Pty ('WKN-WC') are proposing the Highlands Wind Energy Facility (WEF), and associated infrastructure including grid connection infrastructure ('the Proposed Development'), located near the town of Somerset East in the Eastern Cape Province. The Proposed Development Site is situated within the Cookhouse REDZ. This report presents the findings of the noise impacts of the Proposed Development, carried out in accordance with SANS 10328[1]:

This report has been prepared by Michael Reid, Associate Director (Acoustics) of Arcus, who has over twelve years' experience of the assessment of environmental noise, particularly from wind turbines in the UK. He is a member of the UK Institute of Acoustics (UK IOA), holds a Diploma in Acoustics and Noise Control and is a member of an advisory panel to the British Standards Institute in respect of wind turbine noise. The assessor's CV and Declaration of Independence are provided in Appendix 1. On-site measurements of baseline noise conditions were carried out by AJ Rens of Oswald Professional Engineers, under the supervision of Arcus. An external independent review of this report was undertaken by Morné de Jager of Enviro Acoustics (Appendix 3).

A glossary of technical terminology is included at the end of this report.

1.1 Assessed Project Description

The full Project Description of the Proposed Development is provided in the respective Basic Assessment Reports (Highlands North BAR, Highlands Central BAR and Highlands South BAR). In summary there are three phases to the Development, Highlands North, Central and South, comprising 17, 14 and 18 wind turbines respectively, along with associated infrastructure (roads, cabling etc.). Each phase also has an associated grid connection, comprising of substations and transmission lines.

The wind turbines would each be of up to 5 MW capacity, with a maximum tip height of 200 m, maximum hub height of 135 m and a rotor diameter of up to 150 m. For the purposes of the noise assessment, the candidate turbine under consideration is the Acciona AW132-3300, which has been chosen on the basis of its being the worst-case in terms of noise emissions of a number of potential options.

[1] South African National Standard SANS 10328:2008 Methods for environmental noise impact assessments, Edition 3

1.2 DEA Requirements Table

Regulation GNR 326 of 4 December 2014, as amended 7 April 2017, Appendix 6	Section of Report
(a) details of the specialist who prepared the report; and the expertise of that specialist to compile a specialist report including a curriculum vitae;	Appendix 1
(b) a declaration that the specialist is independent in a form as may be specified by the competent authority;	Appendix 1
(c) an indication of the scope of, and the purpose for which, the report was prepared;	1
(cA) an indication of the quality and age of base data used for the specialist report;	3.4
(cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	3
(d) the duration, and season of the site investigation and the relevance of the season to the outcome of the assessment;	2.2 / 3.2
(e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	2
(f) details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives;	4.4
(g) an identification of any areas to be avoided, including buffers;	3.3
(h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Figure 1
(i) a description of any assumptions made and any uncertainties or gaps in knowledge;	2.5
(j) a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment, or activities;	5
(k) any mitigation measures for inclusion in the EMPr;	5
(l) any conditions for inclusion in the environmental authorisation;	7.2
(m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;	7.2
(n) a reasoned opinion— i. as to whether the proposed activity, activities or portions thereof should be authorised; iA. Regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr or Environmental Authorization, and where applicable, the closure plan;	7
(o) a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	None received – see 3.5.
(p) any other information requested by the competent authority	N/A
Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.	N/A

2 METHODOLOGY

2.1 Guidance

The following guidance documents have been taken into consideration:

- The National Noise Control Regulations: GN R154 of 1992 (NCR);
- SANS 10328 Methods for environmental noise impact assessments;
- SANS 10103: 2006 The measurement and rating of environmental noise with respect to annoyance and speech communication[2];
- ETSU-R-97 The Assessment and Rating of Noise from Wind Turbines[3];
- The UK IOA Good Practice Guide (IOA GPG)[4];
- The World Health Organisation (WHO) Guidelines[5]; and
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites.

2.1.1 The National Noise Control Regulations: GN R154 of 1992 (NCR)

The NCR defines "disturbing noise" as a noise level which exceeds the ambient sound level at the same measurement point by 7 dBA or more.

2.1.2 SANS 10328

SANS 10328 defines procedures for environmental noise impact investigations and assessments at the various stages of an Environmental Impact Assessment (EIA), including: screening, scoping, impact assessment and review. Specific requirements for a Basic Assessment are not provided, so this report addresses the requirements for an Impact Assessment.

According to the standard, there could be acoustical implications where a wind generator farm is to be established within 2 km of a noise-sensitive development.

The following stages are defined for an Impact Assessment:

- Determination of the sound emission from the identified noise sources;
- Determination of the expected rating level;
- Determination of the desired rating level;
- Determination of the noise impact;
- Assessment of the noise impact; and
- Assessment of alternatives.

The environmental noise impact report should include the following:

- The purpose of the investigation;
- A brief description of the planned development;
- A brief description of the existing environment;
- An identification of noise sources, together with their respective sound power or sound pressure levels and acoustic characteristics;
- Noise sources that were not taken into account, and the reasons why;
- Identified noise-sensitive development and the noise impact on them;
- Any assumptions made with regard to any calculations or determination of source and propagation characteristics;

[2] South African National Standard SANS 10103: 2006 The measurement an rating of environmental noise with respect to annoyance and speech communication, Edition 6

[3] ETSU-R-97 The Assessment and Rating of Noise from wind Turbines, Energy Technology Support Unit for UK Department of Trade and Industry, 1996.

[4] A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of wind Turbine Noise, Institute of Acoustics (UK), May 2013

[5] World Health Organisation, Guidelines for Community Noise, 1999

- An explanation of all measuring and calculating procedures;
- The location of measurement or calculation points;
- Quantification of the environmental noise impact;
- Alternatives that were considered and the results of those that were investigated;
- A list of all the interested or affected parties that offered any comments;
- 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;
- Conclusions that were reached;
- Proposed recommendations, i.e. if there could be a significant impact or, if more information is needed, a recommendation that an environmental noise impact assessment should be conducted;
- 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
- 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.

2.1.3 SANS 10103

SANS 10103 provides guidance on assessing working and living environments with respect to acoustic comfort, excellence and possible annoyance by noise. It provides information on typical indoor and outdoor noise levels in various districts, of which the outdoor levels in rural districts are of relevance to this report. These are:

- Day/night: 45 dBA, $L_{R,dn}$
- Day: 45 dBA, $L_{Req,d}$
- Night: 35 dBA, $L_{Req,n}$

The descriptor L_{Req} denotes a rated level, i.e. that which has been adjusted to account for tonal character and impulsiveness.

In assessing annoyance, the rating level of the ambient noise (i.e. that with the Development in operation) should be compared with the above typical rating levels or residual noise (determined in the absence of the specific noise under investigation). Table 5 of SANS 10103 details the community or group response to the increase in noise due to a proposed development as follows:

- 0 to 10 dBA: Little response, sporadic complaints:
- 5 to 15 dBA: Medium response, widespread complaints;
- 10 to 20 dBA: Strong response, threats of community of group action; and
- >15 dBA: Very strong response, vigorous community or group action.

2.1.4 ETSU-R-97

In the UK, Guidance on the assessment of noise from wind turbines is provided by ETSU-R-97 *The Assessment and Rating of Noise from Wind Turbines*.

Both ambient noise and noise from wind turbines typically vary with wind speed. According to ETSU-R-97, wind farm noise assessments should therefore consider the site-specific relationship between wind speed and background noise, along with the particular noise emission characteristics of the proposed wind turbines.

ETSU-R-97 recommends that noise limits are set at wind speeds of up 12 ms^{-1} at 10 m above ground level (AGL). The recommended limits are 5 dB above the prevailing, wind

speed-dependent background noise level ($L_{A90,10min}$), subject to fixed lower values of 35-40 dB, $L_{A90,10min}$ during the day and 43 dB, $L_{A90,10min}$ at night. It states that the $L_{Aeq,10min}$ value of wind turbine noise is typically around 2 dB higher than the $L_{A90,10min}$.

At present, noise standards in South Africa do not allow for ambient noise levels to be determined at elevated wind speeds. However, given that wind turbines are unlikely to operate at the low wind speeds under which noise measurements are typically taken, and that ambient noise levels at higher wind speeds, when the turbine do operate, would be elevated, it is considered appropriate to take such effects into consideration in the setting of noise limits or targets.

In Arcus' experience, the difference between noise levels at low wind speeds and those at which wind turbines reach their rated power output is in the range of 5 – 20+ dBA.

2.1.5 The IOA Good Practice Guide

The Good Practice Guide (GPG) was published by the UK Institute of Acoustics (IOA) in May 2013 and has been endorsed by the UK Government as current industry good practice. The guide presents current good practice in the assessment of wind turbine developments at the various stages of the assessment process.

During the development of the GPG, a detailed study was undertaken of wind farm noise propagation and prediction methods used in a number of countries. The outcome of this research resulted in the GPG recommending a modified version of the ISO 9613-2[6] method in calculating the levels of wind turbine noise at receptor locations (immission[7] levels).

The ISO 9613-2 method predicts noise levels at the receptor by taking the octave band sound power level spectrum of the source, and applying a number of attenuation factors that determine the resulting sound pressure level. These factors are:

Geometric Divergence

Geometric divergence is the spherical spreading of noise from a point source. The level of attenuation due to geometric divergence is based upon the distance from source to receptor.

Atmospheric Absorption

Sound is partly attenuated by the air through which it travels. The attenuation achieved is dependent on the frequency of the noise (with higher frequencies being absorbed more readily), along with the temperature and relative humidity of the air itself. The GPG recommends a temperature of 10°C and 70% relative humidity to represent a… "*reasonably low level of air absorption".*

Directivity Factor

The directivity factor is used to account for a source which radiates sound in a non-uniform pattern (i.e. non-spherical).

Wind turbine sound power levels are measured in a downwind direction, therefore providing worst-case predictions. As such, the directivity factor as described in ISO 9613-2 is not used in the prediction of wind turbine noise levels.

The GPG states that account may need to be taken of the effect of wind direction upon wind turbine noise propagation, particularly in complex cumulative noise environments, and provides information on the variation in noise levels with the wind direction relative to the direct path from source to receiver.

[6] ISO 9613-2:1996 Acoustics -- Attenuation of sound during propagation outdoors - Part 2: General method of calculation.

[7] i.e. noise experienced at a noise-sensitive development, as opposed to emission, which is noise given out by a noise source

Ground Effect

The spherical-spreading of noise from a source is affected by the presence of the ground. The ground conditions are described in ISO 9613 through the variation of the Ground Type, G. This variable can be set between 0, which represents non porous, reflective surfaces such as water, ice, concrete etc. and 1, which represents 'soft' ground, such as that covered by trees or other vegetation.

The GPG recommends that use of G=0.5, along with a receptor height of 4 m results in realistic predictions of noise from wind turbines in most cases. The GPG states the use of G=0 can result in over-prediction of noise levels, but is recommended in situations where noise propagates over mainly large bodies of water or paved ground (which can occur in urban environments).

Barrier Attenuation

Any barrier between the source and receiver will reduce predicted noise immission levels. This may be either due to a structure (such a wall or building), or due to the local topography. With regard to wind turbine noise, the GPG states that barrier attenuation should be limited to no more than 2 dB, and is only applicable where there is no line of sight between the tip of the turbine and the receptor.

Propagation through Foliage and Local Structures

ISO 9613 allows for adjustment of noise levels based upon the propagation path travelling through, or close to, vegetation or other nearby structures (such as other houses). Use of this factor is not recommended for use in the prediction of wind turbine noise, and has therefore not been considered, as per GPG guidance.

Additional Parameters

Whilst not part of the standard ISO 9613-2 model, the GPG states that an additional 3 dB should be added to noise immission levels at properties located across a valley or with heavily concave ground[8] between the property and the wind turbine(s).

The GPG states that the turbine sound power levels should be stated and these should include an appropriate allowance for measurement uncertainty (1.645 x uncertainty). If the data provided contains no allowance for measurement uncertainty, or uncertainties are not provided, an additional 2 dB should be included. Declared Apparent Sound Power Levels (L_{wd}) as defined in IEC 61400-14[9], may be used as presented with no additional allowances.

Section 4.1.2 of this report details the turbine sound power levels used in the assessment.

ISO 9613-2 provides a prediction of noise levels likely to occur under worst-case conditions; those favourable to the propagation of sound, i.e. down-wind or under a moderate, ground-based temperature inversion as often occurs at night (often referred to as stable atmospheric conditions).

2.1.6 WHO Guidelines

The WHO Guidelines recommend that noise levels outside bedrooms at night do not exceed 45 dBA, $L_{eq,8hr}$ to prevent sleep disturbance indoors.

[8] The presence of concave ground is determined using the equation presented is Section 4.3.9 of the GPG.

[9] IEC 61400-14 Wind turbines – Part 14: Declaration of apparent sound power level and tonality values.

2.1.7 BS 5228-1:2009+A1:2014

BS 5228-1:2009+A1:2014 refers to the need for the protection against noise and vibration of persons living and working in the vicinity of and those working on construction and open sites. Methods of calculating the levels of noise resulting from construction activities are provided, as are source levels for various types of plant, equipment and construction activities, which have been utilised in this assessment where required.

2.2 Methodology

2.2.1 Determination of Noise Levels

2.2.1.1 Residual Noise Levels

A baseline noise survey was carried out to determine representative residual noise levels in the vicinity of noise-sensitive development within the Study Area, i.e. within 2 km of the Proposed Development. Measurements of residual noise were made at four locations, for a minimum of 24 hours each, during June 2018. A range of statistical indices and parameters were measured, using the 'Fast' time-weighting, with the most relevant being the $L_{Aeq,t}$. A measurement time interval of 1 hour was used. No measurements of impulsive noise were made, and it has therefore been assumed, as a worst-case that residual noise is free from significant impulsivity, and no impulse correction has been applied to residual noise levels.

The equipment used consisted of a Type 1 logging sound level meter (SLM) housed within a protective environmental enclosure with internal long-life batteries. The ½" condenser microphone was mounted on a 1.4 m pole integral to the enclosure and protected by an enhanced windshield (200 mm foam sphere) providing protection from rain and elevated wind speeds. The SLM had a current laboratory calibration certificate and an internal calibration check was carried out before and after each measurement. The windshield used was consistent with advice provided within the GPG.

Residual noise measurements have been compared with wind speeds measured at 10 m AGL on the site of the Proposed Development. A range of wind speeds occurred during the survey from low wind speeds at which the turbine would not operate to those at which they would operate a full capacity. Measurements obtained at very high wind speeds (in excess of approximately 10 ms^{-1}) were excluded from the dataset as a precautionary approach.

Details of the measurement locations and results are provided in Section 3.3 of this Report.

2.2.1.2 Specific Noise Levels

Construction Phase

The method for predicting levels of noise during construction is that described in BS 5228, as discussed in Section 2.1.6 of this Report. Noise emissions during the construction phase are described in Section 4.1.1.

Operational Phase

The method of predicting levels of wind turbine noise at receptors is discussed in Section 2.1.5. Noise emissions during the operational phase are described in Section 4.1.2.

2.2.2 Determination of the Desired Rating Level

Construction Phase

As effects during the construction phase are temporary in nature, the likelihood of complaint is reduced in comparison to longer-term effects such as operational noise. It is therefore considered appropriate to define the desired rating level for construction noise as 10 dB above residual noise levels.

Operational Phase

Based on the guidance provided in SANS 10103, and taking into account the definition of disturbing noise in the NCR, it is considered that appropriate rating levels from noise during operation of the Development are 7 dBA above residual noise levels during the day.

However, taking into account the advice of ETSU-R-97 that appropriate night-time noise limits are at least 43 dB $L_{A90,10min}$ (45 dBA L_{eq}) and the WHO guidelines recommendation of a night-time noise limit of 45 dBA L_{eq}, it is considered appropriate to set an overall noise limit for the development of 45 dBA L_{eq}.

2.3 Assessment Significance Criteria

The rating noise levels (Section 5) associated with each phase of the Development have been compared with Residual Noise Levels (Section 2.2.1) in order to determine the intensity of effects, based on the likely community response derived from the guidance in SANS 10103, and desired rating levels, as detailed in Table 1.

Table 1: Assessment Significance Criteria

Category	Construction & Decommissioning Phase: Excess , dBA $\Delta L_{Req,T}$	Operational Phase: Excess , dBA $\Delta L_{Req,T}$ or Limit dB, L_{Aeq}	Impact Intensity
No Impact	≤ 0 dBA $\Delta L_{Req,T}$	≤ 0 dBA $\Delta L_{Req,T}$	None
Little	0 to 5 dBA $\Delta L_{Req,T}$	0 to 3 dBA $\Delta L_{Req,T}$	Low
Medium	5 to 10 dBA $\Delta L_{Req,T}$	**Day**: 3 to 7 dBA $\Delta L_{Req,T}$ **Night**: Greater than 3 dBA $\Delta L_{Req,T}$ but lower than 45 dBA L_{eq}	Medium
Strong	10 to 20 dBA $\Delta L_{Req,T}$	**Day**: 7 to 15 dBA $\Delta L_{Req,T}$ **Night**: Greater than 45 dBA L_{eq} but lower than 15 dBA $\Delta L_{Req,T}$	High
Very Strong	> 20 dBA $\Delta L_{Req,T}$	> 15 dBA $\Delta L_{Req,T}$	Very High

The following factors have then been assessed:

- Extent;
- Duration;
- Intensity;
- Status (positive / negative);
- Significance;
- Probability of an adverse effect occurring; and
- Confidence.

2.4 Consideration of Alternatives

2.5 A Noise Feasibility Study of the proposed development site was conducted prior to the environmental assessment process. This study identified potential noise sensitive receptors, and resulting areas of high and very high sensitivity. The proposed turbine layout was developed using the results of this study through an iterative process, and therefore represents the preferred alternative layout for assessment. This assessed layout was further refined using the results of the specialists assessments, resulting in the Final Mitigated Layout.

2.6 Assessment Limitations

2.6.1 Baseline Conditions

Measurements of residual noise levels have been made for between 24 and 48 hours each at four locations. As stated in Section 7.2, it is recommended that longer-term measurements are carried out prior to construction of the proposed development, and correlated with wind speed in accordance with the methodology described in ETSU-R-97.

Residual noise measurements were made using the 'Fast' time weighting rather than 'Impulse'. Whilst this is not strictly in accordance with SANS 10103, it is considered that residual noise is unlikely to contain significant impulse noise due to the rural character of the Study Area and that this approach is likely to result in lower measurements results than would have been obtained using the Impulse weighting and is therefore conservative.

2.6.2 Identification and Description of Potential Impacts

Noise sources occurring during construction and decommissioning have been assumed on the basis of typical construction methods for the type of development. Source levels have been obtained from published data, i.e. BS 5228:2014, which is a well-recognised source of such information.

At the time of writing, a definite turbine model has not been selected for use at the proposed development. Therefore, a candidate turbine model has been assessed, which is considered to be worst-case within the range of dimensions under consideration in terms of noise emissions.

3 BASELINE CONDITIONS

3.1 Description of the Existing Environment

The Proposed Development Site is located in the Eastern Cape Province, approximately 20 km west of Somerset East and 20 km east of the town of Pearston, along the R63 route linking these two towns. The Proposed Development Site is situated within the Cookhouse REDZ and the affected land parcels cover an area of approximately 11,180 hectares. The area of interest for development within these land parcels is approximately 9,000 hectares. There are two existing Eskom Transmission lines located within the Proposed Development Site boundary, one a 66 kV and the other a 132 kV.

The landscape at the site consists of gently undulating plains which support open, dry grassland interspersed with woodland vegetation, particularly in drainage lines. The western edge of the site consists of steeper slopes with thicket vegetation. The predominant vegetation types at the site are Bedford Dry Grassland and Camdeboo Escarpment thicket. There is also a small area of Southern Karoo Riviere vegetation. Grazing, and a small amount of cultivation, is the only current land use on the site.

Land use is primarily used for extensive livestock farming based on a mix of beef cattle, sheep and angora goats.

3.2 Seasonal Effects

Ambient noise levels in rural areas can be affected by a number of seasonally-varying factors, including:

- Weather conditions, i.e. wind, rain, temperature and humidity;
- Vegetation, its type, density and the presence and condition of foliage; and
- Animal activity, such as insects.

The variation from season to season is complex and variable and can only be readily determined through observation.

The measurements were undertaken during winter (June 2018). Weather during the survey was dry; the effects of wind are discussed in Section 3.4. The photographs in Appendix 2 show that vegetation was present on many of the trees and shrubs around the monitoring locations, indicating that this is likely to be the case year-round. Sound from animal / insect activity is likely to be lower in the winter.

It is therefore considered that the ambient noise measurements provide a reasonably conservative representation of those likely to occur over the course of a year.

3.3 Developments Included in and Excluded from the Investigation

A desk-based search was carried out to identify potential noise-sensitive developments (principally houses) within 2 km of the proposed Development, using National Geo-Spatial Information 1:50,000 scale digital mapping and aerial imagery.

Figure 1 indicates the potential noise-sensitive developments identified, which have been included in the investigation. It should be noted that the landowner has confirmed that Location 6 is a hunting lodge which is not permanently occupied.

Noise-sensitive developments located more than 2 km from the proposed development have been excluded from investigation, on the basis that SANS 10328 requires assessment of those within 2 km.

3.4 Residual Noise Levels

Residual noise levels were measured at four of the potential noise-sensitive developments considered to be representative of the types of acoustic environments present at noise-sensitive developments within the study area. The measurement locations are indicated in Figure 1. Photographs and descriptions are provided in Appendix 2.

Appendix also 2 details the residual noise measurements obtained at each location. Charts 1 and 2 in Appendix 2 illustrate the relationship between each individual measurement and the corresponding wind speed measured by the nearer of the two meteorological masts on the site of the Proposed Development.

Table 2 summarises the results. As the measurements were made at a range of wind speeds, including those under which the turbines would operate, it is considered appropriate to assume the average of the four sets of measurements as representative residual noise levels for the purposes of the operational noise assessment.

Table 2 – Residual Noise Levels

Location	Residual Noise Level, Day, $L_{eq,16hr}$, dBA	Residual Noise Level, Night, $L_{eq,8hr}$, dBA
ML1	44	36
ML2	49	29
ML3	46	42
ML4	44	35
Average	**48**	**36**

For the construction noise assessment, as construction noise is not wind speed-dependent in the way that operational noise is, it is considered that the typical outdoor levels in rural districts as described in SANS 10103 are the appropriate representative baseline residual noise levels for the study area , i.e.:

- Day: 45 dBA, $L_{eq,16hr}$; and
- Night: 35 dBA, $L_{eq,8hr}$.

3.5 Desired Rating Levels

3.5.1 Construction Phase

Desired rating levels during the construction phase (10 dB above typical outdoor levels in rural districts) are:

- Day: 55 dBA, L_{eq}; and
- Night: 45 dBA, L_{eq}.

3.5.2 Operational Phase

Desired rating levels during the operational phase are:

- Day: 55 dBA, L_{eq} (7 dBA above the daytime average residual noise levels); and
- Night: 45 dBA, L_{eq} (based on WHO and ETSU-R-97 Guidelines).

As the turbines would operate during both day and night, the night-time desired rating levels equates to an effective overall noise limit for operational noise of 45 dBA, L_{eq}.

3.6 Comments from Interested or Affected Parties

No comments were received from interested or affected parties during compilation of this report.

4 IDENTIFICATION AND DESCRIPTION OF POTENTIAL IMPACTS

4.1 Noise Sources Associated with the Proposed Development

4.1.1 Construction Phase

Noise sources during construction would consist of the equipment and vehicles used in the construction process. A list of such items typically employed in wind farm construction is provided in Section 4.2.1.

4.1.2 Operational Phase

Wind Turbines

Sources of noise during operation of a wind turbine are both mechanical (from machinery housed within the turbine nacelle) and aerodynamic (from the movement of the blades

through the air). Modern turbines are designed to minimise mechanical noise emissions from the nacelle through isolation of mechanical components and acoustic insulation of the nacelle. Aerodynamic noise is controlled through the design of the blade tips and edges. In most modern wind turbines, aerodynamic noise is also restricted by control systems which actively regulate the pitch of the blades.

Wind Turbine Auxiliary Plant

There are a number of auxiliary plant items associated with wind turbines, such as transformers and switchgear. As stated in Section 4.3.4, noise emissions from such items are negligible in comparison to those from the wind turbines themselves.

Transmission Line

Under certain circumstances, power transmission lines can emit noise. This is discussed further at Section 4.3.5.

Substation

Electricity substations can emit noise, in the form of a hum at a frequency of 100 Hz. However, this noise is relatively easy to mitigate through the use of acoustic shielding and / or placement of the transformer equipment and will not be considered further as discussed at Section 4.3.6.

4.1.3 Decommissioning Phase

Noise sources during decommissioning would be similar to, though fewer than, those during construction and the duration shorter. Effects during decommissioning would therefore be no greater than those during construction.

4.2 Determination of Sound Emission from Identified Noise Sources

4.2.1 Construction Phase

For each phase of construction, relevant items of plant have been determined from experience of similar developments and their noise emission levels taken from the source level tables contained within BS 5228.

The following construction activities and plant items are considered to be those with most potential to result in adverse noise effects. Plant source levels are presented as sound pressure levels at a distance of 10 m.

Construction of tracks and hardstanding:

- 2 no. Tracked Excavators (BS 5228 Ref C5/18) – 80 dB, L_{Aeq} each
- 1 no. Articulated Dump Truck (Ref C6/16) – 88 dB, L_{Aeq}
- 1 no. Bulldozer (Ref C5/14) – 86 dB, L_{Aeq}
- 1 no. Vibratory Roller (Ref C5/18) – 84 dB, L_{Aeq}
- 6 no. Haulage Trucks per hour (Ref C2/34) – 88 dB, L_{Aeq} each

Excavation and concreting of turbine foundations:

- 1 no. Tracked Excavator (Ref C2/14) – 79 dB, L_{Aeq}
- 1 no. Concrete Mixer Truck with pump and boom arm (Ref C4/32) – 78 dB, L_{Aeq}
- 2 no. Poker Vibrators (Ref C4.33) – 78 dB, L_{Aeq} each
- 1 no. Dump Truck (tipping fill) (Ref C2.30) – 79 dB, L_{Aeq}
- 1 no. Roller (rolling fill) (Ref C2.37) – 79 dB, L_{Aeq}
- 1 no. Concrete Batching Plant (Ref D6/11) – 80 dB, L_{Aeq}
- 1 no. Lorry (Ref C11.18) – 80 dB, L_{Aeq}
- 6 no. Haulage Trucks per hour (Ref C2/34) – 88 dB, L_{Aeq} each

Turbine Erection:

- 1 no. Wheeled Mobile Crane (Ref C4/38) – 78 dB, L_{Aeq}
- 1 no. Mobile Telescopic Crane (Ref C4/39) – 77 dB, L_{Aeq}
- 1 no. Diesel Generator (Ref C4.85) – 66 dB, L_{Aeq}
- 2 no. Torque guns – 82 dB, L_{Aeq} each
- 5 no. Haulage Trucks per hour (Turbine Delivery) (Ref C11.18) – 88 dB, L_{Aeq} each

Any noise from night-time activities is likely to be limited to a generator to maintain power to critical plant (pumps, security systems etc.) (Diesel Generator Ref C4.85 – 66 dB, L_{Aeq}). As the requirement for, and location of such plant is unknown, it has been assumed as a worst-case that their location may be at the closest point of infrastructure to each of the noise-sensitive developments under consideration.

There is potential for the noise from construction operations to include regular impulsive sound. However, tonal noise is unlikely to be present, other than in the form of reversing alarms, which would not occur at the same time as impulsive sound for individual sources. A correction of +5 dB is therefore considered appropriate to account for both potential impulsivity and potential tonality.

This noise emission data presented in Section above has been used to calculate overall rating noise levels for each activity at a reference distance of 10 m, as follows:

- Construction of tracks and hardstanding: 97 dBA, $L_{Req,T}$;
- Excavation and concreting of turbine foundations: 93 dBA, $L_{Req,T}$;
- Turbine Erection: 91 dBA, $L_{Req,T}$; and
- Generator operation (night-time): 71 dBA, $L_{Req,T}$.

4.2.2 Operational Phase

The majority of wind farms at planning stage do not have a preferred turbine model selected for installation; therefore a candidate turbine representative of a range of turbines has been selected to provide an appropriate estimate of noise levels. Once noise levels have been predicted at the potentially affected properties, compliance with noise limits can be assessed and design advice provided to ensure noise limits are met.

The candidate turbine for the purposes of the noise assessment is the Acciona AW132-3300, with an installed capacity of 3.3 MW, a rotor diameter of 132 m and a hub height of 84 m. These dimensions result in a tip height of 150 m, the maximum height in the range under consideration. The turbine is available in a standard configuration or in a noise-mitigated version with blade serrations and nacelle insulation. The standard configuration has been assumed in the assessment of potential effects (Section 4.4). Where mitigation is found necessary, the noise-mitigated version has been modelled to determine which turbines require to be installed in this configuration (Section 5.2).

In accordance with the GPG, an addition has been applied to the manufacturer's stated sound power level data to account for measurement uncertainties of 1.645 x uncertainty. The manufacturer's documentation states a typical uncertainty of up to 1 dB, therefore 1.6 dB has been added, as shown in Table 3 as 'Modelled Sound Power Level'.

Table 4 details the octave-band sound power spectrum provided by the manufacturer. This was scaled to the modelled sound power levels shown in Table 3.

Noise emissions from wind turbines are generally broadband in nature without significant tonality or impulsivity. The manufacturer's datasheet confirms an absence of significant tonality (tonal audibility ≤ 2 dB). No corrections for such characteristics are therefore considered to be necessary.

Table 3 - Manufacturers Noise Emission Data - Acciona AW132-3300

Wind Speed at 10m Height, ms^{-1}	**6**	**7**	**8**	**9**	**10**
Wind Speed at 84 m Height (Z_o = 0.05 m), ms^{-1}	8.4	9.8	11.2	12.6	14.0
Standard Configuration					
Manufacturer's Estimated Sound Power Level, dB L_{WA}	108.5	108.5	108.5	108.5	108.5
Modelled Sound Power Level, dB, L_{WA}	110.1				
Noise-Mitigated – with Blade Serrations and Nacelle Insulation					
Manufacturer's Estimated Sound Power Level, dB L_{WA}	106.0	106.0	106.0	106.0	106.0
Modelled Sound Power Level, dB, L_{WA}	107.6				

Table 4 - Manufacturers Noise Emission Data - Acciona AW132-3300

Octave Band Centre Frequency, Hz	**32**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Sound Power Spectrum, dB, L_{WA}	73.6	84.7	98.1	103.8	103.0	99.5	97.9	95.9	89.3

4.2.3 Decommissioning Phase

Noise sources during decommissioning would be similar to, though fewer than, those during construction and the duration shorter. Effects during decommissioning would therefore be no greater than those during construction.

4.3 Sources Not Taken into Account

4.3.1 Low Frequency Noise and Infrasound

A study[10], published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the UK DTI, investigated low frequency noise from wind farms. This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines, but that complaints attributed to low frequency noise were in fact, possibly due to a phenomenon known as Amplitude Modulation (AM).

In February 2013, the Environmental Protection Authority of South Australia published the results of a study into in infrasound levels near wind farms[11]. This study measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shut-downs of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.

It is therefore not considered necessary to carry out specific assessments of low frequency noise or infrasound.

[10] The measurement of low frequency noise at three UK wind farms, Hayes Mckenzie, The Department for Trade and Industry, URN 06/1412, 2006.
[11] Environment Protection authority (2013) Infrasound levels near wind farms and in other environments [Online] Available at: http://www.epa.sa.gov.au/xstd_files/Noise/Report/infrasound.pdf (Accessed 09/03/18)

4.3.2 Amplitude Modulation

In its simplest form, Amplitude Modulation (AM), by definition, is the regular variation in noise level of a given noise source. This variation (the modulation) occurs at a specific frequency, which, in the case of wind turbines, is defined by the rotational speed of the blades, i.e. it occurs at the rate at which the blades pass a fixed point (e.g. the tower), known as Blade Passing Frequency.

A study[12] was carried out in 2007 on behalf of the UK Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with windfarms and whether these were associated with AM. The study defined AM as aerodynamic noise from wind turbines with a greater degree of fluctuation than normal at blade passing frequency. Its aims were to ascertain the prevalence of AM on UK windfarm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

The study concluded that AM had occurred at only a small number (4 of 133) of windfarms in the UK, and only for between 7% and 15% of the time. It also stated that, the causes of AM are not well understood and that prediction of the effect was not currently possible.

This research was updated in 2013 by an in-depth study undertaken by Renewable UK[13], which has identified that many of the previously suggested causes of AM have little or no association to the occurrence of AM in practice. The generation of AM is based upon the interaction of a number of factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to AM, and the incidence of AM occurring at any particular site remains low, as identified in the University of Salford study.

Section 7.2.1 of the GPG states: *"The evidence in relation to 'Excess' or 'Other' Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM".*

It is therefore not considered necessary to carry out specific assessments of AM.

4.3.3 Vibration

Research undertaken by Snow in 1996[14] found that levels of ground-borne vibration 100 m from a wind turbine were well below criteria for 'critical working areas' given by British Standard BS6472:1992 *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*, and were lower than limits specified for residential premises by an even greater margin.

4.3.4 Wind Turbine Auxiliary Plant

Additional auxiliary plant such as transformers and switchgear are anticipated to produce negligible levels of noise, and will not increase noise levels above those due to the operation of the wind turbines. Such sources have therefore not been considered further.

[12] University of Salford (2007). 'Research into aerodynamic modulation of wind turbine noise'. Report by University of Salford, The Department for Business, Enterprise and Regulatory Reform, URN 07/1235, July 2007.
[13] Renewable UK (2013).'Wind Turbine Amplitude Modulation: Research to improve understanding as to its Cause and effects', Renewable UK, 2013.
[14] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow.

4.3.5 Transmission Line Noise (Corona noise)

Corona noise is caused by the partial breakdown of the insulating properties of the air surrounding the conducting wires. It can generate audible and radio-frequency noise, but generally only occurs in humid conditions as provided by fog or rain. A minimum line potential of 70 kV or higher is generally required to generate corona noise depending on the electrical design.

Corona noise has two major components: a tone associated with the frequency of the AC supply (100 Hz for 50 Hz source) and broadband noise. The tonal component of the noise is related to the point along the electric waveform at which the air begins to conduct. This varies with each cycle and consequently the frequency of the emitted tone is subject to great fluctuations. Corona noise can be characterised as broadband 'crackling' or 'buzzing', but it is generally only a feature during fog or rain.

Corona discharges results in:

- Power losses;
- Audible noises;
- Electromagnetic interference;
- A purple glow;
- Ozone production; and
- Insulation damage

As such, Electrical Service Providers (such as Eskom) go to great lengths to design power transmission equipment to minimise the formation of corona discharges. In addition, it is an infrequent occurrence with a relative short duration compared to other operational noises.

Furthermore, no potential noise-sensitive developments have been identified within the 300 m wide corridor of each of the potential grid connection routes.

Any noise associated with the transmission lines is therefore considered to be negligible and will not be investigated further.

4.3.6 Substation

As substation noise is relatively easy to mitigate through the use of acoustic shielding and / or placement of the transformer equipment it will not be considered further.

4.4 Potential Impacts

4.4.1 Highlands North WEF: Phase 1

4.4.1.1 Construction Phase

Construction phase impacts have been determined for the closest noise-sensitive location to each construction activity, and are shown in Table 5.

Table 5 - Predicted Construction Noise Levels, dBA, $L_{Req,T}$, Phase 1

Activity	Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
			Day	Night	Day	Night
Construction of Tracks and Hardstanding	6	71	26	0	Very High	None
Excavation and Concreting of Turbine foundations	6	61	16	0	High	None
Turbine Erection	6	59	14	0	High	None
Generator	6	45	0	10	None	Medium

As can be seen from Table 5, potential impacts from construction of Phase 1 are generally of high intensity for daytime periods, with the exception of the construction of tracks, which is potentially very high intensity and the generator of no intensity during the day and of medium intensity during the night. The duration of this effect would be limited, however, which is taken into account in the assessment of such effects presented in 6.1.1, along with the mitigation measures presented in Section 5.1.

4.4.1.2 Operational Phase

Table 6 details the predicted operational noise levels for Phase 1 of the proposed Development. The excess of the predicted noise levels over the desired day and night rating levels and consequent impact intensity are also shown. Where '-' is shown, the predicted level is less than 20 dBA and no impact will occur.

Table 6 - Predicted Operational Noise Levels, dBA, $L_{Req,T}$, Phase 1

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
		Day	Night	Day	Night
1	28	-20	-8	None	None
2	29	-19	-7	None	None
3	29	-19	-7	None	None
4	39	-9	3	None	Low
5	40	-8	4	None	Medium
6	45	-3	9	None	High
7	21	-27	-15	None	None
8	33	-15	-3	None	None
9	31	-17	-5	None	None
10	-	-	-	None	None
11	-	-	-	None	None
12	-	-	-	None	None

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
		Day	Night	Day	Night
13	-	-	-	None	None
14	-	-	-	None	None
15	40	-8	4	None	Medium
16	-	-	-	None	None
17	-	-	-	None	None
18	-	-	-	None	None

As can be seen from Table 6, there would be no effects during the day at any of the receptors. At night there would be:

- No effects at 14 locations;
- Low effects at 1 location (4);
- Medium effects at 2 locations (5 and 15); and
- High effects at 1 location (6).

Mitigation for the high-intensity impacts is discussed in Section 5.2. It should be noted, as stated in Section 3.2, that location 6 is a hunting lodge which is not permanently occupied.

4.4.1.3 Decommissioning Phase

During decommissioning, it is likely that fewer noise sources will operate for a shorter duration than during construction. The effects from decommissioning will therefore be no greater than the Phase 1 predicted levels in Section 4.4.1.1.

4.4.2 Highlands Central WEF: Phase 2

4.4.2.1 Construction Phase

Construction phase impacts have been determined for the closest noise-sensitive location to each construction activity, and are shown in Table 7.

Table 7 - Predicted Construction Noise Levels, dBA, $L_{Req,T}$, Phase 2

Activity	Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
			Day	Night	Day	Night
Construction of Tracks and Hardstanding	9	67	22	0	Very High	None
Excavation and Concreting of Turbine foundations	9	62	17	0	High	None
Turbine Erection	9	60	15	0	High	None
Generator	9	41	-4	6	None	Medium

As can be seen from Table 7, potential impacts from construction of Phase 2 are generally of high intensity during the day, with the exception of the construction of tracks, which is potentially very high intensity and the generator which is of no intensity during the day and of medium intensity during the night. The duration of this effect would be limited, however, which is taken into account in the assessment of such effects presented in 6.2.1, along with the mitigation measures presented in 5.1.

4.4.2.2 Operational Phase

Table 8 details the predicted operational noise levels for Phase 2 of the proposed Development. The excess of the predicted noise levels over the desired daytime and night-time rating levels and consequent impact intensity are also shown. Where '-' is shown, the predicted level is less than 20 dBA and no impact will occur.

Table 8 - Predicted Operational Noise Levels, dBA, $L_{Req,T}$, Phase 2

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
		Day	Night	Day	Night
1	-	-	-	None	None
2	23	-25	-13	None	None
3	23	-25	-13	None	None
4	23	-25	-13	None	None
5	31	-17	-5	None	None
6	43	-6	7	None	Medium
7	28	-21	-9	None	None
8	42	-6	6	None	Medium
9	45	-3	9	None	High
10	28	-20	-8	None	None
11	27	-21	-9	None	None
12	-	-	-	None	None
13	-	-	-	None	None
14	-	-	-	None	None
15	32	-16	-4	None	None
16	24	-24	-12	None	None
17	25	-23	-11	None	None
18	-	-	-	None	None

As can be seen from Table 8, there would be no effects during the day at any of the receptors. At night there would be:

- No effects at 15 locations;
- Medium effects at 2 locations (6 and 8); and
- High effects at 1 location (9).

Mitigation for the high-intensity impacts is discussed in Section 5.2.

4.4.2.3 Decommissioning Phase

During decommissioning, it is likely that fewer noise sources will operate for a shorter duration during decommissioning. The effects from decommissioning will therefore be no greater than the phase 2 predicted levels in Section 4.4.2.1.

4.4.3 Highlands South WEF: Phase 3

4.4.3.1 Construction Phase

Construction phase impacts have been determined for the closest noise-sensitive location to each construction activity, and are shown in Table 9.

Table 9 - Predicted Construction Noise Levels, dBA, $L_{Req,T}$, Phase 3

Activity	Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
			Day	Night	Day	Night
Construction of Tracks and Hardstanding	12	66	21	0	Very High	None
Excavation and Concreting of Turbine foundations	12	61	16	0	High	None
Turbine Erection	12	59	16	0	High	None
Generator	12	40	-5	5	None	Low

As can be seen from Table 9, potential impacts from construction of Phase 3 are generally of high intensity during the day, with the exception of the construction of tracks, which is potentially very high intensity and the generator of no intensity and of low intensity during the night. The duration of this effect would be limited, however, which is taken into account in the assessment of such effects presented in 6.3.1, along with the mitigation measures presented in 5.1.

4.4.3.2 Operational Phase

Table 10 details the predicted operational noise levels for Phase 3 of the proposed Development. The excess of the predicted noise levels over the desired day and night rating levels and consequent impact intensity are also shown. Where '-' is shown, the predicted level is less than 20 dBA and no impact will occur.

Table 10 - Predicted Operational Noise Levels, dBA, $L_{Req,T}$, Phase 3

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Significance	
		Day	Night	Day	Night
1	-	-	-	None	None
2	-	-	-	None	None
3	-	-	-	None	None
4	-	-	-	None	None
5	-	-	-	None	None
6	-	-	-	None	None
7	-	-	-	None	None
8	40	-8	4	None	Medium
9	41	-7	5	None	Medium
10	35	-13	-1	None	None
11	34	-14	-2	None	None
12	48	0	12	None	High
13	47	-1	11	None	High
14	45	-3	9	None	High
15	-	-	-	None	None
16	39	-9	3	None	Low
17	40	-8	4	None	Medium
18	37	-11	1	None	Low

As can be seen from Table 10, there would be no effects during the day at any of the receptors. At night there would be:

- No effects at 10 locations;
- Low effects at 2 locations (16 and 18);
- Medium effects at 3 locations (8, 9 and 17); and
- High effects at 3 locations (12, 13 and 14).

Mitigation for the high-intensity impacts is discussed in Section 5.2. It should be noted, as stated in Section 3.2, that location 6 is a hunting lodge which is not permanently occupied.

4.4.3.3 Decommissioning Phase

During decommissioning, it is likely that fewer noise sources will operate for a shorter duration during decommissioning. The effects from decommissioning will therefore be no greater than the phase 3 predicted levels in Section 4.4.3.1.

4.4.4 Cumulative Effects

4.4.4.1 Construction Phase

The cumulative construction noise impact is the worst-case of those for the three individual phases. As discussed above, construction of tacks and hardstanding has the potential for effects of up to very high intensity. The duration of this effect would be limited however, which is taken into account in the assessment of such effects presented in 6.4.1, along with the mitigation measures presented in Section 5.1.

4.4.4.2 Operational Phase

Table 11 details predicted cumulative noise levels at each of the assessed noise-sensitive developments. The excess of the predicted noise levels over the desired day and night rating levels and consequent impact intensity are also shown.

It should be noted that directivity has been accounted for as recommended in the IOA GPG, i.e.:

- No change in noise levels from directly downwind to 80 degrees from downwind;
- 2 dB reduction at 90 degrees to downwind;
- 10 dB reduction upwind;
- Intermediate values obtained by linear interpolation; and
- The values for the worst-case wind direction are presented.

Table 11 - Predicted Cumulative Operational Noise Levels, dBA, $L_{Req,T}$

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
		Day	Night	Day	Night
1	28	-20	-8	None	None
2	30	-18	-6	None	None
3	30	-18	-6	None	None
4	39	-9	3	None	Low
5	41	-7	5	None	Medium
6	47	-1	11	None	High
7	28	-20	-8	None	None
8	45	-3	9	None	Medium

Location	Predicted Rating Level dBA, $L_{Req,T}$	Excess, dBA $\Delta L_{Req,T,}$		Impact Intensity	
		Day	Night	Day	Night
9	47	-1	11	None	High
10	35	-13	-1	None	None
11	35	-13	-1	None	None
12	48	0	12	None	High
13	47	-1	11	None	High
14	45	-3	9	None	High
15	41	-7	5	None	Medium
16	39	-9	3	None	Low
17	40	-8	4	None	Medium
18	37	-11	1	None	Low

As can be seen from Table 11, there would be no effects during the day at any of the receptors. At night there would be:

- No effects at 6 locations;
- Low effects at 2 locations (16 and 18);
- Medium effects at 4 locations (5, 8, 15 and 17); and
- High effects at 5 locations (6, 9, 12, 13 and 14).

Mitigation for the high-intensity impacts is discussed in Section 5.2. It should be noted, as stated in Section 3.2, that location 6 is a hunting lodge which is not permanently occupied.

4.4.4.3 Decommissioning Phase

During decommissioning, it is likely that fewer noise sources will operate for a shorter duration during decommissioning. The effects from decommissioning will therefore be no greater than the phase effects discussed at 4.4.4.1.

5 IDENTIFICATION AND DESCRIPTION OF MITIGATION MEASURES

5.1 Construction Phase

Section 4 identifies potential for impacts of medium to high intensity from the construction of tracks and hardstanding, albeit of relatively short duration. Such activities therefore require mitigation, in the form of management of construction noise.

The assessment considers a worst case, including the assumption that all construction items are in operation for 100 per cent of the time.

The good practice measures detailed below should be implemented to manage the effects of noise from works on site:

- Where practicable, noise from fixed plant and equipment should be contained within suitable acoustic enclosures or behind acoustic screens;
- Noise-generating plant should be located as far away from the noise-sensitive receptors as is feasible for the particular activity;
- Plant and equipment covers and hatches should be properly secured to ensure there are no loose fixings causing rattling;
- Silenced equipment should be used where possible;
- Plant should be turned off when not in use;
- Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms;
- The use of vehicle horns should be limited to emergency use only; and
- Good public relations should be maintained with local residents that may be affected by noise from site operations. Effective communication should be established, keeping local residents informed of the type and timing of works, particularly in relation to temporary activities which may generate additional levels of noise.

It is recommended that a condition is attached to the permission for the proposed Development, requiring the submission for approval of a construction noise management plan prior to the commencement of construction.

5.2 Operational Phase

Section 4 identifies potential for impacts of high intensity from the operation of the proposed Development at night. Such impacts require mitigation to no more than the noise limit of 46 dBA, as defined in Section 3.3, i.e., medium intensity / significance, less than the level at which a disturbing noise occurs in terms of the NCR.

As stated in 4.1.2, the candidate turbine is available in a noise-mitigated configuration with blade trailing edge serrations and nacelle insulation, which would reduce noise emissions by 2.5 dBA. The following turbines would require to be installed in this configuration:

- Phase 1 individually: turbine 16;
- Phase 2 individually: turbine 31;
- Phase 3 individually: turbines 41 to 48; and
- Cumulatively: turbines 16, 17, 31 and 41 to 48.

It should be noted that mitigation of turbines 16 and 17 are only required in respect of location 6. As stated above this is not permanently occupied, so subject to agreement with the appropriate landowner, mitigation of turbines 16 and 17 may not be necessary in practice.

Mitigation of turbine 31 is required in respect of locations 8 and 9, and mitigation of turbines 41 to 48 in respect of locations 12, 13 and 14. It is understood that agreement may be possible with landowners that noise levels are acceptable and / or relocation of

farmworkers at these locations, in which case the use of noise-mitigated turbines may not be necessary.

Should a turbine model other than the candidate be installed, consideration should be given to the noise emission of that turbine model and appropriate mitigation included if necessary.

6 IMPACT ASSESSMENT

6.1 Highlands North WEF: Phase 1

6.1.1 Construction Phase Impact Assessment

6.1.1.1 Construction of Tracks and Hardstanding

Impact Phase: Construction							
Potential impact description: Construction of Tracks and Hardstanding Detailed description of impact: 2 no. Tracked Excavators 1 no. Articulated Dump Truck 1 no. Bulldozer 1 no. Vibratory Roller 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss of resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.1.1.2 Excavation and Concreting of Foundations

Impact Phase: Construction							
Potential impact description: Excavation and Concreting of Turbine Foundations Detailed description of impact: 1 no. Tracked Excavator 1 no. Concrete Mixer Truck with pump and boom arm 2 no. Poker Vibrators 1 no. Dump Truck (tipping fill) 1 no. Roller (rolling fill) 1 no. concrete Batching Plant 1 no. Lorry 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss of resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.1.1.3 Turbine Erection

Impact Phase: Construction							
Potential impact description: Turbine Erection Detailed description of impact: 1 no. Wheeled Mobile Crane 1 no. Mobile Telescopic Crane 1 no. Diesel Generator 2 no. Torque guns 5 no. Haulage Trucks per hour (Turbine Delivery)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss of resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.1.1.4 Generator (Night-time Use)

Impact Phase: Construction							
Potential impact description: Generator (Night-time Use)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	M	L	L	Negative	L	L	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss of resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.1.2 Operational Phase Impact Assessment

6.1.2.1 Daytime Operation

Impact Phase: Operation							
Potential impact description: Operation – Day Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	L	L	H	Negative	L	L	H
With Mitigation	L	L	H	Negative	L	L	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss of resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: None Required							

6.1.2.2 Night-time Operation

Impact Phase: Operation							
Potential impact description: Operation – Night Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	H	Negative	M	M	H
With Mitigation	M	L	H	Negative	M	M	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.2 Use of noise-mitigated turbines							

6.2 Highlands Central WEF: Phase 2

6.2.1 Construction Phase Impact Assessment

6.2.1.1 Construction of Tracks and Hardstanding

Impact Phase: Construction							
Potential impact description: Construction of Tracks and Hardstanding Detailed description of impact: 2 no. Tracked Excavators 1 no. Articulated Dump Truck 1 no. Bulldozer 1 no. Vibratory Roller 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.2.1.2 Excavation and Concreting of Foundations

Impact Phase: Construction							
Potential impact description: Excavation and Concreting of Turbine Foundations Detailed description of impact: 1 no. Tracked Excavator 1 no. Concrete Mixer Truck with pump and boom arm 2 no. Poker Vibrators 1 no. Dump Truck (tipping fill) 1 no. Roller (rolling fill) 1 no. concrete Batching Plant 1 no. Lorry 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.2.1.3 Turbine Erection

Impact Phase: Construction							
Potential impact description: Turbine Erection Detailed description of impact: 1 no. Wheeled Mobile Crane 1 no. Mobile Telescopic Crane 1 no. Diesel Generator 2 no. Torque guns 5 no. Haulage Trucks per hour (Turbine Delivery)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.2.1.4 Generator (Night-time Use)

Impact Phase: Construction							
Potential impact description: Generator (Night-Time Use)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	M	L	L	Negative	L	L	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.2.2 Operational Phase Impact Assessment

6.2.2.1 Daytime Operation

Impact Phase: Operation							
Potential impact description: Operation – Day Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	L	L	H	Negative	L	L	H
With Mitigation	L	L	H	Negative	L	L	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: None Required							

6.2.2.2 Night-time Operation

Impact Phase: Operation							
Potential impact description: Operation – Night Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	H	Negative	M	H	H
With Mitigation	M	L	H	Negative	M	L	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.2 Use of noise-mitigated turbines							

6.3 Highlands South WEF: Phase 3

6.3.1 Construction Phase Impact Assessment

6.3.1.1 Construction of Tracks and Hardstanding

Impact Phase: Construction							
Potential impact description: Construction of Tracks and Hardstanding Detailed description of impact: 2 no. Tracked Excavators 1 no. Articulated Dump Truck 1 no. Bulldozer 1 no. Vibratory Roller 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.3.1.2 Excavation and Concreting of Foundations

Impact Phase: Construction							
Potential impact description: Excavation and Concreting of Turbine Foundations Detailed description of impact: 1 no. Tracked Excavator 1 no. Concrete Mixer Truck with pump and boom arm 2 no. Poker Vibrators 1 no. Dump Truck (tipping fill) 1 no. Roller (rolling fill) 1 no. concrete Batching Plant 1 no. Lorry 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.3.1.3 Turbine Erection

Impact Phase: Construction							
Potential impact description: Turbine Erection Detailed description of impact: 1 no. Wheeled Mobile Crane 1 no. Mobile Telescopic Crane 1 no. Diesel Generator 2 no. Torque guns 5 no. Haulage Trucks per hour (Turbine Delivery)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.3.1.4 Generator (Night-Time Use)

Impact Phase: Construction							
Potential impact description: Generator							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	L	L	L	Negative	L	L	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: None Required							

6.3.2 Operational Phase Impact Assessment

6.3.2.1 Daytime Operation

Impact Phase: Operation							
Potential impact description: Operation – Day Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	L	L	H	Negative	L	L	H
With Mitigation	L	L	H	Negative	L	L	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			Yes				
Mitigation measures to reduce residual risk or enhance opportunities: None Required							

6.3.2.2 Night-time Operation

Impact Phase: Operation							
Potential impact description: Operation – Night Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	H	Negative	M	H	H
With Mitigation	M	L	H	Negative	M	M	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.2 Use of noise-mitigated turbines.							

6.4 Cumulative Impact Assessment

The cumulative impact assessment considers the cumulative effects of the three phases of the proposed development, and other renewable energy projects within 35 km of the proposed Development. Two such other projects have been identified:

- Middleton Wind Energy farm; and
- Pearston Solar Farm.

Each of the above are located more than 20 km from the proposed Development. As such, there is no possibility of cumulative impacts. The cumulative assessment therefore only considers the cumulative effects of the three phases of the development.

6.4.1 Construction Phase

6.4.1.1 Construction of Tracks and Hardstanding

Impact Phase: Construction							
Potential impact description: Construction of Tracks and Hardstanding Detailed description of impact: 2 no. Tracked Excavators 1 no. Articulated Dump Truck 1 no. Bulldozer 1 no. Vibratory Roller 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.4.1.2 Excavation and Concreting of Foundations

Impact Phase: Construction							
Potential impact description: Excavation and Concreting of Turbine Foundations Detailed description of impact: 1 no. Tracked Excavator 1 no. Concrete Mixer Truck with pump and boom arm 2 no. Poker Vibrators 1 no. Dump Truck (tipping fill) 1 no. Roller (rolling fill) 1 no. concrete Batching Plant 1 no. Lorry 6 no. Haulage Trucks per hour							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.4.1.3 Turbine Erection

Impact Phase: Construction							
Potential impact description: Turbine Erection Detailed description of impact: 1 no. Wheeled Mobile Crane 1 no. Mobile Telescopic Crane 1 no. Diesel Generator 2 no. Torque guns 5 no. Haulage Trucks per hour (Turbine Delivery)							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	L	Negative	M	M	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Where practicable, mobile plant should be fitted with broadband, rather than tonal reversing alarms; The use of vehicle horns should be limited to emergency use only; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.4.1.4 Generator (Night-time Use)

Impact Phase: Construction							
Potential impact description: Generator							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	M	L	H	Negative	L	L	H
With Mitigation	L	L	L	Negative	L	L	H
Can the impact be reversed?			YES – impact is temporary during construction phase.				
Will impact cause irreplaceable loss or resources?			NO				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.1 Acoustic enclosures/screens should be used to contain noise-generating/equipment; Noise-generating plant should be located as far away from the noise sensitive receptors as is feasible; Plant and equipment covers and hatches should be properly; Silenced equipment should be used where possible; Plant should be turned off when not in use; Good public relations should be maintained with local residents that may be affected by noise from site operations.							

6.4.2 Operational Phase

6.4.2.1 Daytime Operation

Impact Phase: Operation							
Potential impact description: Operation – Day Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	L	L	H	Negative	L	L	H
With Mitigation	L	L	H	Negative	L	L	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: Not Required							

6.4.2.2 Night-time Operation

Impact Phase: Operation							
Potential impact description: Operation – Night Detailed description of impact: Wind Turbines, Wind Turbine Auxiliary Plant, Transmission Line and Substation							
	Intensity	**Extent**	**Duration**	**Status**	**Probability**	**Significance**	**Confidence**
Without Mitigation	H	L	H	Negative	M	H	H
With Mitigation	M	L	H	Negative	M	M	H
Can the impact be reversed?			YES – Impact would be reversed after decommissioning				
Will impact cause irreplaceable loss or resources?			NO – Impact would be reversed after decommissioning				
Can impact be avoided, managed or mitigated?			YES				
Mitigation measures to reduce residual risk or enhance opportunities: See Section 5.2 Use of noise-mitigated turbines.							

7 CONCLUSIONS

WKN Windcurrent South Africa (Ltd) Pty are proposing the Highlands Wind Energy Facility, and associated infrastructure including grid connection infrastructure, located near the town of Somerset East in the Eastern Cape Province. This report has assessed the (worst-case) noise impacts of the Proposed Development in accordance with SANS 10328, and has been found to be acceptable, subject to appropriate noise mitigation measures. A range of mitigation options are available, including:

- Use of noise-mitigated version of the candidate turbine model;
- Installation of turbines with lower noise emission than those assumed within this report; and / or
- Relocation of farm workers from properties with the greatest noise impact.

The Final Mitigated Layout has been examined, would not have noise impacts different to those detailed within this Report and can therefore be approved.

7.1 Impact Statement

The level of impact of noise effects has been assessed as follows:

7.1.1 Phase 1

- Medium during construction and decommissioning without mitigation;
- Low during construction and decommissioning with mitigation;
- Low during day-time operation; and
- High during night-time operation without mitigation; and
- Medium during night-time operation with mitigation.

7.1.2 Phase 2

- Medium during construction and decommissioning without mitigation;
- Low during construction and decommissioning with mitigation;
- Low during day-time operation; and
- High during night-time operation without mitigation; and
- Medium during night-time operation with mitigation.

7.1.3 Phase 3

- Medium during construction and decommissioning without mitigation;
- Low during construction and decommissioning with mitigation;
- Low during day-time operation;
- High during night-time operation without mitigation; and
- Medium during night-time operation with mitigation.

7.1.4 Cumulative

- Medium during construction and decommissioning without mitigation;
- Low during construction and decommissioning with mitigation;
- Low during day-time operation;
- High during night-time operation without mitigation; and
- Medium during night-time operation with mitigation.

During decommissioning, it is likely that fewer noise sources will operate for a shorter duration than during construction. The impacts associated with decommissioning will therefore be no greater than those presented for construction.

7.2 Conditions to be Included in Environmental Authorisation

Noise due to the operation of the proposed Development is not to exceed 45 dBA, $L_{eq,16hr}$ at any residential dwelling present at the time of this consent.

It is recommended that, prior to construction of the proposed development, ambient noise levels within the study area are re-measured and analysed in relation to wind speed, following the methodology described in ETSU-R-97 and the advice of the GPG.

Such measurements should then be repeated within the first 12 months of operation at selected locations within the 42-45 dBA noise contours as shown in Figure 1 to confirm the effectiveness of mitigation measures.

8 GLOSSARY

Ambient Noise: The all-encompassing sound at a point being composed of sounds from many sources both near and far. It includes the noise from the noise source under investigation.

Annoyance: A negative response to a condition which creates dissatisfaction or interrupts specific activities.

Decibel (dB): The decibel is the basic unit of noise measurement. It relates to the cyclical changes in pressure created by the sound and operates on a logarithmic scale, ranging upwards from 0 dB. 0 dB is equivalent to the normal threshold of hearing at a frequency of 1000 Hz. Each increase of 3 dB on the scale represents a doubling of the sound pressure, and is typically the minimum noticeable change in sound level under typical listening conditions. For example, whilst an increase in noise level from 32 dB to 35 dB represents a doubling of sound pressure, this change would only just be noticeable to the majority of listeners.

dB(A): Environmental noise levels are usually discussed in terms of dB(A). This is known as the A-weighted sound pressure level, and indicates that a correction factor has been applied, which corresponds to the human ear's response to sound across the range of audible frequencies. The ear is most sensitive in the middle range of frequencies (around 1000-3000 Hertz (Hz)), and less sensitive at lower and higher frequencies. The A-weighted noise level is derived by analysing the level of a sound at a range of frequencies and applying a specific correction factor for each frequency before calculating the overall level. In practice this is carried out automatically within noise measuring equipment by the use of electronic filters, which adjust the frequency response of the instrument to mimic that of the ear. Table 18 details typical dB(A) noise levels for a range of noise sources.

Impulsive sound: sound characterised by brief sound pressure impulses that exceed the residual noise significantly.

$L_{Aeq,t}$: This term is known as the A-weighted equivalent continuous sound pressure level for a period of time, t. It is similar to an average, and represents the sound pressure level of a steady sound that has, over a given period, the same energy as the fluctuating sound in question.

Low frequency noise: Sounds containing energy at frequencies below 100 Hz.

$L_{R,dn}$: This term is known as the equivalent continuous day/night rating level. This is the A-weighted equivalent continuous sound pressure level during a reference time interval of 24 hours. It also includes additional corrections for tonality and impulsivity.

$L_{Req,T}$: This term is known as the equivalent continuous rating level. This is the A-weighted equivalent continuous sound pressure level during a specified time interval. It also includes additional corrections for tonality and impulsivity.

Noise: Unwanted sound. May refer to both natural (e.g. wind, birdsong etc.) and artificial sounds (e.g. traffic, noise from wind turbines, etc.)

Noise contour plot: A diagram showing lines of equal sound levels (isobels) in a similar manner to height contours on an Ordnance Survey map or isobars (lines of equal pressure) on a weather map.

Noise sensitive receptors: Locations that may potentially be adversely affected by the addition of a new source of noise, such as residential properties.

Residual noise: Totally encompassing sound of situation, composed of many sources both near and far, excluding noise under investigation.

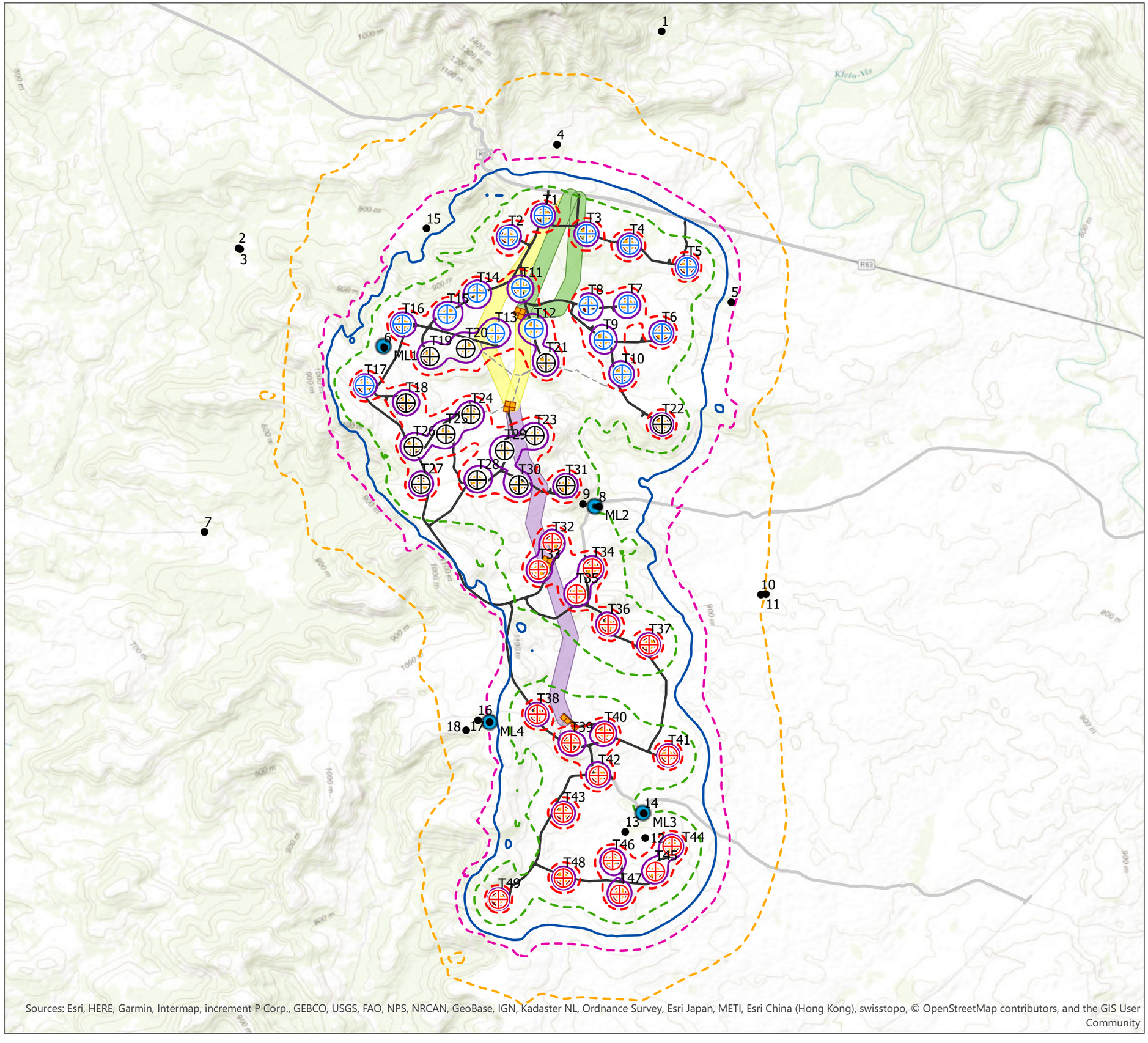
Sound power level (L_w): Sound power measured on the decibel scale, relative to a reference value (Wo) of 10-12 W.

Sound pressure (P): The fluctuations in pressure relative to atmospheric pressure, measured in Pascals (Pa).

Sound pressure level (L_p): Sound pressure measured on the decibel scale, relative to a sound pressure of 2 x 10-5 Pa.

Specific noise: Specific noise source under investigation that contributes to the ambient noise and be identified by acoustical means.

FIGURE 1: LOCATION PLAN AND NOISE CONTOUR PLOT



ARCUS

- House Locations
- Monitoring Locations

Turbine Locations

- Phase 1
- Phase 2
- Phase 3
- Substations
- Substations CraneHardstanding
- Access Tracks
- Internal Cabling
- Existing Roads

Grid Route Corridor

- Central Grid Corridor
- North Grid Corridor
- South Grid Corridor

Predicted Noise Level, dB LAeq

- 35
- 40
- 42
- 45
- 50
- 52
- 55

1:75,000 Scale @ A3

0 1.5 3 km

NORTH

Produced By: SW	Ref: 2780-REP-005
Checked By: MR	Date: 13/07/2018

Noise Contour Plot
Figure 1

Highlands WEF
Noise Report

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

N:\Projects\South Africa\SouthAfrica Noise\SouthAfrica_Noise.aprx\2780-REP-005

APPENDIX 1: CV AND DECLARATION OF INDPENDENCE

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/ or 12/9/11/L
NEAS Reference Number:	DEA/EIA
Date Received:	

Application for integrated environmental authorisation and waste management licence in terms of the-

(1) National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2014; and

(2) National Environmental Management Act: Waste Act, 2008 (Act No. 59 of 2008) and Government Notice 921, 2013

PROJECT TITLE: Highlands Wind Energy Farm

Specialist:	Noise		
Contact person:	Michael Reid		
Postal address:	Arcus Consultancy Services Ltd, 144 West George St, Glasgow, UK		
Postal code:	G2 2HG	Cell:	+44 7878 530174
Telephone:	+44 141 221 9997	Fax:	
E-mail:	michaelr@arcusconsulting.co.uk		
Professional affiliation(s) (if any)	Member of Institute of Acoustics (UK)		

Project Consultant:			
Contact person:			
Postal address:			
Postal code:		Cell:	
Telephone:		Fax:	
E-mail:			

4.2 The specialist appointed in terms of the Regulations_

I, Michael Reid , declare that --

General declaration:

I act as the independent specialist in this application;
I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
I declare that there are no circumstances that may compromise my objectivity in performing such work;
I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
I will comply with the Act, Regulations and all other applicable legislation;
I have no, and will not engage in, conflicting interests in the undertaking of the activity;
I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
all the particulars furnished by me in this form are true and correct; and
I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Arcus Consultancy Services Ltd

Name of company (if applicable):

27/08/2018

Date:

CURRICULUM VITAE

Michael Reid

Associate Director - Acoustics

Email:MichaelR@arcusconsulting.co.uk Tel: 0141 221 9997

Specialisms

- Assessment of potential noise impacts of proposed wind farm developments in accordance with relevant guidance and industry best practice
- Presenting evidence in support of wind farm noise assessments at Public Inquiry
- Environmental Statement Preparation
- Prediction of noise levels from wind farms, industrial developments, transportation and construction activities using specialised computer modelling packages in accordance with appropriate standards (e.g. ISO 9613-2, BS 5228)
- Measurement of background noise levels in accordance with appropriate standards for wind farms and other proposed developments
- Monitoring of wind farm operational noise levels
- Measurement of wind turbine noise emission levels
- Examination of noise assessments as part of Due Diligence studies

Summary of Experience

Michael has extensive (over ten years) experience of the environmental assessment of wind farms, particularly the assessment of noise effects, but also encompassing many other aspects of the process, including scoping and consultation, site feasibility and layout design, negotiation of planning conditions and turbine selection.

Michael has presented evidence at Public Inquiry in support of noise assessment work he has carried out and has supported the preparation of evidence by Andrew Bullmore of Hoare Lea Acoustics in support of Arcus noise assessments at other inquiries.

Michael is a member of the Institute of Acoustics, and has completed the Institute's Diploma in Acoustics and Noise Control and Certificate of Competence in Environmental Noise Monitoring.

Michael was previously employed with RPS Group PLC as a Senior Consultant, specialising in the Environmental Impact Assessment of renewable energy projects. His responsibilities included the assessment of noise from proposed wind farms, hydroelectric installations and wastewater treatment works.

Other experience includes: wind resource analysis; due diligence; shadow flicker assessment; the use of Geographical Information Systems in carrying out Best Practicable Environmental Option (BPEO) analyses for grid connection routes, site evaluation, and constraint mapping for layout design.

In addition to wind farm and renewable energy developments, Michael has experience of the environmental assessment of open-cast coal mining, wastewater infrastructure and other industrial and commercial developments.

Professional History

September 2006 to present - Principal Consultant, Arcus Consultancy Services, Glasgow
2005 to 2006 - Senior Consultant, RPS Group plc, Glasgow
2004 to 2005 - Environmental Consultant, RPS Group plc, Glasgow
2003 to 2004 - Environmental Scientist, RPS Group plc, Glasgow

Qualifications and Professional Interests

- **Full Member of Institute of Acoustics (MIOA)**
- **Institute of Acoustics (Distance Learning), 2006**
  Diploma in Acoustics and Noise Control, with Merit
- **Institute of Acoustics, IOA 2004**
  Certificate of Competence in Environmental Noise Measurement
- **Bell College, 2003**
  Postgraduate Diploma in Environmental Management, with Distinction

CURRICULUM VITAE

- **University of Strathclyde, 1992**
  Bachelor of Science
- Corporate Member, Institute of Acoustics (MIOA)

Selected Project Experience

Inquiry / Appeal Experience:

- Bessy Bell II Extension and Bessy Bell III (Repowering of Bessy Bell I) Wind Farms, Northern Ireland: Expert Witness at Appeal Hearing for 2 x wind farms of up to 41.2 MW (SSE Renewables)
- Sorbie Wind Farm (North Ayrshire): Expert Witness at Appeal Hearing for wind farm consisting of 3 x 2-3 MW turbines (2020 Renewables)
- Bishopthorpe Wind Farm (East Lindsey District): Expert Witness at Public Inquiry for wind farm consisting of 8 x 2-3 MW turbines (ASC Renewables)
- Dunsland Cross Wind Farm (Torridge, Devon): Expert Witness at Public Inquiry for 3 x wind turbine development;
- Harburnhead Wind Farm (West Lothian): Expert witness at Conjoined section 36 Inquiry;
- Fewcott Wind Farm, Oxfordshire, preparation of environmental noise assessment, presented evidence at Public Inquiry. Consented at Inquiry. (Bolsterstone)
- Sillfield Wind Farm, South Lakeland, preparation of environmental noise assessment, presented evidence at Public Inquiry. (Whirlwind Renewables)

Other Experience:

- Griffin Wind Farm, Perth & Kinross: Monitoring of noise levels from operational 156MW wind farm to establish compliance with planning conditions (SSE Renewables)
- Hunterston National Offshore Wind Turbine Test Facility, preparation of noise assessment for test facility for prototype offshore wind turbines. Negotiation of appropriate noise limits and planning conditions. Consented at committee. (SSE Renewables)
- Kilgallioch Wind Farm: preparation of environmental noise assessment for 288MW wind farm consented under s.36. (ScottishPower Renewables)
- Gordonstown Wind Farm, Aberdeenshire, preparation of environmental noise assessment for consented wind farm. (Infinis)
- Carland Cross Wind Farm Repowering (Cornwall): preparation of environmental noise assessment, consented at Inquiry. (ScottishPower Renewables)
- Glenconway wind farm, Northern Ireland: Noise assessment, complicated by presence of existing operational windfarm and a proposed extension nearby. (SSE Renewables)
- Due diligence of 7 x 2.3MW-turbine wind farm site in Northern Ireland. (SSE Renewables)

APPENDIX 2: RESIDUAL NOISE MEASUREMENTS

Noise Survey Record Sheet – Page 1: Location and Equipment Details

Project No:	2780	**Project Name:**	Highlands Windfarm
Client:	WKN Windcurrent South Africa (Ltd) Pty	**Installed by:**	Oswald Professionals Engineers Inc.
Location No (x/y):	1	**Location Name:**	Coetzeesfontein
Start Date:	19/06/2018	**Start Time:**	15:00

Equipment Details	**Make**	**Model**	**Serial No**	**Last calibration Date**
Sound Level Meter:	Rion	NL-31	01062691	09/11/2017
Source of Equipment:		Arcus		
Meter Timestamp:		Start		

GPS grid reference of equipment:	S32 42’ 59.7” E25 19’ 22.6”
Description of Sound Source:	Trees, fences, natural vegetation, wind and animals (goats & sheep)
Distance from façade::	13m
Noise sources observed:	Trees, fences, natural vegetation, wind and animals (goats & sheep)
Reason for selection as monitoring location:	Nearby houses and animals. Also close to gate where vehicles will enter and exit.

Noise Survey Record Sheet – Page 2: Visit Record

Project No	2780	**Location No. (x/y):**	1

Installation:

Date:	19/06/2018	**Time:**	15:00
Filename:	AU2_0101	**Time weighting:**	Fast
Frequency weighting:	A	**Rain gauge installed:**	No

Final Check:

Date:	20/06/2018	**Time:**	14:30

Noise Survey Record Sheet – Page 3: Photographs of Equipment Location

Project No	2780	Location No. (x/y):	1

*Picture above were taken during removal of equipment on the 20/06/2018.

Noise Survey Record Sheet – Page 1: Location and Equipment Details

Project No:	2780	**Project Name:**	Highlands Windfarm
Client:	WKN Windcurrent South Africa (Ltd) Pty	**Installed by:**	Oswald Professionals Engineers Inc.
Location No (x/y):	2	**Location Name:**	Doornrivier
Start Date:	20/06/2018	**Start Time:**	16:00

Equipment Details	**Make**	**Model**	**Serial No**	**Last calibration Date**
Sound Level Meter:	Rion	NL-31	01062691	09/11/2017
Source of Equipment:		Arcus		
Meter Timestamp:		Start		

GPS grid reference of equipment:	S32 44' 45.7" E25 22' 03.1"
Description of Sound Source:	Trees, fences, natural vegetation, wind & animals (cows, sheep & horses)
Distance from façade::	10m
Noise sources observed:	Trees, fences, natural vegetation, wind & animals (cows, sheep & horses)
Reason for selection as monitoring location:	Nearby few houses and sheds. Also close to the kraal (cows) and next to road.

Noise Survey Record Sheet – Page 2: Visit Record

Project No	2780	**Location No. (x/y):**	2

Installation:

Date:	20/06/2018	**Time:**	16:00
Filename:	AU2_0201	**Time weighting:**	Fast
Frequency weighting:	A	**Rain gauge installed:**	No

Final Check:

Date:	21/06/2018	**Time:**	15:30

Noise Survey Record Sheet – Page 3: Photographs of Equipment Location

Project No	2780	Location No. (x/y):	2

Noise Survey Record Sheet – Page 1: Location and Equipment Details

Project No:	2780	**Project Name:**	Highlands Windfarm
Client:	WKN Windcurrent South Africa (Ltd) Pty	**Installed by:**	Oswald Professionals Engineers Inc.
Location No (x/y):	3	**Location Name:**	Mulderskraal
Start Date:	21/06/2018	**Start Time:**	16:30

Equipment Details	**Make**	**Model**	**Serial No**	**Last calibration Date**
Sound Level Meter:	Rion	NL-31	01062691	09/11/2017
Source of Equipment:		Arcus		
Meter Timestamp:		Start		

GPS grid reference of equipment:	S32 48' 05.3" E25 22' 36.1"
Description of Sound Source:	Trees, fences, natural vegetation, wind & animals (cows & dogs)
Distance from façade::	10m
Noise sources observed:	Trees, fences, natural vegetation, wind & animals (cows & dogs) and people
Reason for selection as monitoring location:	Nearby few houses, close to the kraal and next to road.

Noise Survey Record Sheet – Page 2: Visit Record

Project No	2780	**Location No. (x/y):**	3

Installation:

Date:	21/06/2018	**Time:**	16:30
Filename:	AU2_0301	**Time weighting:**	Fast
Frequency weighting:	A	**Rain gauge installed:**	No

Final Check:

Date:	22/06/2018	**Time:**	16:00

Noise Survey Record Sheet – Page 3: Photographs of Equipment Location

Project No	2780	Location No. (x/y):	3

Noise Survey Record Sheet – Page 1: Location and Equipment Details

Project No:	2780	**Project Name:**	Highlands Windfarm
Client:	WKN Windcurrent South Africa (Ltd) Pty	**Installed by:**	Oswald Professionals Engineers Inc.
Location No (x/y):	4	**Location Name:**	Mulderskraal
Start Date:	22/06/2018	**Start Time:**	17:00

Equipment Details	**Make**	**Model**	**Serial No**	**Last calibration Date**
Sound Level Meter:	Rion	NL-31	01062691	09/11/2017
Source of Equipment:		Arcus		
Meter Timestamp:		Start		

GPS grid reference of equipment:	S32 47' 04.8" E25 20' 39.6"
Description of Sound Source:	Trees, fences, natural vegetation, wind & animals (chickens & dogs) and people
Distance from façade::	4m
Noise sources observed:	Trees, fences, natural vegetation, wind & animals (chickens & dogs) and people
Reason for selection as monitoring location:	Nearby house & chicken coop.

Noise Survey Record Sheet – Page 2: Visit Record

Project No	2780	**Location No. (x/y):**	4

Installation:

Date:	22/06/2018	**Time:**	17:00
Filename:	AU2_0401	**Time weighting:**	Fast
Frequency weighting:	A	**Rain gauge installed:**	No

Final Check:

Date:	24/06/2018	**Time:**	06:30

Noise Survey Record Sheet – Page 3: Photographs of Equipment Location

Project No	2780	Location No. (x/y):	4

Table A2.1: Location 1 - Residual Noise Levels

Time	L_{Aeq}
19/06/2018 14:49	51.6
19/06/2018 15:49	48.7
19/06/2018 16:49	35.9
19/06/2018 17:49	33.7
19/06/2018 18:49	22.2
19/06/2018 19:49	16.2
19/06/2018 20:49	21
19/06/2018 21:49	19.5
19/06/2018 22:49	45.4
19/06/2018 23:49	18.2
20/06/2018 00:49	14.5
20/06/2018 01:49	21.1
20/06/2018 02:49	17.4
20/06/2018 03:49	16.9
20/06/2018 04:49	16.4
20/06/2018 05:49	17.8
20/06/2018 06:49	39.2
20/06/2018 07:49	45.1
20/06/2018 08:49	33.4
20/06/2018 09:49	37
20/06/2018 10:49	34.3
20/06/2018 11:49	36.3
20/06/2018 12:49	48.7
20/06/2018 13:49	46.7

Table A2.2: Location 2 - Residual Noise Levels

Time	L_{Aeq}
20/06/2018 15:50	47.8
20/06/2018 16:50	52.5
20/06/2018 17:50	50.4
20/06/2018 18:50	30.9
20/06/2018 19:50	28
20/06/2018 20:50	20.4
20/06/2018 21:50	34.7
20/06/2018 22:50	32
20/06/2018 23:50	28.4
21/06/2018 00:50	20.9
21/06/2018 01:50	23.3
21/06/2018 02:50	23.1
21/06/2018 03:50	22.9
21/06/2018 04:50	20.9
21/06/2018 05:50	32.1
21/06/2018 06:50	42.4
21/06/2018 07:50	40.5
21/06/2018 08:50	44.1
21/06/2018 09:50	44.3
21/06/2018 10:50	52.1
21/06/2018 11:50	55.9
21/06/2018 12:50	49.3
21/06/2018 13:50	43.2
21/06/2018 14:50	49.6

Table A2.3: Location 3 - Residual Noise Levels

Time	L_{Aeq}
21/06/2018 16:15	49.5
21/06/2018 17:15	37.5
21/06/2018 18:15	52.5
21/06/2018 19:15	44.3
21/06/2018 20:15	40.1
21/06/2018 21:15	37.6
21/06/2018 22:15	36.7
21/06/2018 23:15	40.2
22/06/2018 00:15	41.6
22/06/2018 01:15	46.2
22/06/2018 02:15	44.9
22/06/2018 03:15	40.9
22/06/2018 04:15	40.8
22/06/2018 05:15	37.7
22/06/2018 06:15	37.8
22/06/2018 07:15	52.5
22/06/2018 08:15	42.8
22/06/2018 09:15	46.4
22/06/2018 10:15	42.6
22/06/2018 11:15	42.1
22/06/2018 12:15	40.7
22/06/2018 13:15	40
22/06/2018 14:15	40.6
22/06/2018 15:15	44.8

Table A2.4: Location 4 - Residual Noise Levels

Time	L_{Aeq}
22/06/2018 16:21	42.1
22/06/2018 17:21	33
22/06/2018 18:21	37.3
22/06/2018 19:21	22.7
22/06/2018 20:21	36.3
22/06/2018 21:21	34.4
22/06/2018 22:21	23.1
22/06/2018 23:21	19.9
23/06/2018 00:21	26.6
23/06/2018 01:21	30.2
23/06/2018 02:21	27
23/06/2018 03:21	34.3
23/06/2018 04:21	36.4
23/06/2018 05:21	42.4
23/06/2018 06:21	40
23/06/2018 07:21	47.6
23/06/2018 08:21	51.4
23/06/2018 09:21	51
23/06/2018 10:21	52.5
23/06/2018 11:21	58.6
23/06/2018 12:21	63.8
23/06/2018 13:21	61.4
23/06/2018 14:21	61.7
23/06/2018 15:21	59.9
23/06/2018 16:21	53.8
23/06/2018 17:21	49.9
23/06/2018 18:21	47.1
23/06/2018 19:21	41.4

23/06/2018 20:21	45.3
23/06/2018 21:21	51
23/06/2018 22:21	52.3
23/06/2018 23:21	53.8
24/06/2018 00:21	53.1
24/06/2018 01:21	52.4
24/06/2018 02:21	49.6
24/06/2018 03:21	51
24/06/2018 04:21	47.3
24/06/2018 05:21	46.5

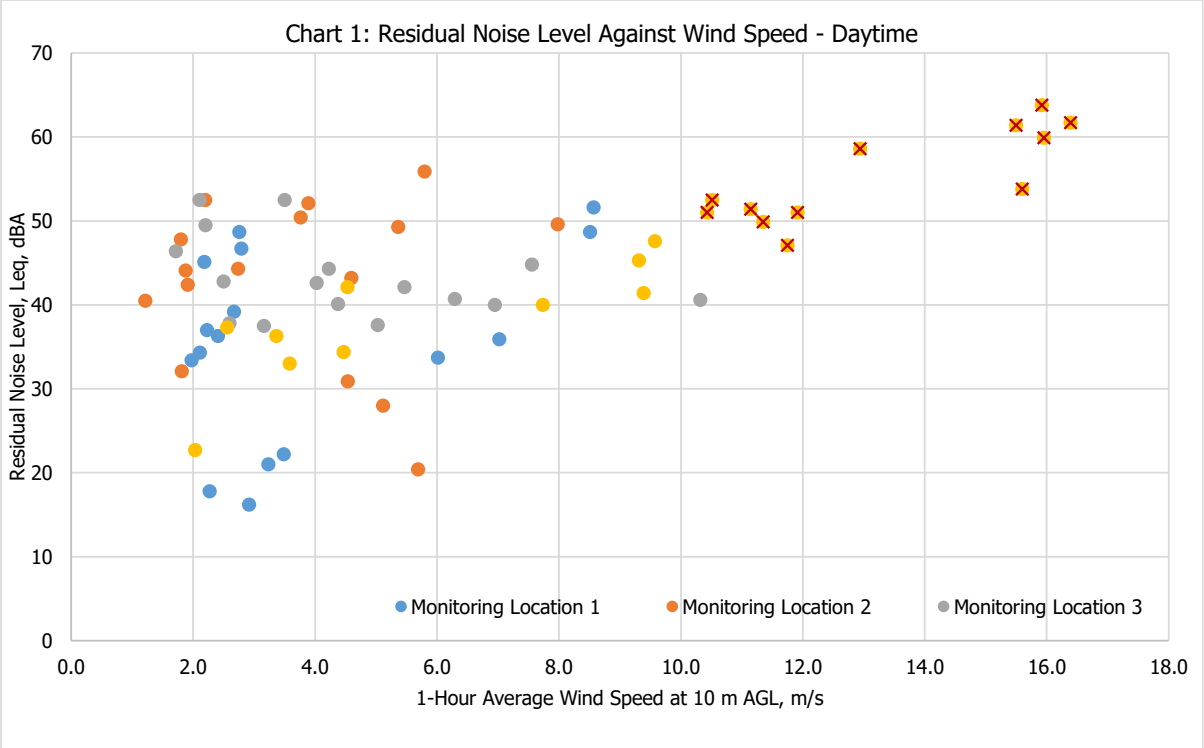


Chart 1: Residual Noise Level Against Wind Speed - Daytime
Residual Noise Level, Leq, dBA
1-Hour Average Wind Speed at 10 m AGL, m/s
Monitoring Location 1
Monitoring Location 2
Monitoring Location 3

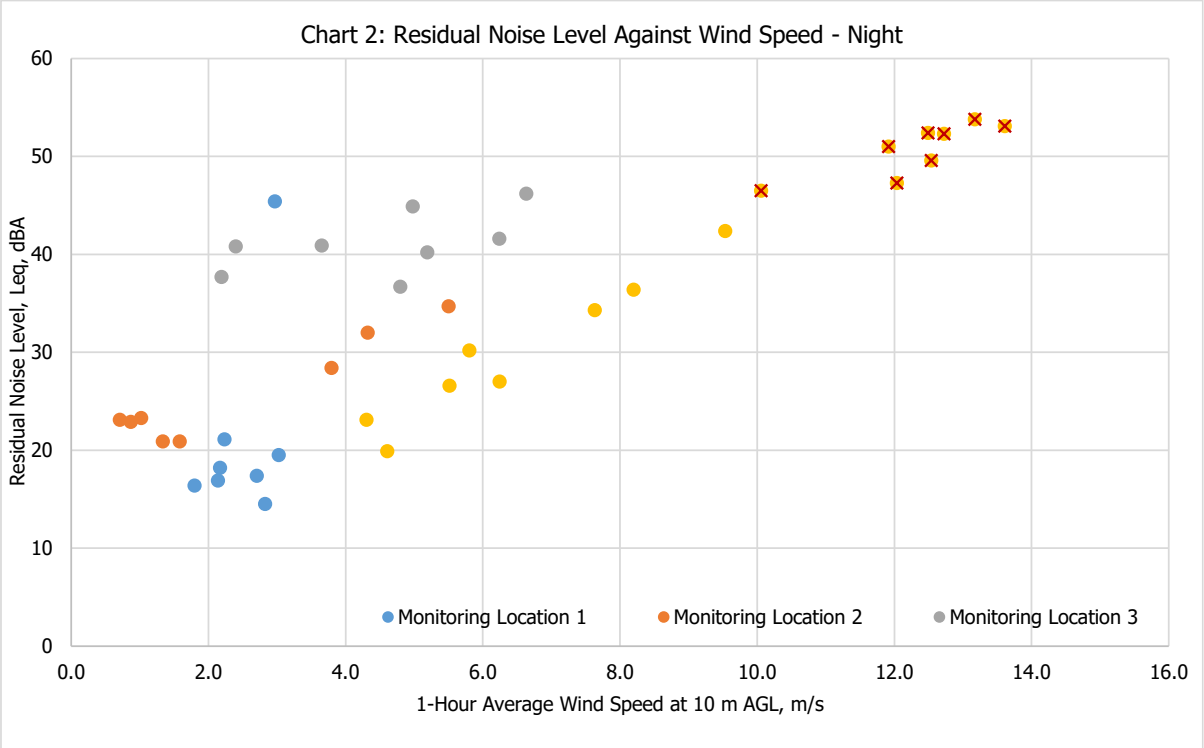


Chart 2: Residual Noise Level Against Wind Speed - Night
Residual Noise Level, Leq, dBA
1-Hour Average Wind Speed at 10 m AGL, m/s
Monitoring Location 1
Monitoring Location 2
Monitoring Location 3

APPENDIX 3: EXTERNAL REVIEW OF REPORT

Name: Morné de Jager
Cell: 082 565 4059
email: morne@eares.co.za
Date: 6 September 2018
Ref: AC/2018/Rev 3

Arcus Consulting
Office 220 Cube Workspace
Cnr Long Street and Hans Strijdom Road
Cape Town
8001

Attention: Ms Anja Albertyn

Dear Madam

REVIEW OF SPECIALIST STUDY: PROPOSED HIGHLANDS WIND ENERGY FACILITIES EASTERN CAPE PROVINCE ENVIRONMENTAL IMPACT ASSESSMENT REPORT NOISE

The above-mentioned report, dated September 2018, has relevance.

Terms of reference for the Review

A review report is normally done to ensure that a comprehensive noise investigation was completed. An Environmental Noise Impact Assessment (ENIA) is normally done as per the guideline set by SANS 10328 (2008). This specialist report however must feed into an Environmental Impact Assessment report, completed in terms of the latest relevant legislative requirements. As such, the specialist report should address both these requirements and this review will consider both aspects.

SANS 10328 proposed a number of review questions in section 9 which will be followed in this review. Any deviations to the guideline will be highlighted and a reason provided. It is critical to understand that the review investigation should not repeat the original investigation. Any shortcomings will be referred back to the original consultant that conducted the investigation.

In addition, it is critical that the review can confirm that the report complies with the requirements of Regulation GNR 326 of 4 December 2014, as amended in 2017 (known as Appendix 6).

As such this review will be divided into two distinct sections; one reviewing the SANS 10328 requirements and the second considering the DEA Requirements.

Qualification and Experience of Reviewer

I studied Chemical Engineering and graduated at the University of Pretoria in 1998 – B. Ing (Chem). I have been involved in Environmental Impact Assessments and Management since 1999 on various projects for Mining, Industry and Urban Development, but started to focus on Environmental Acoustics during 2006. Since 2007 I have done the Environmental Noise Impact Assessments for numerous projects covering Renewable Energy, Power Stations, Road and Railway construction, Industrial and Urban Development as well as numerous noise monitoring and noise audit reports. I have been involved in the Environmental Impact Assessment process for more than 80 different Wind Energy (WE) projects, review reports for more than 40 WE projects, measurements at existing wind energy facilities as well as ambient sound level measurements, scoping and screening level

assessments for a number other WE facilities. This includes the measurement of ambient sound levels at 5 different locations over a total period of more than 50 nights.

Review in terms of section 9.3.3.1 of SANS 10328:2008

Environmental Legislation constantly changes and this review will only consider the checklist highlighted in section 9.3.3.1, and not the requirements of section 9.3. This is because the

- SANS 103028 edition was compiled considering the relevant environmental legislation up to 2008 and does not consider the latest legislative requirements;
- recent promulgation of the renewable energy development zones and the requirement that only a basic assessment level specialist report will be required for a renewable energy project located in these areas. Only an ENIA was required with no need for a screening or scoping report, neither for a plan of study (for EIA).

Check list – Section 9.3.3.1 of SANS 10328	Comment / Remark
Is a detailed plan of study included?	No. Not required as per latest legislation.
Is a list and description of all the noise sources and noise-sensitive developments given?	Yes.
Are the feasible alternatives listed in the scoping report given?	**Scoping report not required.**
Is a description of the noise sources and noise-sensitive developments, as well as the alternatives listed in the scoping report, which need to be further investigated, given?	**Scoping report not required.**
Is a description of the noise sources and noise-sensitive developments, as well as the alternatives listed in the scoping report which need not be further investigated, and reasons for their omission given?	**Scoping report not required.**
Is the sound disturbance from the identified noise sources given together with the sources of origin, procedures used, as well as the measurement results?	Yes.
Is the estimated expected rating level given?	Yes.
Is the desired rating level and its details of determination given?	Yes. Specialist use multiple criteria to define an acceptable rating level.
Is a conclusion reached on a significant impact?	Yes.
Are full details of the results of measurements or calculation at the different identified points given, preferably by means of equal rating level contours?	Yes.
Are any alternative measures proposed?	Alternatives discussed.
Are full details of the proposed alternative measures given?	Alternatives discussed.
Is there a complete study done on the effectiveness of the alternative measures?	Alternatives discussed.
Is information as to possible follow-up investigations given after the project is completed?	Yes.
Is some follow up investigation indicated to ensure	Alternatives discussed.

the reliability of any alternative measures?	
Is a list of all interested or affected parties who partook in the investigation given with their individual comments?	Yes, statement that there was no comments.
Are all items to be covered by the report as given in 8.7 available?	Brief description of measurement locations included.
Is a record of all measurement and calculation results available?	Measurement data reported. Calculation results illustrated as contours of constant sound levels.
Can the proposed recommendation be agreed to?	Yes, considering the approach and findings of report.

Review in terms of GNR 326 requirements

The review considered all the requirements of Appendix 6 as included in the report. The references were followed to confirm whether the requirements were addressed. No issues were found in the DEA Requirements Table.

Summary Conclusions

As an ENIA it is the opinion of the reviewer that the report is objective and scientific. The modeling procedure is precautious and technically accurate. The mitigation measures proposed is appropriate and will reduce the projected noise levels. The reviewer can agree with the conclusions and recommendations.

Should you require any further details, or have any additional questions, please do not hesitate to call me on the above numbers.

Yours Faithfully,

Morné de Jager
Enviro-Acoustic Research cc