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A specialist energy consultancy

Appendix 6.1

# Operational Noise Report

## Viking Wind Farm

Viking Energy Wind Farm LLP

12604-018
25 October 2018

viking energy
Harnessing Shetland's natural resources

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# Executive Summary

Viking Energy Wind Farm LLP (the 'Applicant') is seeking to vary the tip height of the consented turbines from a maximum tip height of 145 m up to a maximum of 155 m in order to allow greater flexibility in the selection of turbines.

TNEI Services Ltd was commissioned by the Applicant to undertake predictions of the wind turbine noise that would be emitted by the operation of wind turbines with the greater tip height and rotor diameter (increase of 10 m from the consented heights) at the consented Viking Wind Farm (hereinafter referred to as the proposed development). The noise predictions were used to assess the potential impact of operational noise from the proposed development on the nearest noise sensitive receptors.

The Scottish Government's web based renewables advice on *'Onshore Wind Turbines'* states: *'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'* Whilst the advice then goes on to state: *'The Institute of Acoustics (IOA) has since published Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* [IOA GPG]. *The document provides significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'* The guidance contained within ETSU-R-97 and current good practice has been used to assess the potential operational noise impact of the proposed development.

The noise assessment has been undertaken in three stages:

1) setting the Total ETSU-R-97 Noise Limits (which are applicable to noise from all wind turbines in the area operating concurrently) at noise sensitive receptors,

2) predicting the likely effects (undertaking a cumulative noise assessment where required) to ensure noise immissions at noise sensitive receptors will meet the Total ESTU-R-97 Noise Limits; and

3) setting Site Specific Noise Limits for the proposed development.

A new background noise survey was undertaken at thirteen receptors which were considered to be representative of the noise sensitive receptors surrounding the proposed development.

None of the other wind farm / turbine developments identified have been consented with conditioned noise limits. As such, background noise data collected during the baseline survey has been used to derive the Total ETSU-R-97 Noise Limits at the respective noise sensitive receptors, and apportioned appropriately.

A total of twenty nine noise sensitive receptors were chosen as assessment locations. The assessment locations were chosen to represent the noise sensitive receptors located closest to the proposed development and additional receptors included to consider cumulative noise impacts. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations deemed representative of the expected background noise environment was used to assess the wind turbine noise impact at those receptors.

Wind speed was measured at various heights using four temporary meteorological mast which were located within the proposed site. The data collected at 40 m and 60 m on one mast and 50 m and 70 m height on the three other masts were used to calculate hub height wind speeds (100 m) which were then standardised to 10 m height, in accordance with current good practice. Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits for each of the assessment locations.

To reflect the presence of the existing wind turbines in the area, the Total ETSU-R-97 daytime noise limit was set at 40 dB(A) or background plus 5 dB whichever is the greater. The night time limit has been set at 43 dB or background plus 5 dB whichever is the greater. In relation to the daytime Site Specific Noise Limits that would be applicable to the proposed development, two scenarios have been considered. This report presents an assessment against both the lower and upper Fixed Minimum Daytime Limit (35 and 40 dB) or background plus 5 dB, whichever is the greater, to allow the decision maker to determine the most appropriate daytime noise limit for the proposed development. The night time Site Specific Noise Limits have been set at 43 dB or background plus 5 dB whichever is the greater.

Predictions of wind turbine noise for the proposed development were made, based upon the sound power level data for the loudest candidate wind turbine under consideration for the site, the Siemens SWT-DD-120 4.3 MW. This wind turbine model has been chosen in order to allow a conservative assessment of the noise impacts. If consented a different turbine model may be chosen which would likely be quieter as the model considered here is the loudest that would fit into the 155 m tip height. Whatever the final turbine choice is, the proposed development would have to meet the noise limits determined and contained within any condition imposed. Modelling was undertaken using the ISO 9613: 1996 'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation' noise prediction model which accords with current good practice and that is considered to provide a realistic impact assessment. For the other schemes, predictions have been undertaken using sound power level data for the installed turbines. The model of turbine installed was either identified during site visits to the area, or through use of the Shetland Islands Council Planning Application Portal.

The likely cumulative assessment shows that the proposed development can operate concurrently with the operational singular turbine installations near to noise assessment locations, whilst still meeting the Total ETSU-R-97 Noise limits established in accordance with ETSU-R-97 at the vast majority of receptors. There are a small number of assessment locations where predicted noise levels from existing wind turbines (consented or operational) already exceed the noise limits recommended by ETSU-R-97 even when a 40 dB daytime fixed minimum limit is adopted. Where such an exceedance already exists the proposed development would operate such that it will cause a negligible increase in levels (i.e. 10dB below the existing noise levels). At some Noise Assessment Locations, it appears that considerably more than 40dB has been allocated, which may suggest that the occupiers of a nearby property have a Financial Involvement in the nearby wind turbine(s) and as such a higher Total ETSU-R-97 Noise Limit may be appropriate (based on a fixed minimum limit of 45 dB).

At this stage it has been assumed that there are no occupiers of properties which should be considered Financially Involved with the proposed development or any of the existing consented developments as this represents a worst case scenario. It would be possible to update the Total ETSU-R-97 Noise Limits and the Site Specific Noise Limits to reflect any financial involvement if details become available.

Site Specific ETSU-R-97 Noise Limits have also been derived which take account (where required) of the other wind turbine developments. Where wind turbine immissions from the other wind turbines at a given receptor were found to be at least 10 dB below the Total ETSU-R-97 Noise Limit, it is considered that they will be using a negligible proportion of the limit, as such it was considered appropriate to allocate the entire noise limit to the proposed development. For the receptors where turbine predictions were found to be within 10 dB of the Total ETSU-R-97 Noise Limit, apportionment of the Total ETSU-R-97 Noise Limits was undertaken in accordance with current good practice. Two sets of daytime Site Specific Noise Limits have been established, one based upon the adoption of the lower 35 dB fixed minimum limit and another using the upper 40 dB value.

Predicted noise levels indicate that at all noise assessment locations wind turbine noise immissions were below the Site Specific Noise Limits when considering the Siemens SWT-DD-120 as a candidate turbine. In order to meet the Site Specific Noise Limits certain turbines will need to be operated in low noise mode / switched off during certain wind speeds and directions which will vary depending on the daytime fixed minimum limit used. Some mode management would also be required during the night-time periods.

The use of Site Specific Noise Limits would ensure that the proposed development could operate concurrently with other consented or operational turbines in the area and would also ensure that the proposed developments individual contribution could be measured and enforced if and when required.

ETSU-R-97 and the IOA GPG provide guidance on three factors which should be considered when determining the most appropriate daytime fixed minimum limit (35 – 40 dB). The three factors are:

1) the number of noise affected properties;
2) the effect on the potential power output of the wind farm; and
3) the duration of exposure of these properties.

The IOA GPG suggests that it may be appropriate to present both scenarios whilst noting that, ultimately, assessment of the factors may be a planning consideration. A commentary regarding the three factors is provided in Table 6.11 of this report.

Should Consent be granted for the proposed development it would be appropriate to include an updated set of noise related planning conditions which detail the noise limits applicable to the proposed development. It is also recommended that additional noise modelling is undertaken to consider the actual turbine model to be installed at the site in order to demonstrate that it can be operated to meet the noise limits. Suggested noise conditions are included in Annex 8 of this report and these can be amended to consider any daytime fixed minimum limit in the range between 35 – 40 dB, as required.

There are a number of wind turbine makes and models that may be suitable for the proposed development. Should the proposed development receive Consent, the final choice of turbine would be subject to a competitive tendering process and as such predictions of wind turbine noise are for information only. As the predictions presented here are based on the loudest turbine currently under consideration for the site, the final choice of turbine would likely be quieter than the turbine assessed here. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

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# 1 Introduction

## 1.1 Brief

1.1.1 TNEI was commissioned by Viking Energy Wind Farm LLP (the 'Applicant') to update the operational noise assessment for the consented Viking Wind Farm in order to consider the installation of larger wind turbines which are being proposed via a Variation Application. For clarity in this report the consented Viking Wind Farm will be referred to as the 'Consented Development' and the scheme proposed as part of the Variation Application will be referred to as the 'proposed development'. The following steps summarise the noise assessment process:

- Monitor existing background noise levels, assess and present the noise data with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*[1] and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'*[2] (IOA GPG) which represents current good practice;
- Determine the Total ETSU-R-97 Noise Limits applicable to all wind turbines in the area;
- Undertake predictions of the operational wind turbine noise immissions from the proposed development that will be incident at neighbouring noise sensitive receptors;
- Assess and undertake a cumulative noise assessment, where required, to take account of other consented or operational schemes near to the proposed development;
- Assess the impact of noise from the proposed development with reference to existing Government Guidance and the recommendations of the Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 and the IOA GPG (current good practice);
- Suggest Site Specific ETSU-R-97 Noise Limits for the proposed development, suitable for inclusion in the noise related planning condition should Scottish Ministers be minded to grant consent for the proposed development; and
- Compare predictions of the operational wind turbine noise immissions from the proposed development against the Site Specific ETSU-R-97 Noise Limits that will be incident at neighbouring noise sensitive receptors.

## 1.2 Background

1.2.1 Viking Wind Farm was consented in April 2012 by the Scottish Ministers. The consent was for 103 wind turbines with a maximum tip height of 145 metres (m). The Applicant is proposing to alter the overall tip height of the turbines from 145 m to a maximum of 155 m. It is proposed that the maximum rotor diameter of the candidate turbine would increase, from 110 m previously assessed, to a maximum of 120 m. The location of the turbines and associated infrastructure will be as per the consented layout.

1.2.2 The proposed development is located on land to the south west of Laxo, south east of Voe, north east of Tresta and north of Catfirth on Shetland Mainland. The approximate OS grid reference for the site centre is 440988, 1158452.

1.2.3 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Siemens SWT-DD-120 4.3 MW. This turbine has been selected as it is the loudest turbine currently under consideration for the site.

1.2.4 There are a number of consented or operational wind turbine developments in proximity to the proposed development. A full list of schemes is included within Annex 7.

1.2.5 No noise related planning conditions have been set in any of the relevant Decision Notices for the consented or operational schemes detailed in Annex 7. As such noise limits will be defined at these receptors in line with current good practice (as detailed in Section 4.2 below).

1.2.6 For the purposes of assessing the above schemes in conjunction with the proposed development, the following terms have been referred to throughout the assessment;

- 'Total ETSU-R-97 Noise Limits'; defined as being the greater of 40 dB or background noise plus 5 dB for daytime periods (as detailed in Section 6.4), and 43 dB or background noise plus 5 dB for night-time periods. The 'Total ETSU-R-97 Noise Limits' should not be exceeded by the cumulative operation of all wind turbine developments, including the proposed development; and
- 'Site Specific Noise Limits'; defined as being the limit that is specific to the proposed development only, and derived through the apportionment (where required), of the 'Total ETSU-R-97 Noise Limits' in accordance with current good practice.

1.2.7 Note that in this report, the term 'noise emission' relates to the sound power level actually radiated from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level (the perceived noise) at any receptor location due to the operation of the wind turbines.

# 2 Noise Planning Policy and Guidance

## 2.1 Overview of Noise Planning Policy and Guidance

2.1.1 In assessing the potential noise impacts of the proposed development the following guidance and policy documents have been considered:

- Local Policy;
- National Planning Policy[3];
- Web Based Renewables Advice: *'Onshore Wind Turbines'*[4];
- Planning Advice Note PAN 1/2011: *'Planning and Noise'*[5];
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*; and
- Institute of Acoustics *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG) May 2013.

## 2.2 Local Policy

### Shetland Local Development Plan

2.2.1 The adopted Development Plan for the area comprises the Shetland Local Development Plan (LDP) which was adopted in September 2014. The LDP assists with the delivery of sustainable economic growth and the preservation of the natural and built environment of Shetland. It sets out the Council's land use strategy which recognises existing developments, promotes sustainable economic growth and conserves Shetland's natural and built environment.

2.2.2 The LDP contains a number of overarching polices, the aim of which is to deliver high standards of development. Policy GP1: Sustainable Development in relation to general amenity states that:

*'Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals.'*

2.2.3 This general development policy takes into account the need to mitigate and adapt to the causes of climate change. It also aims to ensure the amenity of those adjacent users affected by development proposals.

2.2.4 Policy RE1 covers the principal policy guidance in relation to renewable energy. It states:

*'Proposals for renewable energy developments will be supported where it can be demonstrated that there are no unacceptable impacts on people'.*

### Shetland Supplementary Guidance Documents – Onshore Wind Energy

2.2.5 The policy detailed above is supported by more detailed guidance contained within Supplementary Guidance (SG) – Onshore Wind Energy adopted February 2018. One purpose of this SG is to provide developers with information and guidance on where, in principle, large-scale onshore wind energy developments and all associated infrastructure are likely to be acceptable.

2.2.6 Section 2 of the SG sets out the proposed development Criteria which proposals that fall within Spatial Policy 3 must comply with. In relation to amenity, DC4 Impacts on Communities states that:

*'Development proposals must, in combination with existing and consented wind energy developments, assess the likely impact on communities and the long term impacts on amenity including outdoor access, recreation and tourism opportunities. Planning application must be accompanied by an assessment of the effects on these locations covering a range of factors including... noise and shadow flicker'.*

2.2.7 The guidance also includes advice to Developers to include a noise impact assessment within proposals for wind energy applications.

2.2.8 The ETSU-R-97 methodology is designed to protect amenity whilst balancing the need for renewable energy developments.

## 2.3 National Planning Policy

2.3.1 Scottish Planning Policy (SPP) was published in 2014. It states (paragraph 169) that proposals for energy infrastructure should take account of spatial frameworks for wind farms (where relevant) and that considerations may include noise impacts on communities and individual dwellings.

### Planning Advice Note PAN 1/2011: Planning and Noise

2.3.2 PAN 1/2011 provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. Paragraph 29 contains some specific information on noise from wind farms and states the following:

*'There are two sources of noise from wind turbines - the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed, and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for Onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry [DTI] and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise.'*

## 2.4 Web Based Planning Advice – Onshore Wind Turbines

2.4.1 The 'Onshore Wind Turbines' web based document describes the types of noise (mechanical and aerodynamic) that wind turbines generate. Mechanical noise is generated by the gearbox and generator and other parts of the drive train which can be radiated as noise through the nacelle, gear box, tower and supporting structures together with the aerodynamic noise generated by the action of the blades rotating through the air. The document states 'there has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design' and goes on to note:

*'The Report, "The Assessment and Rating of Noise from Wind Farms" (Final Report, Sept 1996, DTI), (ETSU-R-97), describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggests appropriate noise conditions.'*

2.4.2 The web based document then refers to the IOA GPG as a source which provides:

*'significant support on technical issues to all users of the ETSU-R-97 method for rating and assessing wind turbine noise, and should be used by all IOA members and those undertaking assessments to ETSU-R-97. The Scottish Government accepts that the guide represents current industry good practice.'*

2.4.3 The document also refers to the role of PAN1/2011 'Planning and Noise' to:

*'provide advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The associated Technical Advice Note provides guidance which may assist in the technical evaluation of noise assessment.'*

2.4.4 Examination of the Technical Advice Note[6] confirms it provides no further advice on wind farms other than referring to ETSU-R-97 and relevant parameters for modelling identified in the Institute of Acoustics Bulletin March 2009, on page 37. This has been superseded by the introduction of the IOA GPG in May 2013.

## 2.5 ETSU-R-97 The Assessment and Rating of Noise from Wind Farms

2.5.1 As wind farms started to be developed in the UK in the early 1990's, it became apparent that existing noise standards did not fully address the issues associated with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. This methodology was developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.5.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers, wind farm operators, independent acoustic consultants and legal experts who:

*'…between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.'*

2.5.3 In this way it represented the views of all the stakeholders that are involved in the assessment of noise impacts of wind farm developments. The recommendations of the WGNWT are presented in the DTI Report – ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms (1996).'*

2.5.4 The basic aim of the WGNWT in arriving at the recommendations was the intention to provide:

*'Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding to the costs and administrative burdens on wind farm developers or local authorities.'*

2.5.5 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that would arise through the development of renewable energy sources:

*'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'*

2.5.6 Where noise at the nearest noise sensitive receptors is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 $ms^{-1}$ at 10 m, then it does not need to be considered in the noise assessment, as protection of the amenity of these properties can be controlled through a simplified noise limit, as detailed in ETSU-R-97. ETSU-R-97 states that:

*'For single turbines or wind farms with very large separation distances between the turbines and the nearest properties, a simplified noise condition may be suitable. If the noise is limited to an $L_{A90,10min}$ of 35 dB(A) up to wind speeds of 10 m/s at 10 m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary.'*

2.5.7 The ETSU-R-97 assessment procedure specifies that where noise is greater than the simplified limit of 35 dB $L_{A90}$ noise limits should be set relative to existing background noise levels at the nearest receptors and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for daytime and night-time, are applied where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2-3 $ms^{-1}$) and up to 12 $ms^{-1}$, where all wind speeds are referenced to a 10 metre measurement height.

2.5.8 Separate noise limits apply for daytime and for night-time. Daytime limits are chosen to protect a property's external amenity, and night-time limits are chosen to prevent sleep disturbance indoors, with windows open.

2.5.9 The daytime noise limit is derived from background noise data measured during so-called 'quiet periods of the day', which comprise weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of 10 minute background noise levels using the $L_{A90,10min}$ measurement index are logged continuously over a range of wind speed conditions. These measured noise levels are then plotted against concurrent wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU–R-97 daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5 dB(A) above the best fit curve to the background noise data over the desired wind speed range; subject to an appropriate daytime fixed minimum limit:

*'For wind speeds where the best fit curve to the background noise data lies below a level of 30 - 35 dB(A) the criterion curve is set at a fixed level in the range 35 - 40 dB(A). The precise choice of criterion curve level within the range 35 - 40 dB(A) depends on a number of factors: the number of noise affected properties, the likely duration, the level of exposure and the potential impact on the power output of the wind farm. The quiet daytime limits have been set in ETSU-R-97 on the basis of protecting the amenity of residents whilst outside their dwellings in garden areas.'*

2.5.10 The night-time noise limit is derived from background noise data measured during the night-time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10 minute $L_{A90}$ noise levels measured over the night-time periods are plotted against concurrent wind speed data and a 'best fit' correlation is established. The night-time noise limit is also based on a level 5 dB(A) above the best fit curve over the 0 - 12 $ms^{-1}$ wind speed range. Where the night-time noise limit derived from background noise measurements is found to be below 43 dB $L_{A90}$, it is fixed at 43 dB $L_{A90}$.

2.5.11 The exception to the setting of both the daytime and night-time fixed minimum on the noise limits occurs where a property occupier has a financial involvement in the wind farm development. Paragraph 24 of ETSU-R-97 states:

*'The Noise Working Group recommends that both day and night-time lower fixed limits can be increased to 45 dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.'*

2.5.12 ETSU-R-97 provides a robust basis for determining the noise limits for wind turbine(s) and since its introduction has become the accepted standard for such developments across the UK.

## 2.6 Current Good Practice

### A Good Practice Guide on the Application of ETSU-R-97

2.6.1 In May 2013, the Institute of Acoustics issued *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG). The document provides guidance on background data collection, data analysis and limit derivation, noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.6.2 The Authors of the IOA GPG sets out the scope of the document in Section 1.2:

*'This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government.'*

2.6.3 The guidance document was endorsed, on behalf of the Government, by the Cabinet Secretary for Finance, Employment and Sustainable Growth, Mr John Swinney MSP[7]. The recommendations included in the IOA GPG have been considered and applied in the noise assessment for the proposed development.

2.6.4 The IOA GPG refers to six Supplementary Guidance Notes and where applicable these have been considered in this report.

2.6.5 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to assess and rate the operational noise emissions from the proposed development.

# 3 Potential Impacts

## 3.1 Operational Noise Sources

3.1.1 Wind turbines may emit two types of noise. Firstly aerodynamic noise is a more natural sounding 'broad band' noise, albeit with a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. Potential sources of mechanical noise include gearboxes or generators.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are fairly low. At very low wind speeds the blades do not rotate, or rotate very slowly, and so at these wind speeds negligible aerodynamic noise is generated. In higher winds aerodynamic noise may be masked by the normal sound of wind blowing through the trees an around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines [(11)].

## 3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound is usually defined as the frequency range below 20Hz, while low frequency noise describes sound in the frequency range 20-200Hz. An average young healthy adult has an audible range from 20Hz to 20,000Hz, although the sensitivity of the ear varies with frequency and is most sensitive to sounds with frequencies between 500Hz and 4,000Hz. Wind turbines do produce low frequency sounds [(9)], but our threshold of hearing at such low frequencies is relatively high and they therefore go unnoticed. Infrasound from wind turbines is often at levels below that of noise generated by wind around buildings and other obstacles.

3.2.2 In 2004, the former DTI commissioned The Hayes McKenzie Partnership to report on claims that infrasound or low frequency noise (LFN) emitted by wind turbine generators (WTGs) were causing health effects. Of the 126 wind farms operating in the UK, five had reported low frequency noise problems, therefore, such complaints are the exception rather than a general problem which exists for all wind farms. Hayes McKenzie investigated the effects of infrasound and LFN at three wind farms for which complaints had been received, the results were reported in May 2006 [(10)]. The report concluded that:

- *'infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;*

- *low frequency noise was measurable on a few occasions but below the existing permitted Night Time Noise Criterion. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was always lower than that of local road traffic noise;*
- *that the common cause of complaint was not associated with LFN, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep.'*

3.2.3 The Applied and Environmental Geophysics Research Group at Keele University was commissioned by the MOD, the DTI and the British Wind Energy Association to undertake microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms for the purposes of siting wind farms in the vicinity of Eskdalemuir in Scotland. Whilst the testing showed that vibration can be detected several kilometres away from wind turbines, the levels of vibration from wind turbines were so small that only the most sophisticated instrumentation can reveal their presence and they are almost impossible to detect. Nevertheless, the Renewable Energy Foundation alleged potential adverse health effects and when that story was picked up in the popular press, notably the Scotsman, the report's authors expressed concern over the way in which their work had been misinterpreted and issued a rebuttal statement [(11)] in August 2005:

*'Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health.'*

3.2.4 In response to concerns that wind turbines emit infrasound and cause associated health problems, Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Defra Report on Low Frequency Noise and its Effects, said in the article in the Scotsman ('Wind farm noise rules 'dated'- James Reynolds, 5 August 2005'):

*'I can state quite categorically that there is no significant infrasound from current designs of wind turbines.'*

3.2.5 An article [(12)] published in the IOA Bulletin (March/April 2009) concluded that there is no robust evidence that either low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, has an adverse effect on wind farm neighbours.

3.2.6 Work [(13)] by Dr Leventhall looked at infrasound levels within the ear compared to external sources and concluded:

*'The conclusion is that the continuous inner ear infrasound levels due to internal sources, which are in the same frequency range as wind turbine rotational frequencies, are higher than the levels produced in the inner ear by wind turbines, making it unlikely that the wind turbine noise will affect the vestibular systems, contrary to suggestions made following the measurements at Shirley. The masking effect is similar to that in the abdomen (Leventhall 2009). The body, and vestibular systems, appear to be built to avoid disturbance from the high levels of infrasound which are produced internally from the heartbeat and other processes. In fact, the hearing mechanisms and the balance mechanisms, although in close proximity, have developed to minimise interaction (Carey and Amin 2006).'*

3.2.7 More recently during a planning Appeal (PPA-310-2028, Clydeport Hunterston Terminal Facility, approximately 2.5 km south-west of Fairlie, 9 Jan 2018), the health impacts related to low frequency noise associated with wind turbines were considered at length by the appointed Reporter (Mr M Croft). The Reporter considered evidence from Health Protection Scotland and the National Health Service. In addition he also considered low frequency noise surveys undertaken by the Appellant and the Local Authority both of which demonstrated compliance with planning conditions and did not identify any problems attributable to the turbine operations; some periods with highest levels of low frequency noise were recorded when the turbines were not operating.

3.2.8 The Reporter concluded that:

- The literature reviews by bodies with very significant responsibilities for the health of local people found insufficient evidence to confirm a causal relationship between wind turbine noise and the type of health complaints cited by some local residents.
- The NHS's assessment is that concerns about health impact are not supported by good quality research.
- Although given the opportunity, the Community Council failed to provide evidence that can properly be set against the general tenor of the scientific evidence.

3.2.9 It is therefore not considered necessary to carry out specific assessments of low frequency noise and it has not been considered further in the noise assessment.

## 3.3 Amplitude Modulation of Aerodynamic Noise (AM)

3.3.1 In the context of wind turbine noise amplitude modulation describes a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. Amplitude Modulation of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68:

*'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.*

*This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dBA (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'*

3.3.2 In recent times the Acoustics community has sought to make a distinction between AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is increasingly used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In some appeal decisions it may also be referred to as 'Excess Amplitude Modulation' (EAM). The noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

3.3.3 On 16 December 2013, RenewableUK (RUK) released six technical papers [(14)] on AM which reflect the outcomes of research commissioned over the last three years, together with a template planning condition. Whilst this research undoubtedly improves understanding of Other Amplitude Modulation (OAM) and its effects, it should be noted that at the time of writing it has not been endorsed by any relevant body such as the Institute of Acoustics (IOA).

3.3.4 On 22 January 2014, the IOA released a statement regarding the RUK research and the proposed planning condition to deal with the issue of amplitude modulation from a wind turbine and stated:

*'This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it. The proposed planning condition, though, needs a period of testing and validation before it can be considered to be good practice. The IOA understands that RenewableUK will shortly be making the analysis tool publicly available on their website so that all interested parties can test the proposed condition, and the IOA will review the results later in the year. Until that time, the IOA cautions the use of the proposed planning condition.'*

3.3.5 Research regarding amplitude modulation continued. In April 2015, the Institute of Acoustics issued a discussion document entitled *'Methods for Rating Amplitude Modulation in Wind Turbine Noise'*. The document presents three methods which can be used to quantify the level of AM at a given measurement location. After extensive consultation a preferred method of measuring OAM, which provides a framework for practitioners to measure and rate AM was recommended by the IOA.

3.3.6 On 3 August 2015, the Department for Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS), commissioned independent consultants WSP Parsons Brinkerhoff to carry out a literature review on OAM (which they refer to simply as AM). The stated aims were as follows:

- *To review the available evidence on Amplitude Modulation (AM) in relation to wind turbines, including but not limited to the research commissioned and published by RenewableUK in December 2013;*
- *To work closely with the Institute of Acoustics' AM working group, who are expected to recommend a preferred metric and methodology for quantifying and assessing the level of AM in a sample of wind turbine noise data;*
- *To review the robustness of relevant dose response relationships, including the one developed by the University of Salford as part of the RenewableUK study, on which the correction (or penalty) for amplitude modulation proposed as part of its template planning condition is based;*
- *To consider how, in a policy context, the level(s) of AM in a sample of noise data should be interpreted, in particular determining at what point it causes a significant adverse impact;*
- *To recommend how excessive AM might be controlled through the use of an appropriate planning condition; and*
- *To consider the engineering/cost trade-offs of possible mitigation measures.*

3.3.7 Their report which was released in October 2016, concluded that there is sufficient robust evidence that excessive AM leads to increased annoyance from wind turbine noise, and recommended that excessive AM is controlled through a suitably worded planning condition which will control it during periods of complaint. Those periods should be identified by measurement using the metric proposed by work undertaken by the Institute of Acoustics, and enforcement action would rely upon professional judgement by Local Authority Environmental Health Officers based on the duration and frequency of occurrence.

3.3.8 It is not clear within the body of the report which evidence the authors relied upon to arrive at their conclusions, although the Executive Summary states (page 4);

*"It is noted that none of the Category 1 or 2 papers have been designed to answer the main aim of the current review in its entirety. The Category 1 studies have limited representativeness due to sample constraints and the artificiality of laboratory environments, whereas the Category 2 studies generally do not directly address the issue of AM WTN exposure-response. A meta - analysis of the identified studies was not possible due to the incompatibility of the various methodologies employed. Notwithstanding the limitations in the evidence, it was agreed with DECC that the factors to be included in a planning condition should be recommended based on the available evidence, and supplemented with professional experience".*

3.3.9 The report [13] states that any planning condition must accord with existing planning guidance, and should be subject to legal advice on a case by case basis. Existing guidance would include compliance with the six tests of a planning condition embodied in Circular 4/98. The report's authors did not dictate a particular condition to be used but did suggest that any condition should include the following elements (p5):

- *"The AM condition should cover periods of complaints (due to unacceptable AM);*
- *The IoA-recommended metric should be used to quantify AM (being the most robust available objective metric);*
- *Analysis should be made using individual 10-minute periods, applying the appropriate decibel 'penalty' to each period, with subsequent analysis;*
- *The AM decibel penalty should be additional to any decibel penalty for tonality;* [tonality means mechanical sound already covered by ETSU noise limits]*; and*
- *An additional decibel penalty is proposed during the night time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day."*

3.3.10 At the time of writing there has been no official response to those recommendations from the IOA Noise Working Group and, as yet, no endorsement from any Scottish Government Minister or Department. The recommendation to impose a planning condition and the associated penalty scheme is at odds with the advice from the IOA GPG which currently states (paragraph 7.2.10):

*'7.2.1 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.'*

3.3.11 On that basis Amplitude Modulation has not been considered further in this assessment.

# 4 Methodology

## 4.1 Assessing Operational Noise Impact

4.1.1 To undertake an assessment of the operational noise impact in accordance with the requirements of ETSU-R-97, the following steps are required:

- Specify the location of the wind turbines for the proposed development;
- Measure the background noise levels as a function of on-site wind speed at a selection of representative Noise Monitoring Locations (NML);
- Establish for each NML the 'Total ETSU-R-97 Noise Limits' on analysis of the measured background noise levels;
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise data;
- Specify the likely noise emission characteristics of the wind turbines for the proposed development and all nearby cumulative wind turbines;
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total ETSU-R-97 Limits;
- If required, determine the 'Site Specific Noise Limits' which take allowance of the noise immissions due to other schemes; and
- Calculate the likely noise immission levels due to the operation of the proposed development on its own and compare it to the proposed development's 'Site Specific Noise Limits'.

4.1.2 In order to consider the steps outlined above the assessment has been split into three separate stages:

- Stage 1 – establish the Total ETSU-R-97 Noise Limits for each NAL based on the measured background noise levels (as detailed in Section 1.2.5 no conditions relating to noise have been set in the relevant Decision Notices for the operational schemes, as such, background noise data collected by TNEI has been used to derive the Total ETSU-R-97 Noise Limits for all NALs);
- Stage 2 – undertake a cumulative assessment, where required, to determine whether the proposed development can operate concurrently with other operational or consented wind turbine developments; and
- Stage 3 – establish the proposed development Site Specific Noise Limits (at levels below the Total ETSU-R-97 Noise Limits, where limit apportionment is required) and compare the noise predictions from the proposed development on its own against the proposed Site Specific Noise Limits.

4.1.3 There are a range of turbine makes and models that may be appropriate for the proposed development. The final selection of turbine will follow a competitive tendering process and thus the final model of turbine may differ from those on which this assessment has been based. However, the final choice of turbine will comply with the noise limits which have been established for the site.

## 4.2 Setting the Total ETSU-R-97 noise limits (Stage 1)

### Consultation

*Background Noise Survey*

4.2.1 Prior to the commencement of the noise impact assessment for the proposed development, direct consultation was undertaken with the Environmental Health Department at Shetland Isles Council (SIC) in order to agree the approach to the noise assessment and the noise monitoring locations. In addition, a representative from the Environmental Health Department was also invited to attend the installation of the noise monitoring equipment.

4.2.2 A number of telephone conversations were held with one of the Assistant Environmental Health Officers (AEHO) from SIC to discuss the proposed methodology and also the proposed noise monitoring locations. The AEHO was unable to attend the installation but did subsequently visit the installed locations with a representative from Viking Energy. During the visit the AEHO recommended the installation of noise monitoring equipment at two additional locations to the south and north west of the site and also suggested moving one of the installed kits to an adjacent property. None of the residents in the area to the north west of the site granted permission to host noise monitoring equipment on their land and therefore none was installed there. An additional noise meter was installed to the south of the site and the other meter moved during a subsequent site visit.

4.2.3 A copy of the original consultation letter is included in Annex 2.

### Existing Noise Limits

4.2.4 As detailed in Section 1.2.4 above, there are a number of operational wind turbine developments within the vicinity of the proposed development, however, no conditions relating to noise have been set in the relevant Decision Notices. As such, background noise data collected by TNEI, and deemed representative of the receptors proximate to the developments, has been used to establish the Total ETSU-R-97 Noise Limits.

### Wind Shear

4.2.5 Wind shear can be defined as *'the change in the relationship between wind speed at different heights'.* Due to wind shear, wind speeds recorded on one meteorological mast at different heights are usually different, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4 $ms^{-1}$ is recorded at 80 m height, 3.5 $ms^{-1}$ may be recorded at 40 m and 2.5 $ms^{-1}$ may be recorded at 10 m.

4.2.6 Hub height wind speed is the key wind speed for a wind farm noise assessment, as it is the wind speed at hub height which will determine the noise emitted by the wind turbines and informs the turbine control system . Ideally, both wind turbine noise predictions and background noise level measurements should refer to hub height wind speed (or a representation thereof), ensuring that there is no discrepancy between the wind speed at which the noise is emitted and the wind speed at which the corresponding background noise is measured.

4.2.7 The IOA GPG states that one of three methods of wind speed measurement may be adopted. For this assessment wind speeds were recorded by anemometers at two different heights, one at a height of more than 60% of the hub height and another located at least 15 metres below it. These were then used to calculate hub height wind speeds in line with 'Method B' of Section 2.6.3 of the IOA GPG.

### Noise Impact Criteria in ETSU-R-97

4.2.8 Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish, for each NAL, the daytime and night-time Total ETSU-R-97 Noise Limits, which would apply for the cumulative operation of all wind turbines in the area. The Total ETSU-R-97 Noise Limits for the daytime has been set at 40 dB(A) or background plus 5 dB whichever is the greater, and the Total ETSU-R-97 Noise Limits at night-time has been set at 43 dB(A) or background plus 5 dB whichever is the greater. This 'Total' limit relates to noise from all wind farm developments in the area. The limit was chosen following a review of the predicted levels for existing wind turbines in the area (and the noise limit that has effectively been allocated already to those consented developments).

4.2.9 As detailed in Section 2.5.9 above, ETSU-R-97 suggests that the daytime fixed minimum limit should be set somewhere in the range between 35 and 40 dB. The precise choice of criterion level within the range 35 - 40 dB(A) depends on a number of factors, including the number of dwellings in the neighbourhood of the wind farm, the effect of noise limits on the number of kWh generated and the duration and level of exposure to any noise. Site Specific Noise Limits have been derived using both the lower and upper fixed minimum limits in order to aid the decision maker in determining the most appropriate fixed minimum daytime noise limit for the proposed development. It should be noted that an alternative daytime fixed minimum limit anywhere within the range 35 – 40 dB may also be deemed appropriate. Further information on each of the three factors detailed above is included within Section 6.6 below.

4.2.10 The acceptable limits for wind turbine operational noise are clearly defined in relation to existing ambient levels for all periods by the application of the ETSU-R-97 methodology. Consequently, the test applied to operational noise is whether or not the predicted wind turbine noise immission levels at nearby noise sensitive properties lie below the noise limits derived in accordance with ETSU-R-97. Depending on the levels of background noise, the satisfaction of the ETSU-R-97 derived limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind turbine noise would be audible.

## 4.3 Assessment of likely effects and the requirement for a cumulative assessment (Stage 2)

4.3.1 A cumulative noise assessment has been undertaken to determine the likely impacts of the proposed development.

4.3.2 The IOA GPG provides current good practice for wind turbines above 50kW, however the wind turbines located in various areas around the Site are less than 50kW. In order to consider the noise immissions from those turbines the turbine source data has been analysed using the data provided by the manufacturers. The location of the wind turbines for the proposed development and the small operational wind turbines around the proposed development are shown on Figure A1.3.

4.3.3 In the absence of noise limits for any of the schemes considered in the cumulative noise assessment, the schemes have been considered in the context of the noise limits established in this report using the guidance contained in ETSU-R-97.

### Noise Prediction / Propagation Model

4.3.4 The ISO 9613-2: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'*[8] model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors. A European Commission (EC) research project into wind farm noise propagation over large distances, published as 'Development of a Wind Farm Noise Prediction Model,' JOULE project JOR3-CT95-0051 in 1998, identified a simplified version of ISO 9613-2 as the most suitable at that time, but the full method has been used for this assessment.

4.3.5 The use of ISO 9613-2 is discussed in the IOA GPG which states, in Section 4.1.4:

*'ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'*

4.3.6 There is currently no standard approach to specifying error bands on noise predictions. Table 5 of ISO 9613-2 suggests, at best, an estimated of accuracy of ± 3 dB(A). The work undertaken as part of the EC research study concluded that the ISO 9613-2 algorithm reliably predicted noise levels that would generally occur under downwind propagation conditions.

4.3.7 The ISO 9613-2 model can take account of the following factors that influence sound propagation outdoors:

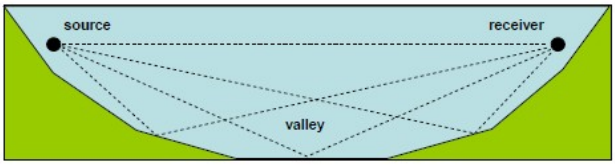
- Geometric divergence;
- Atmospheric absorption;
- Reflecting obstacles;
- Screening;
- Vegetation; and
- Ground attenuation.

4.3.8 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.3.9 The IOA GPG quotes a comparative study undertaken in Australia which indicated ISO 9613-2 can under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley' while slightly over-predicting on flat terrain. It should be noted that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10 km on an elevated ridge. It also should be noted that no correction for background contribution was undertaken and the monitoring locations were located as far as 1.7 km from the nearest turbine where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For their modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally, but use of topographic data is only used to propagation path between source and receiver, and to test for topographic effects as detailed below in accordance with the IOA GPG.

4.3.10 The IOA GPG states that a *'further correction of +3 dB should be added to the calculated overall A-weighted level for propagation 'across a valley', i.e. a concave ground profile or where the ground falls away significantly between a turbine and the receiver location.'* The potential reflection paths are illustrated in Schematic 4.1 below.

**Schematic 4.1: Multiple reflection paths for sound propagation across concave ground**




Source: IOA GPG, page 21, Figure 5

4.3.11 A formula from the JOULE Project JOR3-CT95-0051 dated 1998 is suggested for determining whether a correction is required.

$$h_m \geq 1.5 \times (abs\ (h_s - h_r) / 2)$$

*where $h_m$ is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and $h_s$ and $h_r$ are the heights above local ground level of the source and receiver respectively).*

4.3.12 The calculation of $h_m$ requires consideration of the digital terrain model and needs to be performed for each path between every turbine and every receiver. Interpretation of the results of the calculation above and the subsequent inclusion of a concave ground profile correction requires careful consideration with any topographical variation considered in the context of a site.

4.3.13 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. Although barrier screening effects in ISO 9613-2 can make corrections of up to 15 dB, the IOA GPG states that where there is no line of sight between the highest point on the rotor and the receiver location a reduction of no more than 2 dB may be applied.

4.3.14 The modelling parameters used for this assessment are detailed in Section 6.3.

## 4.4 Setting the Site Specific Noise Limits (Stage 3)

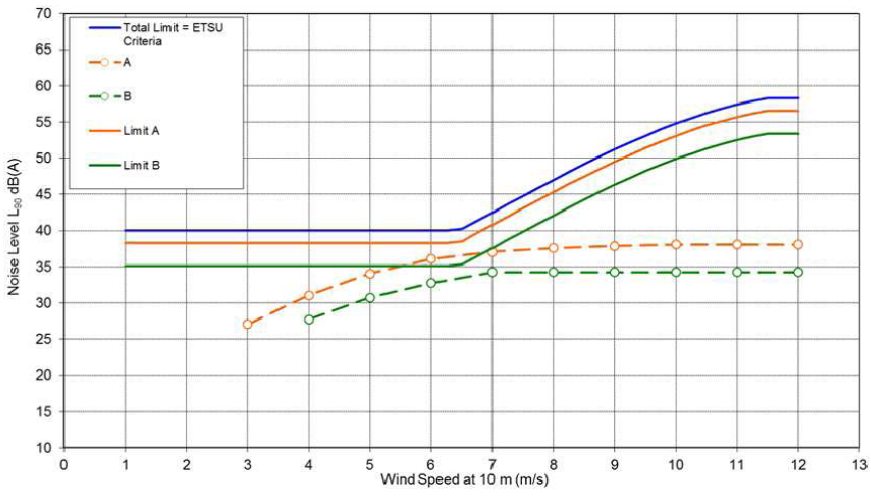
4.4.1 Summary Box 21 of the IOA GPG states:

*'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'*

4.4.2 In order to determine Site Specific Noise Limits at receptors in proximity to the proposed development (where required), limit apportionment will be undertaken. The limit apportionment will consider the noise immissions due to other wind farms / turbine developments in the area. As no noise limits have been set previously for the other schemes the Total ETSU-R-97 Noise Limits will be established based on measured background noise, with apportionment then being undertaken based on the Total ETSU-R-97 Noise Limit derived limit.

4.4.3 This approach is demonstrated in Graph 5.1 below, whereby the Total ETSU-R-97 Noise Limit (shown in blue) is shared between a consented wind farm (A) and a proposed development (B). The two noise limits for a given receptor (the solid orange and green lines) when added together equate to the Total ETSU-R-97 Noise Limit, and the predicted levels for each wind farm (the dashed lines) meet the Site Specific Noise Limits established for the consented wind farm and the proposed development.

***Graph 5.1: Limit Apportionment Example***



4.4.4 The limit derivation can also be undertaken with consideration to the amount of headroom between another schemes(s) predictions and the Total Noise Limit. With regard to this Section 5.4.11 of the IOA GPG states;

*'In cases where there is significant headroom (e.g. 5 to 10 dB) between the predicted noise levels from the existing wind farm and the Total Noise Limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the Total Noise Limits, agreement could be sought with the LPA as to a suitable predicted noise level (including an appropriate margin to cover factors such as potential increases in noise) from the existing wind farm to be used to inform the available headroom for the cumulative assessment without the need for negotiation or cumulative conditioning. This may be the case particularly at low wind speeds.'*

4.4.5 With this in mind, an additional 2 dB buffer has been added to the other schemes' turbine noise predictions. This is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes.

4.4.6 Where predicted wind turbine noise levels from the individual wind farm/ turbine schemes are found to be >10 dB below the Total ETSU-R-97 Noise Limits then it has been deemed appropriate to allocate the entire noise limit to the proposed development. Further information on the approach to apportionment is provided in Section 6.6 below.

# 5 Baseline

## 5.1 Identification of Potential Noise Receptors

5.1.1 At the start of the noise assessment, preliminary desktop noise modelling was undertaken using the 'WindFarm' software in order to locate noise sensitive receptors which may be affected and to identify suitable locations at which to monitor background noise. The consented wind turbine layout was input into the 'WindFarm' software and using noise data for a candidate turbine an initial noise contour plot was produced. The noise contour plot was included in the consultation letter sent to the Environmental Health Department at SIC, a copy of that letter is included in Annex 2.

5.1.2 All properties or clusters of properties within the 35 dB(A) contour were identified and assessed to determine which properties would provide representative background noise data for others in the area. Three receptors located outside of the 35 dB contour were included for completeness due to their proximity and the potential topographical effects which were not considered within the noise contour plot. Other properties outside of the 35 dB(A) contour were not considered in the assessment as protection of the amenity of those receptors would be controlled through a simplified noise condition as detailed in ETSU-R-97 (see Section 2.5.6).

5.1.3 In accordance with ETSU-R-97, the noise contour plot was based on a noise level at a wind speed of 10 $ms^{-1}$ (as standardised to 10 m height) as the manufacturer determined that this is the wind speed with the highest predicted noise level between 0 and 10 $ms^{-1}$ for the candidate turbine.

5.1.4 The IOA GPG notes *that 'noise-sensitive receptors*, [are] *principally houses (existing or for which planning consent is being sought / has been given) and any building used for long-term residential purposes (such as a nursing home)'.* Following a review of noise sensitive receptors surrounding the proposed development, the closest receptors were found to be residential properties.

5.1.5 The properties identified for noise monitoring were selected following a detailed review of the area using aerial photography and local knowledge to identify receptors which would be representative of other nearby properties. Where possible, locations were selected which were subject to minimal influence from other noise sources such as the sea, local watercourses, operational wind turbines and vegetation. The initial list of identified noise monitoring locations were discussed in detail with the AEHO. Based on his local knowledge the AEHO suggested a number of alternative locations and they were adopted for the monitoring. A representative for the Applicant contacted the residents and arranged access for monitoring.

## 5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken for the purposes of setting the ETSU-R-97 Total Noise Limits. Data recorded over the period June to September 2018 at eleven noise sensitive receptors, and July to September 2018 at two receptors (NML12 and NML13), was used for this purpose. Details of the exact monitoring periods, the rationale behind the exact kit location and the dominant noise sources observed at each of the Noise Monitoring Location (NML) are detailed in the Field Data Sheets (FDS) and installation report included in Annex 3.

5.2.2 The NML is the position that the sound level meter was sited in each garden and are shown on Figure A1.1 (Annex 1) and are summarised in Table 5.1 below.

**Table 5.1 Noise Monitoring Locations**

| NML | Receptor Name | Easting | Northing |
|---|---|---|---|
| NML1 | Haa Buttons | 444790 | 1163069 |
| NML2 | Grunnafirth | 445939 | 1159620 |
| NML3 | Hamelea | 448168 | 1157589 |
| NML4 | South Newing | 446854 | 1155947 |
| NML5 | Vergan | 443753 | 1154259 |
| NML6 | Sandwater | 441728 | 1155164 |
| NML7 | Setter House | 439713 | 1154799 |
| NML8 | Langerview | 436258 | 1151269 |
| NML9 | Gruids | 434764 | 1153930 |
| NML10 | Naelea | 435227 | 1156313 |
| NML11 | Hoddins | 437146 | 1161508 |
| NML12* | Setter | 439845 | 1162139 |
| NML13 | Moustoft | 439619 | 1152385 |

*The noise monitoring equipment was originally installed at the adjacent property 'Rocklea' but was moved to Setter following a recommendation from SICs AEHO.

## 5.3 Noise Monitoring Equipment

5.3.1 Section 2.4 of the IOA GPG includes information on the type and specification of noise monitoring equipment which should be used for background noise surveys and states:

*'Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances.'*

5.3.2 The noise monitoring equipment used for the background noise survey meets with the requirements of the IOA GPG. Details of the noise monitoring equipment used, the calibration drift recorded and photographs at each NML are detailed in the FDS included in Annex 3. The IOA GPG states that for calibration drift greater than 1 dB the measurements should be discarded. The maximum positive calibration drift recorded during the noise survey was <0.5 dB as detailed in the FDS (included in Annex 3) therefore no correction has been applied to the noise data.

5.3.3 Copies of the calibration/conformance certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 4.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *'in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), where appropriate, away from obvious local sources of noise such as boiler flues[1], fans and running water. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 All measurement systems were set to log the $L_{A90}$ and $L_{Aeq}$ noise levels over the required ten minute intervals continuously over the deployment period.

## 5.4 Meteorological Data

5.4.1 ETSU-R-97 states on Page 84 that:

*'background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that the actual operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.'*

5.4.2 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.2.7.

5.4.3 For the proposed development, concurrent wind speed/direction were recorded using one 60 m and three 70 m meteorological masts located at the site. The details of the masts are provided in Table 5.2 below. The meteorological data was collected and provided by SSE Renewables. The installation reports and calibration information for the masts can be provided upon request.

[1] NML12 was located near to a boiler flue. The affected data were clearly identifiable in the time series graphs and have been removed in accordance with good practice.

**Table 5.2 Meteorological Mast Information**

| Mast Name | Height | OS Grid Reference |
|---|---|---|
| Flamister | 60 | 443627, 1155897 |
| Mid Kames North | 70 | 440879, 1159369 |
| Runn Hill | 70 | 445828, 1157913 |
| Scalla Field | 70 | 438992, 1156572 |

5.4.4 Noise data from each NML were correlated with wind speed and direction data from the closest mast.

5.4.5 Tipping bucket rain gauges were installed by TNEI at NML3, NML9 and NML12 for the duration of the noise survey to record periods of rainfall with time synchronised to the sound measurements. As per the recommendations in Section 3.1.9 of the IOA GPG, the noise data from 10 minute periods which coincided with rainfall events (at any of the rain gauges) and the preceding 10 minute period have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2m (Annex 1) as blue squares.

5.4.6 Wind speed and direction data were collected over the same time-scale, and averaged over the same ten minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed.

5.4.7 In accordance with the IOA GPG, Method B (detailed within Section 3.2), has been adopted for this assessment which involved using data collected at 60 m and 40 m on the 60 m meteorological mast) and 70 m and 50 m on the 70 m meteorological masts which were used to calculate hub height (100 m) wind speeds which, in turn, were standardised to a height of 10 m above ground. Whilst the hub height of the turbine is expected to be 95 m, using 100 m to standardise to 10 m is considered conservative due to the nature of how standardised wind speeds behave with relation to increasing hub heights; the higher the hub height in which wind speeds are being standardised from, the further the shift of the wind speed data over to the right of the wind speed axis. This has the overall effect of lowering limits over the wind speed range necessary to be assessed in accordance with ETSU-R-97.

## 5.5 Influence of Existing Turbines on Background Measurements

5.5.1 ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise.

5.5.2 The IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise the contribution of the wind turbines can be accounted for by filtering the measured data by direction (only including background data when a receptor is upwind of the wind turbines) or by subtracting predicted turbine noise from the measured levels.

5.5.3 The NMLs were carefully selected such that they were located away from operational turbines wherever possible. There was however an operational wind turbine to the south of NML9 Gruids which was audible on occasion at the NML. In order to minimise any potential influence from the turbine directional filtering was undertaken to remove all data collected when the NML was downwind of the turbine (see Annex 1, Figure A1.2e).

## 5.6 Directional Filtering of Background Noise

5.6.1 In Section 3.1.22 of the IOA GPG the need to directionally filter background noise data is discussed. Where a receiver is located upwind of a dominant local noise source whilst also being systematically downwind of the turbines then it may be necessary to filter background noise data particularly when this corresponds to the prevailing wind direction.

5.6.2 Sea noise was found to be having an influence at NML5, Vergan. On that basis the data was filtered to remove the influence of sea noise (See Figure A1.2e).

## 5.7 Analysis of Measured Data

5.7.1 Analysis of the measured data has been undertaken in accordance with the recommendations in ETSU-R-97 and the IOA GPG.

5.7.2 Time series graphs are provided in Annex 5, which show the variation in measured wind speed/direction and noise level over the monitoring period. These graphs also show where data was excluded, either due to rainfall, birdsong or manual exclusions due to atypical data. A summary of the data exclusions at each receptor is also included within Annex 5.

## 5.8 Prevailing Background Noise Level

5.8.1 Table 5.3 and 5.4 summarise the prevailing background noise levels measured during the noise monitoring period, after filtering of the individual datasets as discussed above.

**Table 5.3 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods (dB(A))**

| NML | Prevailing Background Noise Level $L_{A90,10\ min}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NML1 - Haa Buttons | 21.9 | 22.9 | 24 | 25.1 | 26.3 | 27.6 | 29 | 30.3 | 31.8 | 33.3 | 34.8 | 36.4 |
| NML2 – Grunnafirth | 22 | 22 | 22.5 | 23.6 | 25.2 | 27.1 | 29.3 | 31.6 | 33.8 | 35.9 | 37.6 | 38.9 |
| NML3 – Hamelea | 19.6 | 19.6 | 19.9 | 21.1 | 23.1 | 25.6 | 28.5 | 31.6 | 34.7 | 37.8 | 40.5 | 42.9 |
| NML4 - South Newing | 18.9 | 18.9 | 19.6 | 20.9 | 22.6 | 24.6 | 26.8 | 29.1 | 31.5 | 33.7 | 35.6 | 37.2 |
| NML5 – Vergan | 23 | 23.5 | 24.8 | 26.5 | 28.6 | 31.1 | 33.7 | 36.3 | 38.9 | 41.2 | 43.3 | 44.9 |
| NML6 – Sandwater | 24.6 | 24.6 | 25.4 | 26.7 | 28.5 | 30.7 | 33.1 | 35.6 | 38.1 | 40.5 | 42.7 | 44.5 |
| NML7 - Setter House | 24.6 | 24.6 | 24.6 | 25 | 25.9 | 27.1 | 28.7 | 30.6 | 32.7 | 35 | 37.5 | 40 |
| NML8 – Langerview | 21.8 | 22.8 | 23.9 | 25.1 | 26.5 | 28 | 29.7 | 31.4 | 33.3 | 35.3 | 37.4 | 39.6 |
| NML9 – Gruids | 19.9 | 19.9 | 20.2 | 20.8 | 21.9 | 23.3 | 25.2 | 27.4 | 30.1 | 33.2 | 36.6 | 40.5 |
| NML10 – Naelea | 20.5 | 21.3 | 22.2 | 23.3 | 24.6 | 26.2 | 28 | 30.2 | 32.7 | 35.7 | 39.1 | 43 |
| NML11 – Hoddins | 22.7 | 23.7 | 24.6 | 25.4 | 26.3 | 27.4 | 28.6 | 30.1 | 31.9 | 34.2 | 37 | 40.3 |
| NML12* - Setter | 20.5 | 22.4 | 24 | 25.5 | 26.8 | 28.2 | 29.5 | 31 | 32.6 | 34.4 | 36.6 | 39.1 |
| NML13 – Moustoft | 25 | 25.1 | 25.5 | 26.1 | 26.9 | 27.9 | 29.2 | 30.7 | 32.5 | 34.6 | 36.9 | 39.4 |

**The noise monitoring equipment was originally installed at the adjacent property 'Rocklea' but was moved to Setter following a recommendation from SICs Assistant EHO.*

**Table 5.4 Summary of Prevailing Background Noise Levels during Night-time Periods (dB(A))**

| NML | Prevailing Background Noise Level $L_{A90,10\ min}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NML1 - Haa Buttons | 20.6 | 21 | 21.3 | 21.8 | 22.5 | 23.3 | 24.3 | 25.6 | 27.1 | 28.9 | 31.1 | 33.6 |
| NML2 – Grunnafirth | 21.2 | 20.9 | 21.1 | 21.7 | 22.7 | 24.1 | 25.8 | 27.8 | 30.1 | 32.7 | 35.4 | 38.4 |
| NML3 – Hamelea | 18.8 | 18.8 | 18.9 | 19.7 | 21 | 22.9 | 25.4 | 28.4 | 31.8 | 35.7 | 40 | 44.7 |
| NML4 - South Newing | 18.4 | 18.5 | 18.8 | 19.5 | 20.5 | 21.9 | 23.8 | 26 | 28.8 | 32.1 | 35.9 | 40.4 |
| NML5 – Vergan | 18.6 | 18.6 | 18.6 | 19.7 | 21.8 | 24.7 | 28.1 | 31.5 | 34.9 | 37.8 | 39.9 | 41.1 |
| NML6 – Sandwater | 17.8 | 17.8 | 17.9 | 19 | 21 | 23.7 | 26.9 | 30.4 | 34 | 37.6 | 40.8 | 43.6 |
| NML7 - Setter House | 17.9 | 17.9 | 17.9 | 18.2 | 19.1 | 20.5 | 22.4 | 24.6 | 27.1 | 29.7 | 32.5 | 35.2 |
| NML8 – Langerview | 18.8 | 18.8 | 19 | 19.7 | 20.9 | 22.6 | 24.7 | 27.1 | 29.9 | 32.9 | 36.2 | 39.6 |
| NML9 – Gruids | 18.3 | 18.3 | 18.5 | 18.8 | 19.4 | 20.2 | 21.3 | 22.6 | 24.1 | 26 | 28.1 | 30.4 |
| NML10 – Naelea | 17.1 | 17.1 | 17.1 | 18 | 19.5 | 21.5 | 24 | 26.7 | 29.6 | 32.5 | 35.2 | 37.6 |
| NML11 – Hoddins | 20.9 | 20.9 | 20.9 | 21.2 | 21.8 | 22.7 | 24 | 25.8 | 28.1 | 31 | 34.5 | 38.7 |
| NML12* - Setter | 18.4 | 18.4 | 18.4 | 18.7 | 19.6 | 21.1 | 23.1 | 25.5 | 28.1 | 30.8 | 33.6 | 36.3 |
| NML13 – Moustoft | 19.5 | 19.5 | 19.5 | 19.5 | 20 | 21.1 | 22.8 | 25 | 27.7 | 30.7 | 34.1 | 37.7 |

**The noise monitoring equipment was originally installed at the adjacent property 'Rocklea' but was moved to Setter following a recommendation from SICs Assistant EHO.*

5.8.2 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a - A1.2m (Annex 1). There is a set of graphs for each of the NMLs, which show the range of wind speeds and directions recorded during the survey at the nearest meteorological mast and the 10 minute average wind speeds plotted against the recorded $L_{A90,\ 10min}$ noise levels at the NML along with a calculated 'best fit' polynomial regression line for the quiet daytime and night-time periods. Each Figure also includes a Table with the number of recorded data points per integer wind speed bin and the prevailing measured background noise levels.

5.8.3 The prevailing measured background noise levels have been calculated using a best fit polynomial regression line of no more than a fourth order through the measured $L_{A90,\ 10min}$ noise data, as required by ETSU-R-97 and the IOA GPG.

5.8.4 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. This is presented on the Figures, the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit through the data is shown as a dashed black line.

5.8.5 Section 2.9.5 of the IOA GPG recommends that no fewer than 200 valid data points should be recorded in each of the quiet daytime and night-time periods, with no fewer than 5 valid data points in any 1 $ms^{-1}$ wind speed bin. Where the background noise data has been filtered by wind direction the IOA GPG (Section 2.9.6) recommends that 100 data points and 3 per wind speed bin may be appropriate. Where the minimum number of data points in a wind speed bin was not achieved, data in that bin has been manually excluded from the assessment.

5.8.6 ETSU-R-97 states (Page 101) that data may not be extrapolated beyond the measured range of wind speeds. It is however reasonable to assume that background noise levels will not decrease at higher wind speeds. As such, in the interest of protecting residential amenity, the noise levels for higher wind speeds where data has not been collected have been set equal to those derived for lower wind speeds as set out below (as per Section 3.1.20 of the IOA GPG).

5.8.7 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.5 below.

**Table 5.5 Analysis of Measured Datasets**

| NML | Quiet Daytime | Night-Time |
|---|---|---|
| NML1 - Haa Buttons | - | - |
| NML2 - Grunnafirth | Flatlined below 2 $ms^{-1}$ (minimum level recorded) | Flatlined below 1 $ms^{-1}$ (minimum level recorded) |
| NML3 - Hamelea | Flatlined below 2 $ms^{-1}$ (minimum level recorded) | Flatlined below 2 $ms^{-1}$ (minimum level recorded) |

| NML | Quiet Daytime | Night-Time |
|---|---|---|
| NML4 - South Newing | - | - |
| NML5 - Vergan | - | Flatlined below 3 $ms^{-1}$ (minimum level recorded). |
| NML6 - Sandwater | - | Flatlined below 2 $ms^{-1}$ (minimum level recorded). |
| NML7 - Setter House | Flatlined below 3 $ms^{-1}$ (minimum level recorded) | Flatlined below 3 $ms^{-1}$ (minimum level recorded). |
| NML8 - Langerview | - | Flatlined below 2 $ms^{-1}$ (minimum level recorded). |
| NML9 - Gruids | Flatlined below 3 $ms^{-1}$ (minimum level recorded) | Flatlined below 3 $ms^{-1}$ (minimum level recorded). |
| NML10 - Naelea | - | Flatlined below 2 $ms^{-1}$ (minimum level recorded). |
| NML11 - Hoddins | - | Flatlined below 3 $ms^{-1}$ (minimum level recorded). |
| NML12 - Setter | - | Flatlined below 3 $ms^{-1}$ (minimum level recorded) |
| NML13 - Moustoft | - | Flatlined below 4 $ms^{-1}$ (minimum level recorded). |

5.8.8 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a - A1.2m (Annex 1). The Figures also show the final prevailing background noise levels which have been determined following the analysis detailed above.

# 6 Noise Assessment Results

## 6.1 Noise Assessment Locations

6.1.1 Noise assessment locations (NAL) refer to the position on the curtilage denoted by the red triangle on Figure A1.1 (Annex 1). A total of twenty nine noise sensitive receptors were chosen as representative NALs. The NALs chosen were the closest receptors to the proposed development and other wind farm developments. Predictions of wind turbine noise have been made at each of the NAL as detailed in Table 6.1.

6.1.2 This approach ensures that the report models the worst case (loudest) noise immission level expected at each group of noise sensitive receptors, as, generally speaking, sound levels decrease due to the attenuating factors described in Section 5.4.3 and thus the closer to a noise source, the higher the noise level. Table 6.1 details which NML has been used to set noise limits for each NAL. The noise limits have been derived for each receptor using the closest meteorological mast to a given NAL. The location of the four meteorological masts are shown on Figure A1.1.

**Table 6.1 Noise Assessment Locations**

| Noise Assessment Location (NAL) | Easting (m) | Northing (m) | Elevation (m Above Ordnance Datum) | Approximate Distance to Nearest Viking Turbine (m) | Background Noise Data Used |
|---|---|---|---|---|---|
| NAL1 - Glenlea | 444322 | 1163627 | 23 | 1,480 | NML1 |
| NAL2 – Taratet | 445001 | 1162940 | 36 | 1,293 | NML1 |
| NAL3 - Grunnafirth | 445947 | 1159638 | 16 | 1,491 | NML2 |
| NAL4 – New House at Dury | 445673 | 1160441 | 30 | 1,244 | NML2 |
| NAL5 – Hamelea | 448170 | 1157574 | 45 | 1,831 | NML3 |
| NAL6 – Whinnia Lee | 446682 | 1155852 | 26 | 1,436 | NML4 |
| NAL7 - Hollydell | 443843 | 1154352 | 30 | 1,143 | NML5 |
| NAL8 - Sandwater | 441732 | 1155184 | 50 | 1,064 | NML6 |
| NAL9 – Setter House | 439705 | 1154796 | 52 | 1,367 | NML7 |
| NAL10 - Millhouse | 439460 | 1153086 | 13 | 1,650 | NML13 |

| Noise Assessment Location (NAL) | Easting (m) | Northing (m) | Elevation (m Above Ordnance Datum) | Approximate Distance to Nearest Viking Turbine (m) | Background Noise Data Used |
|---|---|---|---|---|---|
| NAL11 - Koopins | 439511 | 1152903 | 13 | 1,670 | NML13 |
| NAL12 - Dykeside | 436370 | 1151231 | 34 | 1,870 | NML8 |
| NAL13 - Breckenlea | 435463 | 1151606 | 18 | 2,250 | NML8 |
| NAL14 - Gruids | 434765 | 1153921 | 56 | 2,180 | NML9 |
| NAL15 - Mid Town | 434695 | 1153637 | 55 | 2,354 | NML9 |
| NAL16 - Valhalla | 436728 | 1157749 | 11 | 1,470 | NML10 |
| NAL17 – 12 Whitelaw Road | 434911 | 1155664 | 12 | 1,900 | NML10 |
| NAL18 - Roadside | 436191 | 1157714 | 21 | 1,690 | NML10 |
| NAL19 - Hoddins | 437135 | 1161516 | 29 | 2,750 | NML11 |
| NAL20 - Rocklea | 439858 | 1162158 | 60 | 1,570 | NML12 |
| NAL21- Norbrek | 440923 | 1164030 | 58 | 2,590 | NML12 |
| NAL22 - Muness | 445131 | 1153152 | 10 | 2,790 | NML5 |
| NAL23 - Parkhead | 440737 | 1151832 | 37 | 3,070 | NML13 |
| NAL24 – Moars Park | 438150 | 1150032 | 13 | 2,750 | NML13 |
| NAL25 - The Mark | 433431 | 1158405 | 24 | 4,110 | NML10 |
| NAL26 – Lonabrek | 433980 | 1155778 | 28 | 2,840 | NML10 |
| NAL27 - Adnashoor | 434622 | 1155969 | 1 | 2,250 | NML10 |
| NAL28 – South Voxter | 436072 | 1161942 | 13 | 3,850 | NML11 |
| NAL29 – East Lynn | 436347 | 1165646 | 23 | 6,500 | NML11 |

6.1.3 Table 6.1 above summarises which dataset has been used as proxy data for other noise sensitive receptors.

## 6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the proposed development. This assessment considers the Siemens SWT-DD-120 4.3 MW with a 95 m hub height. For the cumulative assessment the turbines used are summarised in Annex 7.

6.2.2 Noise data for the various cumulative schemes considered in this assessment have been obtained from the manufacturers and have been analysed in detail by TNEI. Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG (2013). Details of the sound power level and octave data used for the turbines considered in this assessment are included in Annex 6.

6.2.3 Manufacturer data is usually supplied based on a specific hub height whilst values are presented as standardised to 10 m height. The noise model used in this assessment alters turbine noise data to account for different hub heights, where applicable. The hub height considered for the proposed development is 95 m. The hub heights considered for the other wind farm/turbine developments are summarised in Annex 7.

6.2.4 The location of the wind turbines are shown on Figure A1.3 and grid references are included in Annex 7.

## 6.3 Noise Propagation Parameters

6.3.1 As detailed in Section 5.3 above, the full version of the ISO 9613-2 model has been used to calculate the noise immission levels at the nearest receptors.

6.3.2 For the purposes of the present assessment, all noise level predictions have been undertaken using a receiver height of 4.0 m above local ground level, mixed ground (G=0.5) and air absorption coefficients based on a temperature of 10 °C and 70 % relative humidity to provide a realistic impact assessment. The modelling parameters reflect current good practice as detailed within the IOA GPG.

6.3.3 The wind turbine noise immission levels are based on the $L_{A90,10\ minute}$ noise indicator in accordance with the recommendations in ETSU-R-97, which were obtained by subtracting 2dB(A) from the turbine sound power level data ($L_{Aeq}$ indicator).

6.3.4 A topographical assessment has been undertaken between each noise sensitive receptor and each Viking wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA[9] and an Excel model found that if the formula in the IOA GPG is applied directly a +3 dB correction is required for some turbines at a number of receptors as summarised in Annex 7.

6.3.5 In addition, an assessment has been undertaken to determine whether any topographical screening effects of the terrain occur where there is no direct line of site between the highest point on the turbine rotor and the receiver location. Upon analysis of each noise sensitive receptor it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors as detailed in Annex 7. In reality, there is significant screening at some of the locations so more attenuation may occur in practice, the use of a 2 dB value is therefore considered to be conservative as it results in the highest predicted levels. All corrections have been applied, where necessary, in all of the Tables and Graphs in this report. In accordance with the scope of the IOA GPG, the topographical assessment only considers wind turbines >50 kW; corrections for smaller turbines are not considered to be appropriate and have not been included.

6.3.6 The need to include a concave ground/screening correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits established in this report regardless of any increases in noise propagation caused by topography. Should consent be granted for the proposed development, the need to apply a concave slope correction will need to be considered by the Applicant prior to the final selection of a turbine model for the proposed development.

6.3.7 The cumulative assessment has taken into account directivity effects in line with good practice. The directivity of wind turbines has been recognised for some time. Building on earlier work by NASA, in 1988 Wyle Laboratories studied sound propagation using an omnidirectional loudspeaker source elevated 80 ft above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range, but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

6.3.8 Hubbard (1990) described a number of factors believed to influence propagation and directivity, notably refraction caused by vertical wind and temperature gradients. In the downwind direction the wind gradient causes the sound rays to bend toward the ground, whereas in the upwind direction the rays curve upward away from the ground. Upwind of the turbine this results in a region of increased attenuation termed the 'shadow zone'. The excess attenuation is frequency dependent, with lowest frequencies least attenuated. Relating this to the earlier NASA studies, Hubbard noted that the distance from the source to the edge of the shadow zone is related to the wind speed gradient and the elevation of the source, which for a typical turbine source was calculated to be approximately 5 times the source height.

6.3.9 This observation was adopted in the IOA GPG, which states (4.4.2) 'Such reductions (due to "shadow zone" refraction effects) will in practice only progressively come into play at distances of between 5 and 10 turbine tip heights', while 4.4.3 provides graphical examples of increasing broadband directivity with increasing tip height scaling in both flat and hilly terrain, without qualifying either of those designations.

6.3.10 The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The TNEI noise model can consider the effect of directivity, and in line with current good practice the attenuation values used are in detailed in Table 6.2. These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required, and adopt a single attenuation value for receptors located more than 5 tip heights from a receiver.

**Table 6.2 Wind Directivity Attenuation Factors used in Modelling**

| Direction (º) | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Attenuation dB(A)) | -10 | -9.9 | -9.3 | -8.3 | -6.7 | -4.6 | -2 | 0 | 0 | 0 | 0 | 0 |
| Direction (º) | 180 | 195 | 210 | 225 | 240 | 255 | 270 | 285 | 300 | 315 | 330 | 345 |
| Attenuation (dB(A)) | 0 | 0 | 0 | 0 | 0 | 0 | -2 | -4.6 | -6.7 | -8.3 | -9.3 | -9.9 |

## 6.4 Total ETSU-R-97 Noise Limits (Stage 1)

6.4.1 The ETSU-R-97 noise limits are derived by first establishing the 'best fit' correlation between background noise level and wind speed. These limits, sometimes referred to as the 'criterion curve', are based on a level 5 dB(A) above this best fit correlation curve, over a wind speed range from 0 to 12 $ms^{-1}$. Where the derived criterion curve for the daytime period lies below a fixed level in the range 35 – 40 dB(A) then ETSU-R-97 provides that the criterion curve may be set at an absolute level somewhere within that range.

6.4.2 When considering the cumulative impacts of the proposed development operating in conjunction with other operational or consented schemes a Fixed Minimum Limit of 40 dB has been adopted to establish the daytime Total ETSU-R-97 Noise Limit. The limit was chosen following a review of the predicted levels for existing wind turbines in the area (and in recognition that the 40 dB noise limit has effectively been allocated already to those consented developments).

6.4.3 The Total ETSU-R-97 Noise Limits have been established for each of the NALs as detailed in Table 6.3 and Table 6.4 below, based on a fixed minimum of 40dB(A) (daytime) or 43 dB(A) (Night-time) or background plus 5 dB(A).

**Table 6.3 - Total ETSU-R-97 Noise Limits Daytime**

| Location | Wind Speed ($ms^{-1}$) as standardised to 10m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.4 |
| NAL2 – Taratet | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.4 |
| NAL3 - Grunnafirth | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.9 |
| NAL4 – New House at Dury | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.9 |
| NAL5 – Hamelea | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.8 | 45.5 | 47.9 |
| NAL6 – Whinnia Lee | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 42.2 |
| NAL7 - Hollydell | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| NAL8 - Sandwater | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 43.1 | 45.5 | 47.7 | 49.5 |
| NAL9 – Setter House | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.5 | 45 |
| NAL10 - Millhouse | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| NAL11 - Koopins | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| NAL12 - Dykeside | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| NAL13 - Breckenlea | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| NAL14 - Gruids | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 45.5 |
| NAL15 - Mid Town | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 45.5 |

| Location | Wind Speed ($ms^{-1}$) as standardised to 10m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL16 - Valhalla | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL17 – 12 Whitelaw Road | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL18 - Roadside | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL19 - Hoddins | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| NAL20 - Rocklea | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 44.1 |
| NAL21- Norbrek | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 44.1 |
| NAL22 - Muness | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| NAL23 - Parkhead | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| NAL24 – Moars Park | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| NAL25 - The Mark | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL26 – Lonabrek | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL27 - Adnashoor | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| NAL28 – South Voxter | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| NAL29 – East Lynn | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |

**Table 6.4 - Total ETSU-R-97 Noise Limits Night Time**

| Location | Wind Speed ($ms^{-1}$) as standardised to 10m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL2 – Taratet | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL3 - Grunnafirth | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.4 |
| NAL4 – New House at Dury | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.4 |
| NAL5 – Hamelea | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45 | 49.7 |

| Location | Wind Speed ($ms^{-1}$) as standardised to 10m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL6 – Whinnia Lee | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.4 |
| NAL7 - Hollydell | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.9 | 46.1 |
| NAL8 - Sandwater | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.8 | 48.6 |
| NAL9 – Setter House | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL10 - Millhouse | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL11 - Koopins | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL12 - Dykeside | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| NAL13 - Breckenlea | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| NAL14 - Gruids | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL15 - Mid Town | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL16 - Valhalla | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL17 – 12 Whitelaw Road | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL18 - Roadside | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL19 - Hoddins | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| NAL20 - Rocklea | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL21- Norbrek | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL22 - Muness | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.9 | 46.1 |
| NAL23 - Parkhead | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL24 – Moars Park | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL25 – The Mark | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL26 – Lonabrek | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL27 - Adnashoor | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| NAL28 – South Voxter | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| NAL29 – East Lynn | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |

## 6.5 Predicting the likely effects and the requirement for a cumulative assessment (Stage 2)

6.5.1 As detailed above, as part of the NAL selection process, predictions were undertaken at all 261 NSRs in order to determine where turbine noise immissions from the proposed development and cumulative predictions were the highest. The NAL refinement process therefore identified the worst case NALs to consider as part of the cumulative noise assessment (see Table 6.1 above).

6.5.2 Figure A1.3 (Annex 1) shows the NALs and the location of the proposed development and the other wind farms. A likely cumulative noise assessment was undertaken at all NALs detailed in Table 6.1. A detailed list of the wind farms considered in the noise predictions are included in Annex 7.

6.5.3 In order to protect residential amenity, the IOA GPG (2013) recommendations are that cumulatively, all schemes operate within the 'Total ETSU-R-97 Noise Limits'. This can be found in summary box SB21 of the IOA GPG (2013) which states:

*'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'*

6.5.4 The result of the likely cumulative noise assessment are summarised in tabular form in Table 6.5 and Table 6.6 and show that the proposed development can operate concurrently with the operational singular turbine installations near to noise assessment locations, whilst still meeting the Total ETSU-R-97 Noise limits established in accordance with ETSU-R-97 at the vast majority of receptors. There are a small number of assessment locations where predicted noise levels from existing wind turbines (consented or operational) already exceed the noise limits recommended by ETSU-R-97 even when a 40 dB daytime fixed minimum limit is adopted. Where such an exceedance already exists the proposed development would operate such that it will cause a negligible increase in levels. To ensure that the Total ETSU-R-97 Noise Limits are achieved certain turbines will need to be operated in low noise mode / switched off during certain wind speeds and directions. Some mode management would also be required during the night-time periods. The Tables below consider the adoption of the upper daytime fixed limit for the proposed development as this provides the worst case (highest) predicted levels.

6.5.5 A series of graphs to show the predicted cumulative wind turbine noise from all schemes compared to the Total ETSU-R-97 Noise Limits are included as Figures A1.4a - A1.4ac (based on mode management predictions to meet a fixed minimum of 35 dB) and Figures A1.5a – A1.5ac (based on mode management predictions to meet on a fixed minimum of 40 dB) (Annex 1). There is a set of graphs for each of the NAL, which show the Total ETSU-R-97 Noise Limit (solid red line), the prevailing background noise level (black line), the total cumulative noise (yellow line), the predicted noise from all other schemes (blue line) and the predicted wind turbine noise from the proposed development which includes mode management (dashed green line with triangles).

**Table 6.5 ETSU-R-97 Compliance Table – Likely Cumulative Noise - Daytime**

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.1 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.9 | -2.2 | -2.2 | -2.2 | -2.2 | -2.2 | -3.6 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.1* | *13.4* | *15.6* | *17.8* | *20.1* | *22.3* | *22.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.9* | *-26.6* | *-24.4* | *-22.2* | *-19.9* | *-17.7* | *-19.1* |
| NAL2 - Taratet | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 38.7 | 39.2 | 40.9 | 43.2 | 45.4 | 47.7 | 47.7 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -1.3 | -0.8 | 0.9 | 3.2 | 5.4 | 7.7 | 6.3 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *36.4* | *38.7* | *40.9* | *43.2* | *45.4* | *47.7* | *47.7* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-3.6* | *-1.3* | *0.9* | *3.2* | *5.4* | *7.7* | *6.3* |
| NAL3 - Grunnafirth | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.9 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 | -0.6 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *10* | *12.4* | *14.5* | *16.7* | *18.9* | *21.1* | *21.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-30* | *-27.6* | *-25.5* | *-23.3* | *-22* | *-21.5* | *-22.8* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL4 – New House at Dury | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.9 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37.7 | 40 | 40 | 40 | 40.3 | 41 | 41 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -2.3 | 0 | 0 | 0 | -0.6 | -1.6 | -2.9 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *20.8* | *23.1* | *25.3* | *27.5* | *29.8* | *32* | *32* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-19.2* | *-16.9* | *-14.7* | *-12.5* | *-11.1* | *-10.6* | *-11.9* |
| NAL5 - Hamelea | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.8 | 45.5 | 47.9 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 32.8 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.2 | -4.5 | -4.5 | -4.5 | -7.3 | -10 | -12.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *8.8* | *11.6* | *13.1* | *14.2* | *15.6* | *17.3* | *17.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.2* | *-28.4* | *-26.9* | *-25.8* | *-27.2* | *-28.2* | *-30.6* |
| NAL6 – Whinnia Lee | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 42.2 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.5 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.5 | -1.8 | -1.8 | -1.8 | -1.8 | -2.4 | -4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.6* | *14.4* | *15.9* | *17* | *18.4* | *20.1* | *20.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.4* | *-25.6* | *-24.1* | *-23* | *-21.6* | *-20.5* | *-22.1* |
| NAL7 - Hollydell | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37.5 | 40 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -2.5 | 0 | -1.1 | -3.7 | -6 | -8.1 | -9.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *14.1* | *16.8* | *18.5* | *20* | *21.7* | *23.9* | *23.9* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-25.9* | *-23.2* | *-22.8* | *-23.9* | *-24.5* | *-24.4* | *-26* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL8 - Sandwater | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 43.1 | 45.5 | 47.7 | 49.5 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40 | 40 | 40.6 | 43.1 | 43.3 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | 0 | 0 | 0 | 0 | -2.2 | -4.4 | -6.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *8.9* | *11.6* | *13.8* | *15.9* | *18.3* | *21.1* | *21.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.1* | *-28.4* | *-26.8* | *-27.2* | *-27.2* | *-26.6* | *-28.4* |
| NAL9 – Setter House | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.5 | 45 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 38.8 | 40 | 40 | 40 | 40 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -1.2 | 0 | 0 | 0 | 0 | -1 | -3.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *10* | *12.7* | *15* | *17.5* | *20.1* | *23.1* | *23.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-30* | *-27.3* | *-25* | *-22.5* | *-19.9* | *-19.4* | *-21.9* |
| NAL10 - Millhouse | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.1 | 36.8 | 36.8 | 36.8 | 36.8 | 37.2 | 37.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -5.9 | -3.2 | -3.2 | -3.2 | -3.2 | -4.7 | -7.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.2* | *14.4* | *17.3* | *20.3* | *23.6* | *27.1* | *27.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.8* | *-25.6* | *-22.7* | *-19.7* | *-16.4* | *-14.8* | *-17.3* |
| NAL11 - Koopins | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.7 | 36.4 | 36.4 | 36.4 | 36.4 | 37 | 37 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6.3 | -3.6 | -3.6 | -3.6 | -3.6 | -4.9 | -7.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.7* | *14.9* | *17.9* | *21.1* | *24.5* | *28.1* | *28.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.3* | *-25.1* | *-22.1* | *-18.9* | *-15.5* | *-13.8* | *-16.3* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL12 - Dykeside | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 29.4 | 32.1 | 32.1 | 32.1 | 32.7 | 33.2 | 33.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -10.6 | -7.9 | -7.9 | -7.9 | -7.6 | -9.2 | -11.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *14.1* | *16.5* | *18.9* | *21.4* | *23.9* | *26.5* | *26.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-25.9* | *-23.5* | *-21.1* | *-18.6* | *-16.4* | *-15.9* | *-18.1* |
| NAL13- Breckenlea | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 27.7 | 30.4 | 30.9 | 31.3 | 31.9 | 32.9 | 32.9 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -12.3 | -9.6 | -9.1 | -8.7 | -8.4 | -9.5 | -11.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *16.8* | *19.2* | *21.6* | *24.2* | *26.7* | *29.3* | *29.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-23.2* | *-20.8* | *-18.4* | *-15.8* | *-13.6* | *-13.1* | *-15.3* |
| NAL14- Gruids | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 45.5 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.4 | 36.1 | 36.8 | 37.8 | 38.3 | 41.2 | 41.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6.6 | -3.9 | -3.2 | -2.2 | -1.7 | -0.4 | -3.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *25.8* | *28.5* | *31.4* | *34.3* | *37.5* | *40.7* | *40.7* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-14.2* | *-11.5* | *-8.6* | *-5.7* | *-2.5* | *-0.9* | *-4.8* |
| NAL15- Mid Town | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 45.5 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.9 | 38.5 | 38.9 | 40.7 | 43.1 | 45.5 | 45.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.1 | -1.5 | -1.1 | 0.7 | 3.1 | 3.9 | 0 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.7* | *36.1* | *38.3* | *40.7* | *43.1* | *45.5* | *45.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-6.3* | *-3.9* | *-1.7* | *0.7* | *3.1* | *3.9* | *0* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL16 - Valhalla | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -3 | -0.3 | -0.3 | -0.3 | -1 | -4.4 | -8.3 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *12.6* | *14.9* | *17.3* | *19.8* | *22.4* | *25.1* | *25.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-27.4* | *-25.1* | *-22.7* | *-20.2* | *-18.3* | *-19* | *-22.9* |
| NAL17– 12 Whitelaw Road | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.5 | 37.3 | 38.2 | 38.5 | 40.8 | 44.5 | 45.1 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -5.5 | -2.7 | -1.8 | -1.5 | 0.1 | 0.4 | -2.9 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *26.6* | *30* | *33.5* | *37.1* | *40.8* | *44.5* | *44.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-13.4* | *-10* | *-6.5* | *-2.9* | *0.1* | *0.4* | *-3.5* |
| NAL18 - Roadside | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 36.8 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -3.2 | -0.5 | -0.5 | -0.5 | -1.2 | -4.6 | -8.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *13.7* | *16* | *18.4* | *20.9* | *23.4* | *26.2* | *26.2* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-26.3* | *-24* | *-21.6* | *-19.1* | *-17.3* | *-17.9* | *-21.8* |
| NAL19 - Hoddins | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 28.8 | 31.5 | 31.5 | 31.5 | 31.5 | 32.2 | 32.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -11.2 | -8.5 | -8.5 | -8.5 | -8.5 | -9.8 | -13.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *12.2* | *14.5* | *16.8* | *19* | *21.3* | *23.6* | *23.6* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-27.8* | *-25.5* | *-23.2* | *-21* | *-18.7* | *-18.4* | *-21.7* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL20 - Rocklea | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 44.1 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.3 | 38 | 38 | 38 | 38 | 38 | 38 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.7 | -2 | -2 | -2 | -2 | -3.6 | -6.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *9.2* | *11.5* | *13.9* | *16.2* | *18.6* | *21* | *21* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-30.8* | *-28.5* | *-26.1* | *-23.8* | *-21.4* | *-20.6* | *-23.1* |
| NAL21- Norbrek | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 44.1 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.4 | 37.9 | 38.6 | 40.3 | 42.5 | 44.8 | 44.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.6 | -2.1 | -1.4 | 0.3 | 2.5 | 3.2 | 0.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.5* | *35.8* | *38* | *40.3* | *42.5* | *44.8* | *44.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-6.5* | *-4.2* | *-2* | *0.3* | *2.5* | *3.2* | *0.7* |
| NAL22- Muness | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 36.7 | 38.5 | 39.9 | 42.2 | 44.3 | 46 | 46 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -3.3 | -1.5 | -1.4 | -1.7 | -1.9 | -2.3 | -3.9 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *34.8* | *37.1* | *39.3* | *41.5* | *43.8* | *46* | *46* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-5.2* | *-2.9* | *-2* | *-2.4* | *-2.4* | *-2.3* | *-3.9* |
| NAL23 - Parkhead | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 30.5 | 33.6 | 35.5 | 38.2 | 41 | 44.8 | 44.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -9.5 | -6.4 | -4.5 | -1.8 | 1 | 2.9 | 0.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *25.8* | *29.6* | *33.4* | *37.2* | *41* | *44.8* | *44.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-14.2* | *-10.4* | *-6.6* | *-2.8* | *1* | *2.9* | *0.4* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL24 – Moars Park | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40.3 | 42.5 | 44.8 | 47 | 49.3 | 51.5 | 51.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | 0.3 | 2.5 | 4.8 | 7 | 9.3 | 9.6 | 7.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *40.3* | *42.5* | *44.8* | *47* | *49.3* | *51.5* | *51.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *0.3* | *2.5* | *4.8* | *7* | *9.3* | *9.6* | *7.1* |
| NAL25 - The Mark | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.6 | 36.8 | 38.3 | 39.7 | 41.2 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -5.4 | -3.2 | -1.7 | -0.3 | 0.5 | -0.8 | -4.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.1* | *35.1* | *37.2* | *39.2* | *41.2* | *43.3* | *43.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-6.9* | *-4.9* | *-2.8* | *-0.8* | *0.5* | *-0.8* | *-4.7* |
| NAL26 – Lonabrek | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.8 | 38 | 38.5 | 39.4 | 41.1 | 43.2 | 43.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.2 | -2 | -1.5 | -0.6 | 0.4 | -0.9 | -4.8 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.5* | *35.3* | *37.1* | *38.9* | *40.7* | *42.6* | *42.6* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-6.5* | *-4.7* | *-2.9* | *-1.1* | *0* | *-1.5* | *-5.4* |
| NAL27 - Adnashoor | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.8 | 36.4 | 37.1 | 38.2 | 39.2 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6.2 | -3.6 | -2.9 | -1.8 | -1.5 | -2.6 | -6.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *27.8* | *30.2* | *32.6* | *35.1* | *37.7* | *40.4* | *40.4* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-12.2* | *-9.8* | *-7.4* | *-4.9* | *-3* | *-3.7* | *-7.6* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL28 – South Voxter | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 31.9 | 34.4 | 35.9 | 37.5 | 39.4 | 41.1 | 41.1 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -8.1 | -5.6 | -4.1 | -2.5 | -0.6 | -0.9 | -4.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *29.9* | *32.2* | *34.4* | *36.6* | *38.9* | *41.1* | *41.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-10.1* | *-7.8* | *-5.6* | *-3.4* | *-1.1* | *-0.9* | *-4.2* |
| NAL29 – East Lynn | Total ETSU-R-97 Noise Limit | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 29.1 | 31.6 | 33.2 | 35 | 37 | 38.8 | 38.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -10.9 | -8.4 | -6.8 | -5 | -3 | -3.2 | -6.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *27.6* | *29.9* | *32.1* | *34.3* | *36.6* | *38.8* | *38.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-12.4* | *-10.1* | *-7.9* | *-5.7* | *-3.4* | *-3.2* | *-6.5* |

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 6 $ms^{-1}$ therefore no cumulative predictions are included for wind speeds less than 6 $ms^{-1}$.

**Table 6.6 ETSU-R-97 Compliance Table – Likely Cumulative Noise - Night-time**

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.1 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.9 | -5.2 | -5.2 | -5.2 | -5.2 | -5.2 | -5.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.1* | *13.4* | *15.6* | *17.8* | *20.1* | *22.3* | *22.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.9* | *-29.6* | *-27.4* | *-25.2* | *-22.9* | *-20.7* | *-20.7* |
| NAL2 - Taratet | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 38.9 | 41.3 | 41.6 | 43.2 | 45.4 | 47.7 | 47.7 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.1 | -1.7 | -1.4 | 0.2 | 2.4 | 4.7 | 4.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *36.4* | *38.7* | *40.9* | *43.2* | *45.4* | *47.7* | *47.7* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-6.6* | *-4.3* | *-2.1* | *0.2* | *2.4* | *4.7* | *4.7* |
| NAL3 - Grunnafirth | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40.6 | 43 | 43 | 43 | 43 | 43 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -2.4 | 0 | 0 | 0 | 0 | 0 | -0.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *10* | *12.4* | *14.5* | *16.7* | *18.9* | *21.1* | *21.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-33* | *-30.6* | *-28.5* | *-26.3* | *-24.1* | *-21.9* | *-22.3* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL4 – New House at Dury | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37.7 | 40.4 | 40.4 | 40.4 | 40.4 | 41 | 41 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -5.3 | -2.6 | -2.6 | -2.6 | -2.6 | -2 | -2.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *20.8* | *23.1* | *25.3* | *27.5* | *29.8* | *32* | *32* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-22.2* | *-19.9* | *-17.7* | *-15.5* | *-13.2* | *-11* | *-11.4* |
| NAL5 - Hamelea | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45 | 49.7 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 32.8 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -10.2 | -7.5 | -7.5 | -7.5 | -7.5 | -9.5 | -14.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *8.8* | *11.6* | *13.1* | *14.2* | *15.6* | *17.3* | *17.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-34.2* | *-31.4* | *-29.9* | *-28.8* | *-27.4* | *-27.7* | *-32.4* |
| NAL6 – Whinnia Lee | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.4 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.5 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.5 | -4.8 | -4.8 | -4.8 | -4.8 | -4.8 | -7.2 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.6* | *14.4* | *15.9* | *17* | *18.4* | *20.1* | *20.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.4* | *-28.6* | *-27.1* | *-26* | *-24.6* | *-22.9* | *-25.3* |
| NAL7 - Hollydell | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.9 | 46.1 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37.5 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -5.5 | -2.8 | -2.8 | -2.8 | -2.8 | -4.7 | -5.9 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *14.1* | *16.8* | *18.5* | *20* | *21.7* | *23.9* | *23.9* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.9* | *-26.2* | *-24.5* | *-23* | *-21.3* | *-21* | *-22.2* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL8 - Sandwater | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.8 | 48.6 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40.6 | 43 | 43 | 43 | 43 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -2.4 | 0 | 0 | 0 | 0 | -2.5 | -5.3 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *8.9* | *11.6* | *13.8* | *15.9* | *18.3* | *21.1* | *21.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-34.1* | *-31.4* | *-29.2* | *-27.1* | *-24.7* | *-24.7* | *-27.5* |
| NAL9 – Setter House | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 38.8 | 41.5 | 41.5 | 41.5 | 41.5 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -4.2 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *10* | *12.7* | *15* | *17.5* | *20.1* | *23.1* | *23.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-33* | *-30.3* | *-28* | *-25.5* | *-22.9* | *-19.9* | *-19.9* |
| NAL10 - Millhouse | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.1 | 36.8 | 36.8 | 36.8 | 36.8 | 37.2 | 37.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -8.9 | -6.2 | -6.2 | -6.2 | -6.2 | -5.8 | -5.8 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.2* | *14.4* | *17.3* | *20.3* | *23.6* | *27.1* | *27.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.8* | *-28.6* | *-25.7* | *-22.7* | *-19.4* | *-15.9* | *-15.9* |
| NAL11 - Koopins | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.7 | 36.4 | 36.4 | 36.4 | 36.4 | 37 | 37 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -9.3 | -6.6 | -6.6 | -6.6 | -6.6 | -6 | -6 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *11.7* | *14.9* | *17.9* | *21.1* | *24.5* | *28.1* | *28.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-31.3* | *-28.1* | *-25.1* | *-21.9* | *-18.5* | *-14.9* | *-14.9* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL12 - Dykeside | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 29.4 | 32.1 | 32.1 | 32.1 | 32.7 | 33.2 | 33.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -13.6 | -10.9 | -10.9 | -10.9 | -10.3 | -9.8 | -11.4 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *14.1* | *16.5* | *18.9* | *21.4* | *23.9* | *26.5* | *26.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-28.9* | *-26.5* | *-24.1* | *-21.6* | *-19.1* | *-16.5* | *-18.1* |
| NAL13- Breckenlea | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 27.7 | 30.4 | 30.9 | 31.3 | 31.9 | 32.9 | 32.9 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -15.3 | -12.6 | -12.1 | -11.7 | -11.1 | -10.1 | -11.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *16.8* | *19.2* | *21.6* | *24.2* | *26.7* | *29.3* | *29.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-26.2* | *-23.8* | *-21.4* | *-18.8* | *-16.3* | *-13.7* | *-15.3* |
| NAL14- Gruids | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.4 | 36.1 | 36.8 | 37.8 | 39.5 | 41.4 | 41.4 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -9.6 | -6.9 | -6.2 | -5.2 | -3.5 | -1.6 | -1.6 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *25.8* | *28.5* | *31.4* | *34.3* | *37.5* | *40.7* | *40.7* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-17.2* | *-14.5* | *-11.6* | *-8.7* | *-5.5* | *-2.3* | *-2.3* |
| NAL15- Mid Town | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.9 | 38.5 | 39.9 | 41.4 | 43.1 | 45.5 | 45.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.1 | -4.5 | -3.1 | -1.6 | 0.1 | 2.5 | 2.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.7* | *36.1* | *38.3* | *40.7* | *43.1* | *45.5* | *45.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-9.3* | *-6.9* | *-4.7* | *-2.3* | *0.1* | *2.5* | *2.5* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL16 - Valhalla | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 37 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *12.6* | *14.9* | *17.3* | *19.8* | *22.4* | *25.1* | *25.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-30.4* | *-28.1* | *-25.7* | *-23.2* | *-20.6* | *-17.9* | *-17.9* |
| NAL17– 12 Whitelaw Road | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.5 | 37.3 | 38.2 | 39.8 | 41.5 | 44.5 | 44.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -8.5 | -5.7 | -4.8 | -3.2 | -1.5 | 1.5 | 1.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *26.6* | *30* | *33.5* | *37.1* | *40.8* | *44.5* | *44.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-16.4* | *-13* | *-9.5* | *-5.9* | *-2.2* | *1.5* | *1.5* |
| NAL18 - Roadside | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 36.8 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6.2 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *13.7* | *16* | *18.4* | *20.9* | *23.4* | *26.2* | *26.2* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-29.3* | *-27* | *-24.6* | *-22.1* | *-19.6* | *-16.8* | *-16.8* |
| NAL19 - Hoddins | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 28.8 | 31.5 | 31.5 | 31.5 | 31.5 | 32.2 | 32.2 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -14.2 | -11.5 | -11.5 | -11.5 | -11.5 | -10.8 | -11.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *12.2* | *14.5* | *16.8* | *19* | *21.3* | *23.6* | *23.6* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-30.8* | *-28.5* | *-26.2* | *-24* | *-21.7* | *-19.4* | *-20.1* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL20 - Rocklea | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.3 | 38 | 38 | 38 | 38 | 38 | 38 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.7 | -5 | -5 | -5 | -5 | -5 | -5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *9.2* | *11.5* | *13.9* | *16.2* | *18.6* | *21* | *21* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-33.8* | *-31.5* | *-29.1* | *-26.8* | *-24.4* | *-22* | *-22* |
| NAL21- Norbrek | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.4 | 37.9 | 39.4 | 41.2 | 43 | 44.8 | 44.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.6 | -5.1 | -3.6 | -1.8 | 0 | 1.8 | 1.8 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.5* | *35.8* | *38* | *40.3* | *42.5* | *44.8* | *44.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-9.5* | *-7.2* | *-5* | *-2.7* | *-0.5* | *1.8* | *1.8* |
| NAL22- Muness | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.9 | 46.1 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 36.7 | 39.2 | 40.7 | 42.1 | 43.8 | 46 | 46 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -6.3 | -3.8 | -2.3 | -0.9 | 0.8 | 1.1 | -0.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *34.8* | *37.1* | *39.3* | *41.5* | *43.8* | *46* | *46* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-8.2* | *-5.9* | *-3.7* | *-1.5* | *0.8* | *1.1* | *-0.1* |
| NAL23 - Parkhead | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 30.5 | 33.6 | 35.5 | 38.2 | 41.5 | 44.8 | 44.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -12.5 | -9.4 | -7.5 | -4.8 | -1.5 | 1.8 | 1.8 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *25.8* | *29.6* | *33.4* | *37.2* | *41* | *44.8* | *44.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-17.2* | *-13.4* | *-9.6* | *-5.8* | *-2* | *1.8* | *1.8* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL24 – Moars Park | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 40.3 | 42.5 | 44.8 | 47 | 49.3 | 51.5 | 51.5 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -2.7 | -0.5 | 1.8 | 4 | 6.3 | 8.5 | 8.5 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *40.3* | *42.5* | *44.8* | *47* | *49.3* | *51.5* | *51.5* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-2.7* | *-0.5* | *1.8* | *4* | *6.3* | *8.5* | *8.5* |
| NAL25 - The Mark | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 34.6 | 36.8 | 38.3 | 39.9 | 41.7 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -8.4 | -6.2 | -4.7 | -3.1 | -1.3 | 0.3 | 0.3 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.1* | *35.1* | *37.2* | *39.2* | *41.2* | *43.3* | *43.3* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-9.9* | *-7.9* | *-5.8* | *-3.8* | *-1.8* | *0.3* | *0.3* |
| NAL26 – Lonabrek | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 35.8 | 38 | 39 | 40.3 | 41.4 | 43.1 | 43.1 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -7.2 | -5 | -4 | -2.7 | -1.6 | 0.1 | 0.1 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *33.5* | *35.3* | *37.1* | *38.9* | *40.7* | *42.6* | *42.6* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-9.5* | *-7.7* | *-5.9* | *-4.1* | *-2.3* | *-0.4* | *-0.4* |
| NAL27 - Adnashoor | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 33.8 | 36.4 | 37.1 | 38.2 | 39.6 | 41.3 | 41.3 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -9.2 | -6.6 | -5.9 | -4.8 | -3.4 | -1.7 | -1.7 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *27.8* | *30.2* | *32.6* | *35.1* | *37.7* | *40.4* | *40.4* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-15.2* | *-12.8* | *-10.4* | *-7.9* | *-5.3* | *-2.6* | *-2.6* |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL28 – South Voxter | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 31.9 | 34.4 | 35.9 | 37.5 | 39.5 | 41.1 | 41.1 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -11.1 | -8.6 | -7.1 | -5.5 | -3.5 | -1.9 | -2.6 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *29.9* | *32.2* | *34.4* | *36.6* | *38.9* | *41.1* | *41.1* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-13.1* | *-10.8* | *-8.6* | *-6.4* | *-4.1* | *-1.9* | *-2.6* |
| NAL29 – East Lynn | Total ETSU-R-97 Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| | Predicted Cumulative Wind Turbine Noise $L_{A90}$ | - | - | - | - | - | 29.1 | 31.6 | 33.2 | 35 | 37 | 38.8 | 38.8 |
| | Exceedance Level $L_{A90}$ (all schemes) | - | - | - | - | - | -13.9 | -11.4 | -9.8 | -8 | -6 | -4.2 | -4.9 |
| | *Predicted Wind Turbine Noise (other schemes only) $L_{A90}$* | - | - | - | - | - | *27.6* | *29.9* | *32.1* | *34.3* | *36.6* | *38.8* | *38.8* |
| | *Exceedance Level $L_{A90}$ (other schemes only)* | - | - | - | - | - | *-15.4* | *-13.1* | *-10.9* | *-8.7* | *-6.4* | *-4.2* | *-4.9* |

Note: For the cumulative noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 6 $ms^{-1}$ therefore no cumulative predictions are included for wind speeds less than 6 $ms^{-1}$.

## 6.6 Derivation of Site Specific Noise Limits (Stage 3)

6.6.1 In order to protect residential amenity, the IOA GPG (2013) recommendations are that cumulatively, all schemes operate within the Total ETSU-R-97 Noise Limits. This can be found in summary box SB21 of the IOA GPG (2013) which states:

*'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'*

6.6.2 As detailed in Section 3.2.12 above, two sets of daytime Site Specific Noise Limits have been derived to consider the lower and upper range of Fixed Minimum Noise Limits as detailed within ETSU-R-97. At this stage, the Site Specific Noise Limits do not consider whether the occupiers of a property have a financial interest in the proposed development or a nearby scheme. As detailed in Section 2.5.11 above, if the occupiers of a property are financially involved then both the day and night-time fixed limits can be increased to 45 dB. It also assumes that all consented turbines are built and that all existing turbines continue to operate for the lifetime of this consent and that their noise immissions are as per the levels considered in this assessment.

6.6.3 Site Specific Noise Limits have been derived for each of the noise sensitive receptors considered within Table 6.1 above. Table 6.7 below summarises the approach adopted at each NAL in order to derive the Site Specific Noise Limits for the proposed development.

**Table 6.7 Limit Derivation Strategy**

| NAL | Limit Derivation Strategy |
|---|---|
| NALs 4, 14, and 29 | Predictions from other schemes were found to be within 10 dB of the Total Noise Limits. As such, the limit has been apportioned based on a cautious prediction of cumulative turbine noise.<br>The noise predictions for the other consented or operational schemes show that there is, in theory, significant headroom as there are no noise limits set for the existing developments. In accordance with section 4.4 above, a 2 dB buffer has therefore been added to the turbine noise predictions; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes. This approach is identical to the one agreed between TNEI and SIC as part of the Beaw Field Wind Farm Application (ECU No: EC00003121), consented on 30 November 2017.<br>The resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total ETSU-R-97 Noise Limit to determine the 'residual noise limit'.<br>The Site Specific Noise Limits are then determined as follows:<br>• The night time limit is set to the residual noise limit.<br>• The daytime noise limit is determined by taking the lowest of either:<br>o The residual noise limit; or<br>o Background noise plus 5 dB or the chosen fixed minimum limit |

| NAL | Limit Derivation Strategy |
|---|---|
| | (whichever is greater). For the purposes of this assessment two scenarios are presented, one using the upper limit of 40 dB and another using the lower limit of 35 dB. |
| NALs 2, 15, 17 and 21-28. | Predictions from other schemes were found to already be exceeding or using the Total ETSU-R-97 Noise Limits at certain wind speeds. As such at those wind speeds, because the recommended limits have already been used up by the other schemes at this receptor, a limit 10 dB below the Total ETSU-R-97 Noise Limits has been set for the proposed development such that no further cumulative impact is observed here[2]. |
| NALs 1, 3, 5 – 13, 16 and 18 - 20. | Predictions from other schemes were found to be more than 10 dB below the Total ETSU-R-97 Noise Limits and as such the entire noise limits has been allocated to the proposed development. |

6.6.4 As summarised in Table 6.7 above, it is proposed that the full ETSU-R-97 noise limits be allocated to the proposed development at fifteen of the twenty nine noise assessment locations (subject to the imposition of a suitable Site Specific daytime fixed minimum limit), as the other schemes do not need a portion of the limit. For four noise assessment locations, apportionment is required in order to allow the proposed development and the other wind turbine developments to co-exist to within the Total ETSU-R-97 Noise Limits. In addition, for eleven noise assessment locations, the allotted Total ETSU-R-97 Noise Limits are already used up at certain wind speeds by an existing wind turbine and as such the proposed development has had limits derived to be 10 dB below the Total ETSU-R-97 Noise Limit (for the relevant wind speeds) such that any potential increase in turbine noise level would be negligible.

6.6.5 Table 6.8 (based on the lower fixed minimum noise limit of 35 dB), Table 6.9 (based on the upper fixed minimum noise limit of 40 dB) for the daytime and Table 6.10 for the night time show the Site Specific Noise Limits, noise predictions for the Proposed Developed and the exceedance level. A negative exceedence demonstrates compliance with the Site Specific Noise Limits.

6.6.6 The Tables show that the predicted Wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods. In order to meet the Site Specific Noise Limits certain turbines will need to be operated in low noise mode / switched off during certain wind speeds and directions. The level of mode management required would vary depending on whether the lower or upper daytime fixed minimum noise limit is adopted. Some mode management would also be required during the night-time periods.

[2] For clarity, this is because of the logarithmic way in which the decibel is expressed, adding one noise level 10dB lower than another results in an insignificant increase e.g. 40 dB + 30 dB ~ 40 dB (it is actually 40.4 dB but the increase is considered to be negligible).

6.6.7 A series of graphs to show the predicted wind turbine noise from the proposed development compared to the Site Specific Noise are included as Figures A1.4a - A1.4ac (based on a fixed minimum of 35 dB) and Figures A1.5a – A1.5ac (based on a fixed minimum of 40 dB) (Annex 1). There is a set of graphs for each of the NAL, which show the Total ETSU-R-97 Noise Limit (solid red line), the prevailing background noise level (black line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the proposed development (dashed green line with triangles).

**Table 6.8 Site Specific Noise Limits Compliance Table –Lower Fixed Minimum (LFM) Daytime Limit**

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.3 | 36.8 | 38.3 | 39.8 | 41.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.2 | 27.5 | 31.7 | 35 | 35 | 35.3 | 36.8 | 37.8 | 37.8 | 37.8 |
| | Exceedance Level $L_{A90}$ | - | - | -11.8 | -7.5 | -3.3 | 0 | 0 | 0 | 0 | -0.5 | -2 | -3.6 |
| NAL2 - Taratet | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 34.9 | 30 | 30 | 30 | 30 | 30 | 31.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.3 | 27.6 | 31.8 | 34.9 | 30 | 30 | 30 | 30 | 30 | 31.4 |
| | Exceedance Level $L_{A90}$ | - | - | -11.7 | -7.4 | -3.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAL3 - Grunnafirth | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.6 | 38.8 | 40.9 | 42.6 | 43.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 35 | 35 | 35 | 36.6 | 38.8 | 40.9 | 42.6 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -6.3 | -2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.6 |
| NAL4 – New House at Dury | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.6 | 38.8 | 40.3 | 42 | 43.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.8 | 30.1 | 34.3 | 35 | 35 | 36.6 | 38.8 | 40.3 | 40.4 | 40.4 |
| | Exceedance Level $L_{A90}$ | - | - | -9.2 | -4.9 | -0.7 | 0 | 0 | 0 | 0 | 0 | -1.6 | -3 |
| NAL5 - Hamelea | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.6 | 39.7 | 42.8 | 45.5 | 47.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.9 | 25.2 | 29.4 | 32.8 | 35 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 |
| | Exceedance Level $L_{A90}$ | - | - | -14.1 | -9.8 | -5.6 | -2.2 | 0 | -1.1 | -4.2 | -7.3 | -10 | -12.4 |
| NAL6 – Whinnia Lee | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.5 | 38.7 | 40.6 | 42.2 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.6 | 27.9 | 32.1 | 35 | 35 | 35 | 36.5 | 38.2 | 38.2 | 38.2 |
| | Exceedance Level $L_{A90}$ | - | - | -11.4 | -7.1 | -2.9 | 0 | 0 | 0 | 0 | -0.5 | -2.4 | -4 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL7 - Hollydell | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 36.1 | 38.7 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.6 | 29.9 | 34.1 | 36.1 | 38.7 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| | Exceedance Level $L_{A90}$ | - | - | -9.4 | -5.1 | -0.9 | 0 | 0 | -1.1 | -3.7 | -6 | -8.1 | -9.7 |
| NAL8 - Sandwater | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35.7 | 38.1 | 40.6 | 43.1 | 45.5 | 47.7 | 49.5 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 35 | 35.7 | 38.1 | 40.6 | 43.1 | 43.3 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -6.3 | -2 | 0 | 0 | 0 | 0 | 0 | -2.2 | -4.4 | -6.2 |
| NAL9 – Setter House | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.6 | 37.7 | 40 | 42.5 | 45 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 26.9 | 31.2 | 35 | 35 | 35 | 35.6 | 37.7 | 40 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ | - | - | -8.1 | -3.8 | 0 | 0 | 0 | 0 | 0 | 0 | -1 | -3.5 |
| NAL10 - Millhouse | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.7 | 37.5 | 39.6 | 41.9 | 44.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 22.2 | 26.5 | 30.7 | 34.1 | 35 | 35.7 | 36.8 | 36.8 | 36.8 | 36.8 |
| | Exceedance Level $L_{A90}$ | - | - | -12.8 | -8.5 | -4.3 | -0.9 | 0 | 0 | -0.7 | -2.8 | -5.1 | -7.6 |
| NAL11 - Koopins | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.7 | 37.5 | 39.6 | 41.9 | 44.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 35 | 35.7 | 36.4 | 36.4 | 36.4 | 36.4 |
| | Exceedance Level $L_{A90}$ | - | - | -13.2 | -8.9 | -4.7 | -1.3 | 0 | 0 | -1.1 | -3.2 | -5.5 | -8 |
| NAL12 - Dykeside | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.4 | 38.3 | 40.3 | 42.4 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.5 | 21.8 | 26 | 29.4 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 |
| | Exceedance Level $L_{A90}$ | - | - | -17.5 | -13.2 | -9 | -5.6 | -2.9 | -4.3 | -6.2 | -8.2 | -10.3 | -12.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL13- Breckenlea | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36.4 | 38.3 | 40.3 | 42.4 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -19.2 | -14.9 | -10.7 | -7.3 | -4.6 | -6 | -7.9 | -9.9 | -12 | -14.2 |
| NAL14- Gruids | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.1 | 30.4 | 31.6 | 42.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.7 | 25 | 29.2 | 32.6 | 35 | 35 | 35.1 | 30.4 | 31.6 | 35.3 |
| | Exceedance Level $L_{A90}$ | - | - | -14.3 | -10 | -5.8 | -2.4 | 0 | 0 | 0 | 0 | 0 | -7 |
| NAL15- Mid Town | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 30 | 30 | 30 | 31.6 | 35.5 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.1 | 24.4 | 28.6 | 32 | 34.7 | 30 | 30 | 30 | 31.6 | 34.7 |
| | Exceedance Level $L_{A90}$ | - | - | -14.9 | -10.6 | -6.4 | -3 | -0.3 | 0 | 0 | 0 | 0 | -0.8 |
| NAL16 - Valhalla | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.2 | 37.7 | 40.7 | 44.1 | 48 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.1 | 29.4 | 33.6 | 35 | 35 | 35.2 | 37.7 | 39.7 | 39.7 | 39.7 |
| | Exceedance Level $L_{A90}$ | - | - | -9.9 | -5.6 | -1.4 | 0 | 0 | 0 | 0 | -1 | -4.4 | -8.3 |
| NAL17– 12 Whitelaw Road | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.2 | 32.7 | 30.7 | 34.1 | 42.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 35 | 35.2 | 32.7 | 30.7 | 34.1 | 36.4 |
| | Exceedance Level $L_{A90}$ | - | - | -13.2 | -8.9 | -4.7 | -1.3 | 0 | 0 | 0 | 0 | 0 | -6.3 |
| NAL18 - Roadside | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.2 | 37.7 | 40.7 | 44.1 | 48 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 24.9 | 29.2 | 33.4 | 35 | 35 | 35.2 | 37.7 | 39.5 | 39.5 | 39.5 |
| | Exceedance Level $L_{A90}$ | - | - | -10.1 | -5.8 | -1.6 | 0 | 0 | 0 | 0 | -1.2 | -4.6 | -8.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL19 - Hoddins | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.1 | 36.9 | 39.2 | 42 | 45.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.9 | 21.2 | 25.4 | 28.8 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 |
| | Exceedance Level $L_{A90}$ | - | - | -18.1 | -13.8 | -9.6 | -6.2 | -3.5 | -3.6 | -5.4 | -7.7 | -10.5 | -13.8 |
| NAL20 - Rocklea | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 36 | 37.6 | 39.4 | 41.6 | 44.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.4 | 27.7 | 31.9 | 35 | 35 | 36 | 37.6 | 38 | 38 | 38 |
| | Exceedance Level $L_{A90}$ | - | - | -11.6 | -7.3 | -3.1 | 0 | 0 | 0 | 0 | -1.4 | -3.6 | -6.1 |
| NAL21- Norbrek | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 30 | 30 | 30 | 31.6 | 34.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 19.1 | 23.4 | 27.6 | 31 | 33.7 | 30 | 30 | 30 | 31.6 | 33.7 |
| | Exceedance Level $L_{A90}$ | - | - | -15.9 | -11.6 | -7.4 | -4 | -1.3 | 0 | 0 | 0 | 0 | -0.4 |
| NAL22- Muness | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 36.1 | 32.7 | 31.3 | 33.9 | 35.6 | 38.3 | 45.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.4 | 24.7 | 28.9 | 32.3 | 32.7 | 31.3 | 33.9 | 35 | 35 | 35 |
| | Exceedance Level $L_{A90}$ | - | - | -14.6 | -10.3 | -6.1 | -3.8 | 0 | 0 | 0 | -0.6 | -3.3 | -10.4 |
| NAL23 - Parkhead | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.7 | 32.3 | 30 | 31.9 | 34.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.8 | 21.1 | 25.3 | 28.7 | 31.4 | 31.4 | 31.4 | 30 | 31.4 | 31.4 |
| | Exceedance Level $L_{A90}$ | - | - | -18.2 | -13.9 | -9.7 | -6.3 | -3.6 | -4.3 | -0.9 | 0 | -0.5 | -3 |
| NAL24 – Moars Park | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 30 | 30 | 30 | 30 | 30 | 31.9 | 34.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 13.9 | 18.2 | 22.4 | 25.8 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 |
| | Exceedance Level $L_{A90}$ | - | - | -21.1 | -16.8 | -12.6 | -4.2 | -1.5 | -1.5 | -1.5 | -1.5 | -3.4 | -5.9 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL25 - The Mark | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 32.3 | 30 | 30.7 | 34.1 | 44.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.2 | 21.5 | 25.7 | 29.1 | 31.8 | 31.8 | 30 | 30.7 | 31.8 | 31.8 |
| | Exceedance Level $L_{A90}$ | - | - | -17.8 | -13.5 | -9.3 | -5.9 | -3.2 | -0.5 | 0 | 0 | -2.3 | -12.9 |
| NAL26 – Lonabrek | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 32.7 | 30 | 30.7 | 34.1 | 45.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20 | 24.3 | 28.5 | 31.9 | 34.6 | 32.7 | 30 | 30.7 | 34.1 | 34.6 |
| | Exceedance Level $L_{A90}$ | - | - | -15 | -10.7 | -6.5 | -3.1 | -0.4 | 0 | 0 | 0 | 0 | -10.7 |
| NAL27 - Adnashoor | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.2 | 36.9 | 33.8 | 39.2 | 46.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.6 | 24.9 | 29.1 | 32.5 | 35 | 35.2 | 35.2 | 33.8 | 35.2 | 35.2 |
| | Exceedance Level $L_{A90}$ | - | - | -14.4 | -10.1 | -5.9 | -2.5 | 0 | 0 | -1.7 | 0 | -4 | -11.4 |
| NAL28 – South Voxter | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.1 | 34.4 | 30 | 32 | 41.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -19.2 | -14.9 | -10.7 | -7.3 | -4.6 | -4.7 | -4 | 0 | -1.6 | -10.9 |
| NAL29 – East Lynn | Site Specific Noise Limit (LFM) | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35.1 | 36.9 | 34.4 | 35.8 | 43.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 12 | 16.3 | 20.5 | 23.9 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 |
| | Exceedance Level $L_{A90}$ | - | - | -23 | -18.7 | -14.5 | -11.1 | -8.4 | -8.5 | -10.3 | -7.8 | -9.2 | -16.8 |

**Table 6.9 Site Specific Noise Limits Compliance Table – Upper Fixed Minimum (UFM) Daytime Limit**

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.2 | 27.5 | 31.7 | 35.1 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 |
| | Exceedance Level $L_{A90}$ | - | - | -16.8 | -12.5 | -8.3 | -4.9 | -2.2 | -2.2 | -2.2 | -2.2 | -2.2 | -3.6 |
| NAL2 - Taratet | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 34.9 | 30 | 30 | 30 | 30 | 30 | 31.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.3 | 27.6 | 31.8 | 34.9 | 30 | 30 | 30 | 30 | 30 | 31.4 |
| | Exceedance Level $L_{A90}$ | - | - | -16.7 | -12.4 | -8.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| NAL3 - Grunnafirth | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 37.2 | 40 | 40 | 40 | 40 | 40.9 | 42.6 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -11.3 | -7 | -2.8 | 0 | 0 | 0 | 0 | 0 | 0 | -0.6 |
| NAL4 – New House at Dury | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42 | 43.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.8 | 30.1 | 34.3 | 37.7 | 40 | 40 | 40 | 40.3 | 40.4 | 40.4 |
| | Exceedance Level $L_{A90}$ | - | - | -14.2 | -9.9 | -5.7 | -2.3 | 0 | 0 | 0 | 0 | -1.6 | -3 |
| NAL5 - Hamelea | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.8 | 45.5 | 47.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.9 | 25.2 | 29.4 | 32.8 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 |
| | Exceedance Level $L_{A90}$ | - | - | -19.1 | -14.8 | -10.6 | -7.2 | -4.5 | -4.5 | -4.5 | -7.3 | -10 | -12.4 |
| NAL6 – Whinnia Lee | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 42.2 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.6 | 27.9 | 32.1 | 35.5 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 |
| | Exceedance Level $L_{A90}$ | - | - | -16.4 | -12.1 | -7.9 | -4.5 | -1.8 | -1.8 | -1.8 | -1.8 | -2.4 | -4 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL7 - Hollydell | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.3 | 43.9 | 46.2 | 48.3 | 49.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.6 | 29.9 | 34.1 | 37.5 | 40 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| | Exceedance Level $L_{A90}$ | - | - | -14.4 | -10.1 | -5.9 | -2.5 | 0 | -1.1 | -3.7 | -6 | -8.1 | -9.7 |
| NAL8 - Sandwater | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.6 | 43.1 | 45.5 | 47.7 | 49.5 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 37.2 | 40 | 40 | 40.6 | 43.1 | 43.3 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -11.3 | -7 | -2.8 | 0 | 0 | 0 | 0 | -2.2 | -4.4 | -6.2 |
| NAL9 – Setter House | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42.5 | 45 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 26.9 | 31.2 | 35.4 | 38.8 | 40 | 40 | 40 | 40 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ | - | - | -13.1 | -8.8 | -4.6 | -1.2 | 0 | 0 | 0 | 0 | -1 | -3.5 |
| NAL10 - Millhouse | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 22.2 | 26.5 | 30.7 | 34.1 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 |
| | Exceedance Level $L_{A90}$ | - | - | -17.8 | -13.5 | -9.3 | -5.9 | -3.2 | -3.2 | -3.2 | -3.2 | -5.1 | -7.6 |
| NAL11 - Koopins | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.9 | 44.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 |
| | Exceedance Level $L_{A90}$ | - | - | -18.2 | -13.9 | -9.7 | -6.3 | -3.6 | -3.6 | -3.6 | -3.6 | -5.5 | -8 |
| NAL12 - Dykeside | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.5 | 21.8 | 26 | 29.4 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 |
| | Exceedance Level $L_{A90}$ | - | - | -22.5 | -18.2 | -14 | -10.6 | -7.9 | -7.9 | -7.9 | -8.2 | -10.3 | -12.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL13- Breckenlea | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.3 | 42.4 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -24.2 | -19.9 | -15.7 | -12.3 | -9.6 | -9.6 | -9.6 | -9.9 | -12 | -14.2 |
| NAL14- Gruids | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 39.5 | 38.9 | 37.6 | 30.4 | 31.6 | 42.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.7 | 25 | 29.2 | 32.6 | 35.3 | 35.3 | 35.3 | 30.4 | 31.6 | 35.3 |
| | Exceedance Level $L_{A90}$ | - | - | -19.3 | -15 | -10.8 | -7.4 | -4.2 | -3.6 | -2.3 | 0 | 0 | -7 |
| NAL15- Mid Town | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 38 | 35.5 | 30 | 30 | 30 | 31.6 | 35.5 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.1 | 24.4 | 28.6 | 32 | 34.7 | 30 | 30 | 30 | 31.6 | 34.7 |
| | Exceedance Level $L_{A90}$ | - | - | -19.9 | -15.6 | -11.4 | -6 | -0.8 | 0 | 0 | 0 | 0 | -0.8 |
| NAL16 - Valhalla | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.1 | 29.4 | 33.6 | 37 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 |
| | Exceedance Level $L_{A90}$ | - | - | -14.9 | -10.6 | -6.4 | -3 | -0.3 | -0.3 | -0.3 | -1 | -4.4 | -8.3 |
| NAL17– 12 Whitelaw Road | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 39.3 | 38.1 | 32.7 | 30.7 | 34.1 | 42.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 36.4 | 36.4 | 32.7 | 30.7 | 34.1 | 36.4 |
| | Exceedance Level $L_{A90}$ | - | - | -18.2 | -13.9 | -9.7 | -6.3 | -2.9 | -1.7 | 0 | 0 | 0 | -6.3 |
| NAL18 - Roadside | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40.7 | 44.1 | 48 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 24.9 | 29.2 | 33.4 | 36.8 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 |
| | Exceedance Level $L_{A90}$ | - | - | -15.1 | -10.8 | -6.6 | -3.2 | -0.5 | -0.5 | -0.5 | -1.2 | -4.6 | -8.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL19 - Hoddins | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 42 | 45.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.9 | 21.2 | 25.4 | 28.8 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 |
| | Exceedance Level $L_{A90}$ | - | - | -23.1 | -18.8 | -14.6 | -11.2 | -8.5 | -8.5 | -8.5 | -8.5 | -10.5 | -13.8 |
| NAL20 - Rocklea | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 41.6 | 44.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.4 | 27.7 | 31.9 | 35.3 | 38 | 38 | 38 | 38 | 38 | 38 |
| | Exceedance Level $L_{A90}$ | - | - | -16.6 | -12.3 | -8.1 | -4.7 | -2 | -2 | -2 | -2 | -3.6 | -6.1 |
| NAL21- Norbrek | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 38.1 | 36 | 30 | 30 | 30 | 31.6 | 34.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 19.1 | 23.4 | 27.6 | 31 | 33.7 | 30 | 30 | 30 | 31.6 | 33.7 |
| | Exceedance Level $L_{A90}$ | - | - | -20.9 | -16.6 | -12.4 | -7.1 | -2.3 | 0 | 0 | 0 | 0 | -0.4 |
| NAL22- Muness | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 37.2 | 32.7 | 31.3 | 33.9 | 35.6 | 38.3 | 45.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.4 | 24.7 | 28.9 | 32.3 | 32.7 | 31.3 | 33.9 | 35 | 35 | 35 |
| | Exceedance Level $L_{A90}$ | - | - | -19.6 | -15.3 | -11.1 | -4.9 | 0 | 0 | 0 | -0.6 | -3.3 | -10.4 |
| NAL23 - Parkhead | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 39.3 | 38.2 | 32.3 | 30 | 31.9 | 34.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.8 | 21.1 | 25.3 | 28.7 | 31.4 | 31.4 | 31.4 | 30 | 31.4 | 31.4 |
| | Exceedance Level $L_{A90}$ | - | - | -23.2 | -18.9 | -14.7 | -11.3 | -7.9 | -6.8 | -0.9 | 0 | -0.5 | -3 |
| NAL24 – Moars Park | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 30 | 30 | 30 | 30 | 30 | 31.9 | 34.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 13.9 | 18.2 | 22.4 | 25.8 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 |
| | Exceedance Level $L_{A90}$ | - | - | -26.1 | -21.8 | -17.6 | -4.2 | -1.5 | -1.5 | -1.5 | -1.5 | -3.4 | -5.9 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL25 - The Mark | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 38.3 | 36.9 | 32.3 | 30 | 30.7 | 34.1 | 44.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.2 | 21.5 | 25.7 | 29.1 | 31.8 | 31.8 | 30 | 30.7 | 31.8 | 31.8 |
| | Exceedance Level $L_{A90}$ | - | - | -22.8 | -18.5 | -14.3 | -9.2 | -5.1 | -0.5 | 0 | 0 | -2.3 | -12.9 |
| NAL26 – Lonabrek | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 38.1 | 36.7 | 32.7 | 30 | 30.7 | 34.1 | 45.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20 | 24.3 | 28.5 | 31.9 | 34.6 | 32.7 | 30 | 30.7 | 34.1 | 34.6 |
| | Exceedance Level $L_{A90}$ | - | - | -20 | -15.7 | -11.5 | -6.2 | -2.1 | 0 | 0 | 0 | 0 | -10.7 |
| NAL27 - Adnashoor | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 39.2 | 38.5 | 36.9 | 33.8 | 39.2 | 46.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.6 | 24.9 | 29.1 | 32.5 | 35.2 | 35.2 | 35.2 | 33.8 | 35.2 | 35.2 |
| | Exceedance Level $L_{A90}$ | - | - | -19.4 | -15.1 | -10.9 | -7.5 | -4 | -3.3 | -1.7 | 0 | -4 | -11.4 |
| NAL28 – South Voxter | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 39.3 | 38.7 | 37.5 | 34.4 | 30 | 32 | 41.3 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -24.2 | -19.9 | -15.7 | -11.6 | -8.3 | -7.1 | -4 | 0 | -1.6 | -10.9 |
| NAL29 – East Lynn | Site Specific Noise Limit (UFM) | 40 | 40 | 40 | 40 | 40 | 40 | 39.3 | 38.7 | 37.6 | 34.4 | 35.8 | 43.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 12 | 16.3 | 20.5 | 23.9 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 |
| | Exceedance Level $L_{A90}$ | - | - | -28 | -23.7 | -19.5 | -16.1 | -12.7 | -12.1 | -11 | -7.8 | -9.2 | -16.8 |

**Table 6.10 Site Specific Noise Limits Compliance Table – Night-time**

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL1 - Glenlea | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.2 | 27.5 | 31.7 | 35.1 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 | 37.8 |
| | Exceedance Level $L_{A90}$ | - | - | -19.8 | -15.5 | -11.3 | -7.9 | -5.2 | -5.2 | -5.2 | -5.2 | -5.2 | -5.2 |
| NAL2 - Taratet | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 41.2 | 39.1 | 33 | 33 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.3 | 27.6 | 31.8 | 35.2 | 37.9 | 33 | 33 | 33 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -19.7 | -15.4 | -11.2 | -6 | -1.2 | 0 | 0 | 0 | 0 | 0 |
| NAL3 - Grunnafirth | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 37.2 | 40.6 | 43 | 43 | 43 | 43 | 43 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -14.3 | -10 | -5.8 | -2.4 | 0 | 0 | 0 | 0 | 0 | -0.1 |
| NAL4 – New House at Dury | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.4 | 42.9 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.8 | 30.1 | 34.3 | 37.7 | 40.4 | 40.4 | 40.4 | 40.4 | 40.4 | 40.4 |
| | Exceedance Level $L_{A90}$ | - | - | -17.2 | -12.9 | -8.7 | -5.3 | -2.6 | -2.6 | -2.6 | -2.6 | -2 | -2.5 |
| NAL5 - Hamelea | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45 | 49.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.9 | 25.2 | 29.4 | 32.8 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 | 35.5 |
| | Exceedance Level $L_{A90}$ | - | - | -22.1 | -17.8 | -13.6 | -10.2 | -7.5 | -7.5 | -7.5 | -7.5 | -9.5 | -14.2 |
| NAL6 – Whinnia Lee | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.4 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.6 | 27.9 | 32.1 | 35.5 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 | 38.2 |
| | Exceedance Level $L_{A90}$ | - | - | -19.4 | -15.1 | -10.9 | -7.5 | -4.8 | -4.8 | -4.8 | -4.8 | -4.8 | -7.2 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL7 - Hollydell | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.9 | 46.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.6 | 29.9 | 34.1 | 37.5 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 | 40.2 |
| | Exceedance Level $L_{A90}$ | - | - | -17.4 | -13.1 | -8.9 | -5.5 | -2.8 | -2.8 | -2.8 | -2.8 | -4.7 | -5.9 |
| NAL8 - Sandwater | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 45.8 | 48.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 28.7 | 33 | 37.2 | 40.6 | 43 | 43 | 43 | 43 | 43.3 | 43.3 |
| | Exceedance Level $L_{A90}$ | - | - | -14.3 | -10 | -5.8 | -2.4 | 0 | 0 | 0 | 0 | -2.5 | -5.3 |
| NAL9 – Setter House | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 26.9 | 31.2 | 35.4 | 38.8 | 41.5 | 41.5 | 41.5 | 41.5 | 41.5 | 41.5 |
| | Exceedance Level $L_{A90}$ | - | - | -16.1 | -11.8 | -7.6 | -4.2 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 | -1.5 |
| NAL10 - Millhouse | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 22.2 | 26.5 | 30.7 | 34.1 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 | 36.8 |
| | Exceedance Level $L_{A90}$ | - | - | -20.8 | -16.5 | -12.3 | -8.9 | -6.2 | -6.2 | -6.2 | -6.2 | -6.2 | -6.2 |
| NAL11 - Koopins | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 | 36.4 |
| | Exceedance Level $L_{A90}$ | - | - | -21.2 | -16.9 | -12.7 | -9.3 | -6.6 | -6.6 | -6.6 | -6.6 | -6.6 | -6.6 |
| NAL12 - Dykeside | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.5 | 21.8 | 26 | 29.4 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 | 32.1 |
| | Exceedance Level $L_{A90}$ | - | - | -25.5 | -21.2 | -17 | -13.6 | -10.9 | -10.9 | -10.9 | -10.9 | -10.9 | -12.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL13- Breckenlea | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 44.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -27.2 | -22.9 | -18.7 | -15.3 | -12.6 | -12.6 | -12.6 | -12.6 | -12.6 | -14.2 |
| NAL14- Gruids | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.5 | 42 | 40.4 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.7 | 25 | 29.2 | 32.6 | 35.3 | 35.3 | 35.3 | 35.3 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -22.3 | -18 | -13.8 | -10.4 | -7.7 | -7.2 | -6.7 | -5.1 | 0 | 0 |
| NAL15- Mid Town | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 42.1 | 41.3 | 39.7 | 33 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.1 | 24.4 | 28.6 | 32 | 34.7 | 34.7 | 33 | 33 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -22.9 | -18.6 | -14.4 | -10.1 | -6.6 | -5 | 0 | 0 | 0 | 0 |
| NAL16 - Valhalla | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 25.1 | 29.4 | 33.6 | 37 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 | 39.7 |
| | Exceedance Level $L_{A90}$ | - | - | -17.9 | -13.6 | -9.4 | -6 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 | -3.3 |
| NAL17– 12 Whitelaw Road | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.1 | 40.7 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 21.8 | 26.1 | 30.3 | 33.7 | 36.4 | 36.4 | 36.4 | 33 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -21.2 | -16.9 | -12.7 | -9.3 | -6.6 | -5.7 | -4.3 | 0 | 0 | 0 |
| NAL18 - Roadside | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 24.9 | 29.2 | 33.4 | 36.8 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 | 39.5 |
| | Exceedance Level $L_{A90}$ | - | - | -18.1 | -13.8 | -9.6 | -6.2 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 | -3.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL19 - Hoddins | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43.7 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.9 | 21.2 | 25.4 | 28.8 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 | 31.5 |
| | Exceedance Level $L_{A90}$ | - | - | -26.1 | -21.8 | -17.6 | -14.2 | -11.5 | -11.5 | -11.5 | -11.5 | -11.5 | -12.2 |
| NAL20 - Rocklea | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 43 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 23.4 | 27.7 | 31.9 | 35.3 | 38 | 38 | 38 | 38 | 38 | 38 |
| | Exceedance Level $L_{A90}$ | - | - | -19.6 | -15.3 | -11.1 | -7.7 | -5 | -5 | -5 | -5 | -5 | -5 |
| NAL21- Norbrek | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 42.1 | 41.4 | 40 | 34.7 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 19.1 | 23.4 | 27.6 | 31 | 33.7 | 33.7 | 33.7 | 33 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -23.9 | -19.6 | -15.4 | -11.1 | -7.7 | -6.3 | -1 | 0 | 0 | 0 |
| NAL22- Muness | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 41.8 | 40.7 | 38.1 | 33 | 33 | 34.9 | 36.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.4 | 24.7 | 28.9 | 32.3 | 35 | 35 | 33 | 33 | 34.9 | 35 |
| | Exceedance Level $L_{A90}$ | - | - | -22.6 | -18.3 | -14.1 | -9.5 | -5.7 | -3.1 | 0 | 0 | 0 | -1.1 |
| NAL23 - Parkhead | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.2 | 40.7 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 16.8 | 21.1 | 25.3 | 28.7 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 | 31.4 |
| | Exceedance Level $L_{A90}$ | - | - | -26.2 | -21.9 | -17.7 | -14.3 | -11.6 | -10.8 | -9.3 | -1.6 | -1.6 | -1.6 |
| NAL24 – Moars Park | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 34.7 | 33 | 33 | 33 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 13.9 | 18.2 | 22.4 | 25.8 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 | 28.5 |
| | Exceedance Level $L_{A90}$ | - | - | -29.1 | -24.8 | -20.6 | -8.9 | -4.5 | -4.5 | -4.5 | -4.5 | -4.5 | -4.5 |

| Location | | Wind Speed ($ms^{-1}$) as standardised to 10 m height | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| NAL25 - The Mark | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 42.2 | 41.7 | 40.7 | 38.3 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 17.2 | 21.5 | 25.7 | 29.1 | 31.8 | 31.8 | 31.8 | 31.8 | 31.8 | 31.8 |
| | Exceedance Level $L_{A90}$ | - | - | -25.8 | -21.5 | -17.3 | -13.1 | -9.9 | -8.9 | -6.5 | -1.2 | -1.2 | -1.2 |
| NAL26 – Lonabrek | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 42.1 | 41.6 | 40.7 | 38.8 | 33 | 33 | 33 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20 | 24.3 | 28.5 | 31.9 | 34.6 | 34.6 | 34.6 | 33 | 33 | 33 |
| | Exceedance Level $L_{A90}$ | - | - | -23 | -18.7 | -14.5 | -10.2 | -7 | -6.1 | -4.2 | 0 | 0 | 0 |
| NAL27 - Adnashoor | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.3 | 41.7 | 40.3 | 34.1 | 34.1 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 20.6 | 24.9 | 29.1 | 32.5 | 35.2 | 35.2 | 35.2 | 35.2 | 34.1 | 34.1 |
| | Exceedance Level $L_{A90}$ | - | - | -22.4 | -18.1 | -13.9 | -10.5 | -7.8 | -7.1 | -6.5 | -5.1 | 0 | 0 |
| NAL28 – South Voxter | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 42.4 | 41.9 | 41 | 38.8 | 33 | 34.8 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 15.8 | 20.1 | 24.3 | 27.7 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 | 30.4 |
| | Exceedance Level $L_{A90}$ | - | - | -27.2 | -22.9 | -18.7 | -15.3 | -12 | -11.5 | -10.6 | -8.4 | -2.6 | -4.4 |
| NAl29 – East Lynn | Site Specific Noise Limit | 43 | 43 | 43 | 43 | 43 | 43 | 43 | 42.4 | 42 | 41 | 39 | 40.6 |
| | Predicted Wind Turbine Noise $L_{A90}$ | - | - | 12 | 16.3 | 20.5 | 23.9 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 | 26.6 |
| | Exceedance Level $L_{A90}$ | - | - | -31 | -26.7 | -22.5 | -19.1 | -16.4 | -15.8 | -15.4 | -14.4 | -12.4 | -14 |

### Summary of Mode Management Requirements

6.6.8 Based on wind farm noise predictions for the candidate turbine, the SWT-DD-120 4.3MW, mode management of some of the wind turbines will be required to ensure that the Site Specific Noise Limits are met. The degree of mode management that is required will vary depending on the day time fixed minimum limit that is adopted. Should the proposed development receive Consent, a detailed mode management programme will be designed based on the turbine model to be installed on the site and the final noise limits included within the planning conditions.

### Choice of Daytime Fixed Minimum Noise Limit (35 – 40 dB)

6.6.9 When considering the cumulative impacts of the proposed development operating in conjunction with other consented or operational schemes a fixed minimum limit of 40 dB has been adopted. This limit was chosen with due regard to the guidance in ETSU-R-97 and, in particular following a review of the predicted levels for existing wind turbines in the area. Predictions for the existing consented or operational turbines in the area indicate that existing levels of turbines noise exceed the day time limit based on a 40 dB limit, as such that noise limit has effectively been allocated already to those consented developments. At some NALs it appears that considerably more than 40dB has been allocated, which may suggest that the occupiers of a nearby property have a Financial Involvement in the nearby wind turbine(s) and as such a higher Total ETSU-R-97 Noise Limit may be appropriate (as per Section 2.5.11 above). At this stage no occupiers of any NAL have been considered Financially involved although it would be possible to update the Site Specific Noise Limits to reflect any financial involvement if details become available.

6.6.10 Whilst a cumulative daytime Total Noise Limit of 40 dB is proposed, the proposed developments Site Specific Noise Limit are set separately and can be established using a value between 35 and 40 dB.

6.6.11 The IOA GPG notes that:

*"The rationale for a choice of this limit, or factors which would assist the determining authority in this respect should be set out in the assessment. It is beneficial to the decision maker to display both sets of limits to illustrate the range available and/or the noise limit for the development if agreed previously with the LPA. "*

6.6.12 The choice of daytime fixed minimum limit depends on three factors which are discussed on page 65 of ETSU-R-97 and in Section 3.2.4 of the IOA GPG. The IOA GPG notes that:

*"It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration, and therefore are difficult for noise consultants to fully determine."*

6.6.13 To assist the decision maker, the relevant guidance in summarised in Table 6.11 along with a commentary on each point when considering the proposed development.

**Table 6.11 Consideration of Guidance provided on Choice of FML**

| Factor | Guidance in ETSU-R-97 | Guidance in IOA GPG | Commentary for the proposed development |
|---|---|---|---|
| 1) The number of noise affected properties | *"The planning process is trying to balance the benefits arising out of the development of renewable energy sources against the local environmental impact. The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate. Developers still have to consider the interests of individuals as protected under the Environmental Protection Act 1990."* | *"The number of neighbouring properties will depend on the nature of the area, (rural, semi-rural, urban) and is sometimes considered in relation to the size of the scheme and study area. The predicted 35 dB LA90 contour (at maximum noise output up to 12 m/s) can provide a guide to the dwellings to be considered in this respect."* | The Site itself is located in a rural area although there are a number of settlements which surround the site. The total number of noise sensitive receptors which would experience wind farm noise levels of 35 dB is relatively high in absolute terms (several hundred individual properties) however given the size of proposed development the number of properties affected per MW of installed capacity is relatively low. |
| 2) The effect of using tighter limits on the potential power output of the wind farm: | *"Similar arguments can be made when considering the effect of noise limits on uptake of wind energy. A single wind turbine causing noise levels of 40dB(A) at several nearby residences would have less planning merit (noise considerations only) than 30 wind turbines also causing the same amount of noise at several nearby residences."* | *"This is in practice mainly based on the relative generating capacity of the development, as larger schemes have relatively more planning merit (for noise) according to the description in ETSU-R-97. In cases when the amenity fixed limit has little or no impact on the generating capacity (i.e. noise is not a significant design constraint) then a reduced limit may be applied."* | The proposed development, if approved, would represent one of the largest onshore wind farms in the UK and would generate a significant amount of renewable energy. |

| Factor | Guidance in ETSU-R-97 | Guidance in IOA GPG | Commentary for the proposed development |
|---|---|---|---|
| 3) The duration of exposure of these properties. | *"The proportion of the time at which background noise levels are low and how low the background noise level gets are both recognised as factors which could affect the setting of an appropriate lower limit. For example, a property which experienced background noise levels below 30dB(A) for a substantial proportion of the time in which the turbines would be operating could be expected to receive tighter noise limits than a property at which the background noise levels soon increased to levels above 35dB(A). This approach is difficult to formulate precisely and a degree of judgement should be exercised."* | *"This last test is more difficult to formulate. But ETSU-R-97 notes that the likely excess of turbine noise relative to background noise levels should be a relevant consideration. In rural areas, this will often be determined by the sheltering of the property relative to the wind farm site. Account can also be taken of the effects of wind directions (including prevailing ones at the site) and likely directional effects. For cumulative developments, in some cases the effective duration of exposure may increase because of cumulative effects."* | Background noise levels vary across the thirteen NMLs but in general the daytime noise levels are low. Predicted noise levels indicate that, regardless of the fixed minimum limit that is adopted, mode management will be required and this will increase the duration of exposure at certain properties (as the turbines will operate such that the noise levels will remain fairly constant, regardless of wind direction). Unlike much of the mainland UK there is no single dominant prevailing wind direction meaning that no group of properties will be downwind of the turbines for a particularly high proportion of the time. |

6.6.14 If consent is granted for the proposed development it would be appropriate to set noise limits equal to the Site Specific Noise Limits contained within Tables 6.8 or 6.9 and 6.10. The daytime noise limits included within the assessment consider the lower and upper fixed minimum noise limit only but another fixed minimum limit between the range (35-40 dB) could also be considered appropriate for the proposed development. In the event that an alternative daytime fixed minimum limit is deemed appropriate new Site Specific Noise Limits would need to be calculated in accordance with the methodology presented in this report.

## 6.7 Micrositing

6.7.1 It should be noted that the need to include a concave ground profile correction and/or barrier correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits established in this report regardless of any changes in noise propagation caused by topography. Should consent for the proposed development be granted, the need to apply a concave ground profile/ barrier correction will need to be considered by the Applicant prior to the final selection of a turbine model for the site.

# 7 Conclusions

7.1.1 This report has assessed the potential impact of operational noise from the proposed development on the residents of nearby receptors. The guidance contained within ETSU-R-97 and current good practice (IOA GPG) has been used to assess the potential noise impact of the proposed development.

7.1.2 A cumulative assessment was undertaken at the twenty nine NALs which were selected based on the maximum predictions from the proposed development and cumulative schemes. The cumulative assessment results show that the predicted cumulative wind farm noise immission levels would meet the 'Total ETSU-R-97' derived noise limits at receptor locations surrounding the proposed development for both daytime and night-time periods.

7.1.3 'Site Specific ETSU-R-97 Noise Limits' have also been derived which take account (where required) of the other wind farms. ETSU-R-97 recommends that the fixed minimum daytime noise limit be set within the range 35-40 dB therefore an assessment against both options has been included to enable the Scottish Government to determine the most appropriate daytime limits for the proposed development should consent be granted. At this stage, the Site Specific Noise Limits do not consider whether the occupiers of a property have a financial interest in the proposed development or a nearby scheme (as that information was not available at the time of writing). Where the occupiers of property are financially involved then both the day and night-time lower fixed limits can be increased to 45 dB and therefore the Site Specific Noise Limits at some receptors may be subject to change. It also assumes that all consented turbines are built and that all existing turbines continue to operate for the lifetime of the consent and that their noise immissions are as per the levels considered in this assessment.

7.1.4 An assessment was undertaken to determine whether the proposed development could operate within the 'Site Specific Noise Limits' and it was found that at all receptors wind turbine noise immissions were below the 'Site Specific Noise Limits' when considering the Siemens SWT-DD-120 4.3 MW as a candidate turbine. In order to meet the Site Specific Noise Limits, certain turbines would need to be turned off or mode managed for certain wind directions and wind speeds. The level of mode management will vary depending on the daytime fixed minimum noise limits imposed and the final turbine type chosen for installation at the proposed development. Should the proposed variation receive consent, further modelling will be required to demonstrate compliance with any noise limits imposed..

7.1.5 At some locations, under some wind conditions and for a certain proportion of the time operational wind farm noise from the proposed development would be audible; however, it would be at an acceptable level in relation to the ETSU-R-97 guidelines.

7.1.6 There are a number of wind turbine makes and models that may be suitable for the proposed development. Should the proposed development receive consent, the final choice of turbine would be subject to a competitive tendering process. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed. An amended set of suggested operational noise conditions are included within Annex 8.

# 8 Glossary of Terms

**AOD:** Above Ordnance Datum is the height above sea level.

**Amplitude Modulation:** a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past.

**Attenuation:** the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

**Background Noise**: the noise level rarely fallen below in any given location over any given time period, often classed according to daytime, evening or night-time periods. The $L_{A90}$ indices (see below) is often used to represent the background noise level.

**Bin:** subset or group into which data can be sorted; in the case of wind speeds, bins are often centred on integer wind speeds with a width of 1 m/s. For example the 4 m/s bin would include all data with wind speeds of 3.5 to 4.5 m/s.

**Dawn Chorus:** noise due to birds which can occur at sunrise.

**Broadband Noise:** noise with components over a wide range of frequencies.

**Decibel (dB):** the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

**dB(A):** the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate noise in the same way as the ear, and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Some typical subjective changes in noise levels are:

- a change of 3 dB(A) is just perceptible;
- a change of 5 dB(A) is clearly perceptible;
- a change of 10 dB(A) is twice (or half) as loud.

**Directivity:** the property of a sound source that causes more sound to be radiated in one direction than another.

**Frequency**: the pitch of a sound in Hz or kHz. See Hertz.

**Ground Effects:** the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).

**Hertz (Hz):** sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

**$L_w$**: is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The $L_{WA}$ is the A-weighted sound power level.

**$L_{eq}$**: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $LA_{eq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).

**$L_{90}$**: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

**Noise emission**: the noise energy emitted by a source (e.g. a wind turbine).

**Noise immission:** the sound pressure level detected at a given location (e.g. the nearest dwelling).

**Night-Time Hours:** ETSU-R-97 defines the night-time hours as 23.00 to 07.00 every day.

**Quiet Daytime Hours:** ETSU-R-97 defines the amenity hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.

**Sound Level Meter:** an instrument for measuring sound pressure level.

**Sound Power Level:** the total sound power radiated by a source, in decibels.

**Sound Pressure Level:** a measure of the sound pressure at a point, in decibels**.**

**Standardised Wind Speed:** a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).

**Tonal Noise:** noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise can be more annoying than broadband noise.

**Wind Shear:** the increase of wind speed with height above the ground.

# 9 References

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