10 NOISE AND VIBRATION

10.1 INTRODUCTION

This chapter of the EIAR assesses the potential effects associated with noise and vibration impacts due to the Proposed Development as described in **Chapter 2: Project Description**. The Proposed Development refers to all elements including the 3-turbine wind farm, Site Infrastructure, Grid Route and Turbine Delivery Route.

The assessment considers the potential effects during the following phases of the Proposed Development:

- Construction
- Operation
- Decommissioning

Any effects arising as a result of the future Decommissioning of the Proposed Development, are considered to be no greater than the effects arising during construction.

Common acronyms used throughout this EIAR can be found in **Appendix 1.4**. This chapter of the EIAR is supported by **Figure 10.2** and the following Appendices documents provided in Volume III of this EIAR:

- **Appendix 10.1**: Photos of noise monitors in-situ
- **Appendix 10.2**: Methodology for calculating wind shear from hub height wind speed to standardised to 10 m height wind speed
- **Appendix 10.3**: Calibration certificates of noise instruments
- **Appendix 10.4**: Candidate turbine manufacturer's noise emission data

10.1.1 Statement of Authority

This section of the EIAR has been prepared by Brendan O'Reilly of Noise and Vibration Consultants Ltd. Brendan has a master's degree in noise and vibration from Liverpool University and over 40 years' experience in noise and vibration control (including many years' experience in preparation of noise impact statements. Brendan has been a member of a number of professional organisations including the SFA, ISEE and IMQS. Brendan was a co-author and associate consultant in the EPA, 2003 'Environmental Quality Objectives, Noise in Quiet Areas'. Brendan has extensive experience in the assessment of noise impact and has compiled studies for numerous large scale wind farm developments throughout the country.

10.1.2 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria – a description of the methods used in the Baseline surveys and in the assessment of the significance of effects.
- Baseline Description - a description of the noise Baseline of the receiving environment based on the results of surveys, desk information and consultations, and a summary of any information required for the assessment that could not be obtained.
- Assessment of Potential Effects - identifying the ways in which noise receptors could be affected by the Project, including a summary of the measures taken during design to minimise noise and vibration effects.
- Mitigation Measures and Residual Effects - a description of measures recommended to off-set potential negative effects and a summary of the significance of the effects of the Project after mitigation measures have been implemented.
- Cumulative Effects – identifying the potential for effects of the EIA Development to combine with those from other wind farm developments.
- Summary of Significant Effects.
- Statement of Significance.

10.1.3 Acoustic Terminology

Sound is simply the pressure oscillations that reach our ears. These are characterised by their amplitude, measured in decibels (dB), and their frequency, measured in Hertz (Hz). Noise is unwanted or undesirable sound, it does not accumulate in the environment, is transitory, fluctuates, and is normally localised. Environmental noise is normally assessed in terms of A-weighted decibels, dB (A), when the 'A weighted' filter in the measuring device elicits a response which provides a good correlation with the human ear. The criteria for environmental noise control are of annoyance or nuisance rather than damage. In general, a noise level is liable to provoke a complaint whenever it's level exceeds by a certain margin, the pre-existing noise level or when it attains an absolute level. A change in noise level of 3 dB (A) is 'barely perceptible', while an increase in noise level of 10 dB (A) is perceived as a twofold increase in loudness. A noise level in excess of 85 dB (A) gives a significant risk of hearing damage. Construction and industrial noise sources are normally assessed and expressed using equivalent continuous levels, LAeq[1]. Wind turbine source noise is generally expressed in Leq dBA in sound power levels (L_{WA} dB).

[1] L_{Aeq} is defined as being the A-weighted equivalent continuous steady sound level that has the same sound energy as the real fluctuating sound during the sample period and effectively represents a type of average value.

Sound Power Level (L_{WA} dB) is a measure of the acoustic energy emitted from a source of noise, expressed in decibels. Sound power level refers to the source and sound pressure level is measured by a sound level meter at a distance from a source. Sound power is distance independent, whereas sound pressure is the distance-dependent effect.

Operational wind turbine noise is assessed using the LA90[2] descriptor, which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources. The LA90 should be used for assessing both the wind energy development noise and background noise as stated in the Wind Energy Development Guidelines, Guidelines for Planning Authorities June 2006. As discussed in ETSU-R-97[3] the LA90 is 1.5-2.5dBA less than the LAeq measured over the same period. In this assessment, the difference between LAeq and LA90 is assumed to be 2dBA, which is best practice. Wind turbine noise levels are given as sound power levels (LWA) in dB at integer wind speeds up to maximum LWA levels which is no more than 10 m/s wind speed at 10 m height. The EPA gives a dBA scale and indicative noise levels, (EPA 2016[4]). The L_{PA} (dB) scale denotes sound pressure level in dBA. **Plate 10.1** gives L_{PA} (dB) scale and indicative noise levels.

10.2 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

10.2.1 Assessment Methodology

This assessment has involved the following elements, further details of which are provided in the following sections:

- Legislation and guidance review
- Desktop study, including review of available maps and published information
- Baseline study
- Identification of measures to avoid and mitigate potential effects
- Description of effects for construction, operation and Decommissioning phases;
- Evaluation of Potential Effects

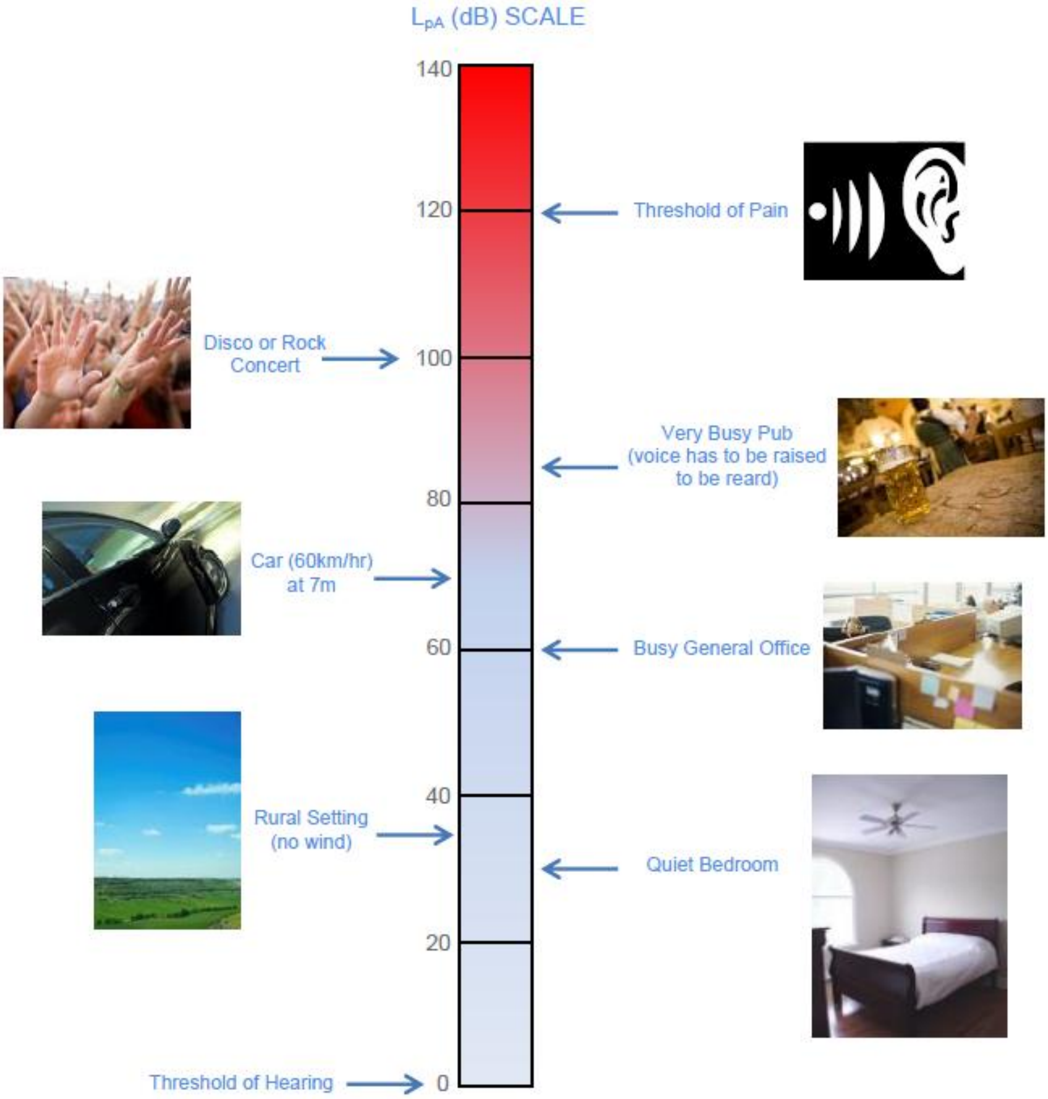
10.2.2 Description of Effects

The significance of effects of the Project is described in accordance with the EPA guidance document '*Guidelines on the information to be contained in the Environmental Impact Assessment Reports (EIAR), EPA May 2022'*. The details of the methodology for describing

[2] LA90, or L90dBA is defined as the noise level equaled or exceeded for 90% of the measurement interval and with wind farm noise the interval used is 10 minutes.
[3] ETSU-R-97, The Assessment & Rating of Noise from Wind Farms, June 1996
[4] EPA Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)

the significance of effects are provided in Table 3.4: Section 3.7.3 of the EPA 2022 document.

Plate 10.1: L_{PA} (dB) scale and indicative noise levels



10.3 RELEVANT LEGISLATION AND GUIDANCE

The noise assessment is carried out in accordance with the guidance and consideration of the following documents, with references given where relevant in the various sections of the report:

- Wind Energy Development Guidelines[5] (the 2006 Guidelines);
- Recent (16th October 2023, Number ACP-314120-22) An Coimisiún Pleanála Decision on Noise Limits.

[5] Department of Environment, Heritage and Local Government: Wind Energy Development Guidelines, Guidelines for Planning Authorities 2006 Energy

- ETSU-R-97[6]: The Assessment & Rating of Noise from Wind Farms (ETSU-R-97);
- The Institute of Acoustics (IOA) Good Practice Guide (GPG) to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including Supplementary Guidance Note 4: Wind Shear'[7] (the IOA GPG);
- ISO 1996[8]Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures (ISO 1996);
- WHO 2018 Environmental Noise Guidelines for European Region (WHO 2018).
- Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG, 2019);
- National Roads Authority (NRA) Guidelines for Treatment of Noise and Vibration in National Road Schemes, 2004.
- BS 5228-1:2009+A1:2014, Code of Practice for Noise and Vibration Control on Open Sites (BS 5228).
- Guidelines on the information to be contained in the Environmental Impact Assessment Reports (EIAR), EPA May 2022.

10.3.1 Wind Energy Development Guidelines 2006

The following are a number of key extracts from the 2006 Guidelines in relation to noise impact:

General Noise Impact

"*Noise impact should be assessed by reference to the nature and character of noise sensitive locations*."

"*Separate noise limits should apply for day-time and for night-time*"

"Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

Measurement Units

"The descriptor [LA90 10min] which allows reliable measurements to be made without corruption from relatively loud transitory noise events from other sources, should be used for assessing both wind energy development noise and background noise."

Specific Noise Limits

6 ETSU-R-97: Acoustics-The Assessment & Rating of Noise from Wind Farms: ETSU for the DTI, UK, 1996
7 Institute of Acoustics (2013) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise
8 ISO 1996/1- Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures

"Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."

"In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5 dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours.

However, in very quiet areas, the use of the margin of 5 dB(A) above the background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments. Instead in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of LA90,10min of the wind energy development noise should be limited to an absolute level within the range 35-40 dB(A)".

"During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43 dB(A) L90,10min which will protect sleep inside properties during the night"

The 2006 Guidelines do not specify daytime or night-time hours. However, it is considered good practice to follow the framework given in ETSU-R-97 and IOA Good Practice Guide where daytime and night-time hours are specified. The limits are based on the prevailing background noise level for 'quiet daytime' periods, defined in ETSU-R-97 as:

- Quiet waking hours or quiet day-time periods are defined as:
- All evenings from 18:00 to 23:00hrs
- Saturday afternoon from 13:00 to 18:00hrs and all-day Sunday 07:00 to 18:00hrs
- Night-time is defined as 23:00 to 07:00hrs

Recent An Coimisiún Pleanála decisions have applied the 2006 Guidelines.

10.3.2 WHO 2018

The most recent WHO 2018 Guidelines: 'Environmental Noise Guidelines for the European Region' gives a conditional recommendation requiring substantial debate with a limit of 45 dB Lden which is based on low quality evidence. This is an annual average noise level, based on wind speed and direction in the vicinity of the Site with no specific limits for night.

10.3.3 Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG 2019)

There have been a number of draft guidelines over the years with the latest one being the *Draft Revised Wind Energy Guidelines December 2019.* These guidelines in draft form have been the subject of significant public and stakeholder consultation and is in the process of review. In line with best practice the assessment is based on the current guidance and best practice.

10.4 DESKTOP STUDY

The three locations for noise monitoring, shown in **Figure 10.2**, were selected by inspection of site maps, visits to the Site and by identifying the nearest receptors to the wind farm. The Noise Study Area has been defined such that the predicted results have been included for all residential receptors (including some semi-derelict properties) within 2km of the wind farm. The validation of selected locations was made with a visit to the Noise Study Area. The locations selected are considered representative of the local noise environment.

10.5 ACQUISITION AND ANALYSIS OF BACKGROUND NOISE DATA

The 2006 Guidelines, ETSU-R-97 and the IOA Good Practice Guide recommend the measurement and use of wind speed data, against which background noise measurements are correlated. The IOA Good Practice Guide Supplementary Guidance Note 4[9] (**Appendix 10.2**) gives the methodology to account for standardising to 10 m height wind speed.

A Lidar system, which was located close to the Site during the noise survey, was used for wind data measurements at a hub height of 78.3 m that was used to derive charts which provided analysis of the Baseline noise data.

For each 10-minute interval the mean wind speed at 78.3 m hub height was calculated to standardised 10 m height wind speed. A plot of standardised wind speed is made against background noise levels acquired in the noise survey to derive a best-fit polynomial line /curve. From this polynomial line / curve noise levels are derived from integer wind speeds up to 10 m/s.

The procedures to calculate standardised 10 m height wind speed is undertaken according to the method given in the Supplementary Guidance Note 4[10].

[9] IOA, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise- Supplementary Guidance Note 4: Wind Shear

[10] IOA, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise- Supplementary Guidance Note 4: Wind Shear

10.6 PREDICTION OF WIND TURBINE NOISE LEVELS

The predicted noise levels are based on the methodology given in the IOA Good Practice Guide. Noise level calculations are based on ISO 9613-2[11] which provides a prediction of noise levels likely to occur under worst-case down-wind conditions.

There are numerous models for predicting noise from a point source and some of these models are specifically used for the prediction of noise from windfarms. Resoft with the WindFarm Release 4 wind energy development software package was used to calculate the noise levels at all receptors. The propagation model calculates the predicted sound pressure levels by taking the source sound power level for each turbine in their respective octave bands and subtracting a number of attenuation factors according to the following formulae:

Predicted Octave Band Noise level = LW +D – (A_{geo} +A_{atm} +A_{gr} + A_{br} +A_{mis}).

The predicted octaves from each of the turbines are summed to give the predicted noise level expressed as dBA. No allowance has been made for the character of noise emitted by the turbines, however in general the emissions from wind turbines are broadband in nature. In the unlikely event of a turbine exhibiting clearly tonal components at any receptor, the turbine will be turned down or stopped until such tonality is ameliorated. A guarantee will be sought in the procurements of the turbine to be used onsite, stating that there will be no clearly tonal or impulsive components audible at any noise sensitive receptor location.

A_{geo} –Geometric Spreading

Geometric (spherical) spreading from a simple free-field point source result in attenuation over distance according to:

Lp = Lw – (20 log R + 11)

Where:

Lp = sound pressure level

Lw = sound power level

R = distance from the turbine to receiver

D – Directivity Factor

The directivity factor allows for adjustment where the sound radiated in the direction of the

[11] ISO 9613-2 Acoustics -Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation

receptor is higher than that for which the sound power level is specified. In this case, the sound power levels are predicted as worst-case propagation conditions, i.e. all receptors are assumed to be in downwind conditions.

A_{gr} - Ground Effects

Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from the turbine to receiver. The prediction of ground effects is complex and depends on the source height, receiver height, propagation height between the source and receiver and the intervening ground conditions.

Ground conditions are described according to a variable defined as G, which varies between 0 for hard ground and 1 for soft ground. Although in reality the ground is predominately porous, it has been modelled as mixed 50% hard and 50% porous corresponding to a ground absorption coefficient of 0.5. Our predictions have been carried out using a source height corresponding to the proposed height of the turbine nacelle, a receiver height of 4 m and an assumed ground factor of G=0.5 as recommended in the IOA Good Practice Guide.

A_{bar}- Barrier Attenuation

The effect of a barrier (including a natural barrier) between a noise source and receptor is that noise will be reduced according to the path difference (difference between the direct distance between source to receptor and distance between source and receptor over the barrier). The reduction is relative to the frequency spectrum of the sound and may be predicted according to the method given in ISO 9613. In practice, barriers can become less effective in downwind conditions. A barrier can be very effective when it lies within a few metres of the receptor. In the prediction model, zero attenuation is given for barrier effects, which is a worst-case scenario setting.

A_{atm} - Atmospheric Absorption

Sound emergency through the atmosphere is attenuated by conversion of sound energy to heat. This energy is dependent on the temperature and relative humidity of the air, but only weakly on ambient pressure through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies. The attenuation by atmospheric absorption A_{atm} in decibels during propagation through distance in metres is given by:

$A_{atm} = d \times \alpha$,

α = atmospheric absorption coefficient in dBm^{-1}

d = distance from turbine

Values of α from ISO 9613 Part 1, corresponding to a temperature of 10^0C and a relative humidity of 70% has been used for these predictions and are given in **Table 10.1** below. These values are recommended in the IOA Good Practice Guide.

Table 10.1: Frequency dependent atmospheric attenuation coefficients (dB/m)

Octave Band Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.0001	0.0004	0.001	0.0019	0.0037	0.0097	0.0328	0.117

A_{misc} – Miscellaneous Other Effects

ISO 9613 includes effects of propagation through foliage, industrial plants and housing as additional attenuation effects. These have not been included here, and any such effects are unlikely to significantly reduce noise levels below those predicted.

The ISO 9613-2 standard calculates under downwind propagation conditions and therefore predicts the average downwind sound pressure level at each dwelling. The model assumes that the wind is directly downwind from each turbine to each dwelling. The prediction model is calculated as a worst-case scenario.

The predicted noise levels $L_{Aeq\ 10min}$ are converted to the required $L_{A90,10min}$ by subtracting 2 dBA.

10.7 AERODYNAMIC MODULATION OR AERODYNAMIC NOISE

Aerodynamic noise originates from the flow of air over, under and around the blades and is generally broadband in character. It is directly linked to the movement of the rotors through the air and will occur to varying degrees whenever the turbine blades move. Aerodynamic noise is generally both broadband i.e., it does not contain a distinguishable note or tone, and of random character, although the level is not constant and fluctuates in time with the movement of the blades. The dominant character of such aerodynamic noise is therefore normally a 'swish' type of sound, which is familiar to most people who have stood near to a large wind turbine.

The sound level of aerodynamic noise from wind turbine blades is not completely steady but is modulated (fluctuates) in a cycle of increased and then reduced level, sometimes called "*blade swish*", typically occurring in step with the angle of rotation of the blades and so being periodic at the rotor's rotational speed. For typical commercial turbines, this is at a rate of around once or twice per second. This phenomenon is known as Amplitude Modulation of Aerodynamic Noise or more succinctly by the acronym AM. In very rare situations however, the modulation can change in character to the point where it could potentially give rise to annoyance.

In early wind turbine designs, where the rotor was positioned downwind of the tower, a pronounced 'beat' was audible as each blade passed through the turbulent wake shed from the tower. However, this effect does not exist for the upwind rotor designs found on the majority of modern wind farms including the proposed wind farm where the air flow to the blades is not interrupted by the tower structure. Instead, it seems that aerodynamic modulation is due to fluctuation of the primary mechanisms of aerodynamic noise generation i.e. the blade swish mentioned above.

The Temple Group[12] undertook a review of Renewable UK's Research into Amplitude Modulation and concluded the following:
The distinction between normal AM i.e., blade swish (NAM) and other AM (OAM) is important as they are caused by different mechanisms and have separate impacts. Normal AM (NAM) is a commonly occurring typical characteristic of wind turbine noise that occurs persistently for long periods. NAM or "swish" usually disappears at around 3 to 4 rotor lengths from the turbines, except in crosswind conditions.

Based on the evidence available, it was recognised that even at those wind farm sites where OAM has been reported to be an issue, its occurrence may be relatively infrequent.

The study reports that the occurrence and intensity of OAM is dependent on a number of interacting factors that are specific to a location, and it is not feasible to reliably predict the occurrence of OAM at another location simply by cross checking whether similar conditions that arise at a location where OAM has occurred might arise at the new location.

Normal Amplitude Modulation (NAM) is a fundamental component of wind turbine noise and can be heard in proximity to virtually all wind turbine installations. The 2007[13] Salford University Report found instances of "enhanced" AM which occurred at larger distances,

[12] Report for Renewable UK by Temple Group (Dani Fliumicelli). *Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines*, Wind Turbine Amplitude Modulation: *Research to Improve Understanding as to the cause and Effec*t, Dec'2013.
[13] Research into Aerodynamic Modulation of Wind Turbine Noise. Report by University of Salford

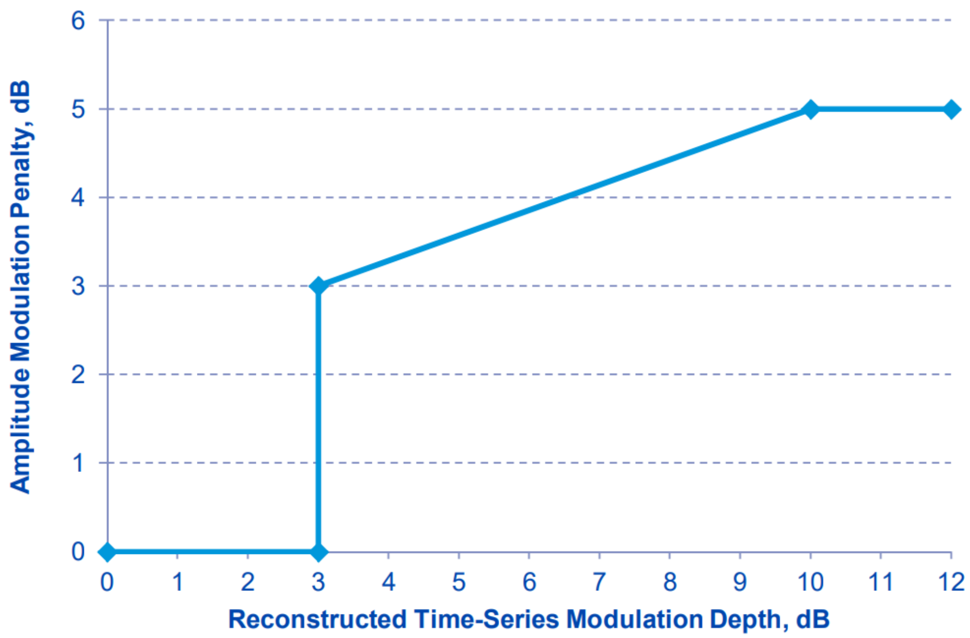
but relatively infrequently and at only a small minority of sites. These characteristics are consistent with and can be explained by OAM.

As described previously, many risk factors have been considered for OAM. However, no single item or specific combination of items have been found to be the controlling factors whereby the occurrence, duration and intensity of OAM at a particular location can be reliably predicted in advance of a wind turbine or wind farm being installed. In the very unlikely event that OAM arises then appropriate mitigation measures will be put in place. Salford University in 2007, found that out of 133 operational wind farms investigated, 27 were associated with noise complaints, but OAM was considered to be a factor in noise complaints at only four sites and a possible factor in a further eight locations. The research has shown that OAM is a rare and unlikely occurrence at operational wind farms.

Most Recent Information

The most recent information in relation assessing AM comes in the IEC TS 61400-11. The scope of this document includes an assessment of the sound characteristics of the noise and relies on the Institute of Acoustics Reference Method (IOA RM) to quantify the AM level along with the WSP Phase 2 Report which identified a penalty scheme as shown **Figure 10.1** below.

Figure 10.1: Proposed Penalty Scheme



Current science cannot predict AM during planning; it can only be measured after the wind farm starts operating. Excess AM (OAM) is very rare in modern turbines and would only require measures following a complaint. The methodology contained within the IOA RM and IEC 61400 allows quantification of all aspects of AM and the penalty scheme identified above allows quantification of the mitigation required, if any. An appropriate penalty can be added onto the measured LA90 noise level, to ensure overall noise levels comply with the applicable noise limit. It is considered highly unlikely that excess AM will be generated with a turbine with TES.

10.8 LOW FREQUENCY NOISE AND VIBRATION

There is always low frequency (or infrasound) noise present in the ambient quiet background. It is generated by natural sources such as distant road traffic, wind effects through air and vegetation, wave motion, water flow in streams and rivers. There are also low frequency emissions from many sources found in modern life, such as household appliances (e.g. washing machines, air conditioners, fridges, heating systems, boilers, burners, heat pumps, extraction systems, computers, electric or battery clocks), water flowing through pipes within the home and water flow from municipal water supply. Vibration of elements of structures (low frequency) is generated in one's home by way of normal routine activity, like climbing stairs, walking on floors, closing doors, etc. When sitting in a moving vehicle very high levels of low frequency vibration / sound is generated and observed.

The frequency range of audible noise is in the range of 20 to 20,000Hz and low frequency noise is generally from about 2 to 200Hz with infrasound typically of frequencies below 20Hz. There appears to be little or no agreement about the biological effects of low frequency noise on human health and there is evidence to suggest that there are no serious consequences to people's health from infrasound exposure.

A study of low frequency noise (infrasound) and vibration around a modern wind farm was carried out for ETSU and reported in ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm*'[14]. The results showed levels of infrasound to be below accepted thresholds of perception even on the Site. Furthermore, a document prepared for the World Health Organisation, states that *'there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects'.*

Significant research carried out on low frequency noise has been in the area of blasting (air overpressure) which falls into a very low frequency range (2-40Hz), although with a considerably higher magnitude – typically in a range of 110-125dB. Interestingly, most

14 ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm'.*

microphones recording air-overpressure (low frequency sound) is linear down to 2Hz with a range that does not go below 88dB, as below that value trigger will occur by relatively low wind speeds (a gust of wind at 9 m/s equates to an air overpressure of 133dB). Wind in the natural environment, along with streams and rivers, generates elevated levels of low frequency (infrasound) yet nobody complains about these sources. Low frequency sound is generated from wind effects on vegetation close to receptors in the wind speed range that turbines operate in, yet nobody complains about wind (or rivers or streams) being the cause of sickness.

South Australian Environment Protection Authority (EPA) Infrasound Study

A report released in January 2013 by the South Australian EPA[15] found that the level of infrasound from wind turbines is insignificant and no different to any other sources of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people. The study included several houses in rural and urban areas, houses both adjacent to a wind farm, away from turbines and measured the levels of infrasound with the wind farms operating and also switched off. There were no noticeable differences in the level of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building. The South Australian study found: '*the contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment'*.

Massachusetts Institute of Technology (MIT)

A report by an Independent Expert Panel prepared for Massachusetts Department of Health (2012)[16] which consisted of a panel that included seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering, all considered independent experts from academic institutions. The report found that *'there is insufficient evidence that the noise from wind turbines is directly (i.e., independent from an effect on annoyance or sleep) causing health problems or disease'* and '*available evidence shows that infrasound levels near wind turbines cannot impact the vestibular system'*.

[15] http://www.epa.sa.gov.au/environmental_info/noise/wind_farms

[16] A Wind Turbine Health Impact Study: Report of Independent Expert Panel in January 2012 prepared for the Massachusetts Department of Environmental Protection, Massachusetts Department of Health

Technical Research Centre of Finland

A long-term study into so-called "wind turbine syndrome"[17] health problems supposedly caused by low-frequency sound from spinning blades has concluded that this "infrasound" has absolutely no physical impact on the human body.

The study conducted by the Technical Research Centre of Finland (VTT) and others, commissioned by the Finnish government, found that infrasound sound waves with frequencies below the range of human hearing cause no measurable changes in the human body, and cannot in any way be detected by the human ear.

Infrasound measurements were taken inside and outside local dwellings near two Finnish wind farms, as well as inside the facilities and beyond them, for 308 days.

"Infrasound samples representing the worst-case scenarios were picked out from the measurement data and used in the listening tests," said VTT.

"The participants in the listening tests were divided into two groups based on how they reported wind turbine infrasound related symptoms: people who suffered from those and people who never had symptoms.

"The participants were unable to make out infrasonic frequencies in wind turbine noise, and the presence of infrasound made no difference to how annoying the participants perceived the noise, and their autonomous nervous system did not respond to it. There were no differences between the results of the two groups". "No evidence of health effects of wind turbine infrasound was found."

Statement from the Institute of Acoustics dated December 2024

Infrasound

'*The IOA is aware that there is information presented at planning inquiries suggesting the potential for physiological health effects from infrasound from wind turbines. It is current advice to members that there is no need to assess infrasound as part of the noise impact assessment process as the absolute levels are well below those reported to trigger physiological health effects based on peer reviewed research to date'*.

[17] Infrasound Does Not Explain Symptoms Related to Wind Turbines, Finnish Government, June 2020, https://www.vttresearch.com/en/news-and-ideas/vtt-studied-health-effects-infrasound-wind-turbine-noise-multidisciplinary.

Low Frequency Noise

'The IOA is aware that there is information presented at planning inquiries suggesting the potential for physiological health effects from low frequency sound from wind turbines. It is current advice to members that there is no need to assess low frequency sound as part of the noise impact assessment process as the absolute levels whilst potentially audible at typical receptor distances, are well below those reported to trigger physiological health effects based on peer reviewed research to date'.

10.9 NOISE ASSESSMENT METHODOLOGY

In summary, the assessment process comprises:

- Identification of potential receptors, i.e., houses and other potentially noise-sensitive locations;
- Measurement of existing background noise levels at representative locations close to the wind farm;
- Prediction of the likely noise levels of wind turbines at each receptor;
- Comparison of the predicted levels with noise limits, and
- Description of effects of construction, operation and Decommissioning

The onsite 20kV substation is considered. However, it is discounted from the operational noise assessment as the noise emissions are very low compared to the wind turbines i.e., less than 30dBA at 100 m and will have negligible impact at the nearest noise sensitive receptor H2 which is 420m away.

Potential receptors in the area surrounding the Wind Farm were initially identified from Ordnance Survey maps, Google maps, EPA maps and Site visits. Background measurements were carried out at locations given in **Table 10.7 and Figure 10.2**.

<u>Consultation</u>

The landowner asked local residents for permission to install noise monitors at three locations for Baseline monitoring. Access to dwellings was carried out with permission from the householders and landowners. Similar consultation was carried out with the landowner for the Lidar installation.

The method of measuring background noise is described in ISO 1996 and ETSU-R-97. In practice, it means carrying out continuous monitoring of background noise levels at receptors for a period which is usually 3 to 4 weeks duration including a range of wind speeds which at minimum correspond to the maximum sound power of the candidate turbines being assessed. The candidate turbine being assessed reaches maximum sound power level at a standardised wind speed of 8 m/s at 10 m height. The maximum sound power level does not increase above 8 m/s.

The method of predicting noise levels of wind turbines at receptors is discussed in **Section 10.6**. This method was applied to the calculations for both contour plots and individual receptor predictions.

It is standard practice to predict noise levels for a reference wind speed and to adjust these for other wind speeds, according to the variation in sound power level with wind speed.

There are a range of turbines that fit within the proposed range available on the market. The final turbine choice will be made through a commercial tender process. For the EIA the preferred turbine, the Enercon E82-E4 with an output of 2.34MW has been selected as it is the proposed turbine for the Site.

All turbines to be used will have as best practice Trailing Edge Serrations (TES) fitted as standard, which reduces the sound power levels of each turbine. **Table 10.2** provides details of the preferred turbine used for the noise assessment.

A copy of the manufacturer's noise specification of the turbine used in the assessment are given in the **Appendix 10.4**.

Table 10.2: Candidate Turbine Assessed

Turbine Manufacturer	Model	Turbine Output (MW)	Sound Power Level at Source dB LWA
Enercon	E82 E4 with TES	2.35	102.0

The Enercon E82 E4 turbine has a range of hub heights, however the proposed hub height of turbine chosen is 78.3m. A wind farm noise assessment is based on a standardised noise level referenced to a wind speed at 10 m height. The change in hub height does not change the maximum sound power level of any specific turbine.

The maximum sound power level of the Enercon E82 E4 operating at maximum out-put of 2.35MW is 102.0 dBA. The manufacturer's data gives the sound power levels at standardised varying wind speeds in one third octaves were converted to 1/1 Octave in dBA levels for each wind speed. **Table 10.3** give the sound power levels at varying wind speeds at standardised 10 m height wind speed for a hub height of 78.3m using the methodology in the IOA Good Practice Guide and given in **Appendix 10.2**.

The prediction modelling is based on the turbines operating at an output of 2.35MW. The IOA Good Practice Guide recommends that an uncertainty value is required to be added to the turbine emission data prior to modelling. Depending on the type of manufacturer's data, the uncertainty value will range from 0 to 2dBA. However, for the Enercon E82 E4 an uncertainty value of 2dBA is added in line with guidance. **Table 10.3** gives the maximum sound power levels at varying wind speeds (presented at standardised 10 m height) for the Enercon E82 E4 with a hub height of 78.3m operating at 2.35MW out-put.

Table 10.3: Noise Emission Levels, Enercon E82 E4 with TES

Standardised 10 m height wind Speed, ms^{-1}	4	5	6	7	8	9	10
Sound Power Level, LWA dB at 78.3m hub height	91.6	95.8	99.7	101.8	102.0	102.0	102.0
Uncertainty of 2dBA added and conversion from LAeq to LA90 using minus 2dBA	91.6	95.8	99.7	101.8	102.0	102.0	102.0

The octave band values at maximum sound power levels are given in **Table 10.4** with uncertainty values of 2 dB added and conversion of LAeq to LA90 added as input to the prediction model which is best practice.

Table 10.4: Octave Band Spectrum of Enercon E82 E4 at 2.35mw output with STE

Octave Band Frequency (Hz)	63	125	250	500	1000	2000	4000	8000
Sound Power Level, dB LWA 8 ms^{-1}	83.7	89.5	93.7	97.6	96.5	92.8	84.8	70.7
Uncertainty added to octaves and conversion of LAeq to LA90	83.7	89.5	93.7	97.6	96.5	92.8	84.8	70.7

10.9.1 Cumulative Assessment

There is no operating or permitted turbines within 3km of the Proposed Development, so cumulative impacts do not exist.

10.10 CONSTRUCTION ASSESSMENT METHODOLOGY

10.10.1 Relevant Guidance

There is no published national guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. However, the National Roads Authority (NRA) give limit values which are deemed acceptable (the NRA Guidelines)[18]. Guidance to predict and control noise is also given in BS 5228:2009-1+A1:2014[19].

10.10.2 NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes

The NRA Guidelines provide noise limits which are typically acceptable and states that where it is deemed necessary to predict noise levels associated with construction noise that this should be done in accordance with BS 5228:2009-1+A1:2014.

10.10.3 BS 5228;2009-1+A1 ;2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites

Part 1 of BS5228 deals with noise prediction and control. It recommends procedures for noise control in respect of construction operations. The standard stresses the importance of community relations, and states that early establishment and maintenance of the relations throughout the carrying out of site operations will go some way towards allaying people's concerns. Some of the more relevant factors that are likely to affect the acceptability of construction noise are:

- The attitude of local receptors to the Proposed Development;
- Site location relevant to noise sensitive receptors;
- Duration of Site operations;
- Hours of work, and
- The characteristics of the noise produced.

Recommendations are made regarding the supervision, planning, preparation and execution of works, emphasising the need to consider noise at every stage of the activity. Measures to control noise are described including control of noise at source by:

- Substitution of plant or activities by less noisy ones;
- Modification of plant or equipment by less noisy ones;
- Using noise control enclosures;
- Siting of equipment and its method of use;

[18] National Roads Authority, *Guidelines for Noise and Vibration in National Road Schemes, October 2004.*
[19] BS 5228-1: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites: *Code of Practice for Basic Information and Procedures for Noise Control*.

- Maintenance of equipment, and
- Controlling the spread of noise by increasing distance between plant and receptors, or by the provision of acoustic screening.

Example criteria for the assessment of the significance of noise effects are also given, although these are not mandatory.

Methods of calculating the levels of noise resulting from construction activities are provided, as are updated source levels for various plant, equipment and construction activities.

10.10.4 Construction and Decommissioning Noise Assessment Methodology

The NRA guidelines for construction noise which are considered acceptable are given in **Table 10.5**.

Table 10.5: Noise levels that are acceptable based on the NRA Guidelines

Day / Times	Guideline Limits
Monday to Friday 07:00 – 19:00hrs 19:00 – 22:00hrs	 70dB LAeq, (1h) and LAmax 80dB *60dB LAeq, (1h) and LAmax 65dB*
Saturday 08:00 – 16:30hrs	 65dB LAeq,1h and LAmax75dB
Sunday and Bank Holidays 08:00 – 16:00hrs	 *60dB LAeq,1h and LAmax 65dB*

*Construction at these times, other than required by an emergency works, will normally require explicit permission from the relevant local authority.

<u>Construction Times for Development</u>

Except for emergencies, delivery of concrete for foundations, or delivery of turbines, the normal construction times for the Proposed Development is:

Monday to Friday: 07.00 to 19.00hrs, Saturday 08.00 to 13.00hrs with no work on Sunday, or Bank Holidays

Construction noise from wind farm development, or Decommissioning is not considered an intensive activity. The main noise sources normally associated are with the excavation and construction of the Turbine Foundations, Hardstands and access roads. In the Proposed Development, the more significant works associated with the aforementioned tasks have already been completed. Other sources of noise include the construction onsite of a 20kV

Substation and Control Building (construction of the substation and building will generate no more noise than construction of a standard bungalow). Decommissioning will be in the same order as construction activity but less intensive.

Quantities of material for turbine bases and Turbine Hardstands have already been utilised from the Site excavation of Turbine and Hardstand Foundations. The Site access roads are already in place. The Turbine Hardstands, bases and access roads having been permitted by the CCC and ACP. The maximum noise levels will be generated along the local roads by delivery of concrete for the Turbine Foundations – this activity will be over a very short period of maximum of 3 days duration (one day for each turbine).

All workers associated with the Proposed Development will be subject to the Health and Safety Authority Guidance[20] which states that for noise exposure noise levels likely to exceed 80 dBA (expressed as Lep,d 8 hour dBA) there is the potential of risk of damage to hearing. All workers on site will be given guidance on how to comply with the 'First Action Level'.

10.10.5 Evaluation of Potential Effects

The potential effects of construction are evaluated by comparing the predicted noise levels against the guideline limits given in **Table 10.5**.

The potential operational effects are evaluated by comparing the predicted noise levels against the day and night-time noise limits given in **Section 10.11.4**. The predicted noise levels are carried out according to the IOA Good Practice Guide as detailed in **Section 10.6** and potential impacts are assessed at the nearest receptors against the noise limits.

10.10.5.1 Sensitivity

The sensitivity of the Project during construction is based on the guideline values in **Table 10.5**. The sensitivity of the Proposed Development during operation is based on the noise limits in **Section 10.11.4**.

10.10.5.2 Magnitude

The magnitude of potential effects of construction is based on the values in **Table 10.9.**

The magnitude of the potential effects of the Proposed Development during operation is based on the values in **Table 10.10.**

[20] Noise - Frequently Asked Questions - Health and Safety Authority (hsa.ie)

10.10.5.3 Significance Criteria

The significance of construction is based on the potential effects based on the predicted values and compliance with the guideline limits.

The significance of the potential effects of the wind farm have been assessed by taking into account the noise limits at receptors and the degree to which compliance has been met.

10.11 BASELINE DESCRIPTION

10.11.1 Identification of Potential Receptors

A number of predictions were prepared for the layout of the proposed 3 turbine wind farm. Based on the initial layout, potential noise-sensitive receptors (which included occupied and un-occupied properties) were identified from maps. Receptor locations were verified through aerial mapping, Eircode searches and specific site visits.

10.11.1.1 Baseline Noise Survey Locations

Three Baseline noise survey locations were selected on the basis of their location and with permission from receptors as shown in **Figure 10.2.**

10.11.2 Baseline Noise Survey

Baseline noise measurements were analysed for the period 1st to 29th April 2022 at locations given in **Table 10.6**. The Baseline survey monitoring locations were carried out at H2, H13 and H41 (photos of monitors in-situ in **Technical Appendix 10.1**).

Table 10.6: Baseline Noise Survey

Location	ITM Reference	Description of Location
H2	510767, 550866	Microphone 1.2-1.5 m height, approx. 52m SE from house, along road facing Site
H13	509928, 552697	Microphone 1.2-1.5 m height, located approx. 18m from semi-derelict house
H41	512243, 553798	Microphone 1.2-1.5 m height, located approx. 82m SE of house in field facing Site

The survey was carried out in accordance with ISO 1996, ETSU-R-97 and the IOA Good Practice Guide with the following implemented:

- Measurement of background noise levels at 10-minute intervals was undertaken using Type 1 instruments.

- Concurrent measurements of 10-minute interval mean wind speed / direction were recorded from the Lidar system.
- The background noise measurement recorded continuously included 10-minute intervals, as LA90, 10min along with a series of other parameters including LAeq,10min.
- Noise measurements were recorded at a height of 1.2-1.5 m above ground level and more than 5 m from any reflective surface other than the porous ground.
- An electronic rain gauge was installed at receptor H41 to monitor rainfall at 10-minute intervals over the duration of the noise survey. Rain data which impacted on noise levels were removed from the noise data set prior to analysis.
- The wind speed was taken from a Lidar located near the Site which recorded wind speed measurements at the 78.3m hub height.
- Wind speed was calculated to standardised 10 m height using the methodology given in the IOA Supplementary Guidance Note 4.
- The standardised wind speed in 10-minute intervals was plotted against the 10-minute interval background noise levels using a best-fit polynomial line.

Instrumentation Used

The following instrumentation was used in the Baseline survey measurements:

- Three Larson Davis Precision Integrating Sound Level Analyser/Data logger with 1/2" Condenser Microphones. All microphones were fitted with double skin windscreens based on that specified in W/31/00386/REP22'.
- Calibration Type: Larson Davis Precision Acoustic Calibrator
- Rain Gauge Type: TR-525 met tipping bucket rain gauge, 0.2mm pulse with LOGBOX datalogger.

All acoustic instrumentation was calibrated before and after each survey and the drift of calibration was less than 0.3dB which is within accepted guidelines. Calibration certificates of the acoustic instruments are included in **Appendix 10.3**.

10.11.3 Prevailing Background Noise Levels

Table 10.7 gives the background noise levels obtained for quiet daytime, night-time and background plus 5 at the Baseline measurement locations. The day and night-time background noise levels are greater than LA30dB at all locations above wind speeds of

[22] W/31/00386/REP 'Noise Measurements in Windy Conditions'.

5m/s. The background levels are influenced by the numerous rivers and streams and increase in wind speeds.

Table 10.7: Prevailing Background Noise Levels

Monitoring Location		Prevailing Background noise levels LA90dB, 10min Standardised Mean 10 m Height Wind Speed, (m/s)						
		4	5	6	7	8	9	10
H2	Day	27.0	28.2	30.0	32.2	34.8	37.5	40.3
	B/G+5	32	33.2	35.0	37.2	39.8	42.5	45.3
H2	Night	27.5	29.1	31.3	33.7	36.4	39.2	42.1
	B/G+5	32.5	34.1	36.3	38.7	41.6	44.2	47.2
H13	Day	27.4	28.4	30.0	32.0	34.3	36.7	39.0
	B/G+5	32.4	33.4	35.0	37.0	39.3	41.7	44.0
H13	Night	27.6	29.2	31.2	33.5	35.9	38.1	39.8
	B/G+5	32.6	34.2	36.2	38.5	40.5	43.1	44.8
H41	Day	36.6	37.3	38.5	40.2	42.1	44.4	46.8
	B/G+5	41.6	42.3	43.5	45.2	47.1	49.4	51.8
H41	Night	37.0	38.4	40.3	42.4	44.3	45.8	46.7
	B/G+5	42.0	43.4	45.3	47.4	49.3	50.8	51.7

Location H2

The main noise sources were from local streams, very low road traffic and local domestic activity.

Location H13

The rainfall logger was located at this location. The main noise sources were farm animals mainly sheep and road traffic. Streams coming down the mountain side contributes to the background noise level.

Location H41

The main noise sources were from rivers/stream coming down the mountain side, local farming activity and low-level road traffic.

10.11.4 Noise Assessment Locations

The nearest receptors to the Project were selected for assessment and represent the properties most likely to be affected by potential effects. Measured noise levels are representative of the background noise environments surrounding the Proposed Development.

Should the predicted operational noise levels from the Proposed Development comply with the requirements of the WEDG06 at the closest receptors, it may be assumed that the predicted noise levels at receptors further away from the Project will also comply, due to the attenuation of turbine noise levels with distance.

10.11.5 Noise Limits

Noise limits have already been given for this site for a 7-turbine wind farm by Cork County Council and on appeal by ACP. Noise limits set out by ACP Ref. No.PL 88.239767 in Condition 6 was:

(a) Noise levels emanating from the Proposed Development following commissioning, when measured externally at a noise sensitive location shall not exceed the greater of 43dB(A) L90, or 5dB(A) above background levels.

(b) All noise measurements shall be made in accordance with ISO Recommendation R1996/1 and 2 Acoustics – Description and measurement of Environmental noise.

(c) Prior to commencement of development, the Developer shall agree a noise compliance monitoring programme for the operational wind farm with the planning authority, which shall include additional; monitoring of Baseline noise conditions.

Recent An Coimisiún Pleanala Decision (16th October 2023, Number AC9P-314120-22), Planning Ref. No. 21595 gave a similar limit to the above but added a lower limit of 40 dB(A) L90,10min at wind speeds below 5m/s when measured at a height of 10m. This additional limit has been applied in this assessment.

10.11.6 Development Design Mitigation

The preferred turbine model, the E82 E4, will be fitted with TES as is best practice. A serrated extension of the trailing edge to the rotor blades mitigates noise emission by effectively breaking up the turbulence on the tooth flanks into smaller eddies. The intensity of the pressure fluctuations is reduced which mitigates the noise emissions. Since the intensity of the noise emissions is largely dependent on the flow speed, TES is only installed on the outer rotor blade area where the rotary speed is highest. Typically, TES will reduce the noise levels up to 2-3dBA.without reduction of energy output.

10.12 ASSESSMENT OF POTENTIAL EFFECTS

10.12.1 Construction and Decommissioning Noise Levels

As has been previously stated, the construction process associated with wind farms is not considered intensive and is temporary works most of which is carried out a considerable distance from receptors. The main noise sources will be associated with the construction of the Turbine Foundations, Turbine Hardstands with minor sources being site access roads which are already in place, construction of a 20kV substation, compound and the widening of a road along the Turbine Delivery Route. The maximum noise levels from construction traffic to Site will be due to a very short period when ready-mix trucks deliver concrete for the turbine bases. The delivery of turbines by large trucks travelling at very low speed will generate very low levels of noise along the route.

Table 10.8 indicates typical construction range of noise levels for these types of activity (levels from author's database and BS 5228). Predictions are made for receptors nearest Turbine bases / Hardstands activity and concrete delivery to the Site. The construction of the substation (at 480m from nearest receptor) is considerably less intensive and will generate lower noise levels than that generated by the construction of a small bungalow.

Table 10.8: Typical Noise Levels from Construction Works

Activity	L_{Aeq} at 10m
Foundation Works: trucks pouring concrete, tracked excavator operating	70-84dBA
Rock Breaker, vibrating rollers, trucks loading and tipping material extending the already near complete hardstands	76-89dBA
Material spreading (tipping, excavator, dumper)	70-83dBA
Construction of Compound: Loading / tipping, excavator and Vibratory roller	80- 87dBA
Road widening for turbine delivery: excavator, dump truck, lorry tipping, roller	80-84dBA
Grid Connection: Trenching, Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	71-74dBA

The difference in noise levels between two locations can be calculated as:

$$\mathbf{L}_{p2} - \mathbf{L}_{p1} = 10 \log (R_2 / R_1)^2 - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$
$$= 20 \log (R_2 / R_1) - (A_{atm} + A_{gr} + A_{br} + A_{mis})$$

where:

L_{p1} = sound pressure level at location 1

L_{p2} = sound pressure level at location 2

R_1 = distance from source to location 1

R_2 = distance from source to location 2

and where:

A_{atm} = Attenuation due to air absorption

A_{gr} = Attenuation due to ground absorption

A_{br} = Attenuation provided by a barrier

A_{mis} = Attenuation provided by miscellaneous other effects

In the calculation attenuation by A_{atm}, A_{gr} and A_{mis} is assumed as Zero at distances of less than 200m and at greater distances attenuation of 3dBA is used.

Table 10.9 gives the noise levels predicted from construction activity at the nearest receptors. The maximum construction noise levels are at receptors listed in **Table 10.9.** and assumes that all plant is working together 100% of time, something that will not occur in practice. At receptor locations further away, noise levels will be less than that predicted.

Table 10.9: Predicted Construction Noise Levels

Nearest Receptor	Activity	Distance to Activity (m)	LAeq dB 1hr range
H2	Foundation works; trucks pouring concrete, tracked excavator operating	983	27-41
H2	Rock breaking, vibratory roller, trucks loading/tipping	983	33-46
H2	Construction of compound (Loading / tipping, excavator and Vibratory roller.	420	45-52
Road widening with receptors at varying distances	Turbine delivery; Excavator dump truck, lorry tipping, vibratory roller	20 40 80 160	70-75 64-69 58-63 52-57
Grid Connection at varying distances	Trenching, Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	15 20 40 80	67.5-70.5 65-68 59-62 53-56

The predicted construction noise levels in **Table 10.9** are within the guideline values given in **Table 10.5** at the nearest receptors and accordingly at all other receptors further away.

Construction Traffic

The delivery of turbines to the Site will generate low level traffic noise as the vehicles carrying the turbines will move slowly along the local roads where impact is expected to be greatest. The main (maximum) construction noise generated by traffic to the Site will be due to ready-mix trucks delivering concrete pour for foundation of the 3 turbines. The concrete pour for each individual turbine will be required to be completed in a short a period as possible (usually within 10 hours). During this 10-hour period, other trucking to the Site will be curtailed on the local road delivery routes as best practice. For three turbines the concrete pour will be of duration of three days (one day for each Turbine Foundation).

Each turbine will require a pour of 528 m^3 of concrete while each ready-mix truck has a capacity of 6 m^3 which equates to 88 deliveries /day. For delivery of concrete, the timeframe envisaged for each concrete pour is taken as 10 hrs /day. This equates to an average of 20 movements (to and from) per hour on local roads over a 3-day period.

The general expression for predicting the 1 hr LAeq alongside a haul road used by single engine items of mobile plant is:

$$L_{Aeq} = L_{WA} - 33 + 10\log_{10}Q - 10\log_{10}V - 10\log_{10}d \text{ where:}$$

L_{WA} is the sound power level of the truck, in decibels (dB) 105;
Q is 20, the number of vehicles movements per hour;
V is 50, the average vehicle speed, in kilometres per hour (km/h);
d is the distance of receiving position at 20 m from the centre of haul road, in metres (m).

$$LAeq = 105-33 + 10\log 20 - 10\log 50 - 10\log 20 = 55.0 \text{ LAeq 1hr.}$$

At 10 m from the roadside the noise levels from truck equate to 58.0 LAeq 1hr. The trucking for the concrete pour will extend for a total of 3 days (1 day for each turbine). In practice the levels generated by truck movement should be lower than predicted due to the smooth surface on the local roads. The maximum noise levels from temporary construction traffic are well within the guidelines given in **Table 10.5.**

The predicted construction noise levels are within the NRA guidelines for daytime for all development works and are therefore considered not significant**.**

10.12.2 Assessment of Construction and Decommissioning Noise

The maximum predicted site construction noise levels are at H2. The predicted noise levels due to road widening will exist for no more than one week equivalent (12 hours x 5 days) at any receptor. The maximum predicted noise levels from traffic delivering concrete for turbine bases will be well within construction guidelines limits. The higher noise levels will be generated by the Grid Connection, however the maximum noise levels from this activity will persist for no more than 4 hours at any receptor as this activity moves along at a rate of approximately 80 to 150m per day.

The predicted noise levels are well within the NRA guidelines given as acceptable and therefore these temporary works are considered not significant**.**

Ground vibration from rock breaking will be below the threshold of sensitivity to humans of 0.2 mm/s peak particle velocity at all receptors[23] due to distances to nearest receptors.

The effects of noise and vibration from onsite construction activities are therefore considered not significant. The effects for Decommissioning will be no greater than that experienced during construction, but of shorter duration as significant elements of the Proposed Development will be left in place such as access roads, Turbine Foundations and the substation building.

10.12.3 Description of Effects

The criteria for description of effects for all construction noise activity and the potential worst-case effects, at the nearest receptors is given below.

	Quality	Significance	Duration
Construction noise	Negative	Not significant	Temporary

10.12.4 Decommissioning

Noise effects during Decommissioning of the Project are likely to be of a similar nature to that during construction. It is likely that the duration of Decommissioning will be shorter than that during construction. Decommissioning will involve the removal of the 3 wind

[23] Wiss, J. F., and Parmelee, R. A. (1974) Human Perception of Transient Vibrations, "*Journal of Structural Division*", ASCE, Vol 100, No. S74, PP. 773-787

turbines. Turbine bases (excluding plinths) will be left in place and revegetated. It is proposed to leave roadways and drainage in place. All other elements of the Proposed Development including the on-site substation and site ducting will remain in-situ. The Site Access Roads and associated drainage systems will serve ongoing forestry and agriculture activity in the area. All other hard surfaced areas will be allowed to revegetate naturally.

Any legislation, guidance or best practice relevant at the time of Decommissioning will be complied with.

10.12.5 Predicted Operational Noise Levels

Table 10.10 gives the predicted noise levels at all locations within 2 km of the Proposed Development at varying wind speeds for each receptor location. A noise contour map of the 3 turbine Development at maximum sound power output at a wind speed of 8 ms^{-1} at 10 m height is presented in **Figure 10.2.** The noise contour map in **Figure 10.2** assumes that all turbines are simultaneously downwind at the same time to each location which results is an overprediction of the noise levels.

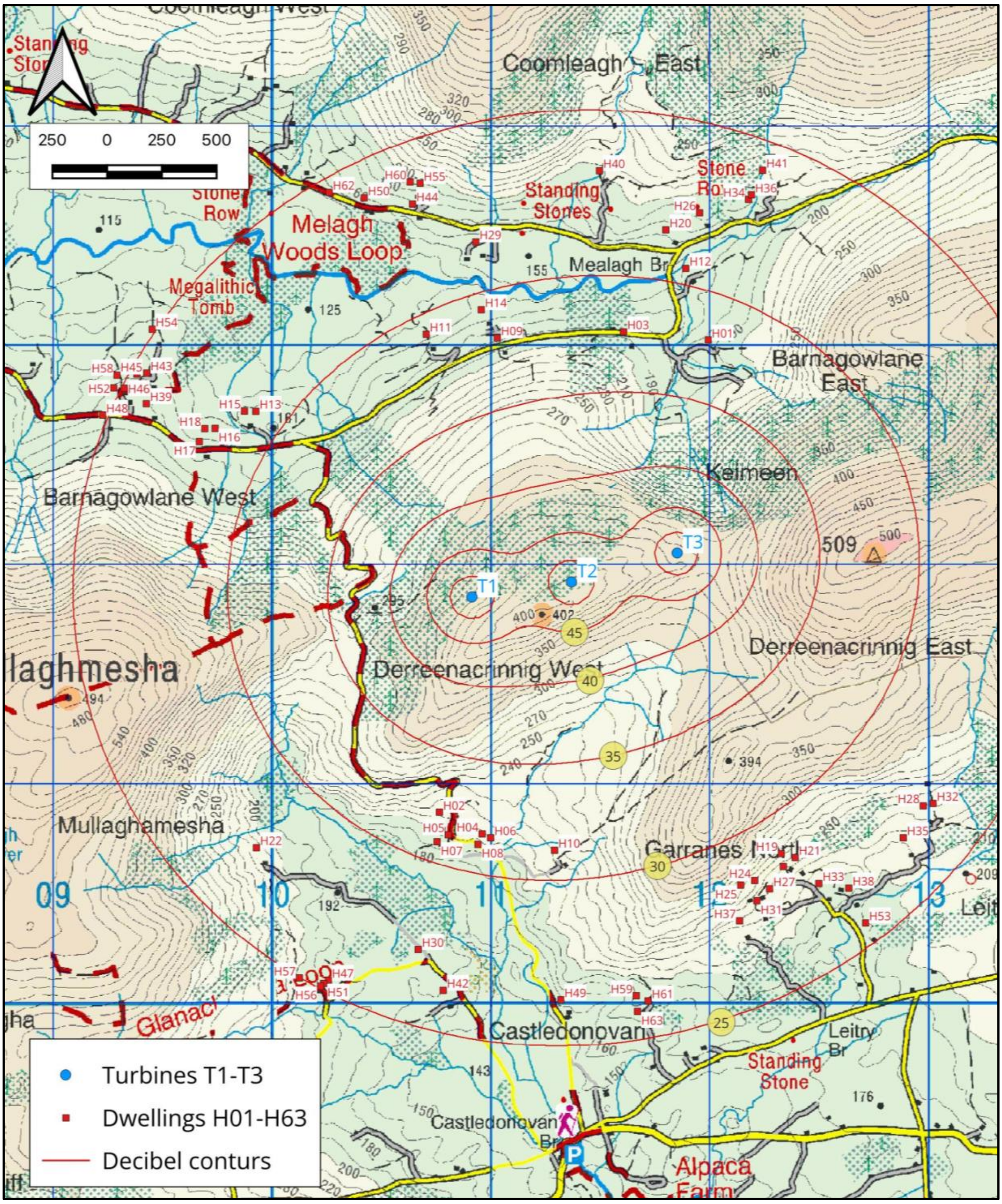


Figure 10.2: Noise contour map at maximum sound power level at 8m/s at 10m height

Table 10.10: Predicted Noise Levels at Varying Wind Speeds for Hub Height of 78.3m Standardised 10 m Height Wind Speed

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H1	511995	553023	20.5	25.7	29.6	31.7	31.9	31.9	31.9
H2	510767	550866	20.6	25.8	29.7	31.8	32.0	32.0	32.0

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H3	511608	553060	20.8	26.0	29.9	32.0	32.2	32.2	32.2
H4	510962	550767	20.1	25.3	29.2	31.3	31.5	31.5	31.5
H5	510807	550763	19.8	25.0	28.9	31.0	31.2	31.2	31.2
H6	511001	550749	20.0	25.2	29.1	31.2	31.4	31.4	31.4
H7	510756	550731	19.4	24.6	28.5	30.6	30.8	30.8	30.8
H8	510943	550719	19.7	24.9	28.8	30.9	31.1	31.1	31.1
H9	511031	553032	20.4	25.6	29.5	31.6	31.8	31.8	31.8
H10	511293	550692	19.7	24.9	28.8	30.9	31.1	31.1	31.1
H11	510707	553049	19.4	24.6	28.5	30.6	30.8	30.8	30.8
H12	511892	553350	18.0	23.2	27.1	29.2	29.4	29.4	29.4
H13	509928	552697	17.5	22.7	26.6	28.7	28.9	28.9	28.9
H14	510958	553161	19.2	24.4	28.3	30.4	30.6	30.6	30.6
H15	509876	552698	17.1	22.3	26.2	28.3	28.5	28.5	28.5
H16	509742	552619	16.6	21.8	25.7	27.8	28.0	28.0	28.0
H17	509670	552559	16.3	21.5	25.4	27.5	27.7	27.7	27.7
H18	509695	552618	16.3	21.5	25.4	27.5	27.7	27.7	27.7
H19	512328	550677	17.3	22.5	26.4	28.5	28.7	28.7	28.7
H20	511801	553526	16.9	22.1	26.0	28.1	28.3	28.3	28.3
H21	512392	550659	16.9	22.1	26.0	28.1	28.3	28.3	28.3
H22	509931	550704	15.8	21.0	24.9	27.0	27.2	27.2	27.2
H23	512338	550618	16.9	22.1	26.0	28.1	28.3	28.3	28.3
H24	512207	550554	16.9	22.1	26.0	28.1	28.3	28.3	28.3
H25	512143	550533	17.0	22.2	26.1	28.2	28.4	28.4	28.4
H26	511955	553604	16.1	21.3	25.2	27.3	27.5	27.5	27.5
H27	512275	550516	16.5	21.7	25.6	27.7	27.9	27.9	27.9
H28	512977	550895	15.4	20.6	24.5	26.6	26.8	26.8	26.8
H29	510933	553471	16.9	22.1	26.0	28.1	28.3	28.3	28.3
H30	510670	550239	15.7	20.9	24.8	26.9	27.1	27.1	27.1
H31	512217	550462	16.3	21.5	25.4	27.5	27.7	27.7	27.7
H32	513022	550906	15.2	20.4	24.3	26.4	26.6	26.6	26.6
H33	512500	550540	15.8	21.0	24.9	27.0	27.2	27.2	27.2
H34	512179	553665	15.3	20.5	24.4	26.5	26.7	26.7	26.7
H35	512886	550749	15.2	20.4	24.3	26.4	26.6	26.6	26.6
H36	512193	553686	15.2	20.4	24.3	26.4	26.6	26.6	26.6

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H37	512138	550370	16.0	21.2	25.1	27.2	27.4	27.4	27.4
H38	512637	550519	15.2	20.4	24.3	26.4	26.6	26.6	26.6
H39	509428	552732	14.4	19.6	23.5	25.6	25.8	25.8	25.8
H40	511498	553796	15.3	20.5	24.4	26.5	26.7	26.7	26.7
H41	512243	553798	14.4	19.6	23.5	25.6	25.8	25.8	25.8
H42	510784	550052	14.7	19.9	23.8	25.9	26.1	26.1	26.1
H43	509430	552872	14.0	19.2	23.1	25.2	25.4	25.4	25.4
H44	510644	553644	15.2	20.4	24.3	26.4	26.6	26.6	26.6
H45	509385	552867	13.8	19.0	22.9	25.0	25.2	25.2	25.2
H46	509327	552803	13.7	18.9	22.8	24.9	25.1	25.1	25.1
H47	510260	550098	13.9	19.1	23.0	25.1	25.3	25.3	25.3
H48	509229	552680	13.5	18.7	22.6	24.7	24.9	24.9	24.9
H49	511322	550009	14.8	20.0	23.9	26.0	26.2	26.2	26.2
H50	510423	553672	14.5	19.7	23.6	25.7	25.9	25.9	25.9
H51	510238	550084	13.8	19.0	22.9	25.0	25.2	25.2	25.2
H52	509279	552804	13.4	18.6	22.5	24.6	24.8	24.8	24.8
H53	512714	550360	14.1	19.3	23.2	25.3	25.5	25.5	25.5
H54	509455	553072	13.5	18.7	22.6	24.7	24.9	24.9	24.9
H55	510679	553739	14.8	20.0	23.9	26.0	26.2	26.2	26.2
H56	510224	550071	13.6	18.8	22.7	24.8	25.0	25.0	25.0
H57	510127	550071	13.4	18.6	22.5	24.6	24.8	24.8	24.8
H58	509294	552862	13.3	18.5	22.4	24.5	24.7	24.7	24.7
H59	511666	550028	14.7	19.9	23.8	25.9	26.1	26.1	26.1
H60	510633	553745	14.6	19.8	23.7	25.8	26.0	26.0	26.0
H61	511720	550004	14.6	19.8	23.7	25.8	26.0	26.0	26.0
H62	510263	553697	14.0	19.2	23.1	25.2	25.4	25.4	25.4
H63	511672	549956	14.3	19.5	23.4	25.5	25.7	25.7	25.7

10.12.6 Operational Noise Assessment

An assessment was made of the predicted operational noise levels from the Proposed Development against noise limits in the Wind Energy Development Guidelines 2006, noise limits which were on the existing site and recent October 2023 ACP decision. All predicted noise levels are well within limits. **Table 10.11** gives the difference (margin) between the predicted noise level in **Table 10.10** and noise limits for each receptor. A negative margin indicates that the predicted noise levels are well within the lower 40 dBA at wind speeds below 5 m/s and well within 43 dBA all other wind speeds.

As can be seen from **Table 10.11** the predicted noise levels at all receptors are lower than the noise limits in all cases, at all wind speeds, and are therefore compliant and are not significant in terms of EIAR Regulations. The predicted noise levels assume that all 3 turbines are directly down-wind and the potential for negative impacts is negligible.

Table 10.11: Margin between predicted noise levels, LA 90, 40dB limit for wind speeds less than 5 m/s and LA90, 43dB at all other wind speeds

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H1	511995	553023	-19.5	-17.3	-13.4	-11.3	-11.1	-11.1	-11.1
H2	510767	550866	-19.4	-17.2	-13.3	-11.2	-11.0	-11.0	-11.0
H3	511608	553060	-19.2	-17.0	-13.1	-11.0	-10.8	-10.8	-10.8
H4	510962	550767	-19.9	-17.7	-13.8	-11.7	-11.5	-11.5	-11.5
H5	510807	550763	-20.2	-18.0	-14.1	-12.0	-11.8	-11.8	-11.8
H6	511001	550749	-20.0	-17.8	-13.9	-11.8	-11.6	-11.6	-11.6
H7	510756	550731	-20.6	-18.4	-14.5	-12.4	-12.2	-12.2	-12.2
H8	510943	550719	-20.3	-18.1	-14.2	-12.1	-11.9	-11.9	-11.9
H9	511031	553032	-19.6	-17.4	-13.5	-11.4	-11.2	-11.2	-11.2
H10	511293	550692	-20.3	-18.1	-14.2	-12.1	-11.9	-11.9	-11.9
H11	510707	553049	-20.7	-18.5	-14.6	-12.5	-12.3	-12.3	-12.3
H12	511892	553350	-22.0	-19.8	-15.9	-13.8	-13.6	-13.6	-13.6
H13	509928	552697	-22.5	-20.3	-16.4	-14.3	-14.1	-14.1	-14.1
H14	510958	553161	-20.8	-18.6	-14.7	-12.6	-12.4	-12.4	-12.4
H15	509876	552698	-22.9	-20.7	-16.8	-14.7	-14.5	-14.5	-14.5
H16	509742	552619	-23.4	-21.2	-17.3	-15.2	-15.0	-15.0	-15.0
H17	509670	552559	-23.7	-21.5	-17.6	-15.5	-15.3	-15.3	-15.3
H18	509695	552618	-23.7	-21.5	-17.6	-15.5	-15.3	-15.3	-15.3
H19	512328	550677	-22.7	-20.5	-16.6	-14.5	-14.3	-14.3	-14.3
H20	511801	553526	-23.1	-20.9	-17.0	-14.9	-14.7	-14.7	-14.7
H21	512392	550659	-23.1	-20.9	-17.0	-14.9	-14.7	-14.7	-14.7
H22	509931	550704	-24.2	-22.0	-18.1	-16.0	-15.8	-15.8	-15.8
H23	512338	550618	-23.1	-20.9	-17.0	-14.9	-14.7	-14.7	-14.7
H24	512207	550554	-23.1	-20.9	-17.0	-14.9	-14.7	-14.7	-14.7

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H25	512143	550533	-23.0	-20.8	-16.9	-14.8	-14.6	-14.6	-14.6
H26	511955	553604	-23.9	-21.7	-17.8	-15.7	-15.5	-15.5	-15.5
H27	512275	550516	-23.5	-21.3	-17.4	-15.3	-15.1	-15.1	-15.1
H28	512977	550895	-24.6	-22.4	-18.5	-16.4	-16.2	-16.2	-16.2
H29	510933	553471	-23.1	-20.9	-17.0	-14.9	-14.7	-14.7	-14.7
H30	510670	550239	-24.4	-22.2	-18.3	-16.2	-16.0	-16.0	-16.0
H31	512217	550462	-23.7	-21.5	-17.6	-15.5	-15.3	-15.3	-15.3
H32	513022	550906	-24.8	-22.6	-18.7	-16.6	-16.4	-16.4	-16.4
H33	512500	550540	-24.2	-22.0	-18.1	-16.0	-15.8	-15.8	-15.8
H34	512179	553665	-24.7	-22.5	-18.6	-16.5	-16.3	-16.3	-16.3
H35	512886	550749	-24.8	-22.6	-18.7	-16.6	-16.4	-16.4	-16.4
H36	512193	553686	-24.9	-22.7	-18.8	-16.7	-16.5	-16.5	-16.5
H37	512138	550370	-24.0	-21.8	-17.9	-15.8	-15.6	-15.6	-15.6
H38	512637	550519	-24.8	-22.6	-18.7	-16.6	-16.4	-16.4	-16.4
H39	509428	552732	-25.6	-23.4	-19.5	-17.4	-17.2	-17.2	-17.2
H40	511498	553796	-24.8	-22.6	-18.7	-16.6	-16.4	-16.4	-16.4
H41	512243	553798	-25.6	-23.4	-19.5	-17.4	-17.2	-17.2	-17.2
H42	510784	550052	-25.3	-23.1	-19.2	-17.1	-16.9	-16.9	-16.9
H43	509430	552872	-26.0	-23.8	-19.9	-17.8	-17.6	-17.6	-17.6
H44	510644	553644	-24.8	-22.6	-18.7	-16.6	-16.4	-16.4	-16.4
H45	509385	552867	-26.2	-24.0	-20.1	-18.0	-17.8	-17.8	-17.8
H46	509327	552803	-26.3	-24.1	-20.2	-18.1	-17.9	-17.9	-17.9
H47	510260	550098	-26.1	-23.9	-20.0	-17.9	-17.7	-17.7	-17.7
H48	509229	552680	-26.6	-24.4	-20.5	-18.4	-18.2	-18.2	-18.2
H49	511322	550009	-25.2	-23.0	-19.1	-17.0	-16.8	-16.8	-16.8
H50	510423	553672	-25.5	-23.3	-19.4	-17.3	-17.1	-17.1	-17.1
H51	510238	550084	-26.3	-24.1	-20.2	-18.1	-17.9	-17.9	-17.9
H52	509279	552804	-26.6	-24.4	-20.5	-18.4	-18.2	-18.2	-18.2
H53	512714	550360	-25.9	-23.7	-19.8	-17.7	-17.5	-17.5	-17.5
H54	509455	553072	-26.5	-24.3	-20.4	-18.3	-18.1	-18.1	-18.1
H55	510679	553739	-25.2	-23.0	-19.1	-17.0	-16.8	-16.8	-16.8
H56	510224	550071	-26.4	-24.2	-20.3	-18.2	-18.0	-18.0	-18.0
H57	510127	550071	-26.6	-24.4	-20.5	-18.4	-18.2	-18.2	-18.2
H58	509294	552862	-26.7	-24.5	-20.6	-18.5	-18.3	-18.3	-18.3

House ID	ITM Easting	ITM Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s+ dBA
H59	511666	550028	-25.3	-23.1	-19.2	-17.1	-16.9	-16.9	-16.9
H60	510633	553745	-25.4	-23.2	-19.3	-17.2	-17.0	-17.0	-17.0
H61	511720	550004	-25.5	-23.3	-19.4	-17.3	-17.1	-17.1	-17.1
H62	510263	553697	-26.0	-23.8	-19.9	-17.8	-17.6	-17.6	-17.6
H63	511672	549956	-25.7	-23.5	-19.6	-17.5	-17.3	-17.3	-17.3

Charts10.1 to **10.6** shows the background noise level, background + 5dBA levels plotted against the predicted noise levels (in red).

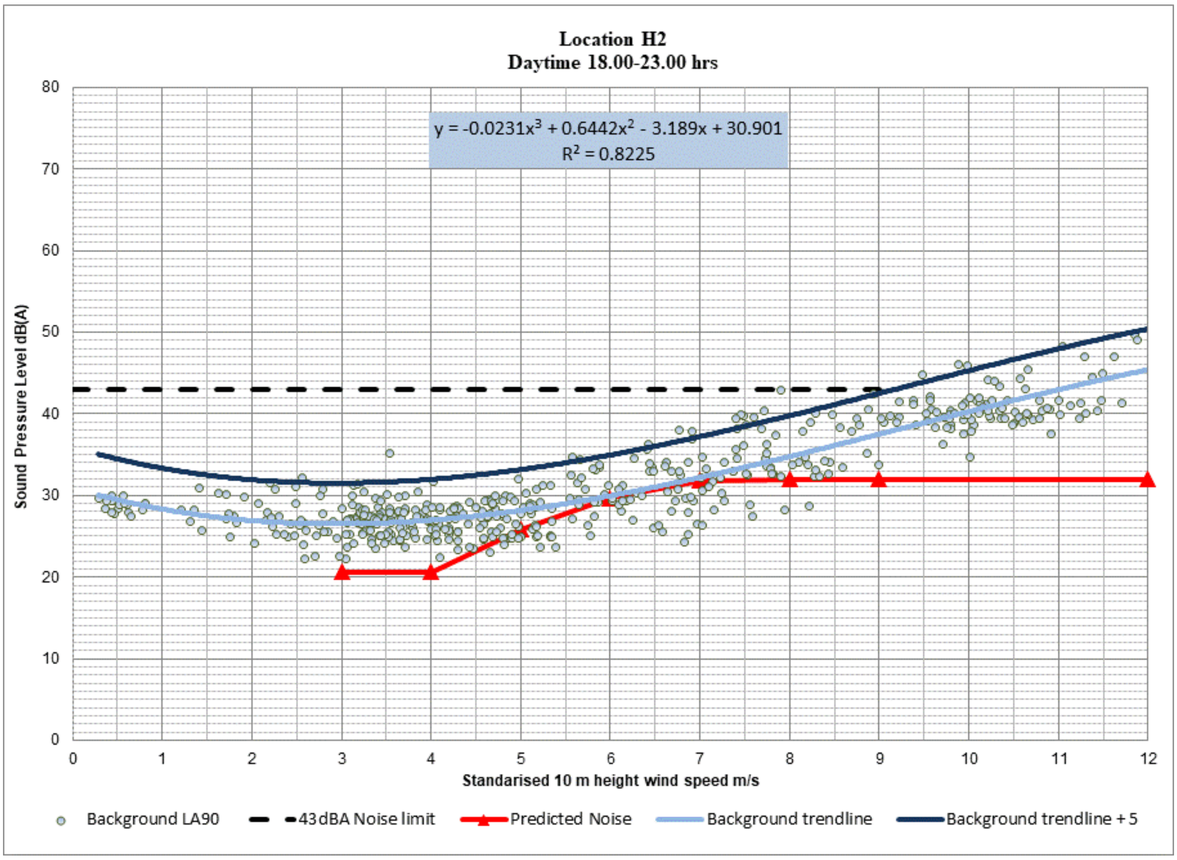


Chart 10.1: Quiet Daytime derived background for House H2

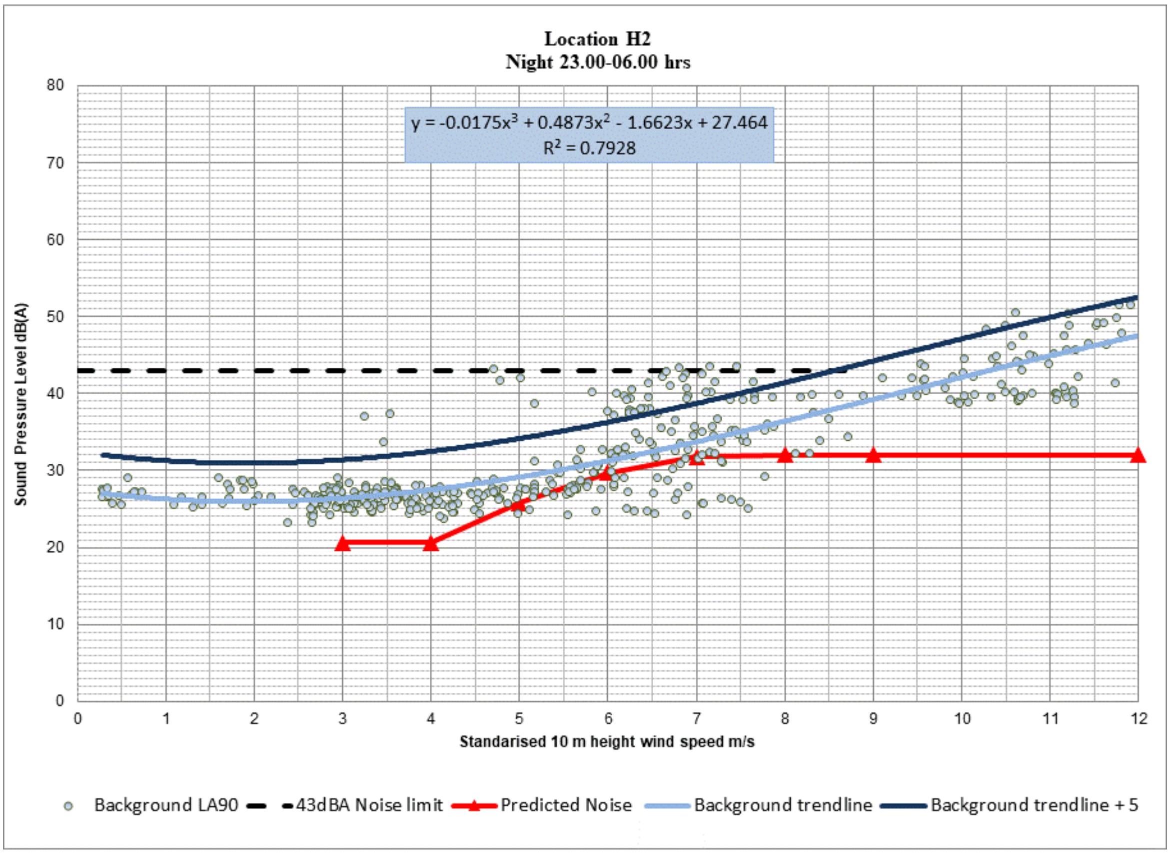


Chart 10.2: Night-time derived background for House H2

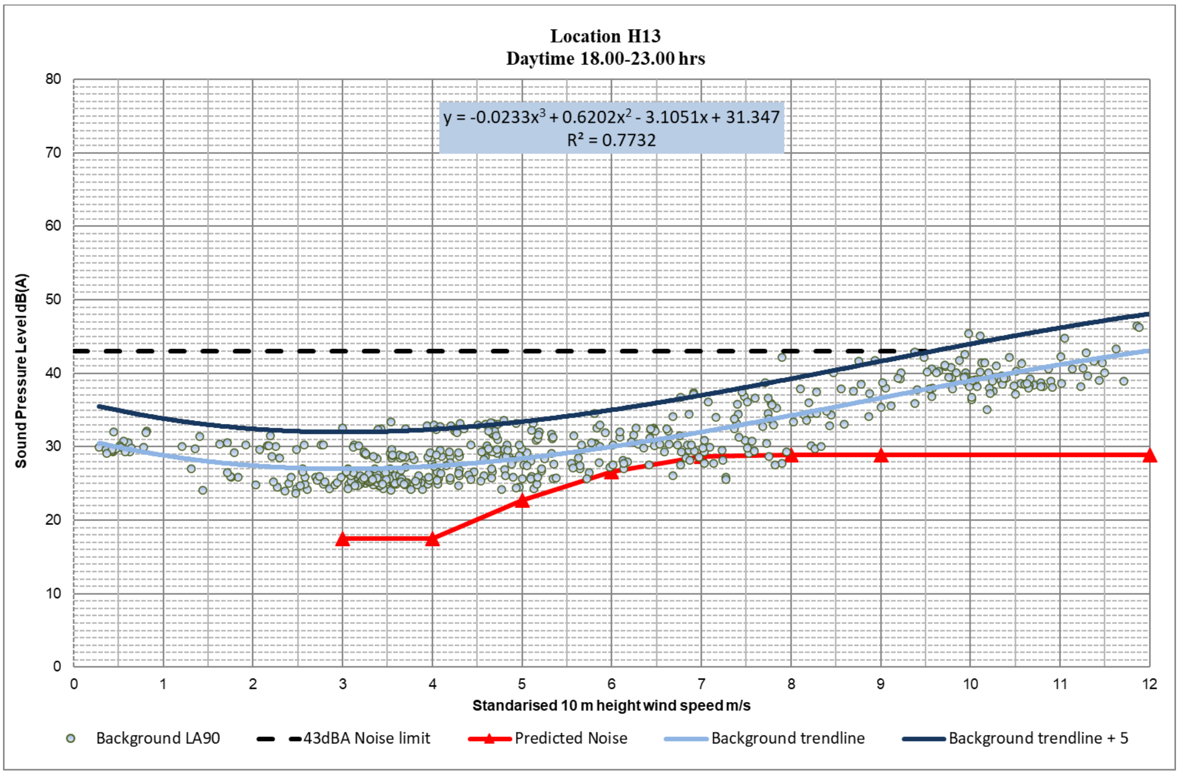


Chart 10.3: Quiet Daytime derived background for House H13

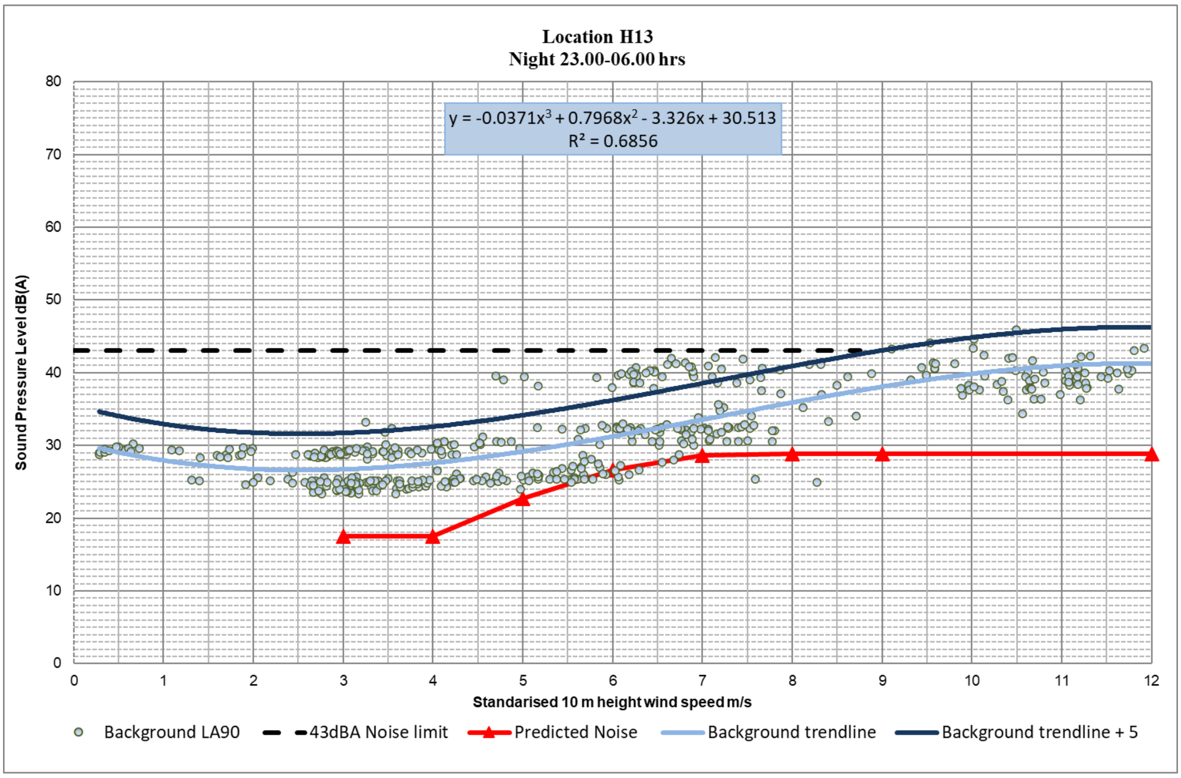


Chart 10.4: Night-time derived background for House H13

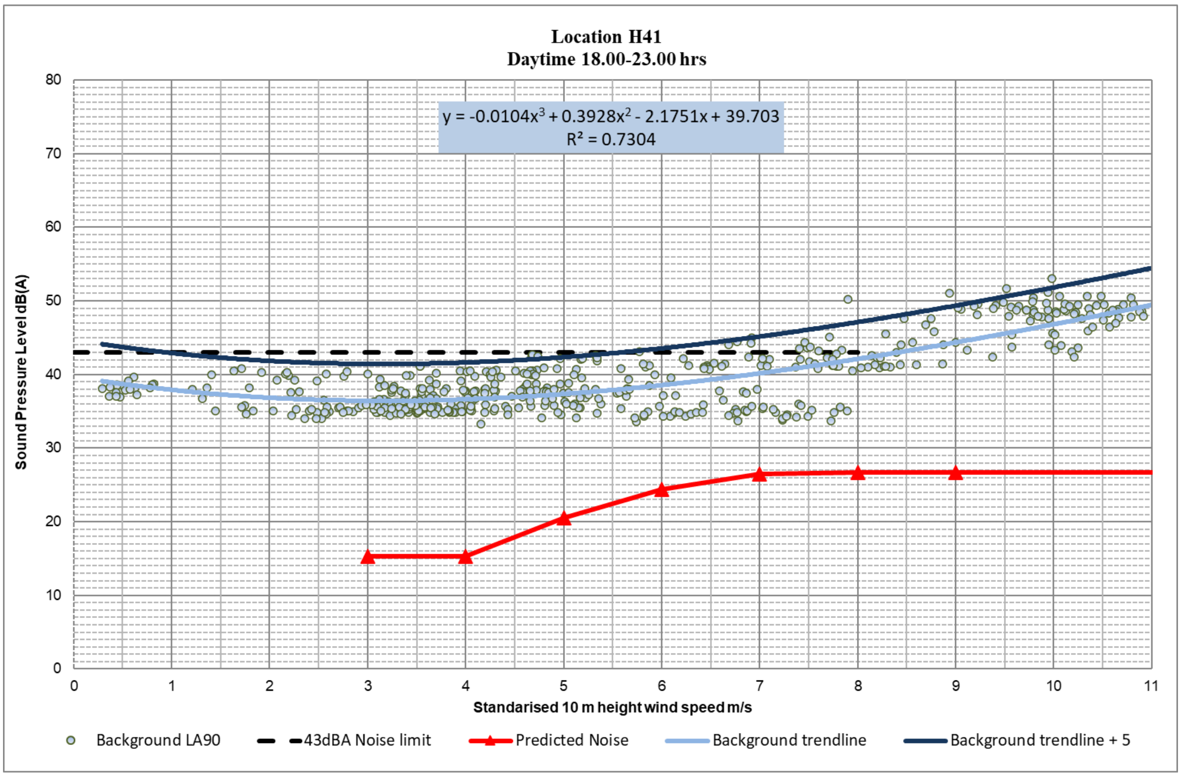


Chart 10.5: Quiet Daytime derived background for House H41

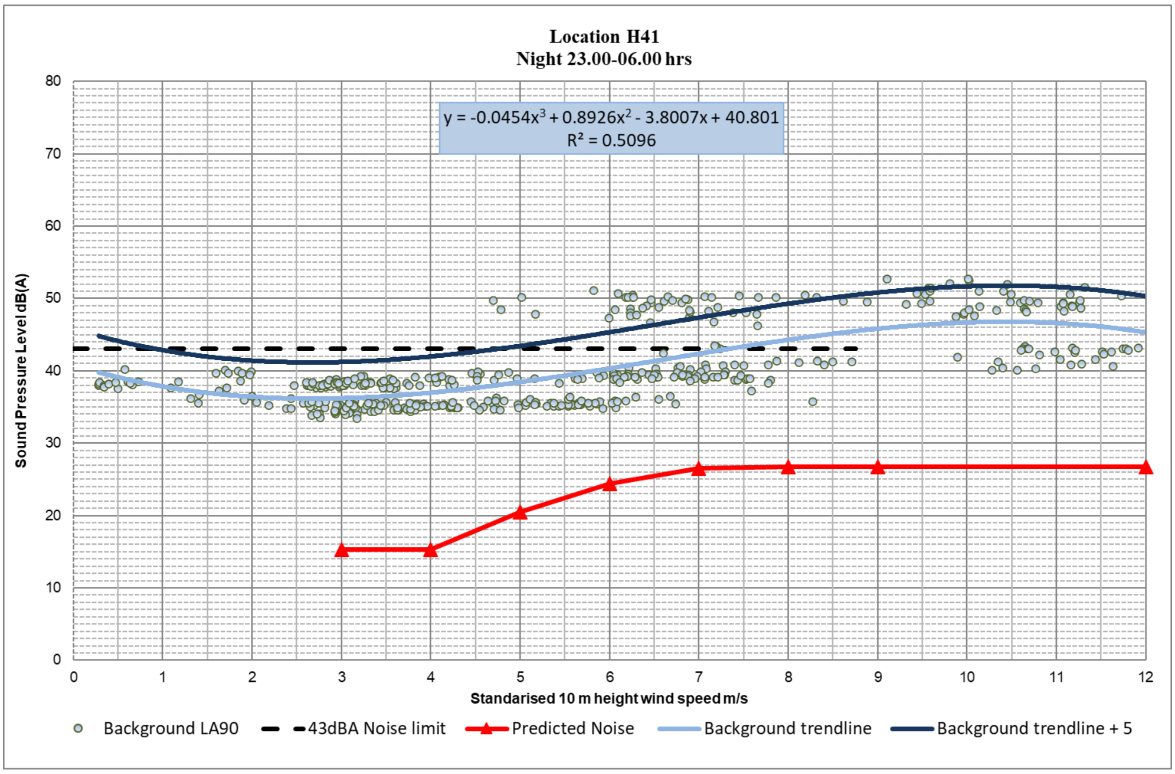


Chart 10.6: Night-time derived background for House H41

10.13 MITIGATION MEASURES AND RESIDUAL EFFECTS

10.13.1 Construction Noise Mitigation

No significant construction noise effects have been identified. Therefore, no specific mitigation measures are required. General guidance for controlling construction noise through the use of good practice given in BS 5228 will be followed. During construction of the Proposed Development, operations shall be limited to working times specified, except where delivery of large transport loads such as turbines where it may be necessary to transport outside of daytime hours.

During Decommissioning, noise levels are likely to be no more than predicted in **Table 10.9** as similar plant will be utilised. Any legislation, guidance or best practice relevant at the time of Decommissioning will be complied with. All construction and Decommissioning is a temporary day time activity.

10.13.2 Residual Construction and Decommissioning Effects

The residual effects are the same as the construction and Decommissioning effects identified in this assessment.

10.13.3 Operational Noise Mitigation

The Proposed Development has been designed to comply with best practice, the Wind Energy Development Guidelines 2006, recent October 2023 ACP noise limits and the existing noise limits granted for the Site by ACP for the previous 7 turbines.

All 3 turbines will have as standard TES fitted as best practice to reduce noise levels, so no additional mitigation is required.

A warranty will be provided from the manufacturer of the turbine selected for the Proposed Development in order to ensure that the turbine selected does not require a tonal noise correction. Low frequency noise emissions from the turbines will be below the level of audibility with the more significant low frequency being generated by rivers /streams flowing down the mountain side and local wind effects.

10.13.4 Residual Operational Effects

The residual effects are the same as the operational effects identified in this assessment.

10.13.5 Cumulative Effects

There are no other operating or permitted wind farms within 3km of the Proposed Development so there will be no cumulative impacts.

10.14 SUMMARY OF SIGNIFICANT EFFECTS

Table 10.12 below summarises the effects.

Table 10.12: Summary of Effects

	Quality	Significance	Duration
Construction noise	Negative	Not significant	Short Term
Operational Noise	Negative	Not Significant	Long Term

10.15 STATEMENT OF SIGNIFICANCE

This Section has assessed the significance of the potential effects of the Proposed Development during operation, construction and Decommissioning.

The effects of noise from the operation of the Proposed Development have been assessed using the methodology in the 2006 Guidelines, the methodology described in ETSU-R-97 and the IOA Good Practice Guide. Noise levels during operation of the wind farm have been predicted using the best practice calculation technique and compared with the noise limits in previous consent for the Site, the 2006 Guidelines and recent An Coimisiún Pleanála decision.

The predicted noise levels are also within the draft 2019 Wind Energy Development Guidelines which are subject to review.

The predicted noise levels noise levels are orders of magnitude below the noise limits imposed previously for the Site and well within the lower noise limits proposed in the draft 2019 Guidelines which are up for review. Furthermore, the levels predicted assume that all turbines are downwind at the same time to all receptors a scenario which will not occur. The maximum predicted noise levels are below the existing background noise levels at all locations.

The noise levels predicted at the nearest receptors are orders of magnitude below the level at which risk of hearing damage, or indeed negative health effects are possible.

Noise during construction of the Proposed Development and Decommissioning will be managed to comply with best practice, legislation and guidelines current at that time so that effects are not significant.