10 NOISE

10.1 INTRODUCTION

This chapter of the EIAR assesses the effects of the Development from noise impacts. The Development refers to all elements of the application for the proposed Wind Farm (**Chapter 2: Development Description**). The assessment considers the potential effects during the following phases of the Development:

- Construction of the Development
- Operation of the Development
- Decommissioning of the Development

The Development refers to all elements of the application for the construction and operation of the wind farm including the grid connection, road traffic to Site, and the 110kV Substation (**Chapter 2: Development Description**).

This chapter of the EIAR is supported by the Figures in **Volume III** and following Technical Appendices documents provided in **Volume IV** of this EIAR:

- **Appendix 10.1:** Photos of noise monitors in-situ
- **Appendix 10.2**: Methodology for calculating wind shear, different hub heights and standardising hub height wind speed
- **Appendix 10.3**: SoundPlan noise outputs
- **Appendix 10.4**: Calibration certificates of noise instruments
- **Appendix 10.5**: Candidate turbine manufacturer's noise emission data

10.1.1 Statement of Authority

Irwin Carr Consulting is based in County Down. The company has a proven track record in noise impact assessments throughout the UK and Ireland, with extensive knowledge of the issues in relation to noise from wind energy developments. Shane Carr carried out the noise modelling in this assessment and contributed to the report. Shane is a Director in Irwin Carr Consulting, primarily responsible for environmental noise and noise modelling. He has over 22 years' experience working in both the public and private sectors having previously obtained a BSc (Hons) Degree in Environmental Health and a Post-Graduate Diploma in Acoustics. Shane has been responsible for undertaking and reviewing noise impact assessments on numerous large scale wind farms throughout the UK and Ireland.

Brendan has a Master's degree in noise and vibration from Liverpool University and has over 40 years' experience in noise and vibration control (and many years' experience in preparation of noise impact statements) and has been a member of a number of professional organisations. Brendan was a co-author and project partner (as a senior noise consultant) in 'Environmental Quality Objectives Noise in Quiet Areas' administered by the EPA. Brendan has considerable experience in the assessment of noise impact and has compiled studies for over 100 wind farm developments throughout Ireland, north and south. Brendan carried out the baseline study.

10.1.2 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 its 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 and in sound power levels (LWA dB). Sound power level is a measure of the noise source while sound pressure level is a measurement taken at a distance from the noise source carried out with a noise meter.

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 2006 and 2019 (draft) Irish wind energy development guidelines. 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 given as 2dBA which is best practice and the value most commonly applied in wind farm assessments in Ireland. Wind turbine noise levels are given as sound power levels (LWA)

[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.

[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

dB at integer wind speeds up to maximum LWA levels. Table 10.1 gives a comparison of noise levels in our everyday environment.

Table 10.1: Comparison of sound pressure level in our Environment[4]

Source/Activity	Indicative noise level dBA
Threshold of hearing	0
Rural night-time background	20-50
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5 km	35-45
Car at 65km/hr at 100m	55
Busy general office	60
Conversation	60
Truck at 50km/hr at 100m	65
Inside a typical shopping centre	70-75
Inside a modern car at around 90km/hr	75-80
Passenger cabin of jet aircraft	85
City Traffic	90
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

10.1.3 Assessment Structure

This Chapter contains the following sections:

- Assessment Methodology and Significance Criteria – a description of the methods used in baseline surveys and in the assessment of the significance of effects
- Baseline Description - a description of the baseline noise of the area surrounding the Development 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 Development, including a summary of the measures taken during design of the Development to minimise noise 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 EIA Development 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 Effects
- Statement of Significance

[4] Fact sheet published by the Australian Government (Greenhouse Office) and the Australian Wind Energy Association

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
- Desk study, including review of available maps and published information
- Site walkover
- Evaluation of potential effects
- Evaluation of the significance of these effects
- Identification of measures to avoid and mitigate potential effects

10.2.2 Description of Effects

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

10.2.3 Relevant Legislation and Guidance

The noise assessment is carried out in accordance with the guidance contained in the following documents:

- Wind Energy Development Guidelines (WEDG)[5] (the 2006 Guidelines)
- Recent 2021 An Bord Pleanála Decisions on Noise Limits
- WHO 2018 Environmental Noise Guidelines for European Region (WHO 2018)
- Draft Revised Wind Energy Development Guidelines December 2019 (DRWEDG 2019).
- A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise including Supplementary Guidance Note 4: Wind Shear'[6] (the IOA Good Practice Guide)
- ISO 1996[7] Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures (ISO 1996)
- ETSU-R-97[8]: The Assessment & Rating of Noise from Wind Farms (ETSU-R-97)
- National Roads Authority (NRA) Guidelines for the Treatment of Noise and Vibration in National Road Schemes, 2004

[5] Department of Environment, Heritage and Local Government: Wind Energy Development Guidelines, Guidelines for Planning Authorities 2006 Energy
[6] Institute of Acoustics (2013) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise
[7] ISO 1996/1- Acoustics-Description and Measurement of Environmental Noise - Part 1: Basic Quantities and Procedures
[8] ETSU-R-97: Acoustics-The Assessment & Rating of Noise from Wind Farms: ETSU for the DTI, UK, 1996

10.2.3.1 Wind Energy Development Guidelines 2006

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

<u>General Noise Impact</u>

"*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."

<u>Measurement Units</u>

"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."

<u>Specific Noise Limits</u>

"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) 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 23:00 hrs

- Saturday afternoon from 13:00 to 18.00 hrs and all-day Sunday 07:00 to 18:00 hrs

- Night-time is defined as 23:00 to 07:00 hrs

10.2.3.2 An Bord Pleanála

2021 An Bord Pleanála Decisions

Recent decision by ABP gave limits (ABP-309306-21, dated 26th September 2022) in accordance with the 2006 Guidelines and were as follows:

(a) between 7am and 11pm:

(i) the greater of 5 dB(A) L90,10min above background noise levels, or 45 dB(A) L90, 10min, at wind speeds of 5m/s or greater,

(ii) 40 dB(A) L90, 10min, at all other wind speeds.

(b) 43 dB(A) L90,10min at all other times

where wind speeds are measured at 10 metres above ground level.

10.2.3.3 World Health Guidelines (WHO) 2018

The most recent WHO 2018 Guidelines: 'Environmental Noise Guidelines for the European Region' gives a recommendation 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.

10.2.3.4 Draft Revised Wind Energy Development Guidelines 2019 (DRWEDG 2019)

There have been a number of draft guidelines over the years with the latest one being in December 2019. The DRWEDG 2019 guidelines, currently in draft format are subject to significant public and stakeholder consultation and liable to change, in line with best practice.

A tender has been issued by the Department of Environment, Climate and Communications to review and re-draft the Wind Energy Development Guidelines. This process has yet to be completed.

This assessment is based on the current guidance outlined in Section 10.2.3.1.

10.2.4 Desk Study

The location for noise monitoring were selected by inspection of Site layout maps and by identifying the nearest receptors surrounding the wind turbines. The Noise Study Area has been defined such that the predicted results have been included for all residential receptors within 2.7km of the wind farm.

The seven noise monitoring locations are considered representative of the local noise environment.

10.2.5 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 wind shear, calculation to hub height and to standardise 10m height wind speed.

A Met Mast located within the Site during the noise survey was used for wind data measurements at heights of 81m and 60m with wind shear derived and used to calculate to the proposed turbine hub height wind speed of 104m.

The 104m hub height wind speed was then standardised to 10m height wind speed with the wind speed plotted against the 10-minute background noise data to derive a best fit polynomial curve.

10.2.6 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[10] 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 wind farms. SoundPLAN software package was used to calculate the noise level at the 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 formula:

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

The predicted octaves from each of the turbines are summed to give the predicted noise level expressed as dBA.

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

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 would be turned down or stopped until such tonality is ameliorated. A guarantee will be required in the procurements of the turbine to be used onsite, stating that there should 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 results 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 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 4m 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 emergence 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 $10^{0}C$ and a relative humidity of 70% has been used for these predictions and are given in **Table 10.2** below. These values are recommended in the IOA Good Practice Guide.

Table 10.2: 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.

10.2.7 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 some situations, however, the modulation characteristics can change in character to the point where it can potentially give rise to increased 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 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.

The Temple Group[11] 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

[11] 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.

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[12] Salford University Report found instances of "enhanced" AM which occurred at larger distances, 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.

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.

10.2.8 Infrasound and 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 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, electric or battery clocks, sky box, etc.), Other sources include water flowing through pipes within your home and in water flow from municipal water supply. Vibration of elements of structures (low frequency, less than 20Hz)) can be generated by local activity in one's home by way of normal routine activity, like climbing stairs, walking on the floor, closing doors etc.

[12] Research into Aerodynamic Modulation of Wind Turbine Noise. Report by University of Salford

When sitting in a moving vehicle very high levels of low frequency vibration/sound is experienced.

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*'[13]. 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 (2-20Hz), although with a considerably higher magnitude. Interestingly most microphones recording air-overpressure (low frequency sound) is linear down to 2 Hz with a range that does not go below a level of 88dB, as below that value trigger can occur from relatively low wind speeds (a gust of wind at 9m/s equates to an air overpressure of 133dB).

The level of ground vibration from the operation of the wind farms is below human threshold of 0.2mm/s[14] at the base of a turbine.

<u>South Australian Environment Protection Authority (EPA) Infrasound Study</u>

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 and 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

[13] ETSU W/13/00392/REP – '*Low Frequency Noise and Vibration Measurements at a Modern Wind Farm'.*
[14] 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
[15] http://www.epa.sa.gov.au/environmental_info/noise/wind_farms

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] consisted of a panel that included seven individuals with backgrounds in public health, epidemiology, toxicology, neurology and sleep medicine, neuroscience, and mechanical engineering, all of which were 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"*.

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.

Measurements showed that the infrasound levels in rural areas with wind farms were about the same as levels in a regular urban environment.
"Infrasound samples representing the worst-case scenarios were picked out from the measurement data and used in the listening tests," said VTT.

[16] 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

[17] Report by Leigh Collins, 21st April 2020 on a study commissioned by the Finnish Government into infrasound and wind turbine syndrome

"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."

10.2.9 Field Work

Baseline noise monitoring was undertaken between 3rd and 27th June 2022 (see Appendix 10.1). The continuous monitoring period coincided with the wind speed monitoring over the same period at the same 10-minute intervals using a Lidar located on site. Noise data was recorded for a representative range of wind speeds during the monitoring period.

10.2.10 Consultation

Consultation was carried out with landowners who were familiar with the Site. Access to the nearest dwellings was carried out with permission from the householders / landowners.

10.2.11 Noise Assessment Methodology

In summary, the assessment process comprised:

- 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 Site
- Prediction of the likely noise levels of wind turbines received at each receptor; and
- Comparison of the predicted levels with noise limits.

Potential receptors in the area around the Development were initially identified from Ordnance Survey maps, google maps, EPA maps and Site visits. Background measurements were carried out at the shown in **Appendix 10.1**.

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 that includes a range of wind speeds which correspond to the maximum sound power of the candidate turbines being proposed which is usually 3 to 4 weeks duration. The candidate turbine assessed reaches maximum sound power level at a mean wind speed of 9m/s at 10m height and generates the highest noise level for that turbine specification.

The method of predicting noise levels of wind turbines at receptors is discussed in Section 10.2.3.2. 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.

For EIA purposes two candidate turbines, the Vestas V162-6.0 megawatts (MW) operating in unrestricted mode PO6000 and the Vestas V162-7.2MW operating in unrestricted Mode PO7200, both with serrated trailing edge (STE), have been selected with a hub height of 104m for the EIA technical assessment. The tip of the blades with STE lowers noise emissions without reducing energy output, and the selected turbine will have STE as standard. The worst-case sound power level at each wind speed from 4m/s to 12m/s was input into the noise model.

A copy of the manufacturers noise specification for the turbines used in the assessment are given in the **Technical Appendix 10.5**.

The prediction modelling is based on the turbines operating at full power and all turbines fitted with STE which reduces noise emissions of each turbine. 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, as no uncertainty is given in the manufacturer's data sheet, an uncertainty value of 2dBA is applied. **Table 10.3** and **Table 10.6** gives the noise emission data for both turbines up to maximum sound power output at varying wind speed at 104m hub height. **Table 10.4** and **Table 10.7** gives the maximum sound power output at varying wind speed (presented at standardised 10m height) for both turbines with a hub height of 104m. A value of 2dBA is subtracted to account for conversion from LAeq to LA90 which is best practise.

Table 10.3: Noise Emission Data, Vestas V162-6.0MW, STE at Maximum Sound Power (LWA dB) at Hub Height at varying wind speeds

Hub Height Wind Speed, ms^{-1}	4	5	6	7	8	9	10	11	12
Sound Power Level, dB LWA at Varying Wind Speeds	94.1	94.3	96.2	99.2	102	104.1	104.3	104.3	104.3

Uncertainty added and conversion of LAeq to LA90	94.1	94.3	96.2	99.2	102	104.1	104.3	104.3	104.3

Table 10.4: Noise Emission Data, Vestas V162-6.0MW, STE at Maximum Sound Power (LWA dB) at Standardised 10m Height wind Speed

Standardised 10m Height Wind Speed ms^{-1}	4	5	6	7	8	9	10	11	12
Sound Power Level dB LWA derived from 119m hub height	96.3	100	102.9	104.3	104.6	104.6	104.6	104.6	104.6
Uncertainty added and Conversion of LAeq to LAeq	96.3	100	102.9	104.3	104.6	104.6	104.6	104.6	104.6

The octave band values are given in **Table 10.5** for the V162–6.0MW with uncertainty values and conversion for LAeq to LA90 added as input to the prediction model.

Table 10.5: Octave Band Spectrum of Vestas V162-6.0MW, STE at Maximum Sound Power (LWA dB) at 8m/s wind speed

Octave Band Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	L_{WA}
Sound Power Level, dB LWA at max sound power level	83.2	91.1	96	97.9	96.6	92.3	84.9	74.5	**104.6**
Uncertainty added to octaves and conversion of LAeq to LA90	83.2	91.1	96	97.9	96.6	92.3	84.9	74.5	

Table 10.6: Noise Emission Data, Vestas V162-7.2MW, STE at Maximum Sound Power (LWA dB) at Hub Height at varying wind speeds

Hub Height Wind Speed, ms^{-1}	4	5	6	7	8	9	10	11	12
Sound Power Level, dB LWA at Varying Wind Speeds	94	94	95	98.3	101.5	104.1	104.6	104.7	104.8
Uncertainty added and conversion of LAeq to LA90	94	94	95	98.3	101.5	104.1	104.6	104.7	104.8

Table 10.7: Noise Emission Data, Vestas V162-7.2MW, STE at Maximum Sound Power (LWA dB) at Standardised 10m Height wind Speed

Standardised 10m Height Wind Speed ms^{-1}	4	5	6	7	8	9	10	11	12
Sound Power Level dB LWA derived from 119m hub height	95.5	99.3	102.5	104.5	105.2	105.2	105.2	105.2	105.2
Uncertainty added and Conversion of LAeq to LAeq	95.5	99.3	102.5	104.5	105.2	105.2	105.2	105.2	105.2

The octave band values are given in **Table 10.8** for the V162–7.2MW with uncertainty values and conversion for LAeq to LA90 added as input to the prediction model.

Table 10.8: Octave Band Spectrum of Vestas V162-7.2MW, STE at Maximum Sound Power (LWA dB) at 8m/s wind speed

Octave Band Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	L_{WA}
Sound Power Level, dB LWA at max sound power level	88	96.3	99.7	99.8	98.3	93.5	85.5	74.3	105.2
Uncertainty added to octaves and conversion of LAeq to LA90	88	96.3	99.7	99.8	98.3	93.5	85.5	74.3	

10.2.11.1 Noise Limits

The method of deriving operational noise limits, described in **Section 10.2.2.1,** is based on the Wind Energy Development Guidelines 2006 and lower limits specified in recent An Bord Pleanála decisions. The noise limits for the Dyrick Wind Farm are designed to meet:

'Wind turbine noise arising from the proposed development, by itself or in combination with other existing or permitted wind energy development in the vicinity, shall not exceed the greater of:

43dB(A) L90,10min for day and night at wind speeds of 5m/s or greater, and

40 dB(A) L90, 10min at all other wind speeds

where wind speeds are measured at 10 metres above ground level. Where properties are financially involved, a 45dB(A) L90,10min limit can be applied.'

10.2.12 Construction Assessment Methodology

10.2.12.1 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 National Roads Authority (NRA) give limit values which are acceptable (the NRA Guidelines)[18]. Guidance to predict and control noise is also given in BS 5228:2009-1+A12014, *Code of Practice for Noise and Vibration Control on Construction and Open Sites* (two parts) where Part 1 deal with Noise[19].

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

The NRA Guidelines provide noise limits which are acceptable and states, where it is deemed necessary to predict noise levels associated with construction noise, that this should be done in accordance with BS 5228.

[18] National Roads Authority, *Guidelines for Noise and Vibration in National Road Schemes.*
[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*.

10.2.12.1.2 BS 5228: 2009-1A; 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 residents to the Development
- Site location relevant to noise sensitive receptors
- Duration of Site operations
- Hours of work
- 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, e.g.

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

10.2.12.2 Construction and Decommissioning Noise Assessment Methodology

The NRA guidelines for construction noise which are considered acceptable are given in **Table 10.10**.

Table 10.10: Noise levels that are considered 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, in this case Waterford City and County Council.

<u>Construction Times for The Development</u>

The construction times for this Development are:

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

Part 1 of BS 5228 provides several example criteria for the assessment of the significance of noise effects from construction activities. Noise levels generated by construction activities are considered significant if:

- The LAeq, period level of construction noise exceeds lower threshold values of 65dB during daytime, 55dB during evenings and weekends or 45dB at night.
- The total noise level (pre-construction ambient noise plus construction noise) exceeds the pre-construction noise level by 5dB or more for a period of one month or more.

Construction noise from wind farm development, or decommissioning is not considered an intensive activity. The main noise sources will be associated with the construction of the Turbine Foundations and Turbine Hardstands. Lesser noise source activity will be construction of Site Access Tracks, temporary construction compound, turbine erection and the construction of a 110kV electrical substation.

Decommissioning will likely involve the remediation of Turbine Hardstand Areas and Turbine Foundations, where they will be covered in topsoil and allowed to revegetate. Site Access Tracks will likely be left in-situ for use by the landowners. Underground Internal Wind Farm Cables will be removed, and the ducting left in-situ. Therefore, the decommissioning phase is likely to be shorter and less intrusive than the construction phase with the resultant effects being less.

All workers associated with the 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'.

10.2.13 Evaluation of Potential Effects

The potential impacts of construction are evaluated by comparing the predicted noise levels against the guideline limits given in **Table 10.10:** Noise levels that are considered acceptable based on the NRA guidelines**,** and sample criteria in Part 1 of BS 5228 in **Section 10.2.8.2**.

The potential operational impacts are evaluated by comparing the predicted noise levels against the day and night-time noise limits given in **Section 10.3.5**. The predicted noise levels are carried out according to the IOA Good Practice Guide as detailed in **Section 10.2.2.5** and potential impacts are assessed against the noise limits at the nearest receptors.

10.2.13.1 Sensitivity

The sensitivity of the Development during construction is based on the guideline values in **Table 10.10:** Noise levels that are considered acceptable based on the NRA guidelines**,** and sample criteria in Part 1 of BS 5228. The sensitivity of the Development during operation is based on the values in **Section 10.4.2** and **Section 10.4.4.3**.

10.2.13.2 Magnitude

The magnitude of potential impacts of construction is based on the values in **Table 10.14.** The magnitude of the Development during operation is based on the values in **Table 10.10**.

10.2.13.3 Significance Criteria

The significance of construction is based on the potential impacts based on the predicted values and compliance with the guideline limits in **Table 10.10** and sample criteria in Part 1 of BS 5228.

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

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

10.3 BASELINE DESCRIPTION

10.3.1 Identification of Potential Receptors

A number of predictions were prepared for the layout of the wind farm. Based on the initial layout, potential noise-sensitive receptors, including occupied and un-occupied dwellings, were identified from maps. Receptor locations were verified through visits to the area surrounding the Development. A number of predictions were prepared for the layout of the wind farm. Based on the initial layout, potential noise-sensitive receptors, including occupied and un-occupied dwellings, were identified from maps. Receptor locations were verified through visits to the area surrounding the Development. The impact of noise on building 320m from turbine 10 has not been assessed. A Deed of Covenant from the landowner confirming that the property will not be used as a residential dwelling from the start of construction the Wind Farm has been included in **Appendix 2.3**.

10.3.2 Selection of Baseline Noise Survey Locations

Seven baseline noise survey locations were selected on the basis of their locations relative to the turbine layout.

10.3.3 Baseline Noise Survey

Baseline noise measurements were carried out continuously between 3rd and 27th June 2022 at the receptor locations given in **Table 10.11** (Photos of monitor in-situ in Technical **Appendix 10.1**).

Table 10.11: Baseline Noise Survey

Location	ING Reference	Description of Location
H19	212995E, 105205N	Monitor located 15m from back of house with main noise sources being local traffic and wind effects on vegetation.
H46	214143E, 107976N	Monitor located 20m west from building beside house in garden with main noise sources being local traffic and wind effects on vegetation.
H93	215586E, 104338N	Monitor located directly across road at 45m from house in field with main noise sources being local traffic, farming activity and wind effects on vegetation.
H63	217167E, 103857N	Monitor located 12m in front of house in garden with main noise sources being local traffic and wind effects on vegetation.
H15	216946E, 106175N	Monitor located directly across road 25m from house in field with main noise sources being local traffic, farming activity and wind effects on vegetation.
H86	217310E, 104789N	Monitor located in field at approx. 200m from nearest receptor with main noise sources being

Location	ING Reference	Description of Location
		local traffic, local stream and wind effects on vegetation.
H58	215912E, 106852N	Monitor located 30m from back of house with main noise sources being local traffic and wind effects on vegetation.

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 noise and mean wind were made at 10-minute intervals with the mean wind speed recorded from a Met Mast on the Development Site. The methodology is given in **Section 10.2.3.1**.
- 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 1.2-1.5m above ground level and more than 5m from any reflective surface, other than the porous ground.
- An electronic rain gauge was installed onsite at H93 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 standardised 10m wind speed was plotted against the time synchronised background noise levels using a best-fit polynomial line.

10.3.3.1 Instrumentation Used

The following instrumentation was used in the baseline survey measurements:

- Larson Davis Precision Integrating Sound Level Analyser/Data logger with 1/2" Condenser Microphones. Microphone was fitted with double skin windscreens based on that specified in W/31/00386/REP 'Noise Measurements in Windy Conditions[21]'.
- Calibration Type: Larson Davis Precision Acoustic Calibrator.
- Rain Gauge Type: TR-525met tipping bucket rain gauge, 0.2mm pulse with LOGBOX datalogger.

All acoustic instrumentation was calibrated before and after the survey and the drift of calibration was less than 0.3dB, which is within accepted guidelines. Survey measurement

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

data and calibration certificates of the acoustic instruments are included in Technical **Appendix 10.3**.

10.3.4 Prevailing Background Noise Levels

Table 10.12 gives the background noise levels obtained from quiet daytime and night-time measurement periods at the baseline measurement location. The main noise sources are low road traffic noise from the R671, and some low intensity agriculture activity in the surrounding farms. The area is not defined as a low noise environment as the background is above 30dB LA90 for most locations at all wind speeds, with the exception of some levels below 30dB at low wind speeds.

Table 10.12: Prevailing Background Noise Levels

Monitoring Location		Prevailing Background (B/G) noise levels LA90dB, 10min Standardised Mean 10 m Height Wind Speed, (m/s)								
		4	5	6	7	8	9	10	11	12
H19	Day	31.1	33.4	36.0	39.0	42.2	45.9	45.9	45.9	45.9
	B/G+5	36.1	38.4	41.0	44.0	47.2	50.9	50.9	50.9	50.9
H19	Night	27.5	30.9	34.7	38.4	41.6	44.1	45.5	45.5	45.5
	B/G+5	32.5	35.9	39.7	43.4	46.6	49.1	50.5	50.5	50.5
H46	Day	33.1	35.8	38.2	40.2	41.4	41.6	41.6	41.6	41.6
	B/G+5	38.1	40.8	43.2	45.2	46.4	46.6	46.6	46.6	46.6
H46	Night	29.1	31.8	34.6	37.1	39.2	40.6	41.2	40.6	40.6
	B/G+5	34.1	36.8	39.6	42.1	44.2	45.6	46.2	45.6	45.6
H93 (FI)*	Day	29.1	30.3	32.1	34.7	38.0	42.1	42.1	42.1	42.1
	B/G+5	34.1	35.3	37.1	39.7	43.0	47.1	47.1	47.1	47.1
H93 (FI)	Night	26.7	29.1	31.8	34.3	36.4	37.9	38.3	38.3	38.3
	B/G+5	31.7	34.1	36.8	39.3	41.4	42.9	43.3	43.3	43.3
H63	Day	31.4	32.3	33.5	34.9	36.6	38.5	38.5	38.5	38.5
	B/G+5	36.4	37.3	38.5	39.9	41.6	43.5	43.5	43.5	43.5
H63	Night	30.4	31.1	32.1	33.1	34.0	34.6	34.8	34.8	34.8
	B/G+5	35.4	36.1	37.1	38.1	39.0	39.6	39.8	39.8	39.8
H15	Day	31.8	33.8	35.8	37.8	39.8	41.8	41.8	41.8	41.8
	B/G+5	36.8	38.8	40.8	42.8	44.8	46.8	46.8	46.8	46.8
H15	Night	26.1	28.3	30.8	33.3	35.7	37.7	39.1	39.1	39.1
	B/G+5	31.1	33.3	35.8	38.3	40.7	42.7	44.1	44.1	44.1
H86	Day	30.9	33.1	35.7	38.6	41.8	45.2	45.2	45.2	45.2

	B/G+5	35.9	38.1	40.7	43.6	46.8	50.2	50.2	50.2	50.2
H86	Night	26.7	29.8	33.2	36.4	39.0	40.7	41.2	41.2	41.2
	B/G+5	31.7	34.8	38.2	41.4	44.0	45.7	46.2	46.2	46.2
H58	Day	30.5	32.6	35.1	38.0	41.2	44.5	44.5	44.5	44.5
	B/G+5	35.5	37.6	40.1	43.0	46.2	49.5	49.5	49.5	49.5
H58	Night	30.2	32.1	34.3	36.8	39.6	42.6	42.6	42.6	42.6
	B/G+5	35.2	37.1	39.3	41.8	44.6	47.6	47.6	47.6	47.6

**(FI) – Financially Involved*

10.3.5 Noise Assessment Locations

The monitoring locations were chosen so that the distance was sufficient to ensure no noise contribution from any other operating wind turbines.

Should the predicted operational noise levels from the Development comply with the requirements of the 2006 Guidelines at the closest receptors, it may be assumed that the predicted noise levels at receptors further away from the Development will also comply, due to the attenuation of turbine noise levels with distance. The location is given in **Table 10.11.**

10.3.6 Noise Limits

The noise limits for the Development are based on the limits contained within the Wind Energy Development Guidelines 2006 and on the background levels obtained in **Table 10.12**. A lower fixed limit of 45dBA for daytime could be applied, however a more stringent limit is applied with the lowest background noise levels obtained at location H63 used as the basis for the assessment at all receptors with a limit of 43dBA being applied for day and night. Where receptors are financially involved, a 45dBA limit can be applied.

Table 10.13: Derived Background Day and Night Noise Levels used in Assessment

Monitoring Location		Prevailing Background (B/G) noise levels LA90dB, 10min Standardised Mean 10 m Height Wind Speed, (m/s)						
		4	5	6	7	8	9	10
H63	Day	31.4	32.3	33.5	34.9	36.6	38.5	38.5
	B/G+5	36.4	37.3	38.5	39.9	41.6	43.5	43.5
Noise Limit		43	43	43	43	43	43.5	43.5
H63	Night	30.4	31.1	32.1	33.1	34.0	34.6	34.8
	B/G+5	35.4	36.1	37.1	38.1	39.0	39.6	39.8
Noise Limit		43	43	43	43	43	43	43

10.3.7 Development Design Mitigation

The preferred turbine model, the V162 will be fitted with STE as standard which is best practice. A serrated extension of the trailing edge to the rotor blades mitigates noise emissions 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, STE are only installed on the outer rotor blade area where the rotary speed is the highest. Typically, STE reduces the noise levels by 2 to 3dBA depending on specific turbine used.

10.4 ASSESSMENT OF POTENTIAL EFFECTS

10.4.1 Construction Noise

10.4.1.1 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, Grid Connection and compound, with lesser sources being the construction of the on Site 110kV Electrical Substation. The main construction traffic to the Site will be during a very short period where ready-mix trucks deliver concrete for the turbine bases. While delivery of material from local quarries for upgrade of Site Access Tracks, Turbine Hardstands, Temporary Storage Compound and 110kV Electrical Substation will be for longer periods but will be of less intensity, generating lower levels of noise along the routes. During delivery of materials, trucks will access the site from a different route than leaving the Site, thereby reducing traffic noise at receptors along the local road network. The delivery of turbines by large trucks travelling at very low speed will generate very low levels of noise at receptors along the Turbine Delivery Route.

It is not possible to specify the precise noise levels of emissions from the construction equipment until such time as a contractor is chosen and construction plant has been selected. However, **Table 10.14** indicates typical construction range of noise levels for this type of activity (levels from author's database and BS 5228). Predictions are made for receptors nearest to the turbine bases / hardstands activity, compound development and for receptors at varying distance from the Grid Connection route.

Table10.14: Typical Noise Levels from Construction Works

Activity	L_{Aeq} at 10m
General Construction (pile driving, ready-mix trucks pouring concrete)	70-84dBA

Activity	L_{Aeq} at 10m
Tracked excavator removing topsoil, subsoil for foundation	80- 87dBA
Rock breaker and excavator loading	82-89dBA
Vibrating rollers including tipping material	76-86dBA
Grid Connection: Trenching Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	71-74dBA
Excavator loading / tipping, excavator and Vibratory roller	80- 87dBA

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 calculations attenuation by A_{atm}, A_{gr} and A_{mis} is taken as 3dBA where distances are more than 200m from a source and as zero within 200m - amelioration by barriers is not accounted for.

Table 10.15 gives the noise levels predicted from construction activity at varying distances. The main noise sources are assumed to be the construction of the Turbine Foundations, Turbine Hardstands and Grid connection. The development of the Site Access Tracks, construction of the new on Site 110kV Electrical Substation, works on the Substation and Site Control Building will also take place, however the noise levels associated with this activity will be lower and of shorter duration than other works. The main road traffic noise will be associated with the delivery of ready-mix concrete for Turbine Foundations.
Road traffic is dealt with under a sub-heading **'Traffic and Transport'** in **Chapter 13**.

The maximum construction noise levels associated with the Development and Grid Connection are listed in **Table 10.15.** At receptor locations further away, noise levels will be less than that predicted. Works associated with Decommissioning will be no more than the levels predicted in **Table 10.15**.

Table 10.15: Predicted Construction Noise Levels

Activity taken as 100% per hour	Distance of Activity (m)	LAeq dB 1hr range
General Construction (pile driving, ready-mix trucks pouring concrete)	710m to H12	36-50dBA
Tracked excavator removing topsoil, subsoil for foundation	710m to H12	46- 53dBA
Rock breaker and excavator loading at nearest turbine T2	710m to H12	48-55dBA
Vibrating rollers including tipping material set down area close to T2	710m to H12	42-52dBA
Grid Connection: Trenching Tracked excavator 14t, pneumatic breaker, vibratory roller 71t, tractor	At varying distances along route: 15m 20m 40m 80m	67.5-70.5dBA 65-68dBA 59-62dBA 53-56dBA
Construction of compound (loading / tipping, excavator and Vibratory roller)	500m to nearest receptor	49- 58dBA

*Noise levels taken in 2022 by author of this report.

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 construction noise generated by traffic to and from the Site will be due to ready-mix trucks delivering concrete with trucking of spoil being carried out at the same time. The concrete pour for each individual turbine will be required to be completed in a short a period as possible (usually within 10 hours).

Each turbine will require approximately 650m^3 of concrete while each ready-mix truck has a capacity of 8m^3. This results in 81 loads of concrete and 162 truck movements for each turbine. For delivery of concrete the timeframe envisaged for each turbine concrete pour is taken as 10 hrs. This equates to an average of 16.2 movements per hour.

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

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

where:

L_{WA} = the sound power level of the truck, in decibels (dB);

Q = 16.2, the number of vehicles per hour;

V = 60, the average vehicle speed, in kilometres per hour (km/h);

d = the distance of receiving position from the centre of haul road, in metres (m).

LAeq = 105-33 +10log16.2 – 10log60 – 10log20 = 53.3 LAeq 1hr.

At 10m from the roadside the noise levels equate to 56.3 LAeq 1hr. The trucking for the concrete pour will extend for a total of 12 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.

<u>Grid Connection-Cable laying along road by trenching</u>

Cable laying and trenching will occur along the Grid Connection route from the On-site 110kV Substation to the Dungarvan 110kV Substation which means maximum levels will pertain no more than 0.5 days equivalent (4 hours) at any single receptor.

Construction noise levels are based on continuous operation. In practice, most plant will operate at a maximum level for short intervals.

10.4.1.2 Assessment of Construction Noise

The higher levels predicted are from the Grid Connection and delivery of concrete for Turbine Foundations. These maximum noise levels will persist for no more than 4 hours at any receptor. All predicted noise levels are well within NRA guidelines given as acceptable and are considered slight. Construction noise is a temporary activity.

All activity is predicted without additional mufflers, or without topographic screening. The maximum road traffic noise which is generated by ready-mix trucks delivering concrete for Turbine Foundations will be short term and of 12 days' duration. The predicted noise levels are well within the NRA guidelines given as acceptable and are therefore considered as not significant.

Ground vibration from rock breaking will be below the threshold of sensitivity to humans of 0.2mm/s peak particle velocity at all receptors[22]. The effects of noise and vibration from onsite construction activities are therefore considered not significant.

[22] 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

10.4.1.3 Description of Effects - Construction

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
Negative	Not Significant	Temporary

10.4.1.4 Decommissioning

Noise effects during the Decommissioning phase of the Development are likely to be of a similar nature to that during construction but of shorter duration. It is likely that Site Access Tracks and Turbine Foundations (excluding plinths) will be left in place and covered over with topsoil unless there are environmental reasons to remove. It is likely that the duration of the Decommissioning phase will be of shorter duration than that during construction. Any legislation, guidance, or best practice relevant at the time of decommissioning will be complied with.

10.4.1.5 Description of Effects - Decommissioning

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

Quality	Significance	Duration
Negative	Not Significant	Temporary

10.4.2 Predicted Operational Noise Levels

Table 10.16 gives the predicted noise levels at the nearest receptors to the Development at varying wind speeds for each receptor location. A noise contour map of the 12no. turbine Development at maximum sound power output at a wind speed of 9ms-1 at 10m height is presented in **Appendix 10.3**. The contour map in **Appendix 10.3** assumes that all turbines are simultaneously downwind to each location all of the time (continuously) which results in an overprediction of the noise levels.

Table 10.16: Predicted Noise Levels as LA90 at Varying Wind Speeds from the Development

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA
H1	216619	102545	22.6	26.4	29.6	31.6	32.3	32.3
H2	216332	102709	23.7	27.5	30.7	32.7	33.4	33.4

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H3	217348	103813	27.1	30.9	34.1	36.1	36.8	36.8
H4	216705	106706	27.1	30.9	34.1	36.1	36.8	36.8
H5	217596	105791	26.4	30.2	33.4	35.4	36.1	36.1
H6	216926	107393	23.5	27.3	30.5	32.5	33.2	33.2
H7	218173	104333	23.9	27.7	30.9	32.9	33.6	33.6
H8	217719	104911	27	30.8	34	36	36.7	36.7
H9	213061	104188	24.2	28	31.2	33.2	33.9	33.9
H10 (FI)*	215562	104355	33.1	36.9	40.1	42.1	42.8	42.8
H11	217065	103403	26.2	30	33.2	35.2	35.9	35.9
H12	215930	103874	31	34.8	38	40	40.7	40.7
H13	217620	106651	23.8	27.6	30.8	32.8	33.5	33.5
H14	216862	103053	24.8	28.6	31.8	33.8	34.5	34.5
H15	216982	106173	28.4	32.2	35.4	37.4	38.1	38.1
H16	216561	102890	24.4	28.2	31.4	33.4	34.1	34.1
H17	213191	104007	24.2	28	31.2	33.2	33.9	33.9
H18	213180	103642	23.1	26.9	30.1	32.1	32.8	32.8
H19	212999	105156	26	29.8	33	35	35.7	35.7
H20	216678	102943	24.5	28.3	31.5	33.5	34.2	34.2
H21	218044	104985	25	28.8	32	34	34.7	34.7
H22	217832	104736	26.2	30	33.2	35.2	35.9	35.9
H23	217438	105025	29.1	32.9	36.1	38.1	38.8	38.8
H24	217414	103958	27.4	31.2	34.4	36.4	37.1	37.1
H25	216357	107001	26.8	30.6	33.8	35.8	36.5	36.5
H26	216594	106781	27.1	30.9	34.1	36.1	36.8	36.8
H27	217040	107344	23.4	27.2	30.4	32.4	33.1	33.1
H28	215911	102379	22.3	26.1	29.3	31.3	32	32
H29	216665	102793	23.8	27.6	30.8	32.8	33.5	33.5
H30	216703	102756	23.5	27.3	30.5	32.5	33.2	33.2
H31	214293	108232	23	26.8	30	32	32.7	32.7
H32	214394	108148	23.5	27.3	30.5	32.5	33.2	33.2

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H33	214222	108128	23.5	27.3	30.5	32.5	33.2	33.2
H34	214224	107943	24.4	28.2	31.4	33.4	34.1	34.1
H35	217305	106545	25.4	29.2	32.4	34.4	35.1	35.1
H36	218069	106041	23.5	27.3	30.5	32.5	33.2	33.2
H37	218051	105201	24.8	28.6	31.8	33.8	34.5	34.5
H38	218076	105081	24.7	28.5	31.7	33.7	34.4	34.4
H39	217772	104916	26.7	30.5	33.7	35.7	36.4	36.4
H40	216854	106536	27.3	31.1	34.3	36.3	37	37
H41	217122	103525	26.7	30.5	33.7	35.7	36.4	36.4
H42	218308	104383	23.3	27.1	30.3	32.3	33	33
H43	216595	102856	24.2	28	31.2	33.2	33.9	33.9
H44	218222	105562	23.6	27.4	30.6	32.6	33.3	33.3
H45	213186	104959	26.6	30.4	33.6	35.6	36.3	36.3
H46	214137	107983	24.1	27.9	31.1	33.1	33.8	33.8
H47	216261	102603	23.2	27	30.2	32.2	32.9	32.9
H48	215967	102454	22.6	26.4	29.6	31.6	32.3	32.3
H49	216915	103197	25.5	29.3	32.5	34.5	35.2	35.2
H50	215831	103863	30.6	34.4	37.6	39.6	40.3	40.3
H51	215787	104013	31.5	35.3	38.5	40.5	41.2	41.2
H52	212998	105059	25.8	29.6	32.8	34.8	35.5	35.5
H53	213266	104289	25.4	29.2	32.4	34.4	35.1	35.1
H54	213198	103736	23.5	27.3	30.5	32.5	33.2	33.2
H55	214189	108038	23.9	27.7	30.9	32.9	33.6	33.6
H56	214142	107946	24.3	28.1	31.3	33.3	34	34
H57	214216	107902	24.6	28.4	31.6	33.6	34.3	34.3
H58	215906	106852	28.8	32.6	35.8	37.8	38.5	38.5
H59	217036	103269	25.5	29.3	32.5	34.5	35.2	35.2
H60	216089	106818	28.5	32.3	35.5	37.5	38.2	38.2
H61	217137	103710	27.7	31.5	34.7	36.7	37.4	37.4
H62	217181	103722	27.6	31.4	34.6	36.6	37.3	37.3

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA
H63	217138	103886	28.8	32.6	35.8	37.8	38.5	38.5
H64	218407	103953	22.2	26	29.2	31.2	31.9	31.9
H65	212617	105419	24.3	28.1	31.3	33.3	34	34
H66	212920	104248	23.8	27.6	30.8	32.8	33.5	33.5
H67	213059	104234	24.3	28.1	31.3	33.3	34	34
H68	213263	104253	25.3	29.1	32.3	34.3	35	35
H69	217027	105999	28.9	32.7	35.9	37.9	38.6	38.6
H70	216888	106093	29.4	33.2	36.4	38.4	39.1	39.1
H71	216880	106211	28.8	32.6	35.8	37.8	38.5	38.5
H72	216883	106422	27.7	31.5	34.7	36.7	37.4	37.4
H73	217177	106525	26	29.8	33	35	35.7	35.7
H74	217256	106787	24.7	28.5	31.7	33.7	34.4	34.4
H75	218210	105565	23.6	27.4	30.6	32.6	33.3	33.3
H76	218204	105502	23.7	27.5	30.7	32.7	33.4	33.4
H77	217931	104913	25.6	29.4	32.6	34.6	35.3	35.3
H78	217947	104621	25.4	29.2	32.4	34.4	35.1	35.1
H79	218081	104607	24.7	28.5	31.7	33.7	34.4	34.4
H80	218060	104488	24.7	28.5	31.7	33.7	34.4	34.4
H81	218455	103936	21.9	25.7	28.9	30.9	31.6	31.6
H82	215869	103848	30.6	34.4	37.6	39.6	40.3	40.3
H83	216573	102948	24.7	28.5	31.7	33.7	34.4	34.4
H84	217109	103689	27.8	31.6	34.8	36.8	37.5	37.5
H85	217751	103926	25.3	29.1	32.3	34.3	35	35
H86	217486	104918	28.8	32.6	35.8	37.8	38.5	38.5
H87	217029	105928	29.2	33	36.2	38.2	38.9	38.9
H88	216919	106453	27.4	31.2	34.4	36.4	37.1	37.1
H89	217852	105520	25.5	29.3	32.5	34.5	35.2	35.2
H90	217905	104830	25.8	29.6	32.8	34.8	35.5	35.5
H91	218295	103802	22.4	26.2	29.4	31.4	32.1	32.1
H92 (FI)	215522	104371	33.2	37	40.2	42.2	42.9	42.9

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA
H93 (FI)	215600	104352	33.1	36.9	40.1	42.1	42.8	42.8
H94	215950	103781	30.3	34.1	37.3	39.3	40	40
H95	216382	103382	27.6	31.4	34.6	36.6	37.3	37.3
H96	216747	102978	24.6	28.4	31.6	33.6	34.3	34.3
H97	216862	103053	24.8	28.6	31.8	33.8	34.5	34.5
H98	217144	103394	25.9	29.7	32.9	34.9	35.6	35.6
H99	217414	103755	26.5	30.3	33.5	35.5	36.2	36.2
H100	217845	104796	26.2	30	33.2	35.2	35.9	35.9
H101	217853	104843	26.1	29.9	33.1	35.1	35.8	35.8
H102	217229	105176	30.6	34.4	37.6	39.6	40.3	40.3
H103	217058	105869	29.3	33.1	36.3	38.3	39	39
H104	216966	105949	29.6	33.4	36.6	38.6	39.3	39.3
H105	216394	106955	26.9	30.7	33.9	35.9	36.6	36.6
H107	216023	102492	24.3	28.1	31.3	33.3	34	34
H108	216946	107449	22.8	26.6	29.8	31.8	32.5	32.5
H109	217309	107242	23.3	27.1	30.3	32.3	33	33
H110	216713	107151	23	26.8	30	32	32.7	32.7
H111	216575	103064	25.1	28.9	32.1	34.1	34.8	34.8
H112	217621	106581	25.3	29.1	32.3	34.3	35	35
H113	217646	106703	24	27.8	31	33	33.7	33.7
H114	216113	102501	23.6	27.4	30.6	32.6	33.3	33.3
H115	217500	106682	22.8	26.6	29.8	31.8	32.5	32.5
H116	214226	108146	24.2	28	31.2	33.2	33.9	33.9
H117	218208	105524	23.4	27.2	30.4	32.4	33.1	33.1
H118	216619	102545	23.7	27.5	30.7	32.7	33.4	33.4

**(FI) – Financially Involved*

10.4.3 Operational Noise Assessment

The assessment was made of the predicted operational noise levels from the Development based on the limits described in **Section 10.2.3.1** in the 2006 Guidelines and taking into consideration the recent 2021 An Bord Pleanála decision described in **Section 10.2.3.2.**

As can be seen from **Table 10.17** the predicted noise levels at all receptors are lower than the noise limits in all cases, at all wind speeds, and are therefore compliant with the noise limits and are not significant in terms of EIA.

The predicted noise levels assume that all turbines are directly down-wind to nearest receptors.

Table 10.17: Margin between Predicted Noise Levels and 43dBA Noise Limit

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9+m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA
H1	**216619**	102545	-20.4	-16.6	-13.4	-11.4	-10.7	-10.7
H2	**216332**	102709	-19.3	-15.5	-12.3	-10.3	-9.6	-9.6
H3	**217348**	103813	-15.9	-12.1	-8.9	-6.9	-6.2	-6.2
H4	**216705**	106706	-15.9	-12.1	-8.9	-6.9	-6.2	-6.2
H5	**217596**	105791	-16.6	-12.8	-9.6	-7.6	-6.9	-6.9
H6	**216926**	107393	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H7	**218173**	104333	-19.1	-15.3	-12.1	-10.1	-9.4	-9.4
H8	**217719**	104911	-16	-12.2	-9	-7	-6.3	-6.3
H9	**213061**	104188	-18.8	-15	-11.8	-9.8	-9.1	-9.1
H10 (FI)*	**215562**	104355	-11.9	-8.1	-4.9	-2.9	-2.2	-2.2
H11	**217065**	103403	-16.8	-13	-9.8	-7.8	-7.1	-7.1
H12	**215930**	103874	-12	-8.2	-5	-3	-2.3	-2.3
H13	**217620**	106651	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5
H14	**216862**	103053	-18.2	-14.4	-11.2	-9.2	-8.5	-8.5
H15	**216982**	106173	-14.6	-10.8	-7.6	-5.6	-4.9	-4.9
H16	**216561**	102890	-18.6	-14.8	-11.6	-9.6	-8.9	-8.9
H17	**213191**	104007	-18.8	-15	-11.8	-9.8	-9.1	-9.1
H18	**213180**	103642	-19.9	-16.1	-12.9	-10.9	-10.2	-10.2

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H19	**212999**	105156	-17	-13.2	-10	-8	-7.3	-7.3
H20	**216678**	102943	-18.5	-14.7	-11.5	-9.5	-8.8	-8.8
H21	**218044**	104985	-18	-14.2	-11	-9	-8.3	-8.3
H22	**217832**	104736	-16.8	-13	-9.8	-7.8	-7.1	-7.1
H23	**217438**	105025	-13.9	-10.1	-6.9	-4.9	-4.2	-4.2
H24	**217414**	103958	-15.6	-11.8	-8.6	-6.6	-5.9	-5.9
H25	**216357**	107001	-16.2	-12.4	-9.2	-7.2	-6.5	-6.5
H26	**216594**	106781	-15.9	-12.1	-8.9	-6.9	-6.2	-6.2
H27	**217040**	107344	-19.6	-15.8	-12.6	-10.6	-9.9	-9.9
H28	**215911**	102379	-20.7	-16.9	-13.7	-11.7	-11	-11
H29	**216665**	102793	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5
H30	**216703**	102756	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H31	**214293**	108232	-20	-16.2	-13	-11	-10.3	-10.3
H32	**214394**	108148	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H33	**214222**	108128	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H34	**214224**	107943	-18.6	-14.8	-11.6	-9.6	-8.9	-8.9
H35	**217305**	106545	-17.6	-13.8	-10.6	-8.6	-7.9	-7.9
H36	**218069**	106041	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H37	**218051**	105201	-18.2	-14.4	-11.2	-9.2	-8.5	-8.5
H38	**218076**	105081	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6
H39	**217772**	104916	-16.3	-12.5	-9.3	-7.3	-6.6	-6.6
H40	**216854**	106536	-15.7	-11.9	-8.7	-6.7	-6	-6
H41	**217122**	103525	-16.3	-12.5	-9.3	-7.3	-6.6	-6.6
H42	**218308**	104383	-19.7	-15.9	-12.7	-10.7	-10	-10
H43	**216595**	102856	-18.8	-15	-11.8	-9.8	-9.1	-9.1
H44	**218222**	105562	-19.4	-15.6	-12.4	-10.4	-9.7	-9.7
H45	**213186**	104959	-16.4	-12.6	-9.4	-7.4	-6.7	-6.7
H46	**214137**	107983	-18.9	-15.1	-11.9	-9.9	-9.2	-9.2
H47	**216261**	102603	-19.8	-16	-12.8	-10.8	-10.1	-10.1
H48	**215967**	102454	-20.4	-16.6	-13.4	-11.4	-10.7	-10.7

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H49	**216915**	103197	-17.5	-13.7	-10.5	-8.5	-7.8	-7.8
H50	**215831**	103863	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7
H51	**215787**	104013	-11.5	-7.7	-4.5	-2.5	-1.8	-1.8
H52	**212998**	105059	-17.2	-13.4	-10.2	-8.2	-7.5	-7.5
H53	**213266**	104289	-17.6	-13.8	-10.6	-8.6	-7.9	-7.9
H54	**213198**	103736	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8
H55	**214189**	108038	-19.1	-15.3	-12.1	-10.1	-9.4	-9.4
H56	**214142**	107946	-18.7	-14.9	-11.7	-9.7	-9	-9
H57	**214216**	107902	-18.4	-14.6	-11.4	-9.4	-8.7	-8.7
H58	**215906**	106852	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5
H59	**217036**	103269	-17.5	-13.7	-10.5	-8.5	-7.8	-7.8
H60	**216089**	106818	-14.5	-10.7	-7.5	-5.5	-4.8	-4.8
H61	**217137**	103710	-15.3	-11.5	-8.3	-6.3	-5.6	-5.6
H62	**217181**	103722	-15.4	-11.6	-8.4	-6.4	-5.7	-5.7
H63	**217138**	103886	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5
H64	**218407**	103953	-20.8	-17	-13.8	-11.8	-11.1	-11.1
H65	**212617**	105419	-18.7	-14.9	-11.7	-9.7	-9	-9
H66	**212920**	104248	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5
H67	**213059**	104234	-18.7	-14.9	-11.7	-9.7	-9	-9
H68	**213263**	104253	-17.7	-13.9	-10.7	-8.7	-8	-8
H69	**217027**	105999	-14.1	-10.3	-7.1	-5.1	-4.4	-4.4
H70	**216888**	106093	-13.6	-9.8	-6.6	-4.6	-3.9	-3.9
H71	**216880**	106211	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5
H72	**216883**	106422	-15.3	-11.5	-8.3	-6.3	-5.6	-5.6
H73	**217177**	106525	-17	-13.2	-10	-8	-7.3	-7.3
H74	**217256**	106787	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6
H75	**218210**	105565	-19.4	-15.6	-12.4	-10.4	-9.7	-9.7
H76	**218204**	105502	-19.3	-15.5	-12.3	-10.3	-9.6	-9.6
H77	**217931**	104913	-17.4	-13.6	-10.4	-8.4	-7.7	-7.7
H78	**217947**	104621	-17.6	-13.8	-10.6	-8.6	-7.9	-7.9

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H79	**218081**	104607	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6
H80	**218060**	104488	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6
H81	**218455**	103936	-21.1	-17.3	-14.1	-12.1	-11.4	-11.4
H82	**215869**	103848	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7
H83	**216573**	102948	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6
H84	**217109**	103689	-15.2	-11.4	-8.2	-6.2	-5.5	-5.5
H85	**217751**	103926	-17.7	-13.9	-10.7	-8.7	-8	-8
H86	**217486**	104918	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5
H87	**217029**	105928	-13.8	-10	-6.8	-4.8	-4.1	-4.1
H88	**216919**	106453	-15.6	-11.8	-8.6	-6.6	-5.9	-5.9
H89	**217852**	105520	-17.5	-13.7	-10.5	-8.5	-7.8	-7.8
H90	**217905**	104830	-17.2	-13.4	-10.2	-8.2	-7.5	-7.5
H91	**218295**	103802	-20.6	-16.8	-13.6	-11.6	-10.9	-10.9
H92 (FI)	**215522**	104371	-11.8	-8	-4.8	-2.8	-2.1	-2.1
H93 (FI)	**215600**	104352	-11.9	-8.1	-4.9	-2.9	-2.2	-2.2
H94	**215950**	103781	-12.7	-8.9	-5.7	-3.7	-3	-3
H95	**216382**	103382	-15.4	-11.6	-8.4	-6.4	-5.7	-5.7
H96	**216747**	102978	-18.4	-14.6	-11.4	-9.4	-8.7	-8.7
H97	**216862**	103053	-18.2	-14.4	-11.2	-9.2	-8.5	-8.5
H98	**217144**	103394	-17.1	-13.3	-10.1	-8.1	-7.4	-7.4
H99	**217414**	103755	-16.5	-12.7	-9.5	-7.5	-6.8	-6.8
H100	**217845**	104796	-16.8	-13	-9.8	-7.8	-7.1	-7.1
H101	**217853**	104843	-16.9	-13.1	-9.9	-7.9	-7.2	-7.2
H102	**217229**	105176	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7
H103	**217058**	105869	-13.7	-9.9	-6.7	-4.7	-4	-4
H104	**216966**	105949	-13.4	-9.6	-6.4	-4.4	-3.7	-3.7
H105	**216394**	106955	-16.1	-12.3	-9.1	-7.1	-6.4	-6.4
H107	**216023**	102492	-18.7	-14.9	-11.7	-9.7	-9	-9
H108	**216946**	107449	-20.2	-16.4	-13.2	-11.2	-10.5	-10.5
H109	**217309**	107242	-19.7	-15.9	-12.7	-10.7	-10	-10

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9+m/s dBA
H110	**216713**	107151	-20	-16.2	-13	-11	-10.3	-10.3
H111	**216575**	103064	-17.9	-14.1	-10.9	-8.9	-8.2	-8.2
H112	**217621**	106581	-17.7	-13.9	-10.7	-8.7	-8	-8
H113	**217646**	106703	-19	-15.2	-12	-10	-9.3	-9.3
H114	**216113**	102501	-19.4	-15.6	-12.4	-10.4	-9.7	-9.7
H115	**217500**	106682	-20.2	-16.4	-13.2	-11.2	-10.5	-10.5
H116	**214226**	108146	-18.8	-15	-11.8	-9.8	-9.1	-9.1
H117	**218208**	105524	-19.6	-15.8	-12.6	-10.6	-9.9	-9.9
H118	**216619**	102545	-19.3	-15.5	-12.3	-10.3	-9.6	-9.6

**(FI) – Financially Involved*

A noise contour map of the cumulative effects of all 12no. turbines is presented with a maximum sound power output at a wind speed of 9ms^{-1} at 10m height in **Appendix 10.3**. The contour map in **Appendix 10.3** assumes that all turbines are simultaneously downwind at the same time to each location which results in an overprediction of the noise levels.

Charts 10.1 and **10.2** of this section plots the derived background noise levels, background plus 5 trendline with the predicted noise levels against a noise limit of 43dB(A).

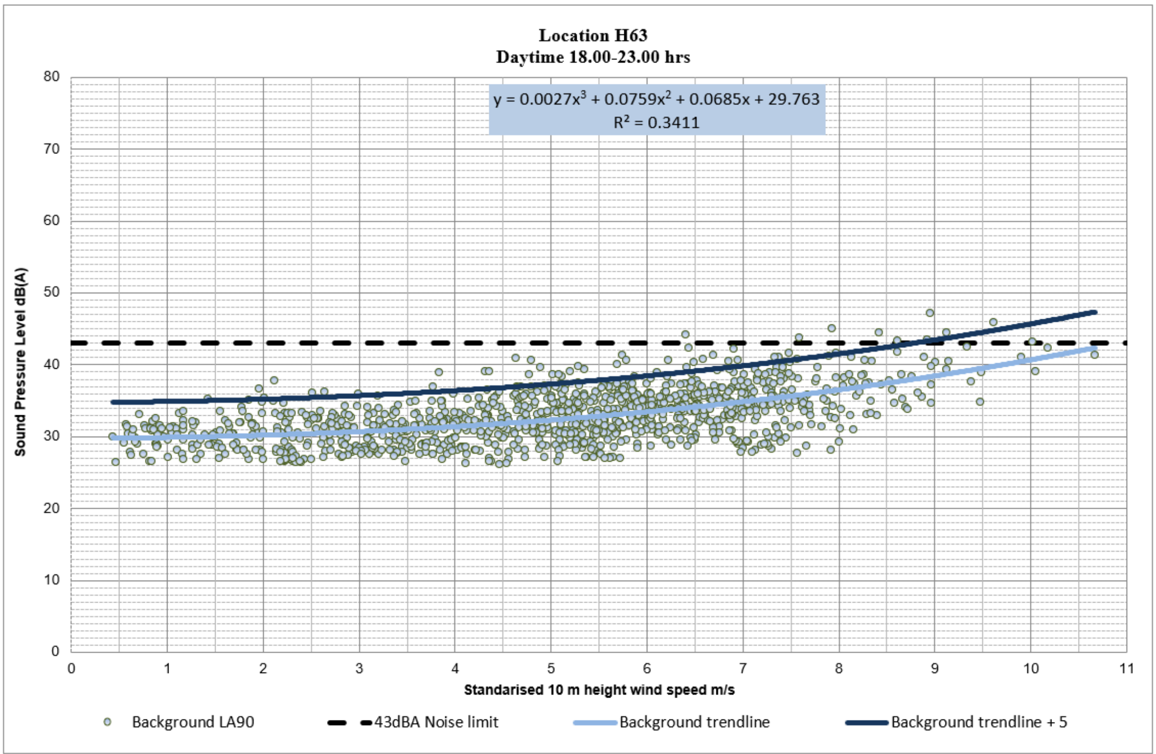

Chart 10.1: H63 for daytime, background noise level, predicted level and assessment limit

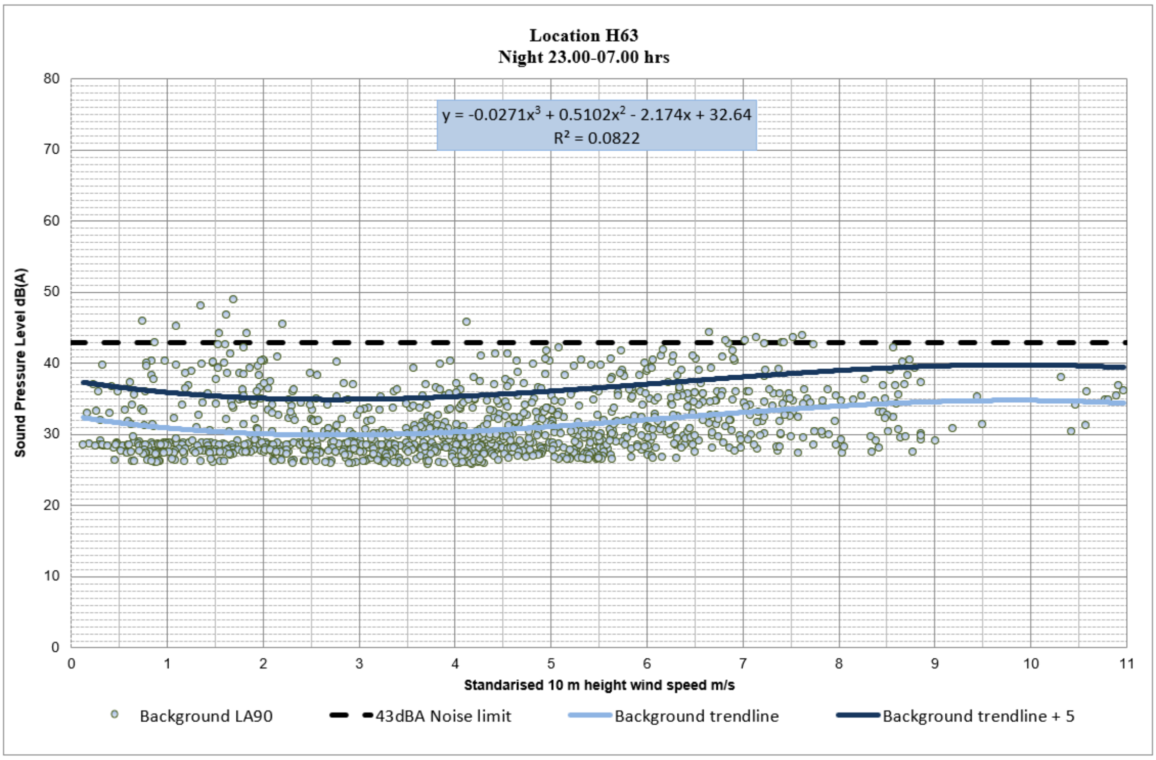

Chart 10.2: H63 for night-time, background noise level, predicted level and assessment limit

10.4.4 Cumulative Effects Assessment

An assessment of the cumulative effects of noise from the Development together with a nearby single operational turbine, located northeast of the Development has been undertaken.

10.4.4.1 Cumulative assessment locations

The same receptor locations used for the proposed Development are also used in the cumulative assessment. The assessment is a worst-case scenario with the assumption made that the predicted noise levels to receptors are downwind from both wind farms and individual turbines at the same time, a scenario that cannot occur in practise.

10.4.4.2 Noise Limits

The noise limits are the same as that used in **Table 10.13**.

10.4.4.3 Cumulative Noise Levels

Table 10.18 gives details of the predicted cumulative noise levels for the nearest receptors to the development.

Table 10.18: Predicted Cumulative Noise Levels for each Receptor

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H1	216619	102545	22.6	26.4	29.6	31.6	32.3	32.3	32.3	32.3	32.3
H2	216332	102709	23.7	27.5	30.7	32.7	33.4	33.4	33.4	33.4	33.4
H3	217348	103813	27.1	30.9	34.1	36.1	36.8	36.8	36.8	36.8	36.8
H4	216705	106706	27.1	30.9	34.1	36.1	36.8	36.8	36.8	36.8	36.8
H5	217596	105791	26.5	30.3	33.4	35.4	36.1	36.1	36.2	36.2	36.2
H6	216926	107393	23.7	27.4	30.6	32.6	33.3	33.3	33.3	33.3	33.4
H7	218173	104333	24.2	27.9	31.0	33.0	33.7	33.7	33.7	33.8	33.8
H8	217719	104911	27.0	30.8	34.0	36.0	36.7	36.7	36.7	36.7	36.7
H9	213061	104188	24.3	28.1	31.2	33.2	33.9	33.9	33.9	34.0	34.0
H10 (FI)*	215562	104355	33.1	36.9	40.1	42.1	42.8	42.8	42.8	42.8	42.8
H11	217065	103403	26.2	30.0	33.2	35.2	35.9	35.9	35.9	35.9	35.9
H12	215930	103874	31.0	34.8	38.0	40.0	40.7	40.7	40.7	40.7	40.7
H13	217620	106651	23.8	27.6	30.8	32.8	33.5	33.5	33.5	33.5	33.5
H14	216862	103053	25.3	28.9	32.0	33.9	34.7	34.7	34.7	34.8	34.8
H15	216982	106173	28.4	32.2	35.4	37.4	38.1	38.1	38.1	38.1	38.1
H16	216561	102890	24.6	28.3	31.5	33.4	34.2	34.2	34.2	34.2	34.2
H17	213191	104007	24.2	28.0	31.2	33.2	33.9	33.9	33.9	33.9	33.9
H18	213180	103642	23.1	26.9	30.1	32.1	32.8	32.8	32.8	32.8	32.8
H19	212999	105156	26.0	29.8	33.0	35.0	35.7	35.7	35.7	35.7	35.7
H20	216678	102943	24.5	28.3	31.5	33.5	34.2	34.2	34.2	34.2	34.2
H21	218044	104985	25.0	28.8	32.0	34.0	34.7	34.7	34.7	34.7	34.7
H22	217832	104736	26.3	30.0	33.2	35.2	35.9	35.9	35.9	35.9	35.9
H23	217438	105025	29.1	32.9	36.1	38.1	38.8	38.8	38.8	38.8	38.8
H24	217414	103958	27.4	31.2	34.4	36.4	37.1	37.1	37.1	37.1	37.1
H25	216357	107001	26.8	30.6	33.8	35.8	36.5	36.5	36.5	36.5	36.5
H26	216594	106781	27.2	30.9	34.1	36.1	36.8	36.8	36.8	36.8	36.8
H27	217040	107344	23.6	27.3	30.5	32.5	33.2	33.2	33.2	33.2	33.2
H28	215911	102379	22.8	26.4	29.5	31.4	32.2	32.2	32.2	32.3	32.3

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H29	216665	102793	23.8	27.6	30.8	32.8	33.5	33.5	33.5	33.5	33.5
H30	216703	102756	23.5	27.3	30.5	32.5	33.2	33.2	33.2	33.2	33.2
H31	214293	108232	23.0	26.8	30.0	32.0	32.7	32.7	32.7	32.7	32.7
H32	214394	108148	23.5	27.3	30.5	32.5	33.2	33.2	33.2	33.2	33.2
H33	214222	108128	23.5	27.3	30.5	32.5	33.2	33.2	33.2	33.2	33.2
H34	214224	107943	24.4	28.2	31.4	33.4	34.1	34.1	34.1	34.1	34.1
H35	217305	106545	25.4	29.2	32.4	34.4	35.1	35.1	35.1	35.1	35.1
H36	218069	106041	23.9	27.5	30.6	32.6	33.3	33.4	33.4	33.4	33.4
H37	218051	105201	25.1	28.8	31.9	33.9	34.6	34.6	34.7	34.7	34.7
H38	218076	105081	24.8	28.6	31.7	33.7	34.4	34.4	34.5	34.5	34.5
H39	217772	104916	26.8	30.5	33.7	35.7	36.4	36.4	36.4	36.4	36.4
H40	216854	106536	27.3	31.1	34.3	36.3	37.0	37.0	37.0	37.0	37.0
H41	217122	103525	26.8	30.6	33.7	35.7	36.4	36.4	36.5	36.5	36.5
H42	218308	104383	23.3	27.1	30.3	32.3	33.0	33.0	33.0	33.0	33.0
H43	216595	102856	24.3	28.0	31.2	33.2	33.9	33.9	33.9	33.9	33.9
H44	218222	105562	23.6	27.4	30.6	32.6	33.3	33.3	33.3	33.3	33.3
H45	213186	104959	26.7	30.5	33.6	35.6	36.3	36.3	36.4	36.4	36.4
H46	214137	107983	24.1	27.9	31.1	33.1	33.8	33.8	33.8	33.8	33.8
H47	216261	102603	23.2	27.0	30.2	32.2	32.9	32.9	32.9	32.9	32.9
H48	215967	102454	22.6	26.4	29.6	31.6	32.3	32.3	32.3	32.3	32.3
H49	216915	103197	25.5	29.3	32.5	34.5	35.2	35.2	35.2	35.2	35.2
H50	215831	103863	30.6	34.4	37.6	39.6	40.3	40.3	40.3	40.3	40.3
H51	215787	104013	31.5	35.3	38.5	40.5	41.2	41.2	41.2	41.2	41.2
H52	212998	105059	25.8	29.6	32.8	34.8	35.5	35.5	35.5	35.5	35.5
H53	213266	104289	25.4	29.2	32.4	34.4	35.1	35.1	35.1	35.1	35.1
H54	213198	103736	23.5	27.3	30.5	32.5	33.2	33.2	33.2	33.2	33.2
H55	214189	108038	23.9	27.7	30.9	32.9	33.6	33.6	33.6	33.6	33.6
H56	214142	107946	24.3	28.1	31.3	33.3	34.0	34.0	34.0	34.0	34.0
H57	214216	107902	24.6	28.4	31.6	33.6	34.3	34.3	34.3	34.3	34.3

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s dBA	11m/s dBA	12m/s dBA
H58	215906	106852	28.8	32.6	35.8	37.8	38.5	38.5	38.5	38.5	38.5
H59	217036	103269	25.6	29.3	32.5	34.5	35.2	35.2	35.2	35.2	35.2
H60	216089	106818	28.5	32.3	35.5	37.5	38.2	38.2	38.2	38.2	38.2
H61	217137	103710	27.7	31.5	34.7	36.7	37.4	37.4	37.4	37.4	37.4
H62	217181	103722	27.6	31.4	34.6	36.6	37.3	37.3	37.3	37.3	37.3
H63	217138	103886	28.8	32.6	35.8	37.8	38.5	38.5	38.5	38.5	38.5
H64	218407	103953	22.3	26.0	29.2	31.2	31.9	31.9	31.9	31.9	31.9
H65	212617	105419	24.3	28.1	31.3	33.3	34.0	34.0	34.0	34.0	34.0
H66	212920	104248	23.8	27.6	30.8	32.8	33.5	33.5	33.5	33.5	33.5
H67	213059	104234	24.3	28.1	31.3	33.3	34.0	34.0	34.0	34.0	34.0
H68	213263	104253	25.3	29.1	32.3	34.3	35.0	35.0	35.0	35.0	35.0
H69	217027	105999	28.9	32.7	35.9	37.9	38.6	38.6	38.6	38.6	38.6
H70	216888	106093	29.5	33.2	36.4	38.4	39.1	39.1	39.1	39.1	39.1
H71	216880	106211	28.9	32.6	35.8	37.8	38.5	38.5	38.5	38.5	38.5
H72	216883	106422	27.8	31.5	34.7	36.7	37.4	37.4	37.4	37.4	37.4
H73	217177	106525	26.1	29.9	33.0	35.0	35.7	35.7	35.8	35.8	35.8
H74	217256	106787	25.0	28.6	31.8	33.8	34.5	34.5	34.5	34.5	34.6
H75	218210	105565	24.0	27.6	30.7	32.7	33.4	33.5	33.5	33.5	33.6
H76	218204	105502	23.9	27.6	30.8	32.8	33.5	33.5	33.5	33.5	33.6
H77	217931	104913	25.8	29.5	32.6	34.6	35.3	35.4	35.4	35.4	35.4
H78	217947	104621	25.5	29.2	32.4	34.4	35.1	35.1	35.1	35.1	35.1
H79	218081	104607	24.8	28.5	31.7	33.7	34.4	34.4	34.4	34.4	34.4
H80	218060	104488	24.8	28.5	31.7	33.7	34.4	34.4	34.4	34.4	34.4
H81	218455	103936	22.0	25.8	28.9	30.9	31.6	31.6	31.7	31.7	31.7
H82	215869	103848	30.6	34.4	37.6	39.6	40.3	40.3	40.3	40.3	40.3
H83	216573	102948	24.7	28.5	31.7	33.7	34.4	34.4	34.4	34.4	34.4
H84	217109	103689	27.8	31.6	34.8	36.8	37.5	37.5	37.5	37.5	37.5
H85	217751	103926	25.3	29.1	32.3	34.3	35.0	35.0	35.0	35.0	35.0
H86	217486	104918	28.8	32.6	35.8	37.8	38.5	38.5	38.5	38.5	38.5

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H87	217029	105928	29.2	33.0	36.2	38.2	38.9	38.9	38.9	38.9	38.9
H88	216919	106453	27.5	31.2	34.4	36.4	37.1	37.1	37.1	37.1	37.1
H89	217852	105520	25.7	29.4	32.5	34.5	35.2	35.3	35.3	35.3	35.3
H90	217905	104830	25.9	29.7	32.8	34.8	35.5	35.5	35.6	35.6	35.6
H91	218295	103802	22.5	26.3	29.4	31.4	32.1	32.2	32.2	32.2	32.2
H92 (FI)	215522	104371	33.2	37.0	40.2	42.2	42.9	42.9	42.9	42.9	42.9
H93 (FI)	215600	104352	33.1	36.9	40.1	42.1	42.8	42.8	42.8	42.8	42.8
H94	215950	103781	30.3	34.1	37.3	39.3	40.0	40.0	40.0	40.0	40.0
H95	216382	103382	27.6	31.4	34.6	36.6	37.3	37.3	37.3	37.3	37.3
H96	216747	102978	24.6	28.4	31.6	33.6	34.3	34.3	34.3	34.3	34.3
H97	216862	103053	24.8	28.6	31.8	33.8	34.5	34.5	34.5	34.5	34.5
H98	217144	103394	25.9	29.7	32.9	34.9	35.6	35.6	35.6	35.6	35.6
H99	217414	103755	26.5	30.3	33.5	35.5	36.2	36.2	36.2	36.2	36.2
H100	217845	104796	26.2	30.0	33.2	35.2	35.9	35.9	35.9	35.9	35.9
H101	217853	104843	26.2	29.9	33.1	35.1	35.8	35.8	35.8	35.8	35.8
H102	217229	105176	30.6	34.4	37.6	39.6	40.3	40.3	40.3	40.3	40.3
H103	217058	105869	29.3	33.1	36.3	38.3	39.0	39.0	39.0	39.0	39.0
H104	216966	105949	29.6	33.4	36.6	38.6	39.3	39.3	39.3	39.3	39.3
H105	216394	106955	27.0	30.7	33.9	35.9	36.6	36.6	36.6	36.6	36.6
H107	216023	102492	24.4	28.2	31.3	33.3	34.0	34.1	34.1	34.1	34.1
H108	216946	107449	22.8	26.6	29.8	31.8	32.5	32.5	32.5	32.5	32.5
H109	217309	107242	23.3	27.1	30.3	32.3	33.0	33.0	33.0	33.0	33.0
H110	216713	107151	23.4	27.0	30.1	32.1	32.8	32.9	32.9	32.9	32.9
H111	216575	103064	25.5	29.1	32.2	34.2	34.9	35.0	35.0	35.0	35.0
H112	217621	106581	25.5	29.2	32.4	34.3	35.1	35.1	35.1	35.1	35.1
H113	217646	106703	24.0	27.8	31.0	33.0	33.7	33.7	33.7	33.7	33.7
H114	216113	102501	24.2	27.7	30.8	32.8	33.5	33.5	33.6	33.6	33.7
H115	217500	106682	23.6	27.0	30.1	32.0	32.8	32.8	32.9	33.0	33.0

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s dBA	11m/s dBA	12m/s dBA
H116	214226	108146	24.2	28.0	31.2	33.2	33.9	33.9	33.9	33.9	33.9
H117	218208	105524	24.0	27.5	30.6	32.6	33.3	33.3	33.4	33.4	33.4
H118	216619	102545	23.7	27.5	30.7	32.7	33.4	33.4	33.4	33.4	33.4

***(FI) – Financially Involved**

A noise contour map of the cumulative effects of all turbines is presented with a maximum sound power output at a wind speed of 12m/s at 10m height in **Appendix 10.3**. The contour map assumes that all turbines are simultaneously downwind at the same time to each location which results in an overprediction of the noise levels.

10.4.4.4 Cumulative Noise assessment

The assessment was made with predicted operational noise levels from the Development against noise limits in the Wind Energy Development Guidelines 2006. All predicted noise levels are within the noise limits. **Table 10.19** gives the difference between the predicted cumulative noise levels in Table **10.18** and noise limits for each receptor. A negative margin indicates that the predicted noise levels are within the lower fixed 43dBA limit (45dBA for financially involved properties), which means the levels are within the day and night limits.

Table 10.19: Margin between Predicted Cumulative Noise Levels and Lower Fixed Limit of 43dBA

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s dBA	11m/s dBA	12m/s dBA
H1	216619	102545	-20.4	-16.6	-13.4	-11.4	-10.7	-10.7	-10.7	-10.7	-10.7
H2	216332	102709	-19.3	-15.5	-12.3	-10.3	-9.6	-9.6	-9.6	-9.6	-9.6
H3	217348	103813	-15.9	-12.1	-8.9	-6.9	-6.2	-6.2	-6.2	-6.2	-6.2
H4	216705	106706	-15.9	-12.1	-8.9	-6.9	-6.2	-6.2	-6.2	-6.2	-6.2
H5	217596	105791	-16.5	-12.7	-9.6	-7.6	-6.9	-6.9	-6.8	-6.8	-6.8
H6	216926	107393	-19.3	-15.6	-12.4	-10.4	-9.7	-9.7	-9.7	-9.7	-9.6
H7	218173	104333	-18.8	-15.1	-12.0	-10.0	-9.3	-9.3	-9.3	-9.2	-9.2
H8	217719	104911	-16.0	-12.2	-9.0	-7.0	-6.3	-6.3	-6.3	-6.3	-6.3
H9	213061	104188	-18.7	-14.9	-11.8	-9.8	-9.1	-9.1	-9.1	-9.0	-9.0
H10 (FI)	215562	104355	-9.9	-6.1	-2.9	-0.9	-0.2	-0.2	-0.2	-0.2	-0.2

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H11	217065	103403	-16.8	-13.0	-9.8	-7.8	-7.1	-7.1	-7.1	-7.1	-7.1
H12	215930	103874	-12.0	-8.2	-5.0	-3.0	-2.3	-2.3	-2.3	-2.3	-2.3
H13	217620	106651	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5	-9.5	-9.5	-9.5
H14	216862	103053	-17.7	-14.1	-11.0	-9.1	-8.3	-8.3	-8.3	-8.2	-8.2
H15	216982	106173	-14.6	-10.8	-7.6	-5.6	-4.9	-4.9	-4.9	-4.9	-4.9
H16	216561	102890	-18.4	-14.7	-11.5	-9.6	-8.8	-8.8	-8.8	-8.8	-8.8
H17	213191	104007	-18.8	-15.0	-11.8	-9.8	-9.1	-9.1	-9.1	-9.1	-9.1
H18	213180	103642	-19.9	-16.1	-12.9	-10.9	-10.2	-10.2	-10.2	-10.2	-10.2
H19	212999	105156	-17.0	-13.2	-10.0	-8.0	-7.3	-7.3	-7.3	-7.3	-7.3
H20	216678	102943	-18.5	-14.7	-11.5	-9.5	-8.8	-8.8	-8.8	-8.8	-8.8
H21	218044	104985	-18.0	-14.2	-11.0	-9.0	-8.3	-8.3	-8.3	-8.3	-8.3
H22	217832	104736	-16.7	-13.0	-9.8	-7.8	-7.1	-7.1	-7.1	-7.1	-7.1
H23	217438	105025	-13.9	-10.1	-6.9	-4.9	-4.2	-4.2	-4.2	-4.2	-4.2
H24	217414	103958	-15.6	-11.8	-8.6	-6.6	-5.9	-5.9	-5.9	-5.9	-5.9
H25	216357	107001	-16.2	-12.4	-9.2	-7.2	-6.5	-6.5	-6.5	-6.5	-6.5
H26	216594	106781	-15.8	-12.1	-8.9	-6.9	-6.2	-6.2	-6.2	-6.2	-6.2
H27	217040	107344	-19.4	-15.7	-12.5	-10.5	-9.8	-9.8	-9.8	-9.8	-9.8
H28	215911	102379	-20.2	-16.6	-13.5	-11.6	-10.8	-10.8	-10.8	-10.7	-10.7
H29	216665	102793	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5	-9.5	-9.5	-9.5
H30	216703	102756	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8	-9.8	-9.8	-9.8
H31	214293	108232	-20.0	-16.2	-13.0	-11.0	-10.3	-10.3	-10.3	-10.3	-10.3
H32	214394	108148	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8	-9.8	-9.8	-9.8
H33	214222	108128	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8	-9.8	-9.8	-9.8
H34	214224	107943	-18.6	-14.8	-11.6	-9.6	-8.9	-8.9	-8.9	-8.9	-8.9
H35	217305	106545	-17.6	-13.8	-10.6	-8.6	-7.9	-7.9	-7.9	-7.9	-7.9
H36	218069	106041	-19.1	-15.5	-12.4	-10.4	-9.7	-9.6	-9.6	-9.6	-9.6
H37	218051	105201	-17.9	-14.2	-11.1	-9.1	-8.4	-8.4	-8.3	-8.3	-8.3
H38	218076	105081	-18.2	-14.4	-11.3	-9.3	-8.6	-8.6	-8.5	-8.5	-8.5
H39	217772	104916	-16.2	-12.5	-9.3	-7.3	-6.6	-6.6	-6.6	-6.6	-6.6

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s dBA	11m/s dBA	12m/s dBA
H40	216854	106536	-15.7	-11.9	-8.7	-6.7	-6.0	-6.0	-6.0	-6.0	-6.0
H41	217122	103525	-16.2	-12.4	-9.3	-7.3	-6.6	-6.6	-6.5	-6.5	-6.5
H42	218308	104383	-19.7	-15.9	-12.7	-10.7	-10.0	-10.0	-10.0	-10.0	-10.0
H43	216595	102856	-18.7	-15.0	-11.8	-9.8	-9.1	-9.1	-9.1	-9.1	-9.1
H44	218222	105562	-19.4	-15.6	-12.4	-10.4	-9.7	-9.7	-9.7	-9.7	-9.7
H45	213186	104959	-16.3	-12.5	-9.4	-7.4	-6.7	-6.7	-6.6	-6.6	-6.6
H46	214137	107983	-18.9	-15.1	-11.9	-9.9	-9.2	-9.2	-9.2	-9.2	-9.2
H47	216261	102603	-19.8	-16.0	-12.8	-10.8	-10.1	-10.1	-10.1	-10.1	-10.1
H48	215967	102454	-20.4	-16.6	-13.4	-11.4	-10.7	-10.7	-10.7	-10.7	-10.7
H49	216915	103197	-17.5	-13.7	-10.5	-8.5	-7.8	-7.8	-7.8	-7.8	-7.8
H50	215831	103863	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7	-2.7	-2.7	-2.7
H51	215787	104013	-11.5	-7.7	-4.5	-2.5	-1.8	-1.8	-1.8	-1.8	-1.8
H52	212998	105059	-17.2	-13.4	-10.2	-8.2	-7.5	-7.5	-7.5	-7.5	-7.5
H53	213266	104289	-17.6	-13.8	-10.6	-8.6	-7.9	-7.9	-7.9	-7.9	-7.9
H54	213198	103736	-19.5	-15.7	-12.5	-10.5	-9.8	-9.8	-9.8	-9.8	-9.8
H55	214189	108038	-19.1	-15.3	-12.1	-10.1	-9.4	-9.4	-9.4	-9.4	-9.4
H56	214142	107946	-18.7	-14.9	-11.7	-9.7	-9.0	-9.0	-9.0	-9.0	-9.0
H57	214216	107902	-18.4	-14.6	-11.4	-9.4	-8.7	-8.7	-8.7	-8.7	-8.7
H58	215906	106852	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5	-4.5	-4.5	-4.5
H59	217036	103269	-17.4	-13.7	-10.5	-8.5	-7.8	-7.8	-7.8	-7.8	-7.8
H60	216089	106818	-14.5	-10.7	-7.5	-5.5	-4.8	-4.8	-4.8	-4.8	-4.8
H61	217137	103710	-15.3	-11.5	-8.3	-6.3	-5.6	-5.6	-5.6	-5.6	-5.6
H62	217181	103722	-15.4	-11.6	-8.4	-6.4	-5.7	-5.7	-5.7	-5.7	-5.7
H63	217138	103886	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5	-4.5	-4.5	-4.5
H64	218407	103953	-20.7	-17.0	-13.8	-11.8	-11.1	-11.1	-11.1	-11.1	-11.1
H65	212617	105419	-18.7	-14.9	-11.7	-9.7	-9.0	-9.0	-9.0	-9.0	-9.0
H66	212920	104248	-19.2	-15.4	-12.2	-10.2	-9.5	-9.5	-9.5	-9.5	-9.5
H67	213059	104234	-18.7	-14.9	-11.7	-9.7	-9.0	-9.0	-9.0	-9.0	-9.0
H68	213263	104253	-17.7	-13.9	-10.7	-8.7	-8.0	-8.0	-8.0	-8.0	-8.0

House ID	ING Easting	ING Northing	4m/s dBA	5m/s dBA	6m/s dBA	7m/s dBA	8m/s dBA	9m/s dBA	10m/s dBA	11m/s dBA	12m/s dBA
H69	217027	105999	-14.1	-10.3	-7.1	-5.1	-4.4	-4.4	-4.4	-4.4	-4.4
H70	216888	106093	-13.5	-9.8	-6.6	-4.6	-3.9	-3.9	-3.9	-3.9	-3.9
H71	216880	106211	-14.1	-10.4	-7.2	-5.2	-4.5	-4.5	-4.5	-4.5	-4.5
H72	216883	106422	-15.2	-11.5	-8.3	-6.3	-5.6	-5.6	-5.6	-5.6	-5.6
H73	217177	106525	-16.9	-13.1	-10.0	-8.0	-7.3	-7.3	-7.2	-7.2	-7.2
H74	217256	106787	-18.0	-14.4	-11.2	-9.2	-8.5	-8.5	-8.5	-8.5	-8.4
H75	218210	105565	-19.0	-15.4	-12.3	-10.3	-9.6	-9.5	-9.5	-9.5	-9.4
H76	218204	105502	-19.1	-15.4	-12.2	-10.2	-9.5	-9.5	-9.5	-9.5	-9.4
H77	217931	104913	-17.2	-13.5	-10.4	-8.4	-7.7	-7.6	-7.6	-7.6	-7.6
H78	217947	104621	-17.5	-13.8	-10.6	-8.6	-7.9	-7.9	-7.9	-7.9	-7.9
H79	218081	104607	-18.2	-14.5	-11.3	-9.3	-8.6	-8.6	-8.6	-8.6	-8.6
H80	218060	104488	-18.2	-14.5	-11.3	-9.3	-8.6	-8.6	-8.6	-8.6	-8.6
H81	218455	103936	-21.0	-17.2	-14.1	-12.1	-11.4	-11.4	-11.3	-11.3	-11.3
H82	215869	103848	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7	-2.7	-2.7	-2.7
H83	216573	102948	-18.3	-14.5	-11.3	-9.3	-8.6	-8.6	-8.6	-8.6	-8.6
H84	217109	103689	-15.2	-11.4	-8.2	-6.2	-5.5	-5.5	-5.5	-5.5	-5.5
H85	217751	103926	-17.7	-13.9	-10.7	-8.7	-8.0	-8.0	-8.0	-8.0	-8.0
H86	217486	104918	-14.2	-10.4	-7.2	-5.2	-4.5	-4.5	-4.5	-4.5	-4.5
H87	217029	105928	-13.8	-10.0	-6.8	-4.8	-4.1	-4.1	-4.1	-4.1	-4.1
H88	216919	106453	-15.5	-11.8	-8.6	-6.6	-5.9	-5.9	-5.9	-5.9	-5.9
H89	217852	105520	-17.3	-13.6	-10.5	-8.5	-7.8	-7.7	-7.7	-7.7	-7.7
H90	217905	104830	-17.1	-13.3	-10.2	-8.2	-7.5	-7.5	-7.4	-7.4	-7.4
H91	218295	103802	-20.5	-16.7	-13.6	-11.6	-10.9	-10.8	-10.8	-10.8	-10.8
H92 (FI)	215522	104371	-9.8	-6.0	-2.8	-0.8	-0.1	-0.1	-0.1	-0.1	-0.1
H93 (FI)	215600	104352	-9.9	-6.1	-2.9	-0.9	-0.2	-0.2	-0.2	-0.2	-0.2
H94	215950	103781	-12.7	-8.9	-5.7	-3.7	-3.0	-3.0	-3.0	-3.0	-3.0
H95	216382	103382	-15.4	-11.6	-8.4	-6.4	-5.7	-5.7	-5.7	-5.7	-5.7
H96	216747	102978	-18.4	-14.6	-11.4	-9.4	-8.7	-8.7	-8.7	-8.7	-8.7

	ING	ING	4m/s	5m/s	6m/s	7m/s	8m/s	9m/s	10m/s	11m/s	12m/s
House ID	Easting	Northing	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA	dBA
H97	216862	103053	-18.2	-14.4	-11.2	-9.2	-8.5	-8.5	-8.5	-8.5	-8.5
H98	217144	103394	-17.1	-13.3	-10.1	-8.1	-7.4	-7.4	-7.4	-7.4	-7.4
H99	217414	103755	-16.5	-12.7	-9.5	-7.5	-6.8	-6.8	-6.8	-6.8	-6.8
H100	217845	104796	-16.8	-13.0	-9.8	-7.8	-7.1	-7.1	-7.1	-7.1	-7.1
H101	217853	104843	-16.8	-13.1	-9.9	-7.9	-7.2	-7.2	-7.2	-7.2	-7.2
H102	217229	105176	-12.4	-8.6	-5.4	-3.4	-2.7	-2.7	-2.7	-2.7	-2.7
H103	217058	105869	-13.7	-9.9	-6.7	-4.7	-4.0	-4.0	-4.0	-4.0	-4.0
H104	216966	105949	-13.4	-9.6	-6.4	-4.4	-3.7	-3.7	-3.7	-3.7	-3.7
H105	216394	106955	-16.0	-12.3	-9.1	-7.1	-6.4	-6.4	-6.4	-6.4	-6.4
H107	216023	102492	-18.6	-14.8	-11.7	-9.7	-9.0	-8.9	-8.9	-8.9	-8.9
H108	216946	107449	-20.2	-16.4	-13.2	-11.2	-10.5	-10.5	-10.5	-10.5	-10.5
H109	217309	107242	-19.7	-15.9	-12.7	-10.7	-10.0	-10.0	-10.0	-10.0	-10.0
H110	216713	107151	-19.6	-16.0	-12.9	-10.9	-10.2	-10.1	-10.1	-10.1	-10.1
H111	216575	103064	-17.5	-13.9	-10.8	-8.8	-8.1	-8.0	-8.0	-8.0	-8.0
H112	217621	106581	-17.5	-13.8	-10.6	-8.7	-7.9	-7.9	-7.9	-7.9	-7.9
H113	217646	106703	-19.0	-15.2	-12.0	-10.0	-9.3	-9.3	-9.3	-9.3	-9.3
H114	216113	102501	-18.8	-15.3	-12.2	-10.2	-9.5	-9.5	-9.4	-9.4	-9.3
H115	217500	106682	-19.4	-16.0	-12.9	-11.0	-10.2	-10.2	-10.1	-10.0	-10.0
H116	214226	108146	-18.8	-15.0	-11.8	-9.8	-9.1	-9.1	-9.1	-9.1	-9.1
H117	218208	105524	-19.0	-15.5	-12.4	-10.4	-9.7	-9.7	-9.6	-9.6	-9.6
H118	216619	102545	-19.3	-15.5	-12.3	-10.3	-9.6	-9.6	-9.6	-9.6	-9.6

**(FI) – Financially Involved*

It can be seen that the predicted noise level at each of the receptors are within the 43dB limit applicable within the WEDG. This considers the predicted noise levels from all of the cumulative turbines to be equivalent of the noise level in a downwind direction from the turbine to the receptor simultaneously. In practise this is not possible due to the location of the turbines.

10.4.5 Description of Effects – Operational Noise

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

Quality	Significance	Duration
Negative	Not Significant	Long Term

10.5 MITIGATION MEASURES AND RESIDUAL EFFECTS

10.5.1 Construction and Decomissioning Noise Mitigation

No significant construction noise effects have been identified. Therefore, no specific mitigation measures are required. However, general guidance for controlling construction noise through the use of good practice given in BS 5228 will be followed. Construction and Decommissioning of the Development shall be limited to working times given and any controls incorporated in any planning permission.

During the Decommissioning phase of the Development, noise levels are likely be no more than predicted in **Table 10.15,** however, it is envisaged that decommissioning will be of shorter duration. Any legislation, guidance or best practice relevant at the time of decommissioning will be complied with. Construction and decommissioning is a temporary day time activity.

10.5.1.1 Residual Construction and Decommissioning Effects

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

10.5.2 Operational Noise Mitigation

The Development has been designed to comply with the 2006 noise Guidelines and noise limits attached as conditions to recent 2021 An Bord Pleanála decisions. The operational noise emissions are predicted to be compliant and well within these guidelines with no special mitigation required apart from fitting rotors with STE which is now considered best practice.

All turbines will have STE fitted as standard to reduce noise emission levels. Mitigation is not considered necessary.

10.5.2.1 Residual Operational Effects

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

10.5.3 Cumulative Effects

The cumulative effects of all nearby wind turbines located within 2km have been assessed and found to be in compliance with the noise limits set in the Wind Energy Development Guidelines 2006.

10.6 SUMMARY OF EFFECTS

Table 10.20 below summarises the Effects.

Table 10.20: Summary of Effects

	Quality	Significance	Duration
Construction noise	Negative	Not Significant	Temporary
Operational Noise	Negative	Not Significant	Long Term
Decommissioning Noise	Negative	Not Significant	Temporary

10.7 STATEMENT OF SIGNIFICANCE

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

The effects of noise from the operation of the Development has been assessed using 2006 Guidelines with the methodology described in ETSU-R-97 and the IOA Good Practice Guide. Noise levels during operation of the Development have been predicted using the best practice of calculation technique. They have been compared with the noise limits in the 2006 Guidelines and recent 2021 An Bord Pleanála limits and found to be compliant.

There has been a consultation process in relation to the revision of the 2019 Wind Energy Development Guidelines. This document provided the basis for a discussion on amendments of the noise limits applicable to wind turbine developments. It is understood that there will be revisions to the draft consultation documents, however a mitigation strategy to incorporate a reduction in sound power level outputs with respect to directionality can be put in place to comply with any specific variation in noise limit levels if new more restrictive guidelines are adopted. All turbines have software incorporated so that the sound power levels can be reduced by direction and energy output.

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 Development and decommissioning will be managed to comply with best practice, legislation and guidelines current at that time so that effects are not significant.