61253

Environmental Impact Assessment Report

Cummeennabuddoge Wind Farm

Chapter 13: Noise

Cummeennabuddoge Wind (DAC)

September 2024

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Glossary of Terms

Term	Definition
The Applicant	Cummeennabuddoge Wind Designated Activity Company (DAC)
The Agent	Atmos Consulting Limited
Environmental Advisors and Planning Consultants	Atmos Consulting Limited
Environmental Impact Assessment	A means of carrying out, in a systematic way, an assessment of the likely significant environmental effects from a development
Environmental Impact Assessment Regulations	Schedule 6 of the Planning and Development Regulations 2001(as amended)
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the EIA Regulations
The Proposed Development	Cummeennabuddoge Wind Farm
The Proposed Development Site	The land enclosed by the red line shown on Figure 1-1a
The Planning Act	Directive 2011/92/EU (as amended by Directive 2014/52/EU, the EIA Directive).

List of Abbreviations

Abbreviation	Description
AM	Amplitude or Aerodynamic Modulation
ANC	Association of Noise Consultants
DECC	Department of Energy and Climate Change
DTI	Department of Trade and Industry
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
GPG	Good Practice Guide
IOA	Institute of Acoustics
RRNL	Relative Rated Noise Limit
SEA	Strategic Environmental Assessment
UGC	Underground Cabling
WHO	World Health Organization
WEDG	Wind Energy Development Guidelines

13 Noise

13.1 Introduction

This chapter of the EIAR assesses the potential impact of noise and vibration as a result of the construction, operation and decommissioning of 17 wind turbines and associated infrastructure (the Proposed Development). The Proposed Development is described in full in Chapter 4 of this EIAR.

The assessment determines the potential noise produced by the Proposed Development and assesses the impact against the baseline noise conditions at identified sensitive receptors in the vicinity of the Proposed Development Site in accordance with the relevant policy and guidance.

13.1.1 Statement of Authority

This Chapter has been produced by Hayes McKenzie Partnership Ltd, who have worked on over 1000 proposed, consented or existing wind farm sites, particularly in the UK and Ireland but also in the rest of Europe, Australia, New Zealand, Canada and the USA.

Hayes McKenzie have provided evidence for around 100 UK public inquiries together with other hearings and in court. All consultants are associate or corporate members of the UK Institute of Acoustics (IOA). The company is a member of the UK Association of Noise Consultants (ANC) and a Sponsor Member of the UK Institute of Acoustics.

This chapter has been written by Aedan Mansfield BEng, AMIOA, who has over 2-years' experience writing environmental impact assessments, has more than 6-years' experience with noise predictions and assessments and is an Associate Member of the Institute of Acoustics.

The chapter has been reviewed by Andy McKenzie PhD, BSc, FIOA who has worked on over 500 wind turbine developments in the UK and Ireland over the last 30+ years.

All work is carried out in line with recognised industry standards, and best practice recommendations of the IOA and ANC.

13.2 Legislation, planning policy and guidance

13.2.1 Construction Noise

BS 5228: 2009 Code Of Practice For Noise And Vibration Control On Construction And Open Sites

There is no specific Irish guidance for assessment and management of construction noise, except in respect of road construction, so reference is normally made to British Standard 5228.

This document provides example criteria for the assessment of the significance of construction noise effects and a method for the prediction of noise levels from construction activities. For the purposes of this assessment, the ABC method has been used to assess significance.

The ABC method is based on predicted noise change but applies minimum criteria of 45, 55 and 65dB L_{Aeq} for night-time (23:00-07:00), evening and weekends (19:00-23:00

weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays), and daytime (07:00-19:00) including Saturdays (07:00-13:00) respectively.

This is applicable when existing noise levels are low, which they are around the proposed development, and subject to a duration of one month or more. It should be noted that the time period to which each limit applies also defines the time averaging period for the calculated L_{Aeq}.

The potential influence of construction traffic will be reviewed and assessed as necessary in terms of the increase in traffic noise at roadside locations, except where there is little or very little traffic movement in which case it will be assessed against the criteria in BS 5228.

13.2.2 Operational Noise

Wind Energy Development Guidelines 2006

The Wind Energy Development Guidelines 2006 (WEDG 2006), published by the Department of Housing, Local Government and Heritage, considers noise from wind farms in Section 5.6. It describes the main sources of wind farm noise:

> *"There are two distinct noise sources associated with the operation of wind turbines; aerodynamic noise caused by blades passing through the air, and mechanical noise created by the operation of mechanical elements in the nacelle - the generator, gearbox and other parts of the drive-train. Aerodynamic noise is a function of many interacting factors including blade design, rotational speed, wind speed and inflow turbulence; it is generally broadband in nature and can display some "character" (swish). Mechanical noise from a wind turbine is tonal in nature."*

The document goes on to list the improvements made to wind turbine design over the past years, which have resulted in reduced noise emissions, particularly mechanical noise from the gearbox.

It states that:

> *"Noise impact should be assessed by reference to the nature and character of noise sensitive locations. In the case of wind energy development, a noise sensitive location includes any occupied dwelling house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational amenity importance. Noise limits should apply only to those areas frequently used for relaxation or activities for which a quiet environment is highly desirable. Noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed. 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 the wind energy development noise and background noise. Any existing turbines should not be considered as part of the prevailing background noise."*

It goes on to say that:

> *"In general, a lower fixed limit of 45 dB(A) [LA90] or a maximum increase of 5dB(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 a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the LA90, 10min of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).*
>
> *Separate noise limits should apply for day-time and for nighttime. During the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night."*

This planning guidance is typically/frequently applied with reference to ETSU-R-97 The Assessment and Rating of Noise from Wind Farms (Department of Trade and Industry, 1996), especially in respect of the means of defining the prevailing (average) background noise level as it varies with wind speed.

The guidance also states:

> *"In general, noise is unlikely to be a significant problem where the distance from the nearest turbine to any noise sensitive property is more than 500 metres."*

However, noise levels at receptor locations are related to the scale and layout of the development such that noise can be a significant issue beyond 500m if the relevant noise limits are not met. In this case operational noise levels have been assessed against the relevant limits even where receptor locations are more than 500m from the Proposed Development.

Proposed Revisions to Wind Energy Development Guidelines 2006

In December 2013, the Department of the Environment, Community and Local Government announced that a review of the WEDG 2006 was being undertaken via release of Proposed Revisions to Wind Energy Development Guidelines 2006 (DoECLG, 2013) in which noise and shadow flicker are specifically discussed.

The document provides general discussion on operational noise from wind turbines in general and proposes a 40dB L_{A90} noise limit externally to dwellings, irrespective of time and background noise levels.

Some leniency is proposed where there are a limited number of sensitive dwellings neighbouring a potential site and provided it can be demonstrated that the owners of these particular properties are supportive of the development and would accept higher noise levels.

The proposed limit is stated to take into account WHO findings (World Health Organization, 2009), applicable at the time of publication of the proposal, and a review of international practice (Marshall Day Acoustics, 2013) undertaken by Marshall Day.

Information Note, Review of the Wind Energy Development Guidelines 2006, "Preferred Draft Approach"

In June 2017, The Department of Housing, Planning, Community and Local Government and the Department of Communications, Climate Action and Environment announced an emerging "Preferred Draft Approach" (Department of Housing, Planning, Community and Local Government & Department of Communications Climate Action and Environment, 2017) to the Proposed Revisions to Wind Energy Development Guidelines 2006.

This followed a high level of response to the initial 2013 proposals, and the announcement sets out timescales for the formal adoption of revised planning policy in respect of wind farm developments subject to Strategic Environmental Assessment (SEA) in line with an EU directive. The document outlines a number of aspects relating to wind farm planning and assessment, including noise.

The proposed noise limits prescribed are ;"*…5 dB(A) above the existing background noise within the range of 35 to 43 dB(A), with 43 dB(A) being the maximum noise limit permitted, day or night*" and are to be applied outdoors at residential properties.

Brief reference is made to specific and potentially audible characteristics associated with the operation of wind turbines including tones, low frequency noise and amplitude modulation, stating that the noise limits would take these factors into account, with the limits being further reduced to mitigate for these factors in instances where they are present.

The review proposals, which are fairly ambiguous as written, have yet to be adopted formally into planning policy. As a result, WEPG 2006 remain relevant in terms of current planning policy in respect of turbine noise.

Draft Revised Wind Energy Development Guidelines 2019

Draft Revised Wind Energy Development Guidelines (Draft Revised WEDG 2019) were issued in December 2019 by the Minister for Housing, Planning and Local Government under Section 28 of the Planning and Development Act, 2000.

They state that planning authorities shall; "*…have regard to the Guidelines and are required to apply any specific planning policy requirements of the Guidelines in carrying out their functions under section 28(1C).*"

These guidelines state at 5.7.11: "*A Relative Rated Noise Limit (RRNL) in the range of 35 – 43 dB(A) shall apply, while not exceeding the background noise level by more than 5dB(A) with an upper limit of 43 dB(A)*", and this concurs with the "Preferred Draft Approach".

The guidelines go on to say that: *"The rated wind turbine noise level (LA rated, 10 min) is determined by the measured noise level attributable to or related to the wind energy development plus any rating penalties for special audible characteristics.*"

In addition, the guidelines state that; "*…where existing background noise levels are measured at less than 30 dB, a maximum 35 dB(A) noise limit will be strictly imposed at lower wind speeds*".

The Proposed Development has been assessed against WEDG 2006. However, an assessment against the Draft Revised WEDG 2019 has been made and a discussion on the differences between these is given.

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

ETSU-R-97, The Assessment and Rating of Noise from Wind Farms, presents the recommendations of the Working Group on Noise from Wind Turbines, set up in 1993 by the UK Department of Trade and Industry (DTI) as a result of difficulties experienced in applying the noise guidelines existing at the time to wind farm noise assessments.

The group comprised independent experts on wind turbine noise, wind farm developers, DTI personnel and local authority Environmental Health Officers. In September 1996 the Working Group published its findings by way of report ETSU-R-97. This document describes a framework for the measurement of wind farm noise.

ETSU-R-97 recommends that although noise limits should be set relative to existing background and should reflect the variation of both turbine and background noise with wind speed (as in the WEDG 2006); this is subject to lower limiting values, as the approach on its own can imply very low noise limits in particularly quiet areas.

In which case; "*…it is not necessary to use a margin above background in such low-noise environments. This would be unduly restrictive on developments which are recognised as having wider global benefits. Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to the wind farm neighbour*". The guidance also specifies noise limits which are adopted in the UK.

The prevailing background noise level is set by calculation of a best fit curve through values of background noise plotted against wind speed as measured during the appropriate time period with background noise measured in terms of $L_{A90,t}$. The $L_{A90,t}$ is the noise level which is exceeded for 90% of the measurement period 't'. It is recommended that at least 1 weeks' worth of measurements is required.

It is stated that the $L_{A90,10min}$ noise descriptor should be adopted for both background and wind farm noise levels and that, for the wind farm noise, this is likely to be between 1.5 and 2.5dB less than the L_{Aeq} measured over the same period.

The $L_{Aeq,t}$ is the equivalent continuous 'A' weighted sound pressure level occurring over the measurement period t. It is often used as a description of the average noise level. Use of the L_{A90} descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise

In May 2013, the UK Institute of Acoustics (IOA) published A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (Cand, et al., 2013). This was subsequently endorsed in all parts of the UK.

The publication of the Good Practice Guide (GPG) followed a review (Department of Energy & Climate Change, 2011) of current practice carried out for the Department of Energy and Climate Change (DECC) and an IOA discussion document (Institute of Acoustics, 2012) which preceded the GPG.

The GPG includes sections on Context; Background Data Collection; Data Analysis and Noise Limit Derivation; Noise Predictions; Cumulative Issues; Reporting; and Other Matters including Planning Conditions; Amplitude Modulation; Post Completion Measurements; and Supplementary Guidance Notes.

The Context section states that the guide "presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine development above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published".

As well as expanding on and, in some areas, clarifying issues which are already referred to in ETSU-R-97, additional guidance is provided on noise prediction and a preferred methodology for dealing with wind shear.

Blade Swish (Amplitude Modulation of Aerodynamic Noise)

The variation in noise level associated with turbine operation, at the rate at which turbine blades pass any fixed point of their rotation (the blade passing frequency), is often referred to as blade swish and amplitude or aerodynamic modulation (AM) and is an inherent feature of wind turbine noise. This effect is identified within ETSU-R-97, where it is envisaged that

> *"…modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine..."*

and that at distances further from the turbine where there are

> *"…more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)".*

It has been noted that complaints about wind farm noise have, in many cases, been specifically concerned with amplitude modulation. This is also apparent from ETSU-R-97, where it is noted that

> *"it is the regular variation of the noise with time that, in some circumstances, enables the listener to distinguish the noise of the turbines from the surrounding noise".*

The modulation of noise may affect perceived annoyance for sounds with the same overall sound pressure level.

RenewableUK (RUK), the main renewable energy trade association in the UK, completed research into the causes and subjective effects of AM (Renewable UK, 2013) (Temple Group, 2013) (Temple Group, 2013) (Renewable UK, 2013) following various reports of increased levels of AM being experienced at dwellings neighbouring some wind turbine sites.

This concluded that the predominant cause is likely to be from individual blades going in and out of stall as they pass through regions of higher wind speed at the top of their rotation under high wind shear conditions.

Subjective tests carried out by Salford University, using loudness matching techniques, have demonstrated the extent to which higher levels of modulation depth result in increased perceived loudness.

This resulted in the inclusion of a mechanism to assess and regulate AM effects in the standard form of a condition (Renewable UK, 2013) (Renewable UK, 2013), frequently applied to wind farm developments as included in the IOA GPG.

The IOA reviewed this mechanism and released a discussion document (Institute of Acoustics, 2015) which reviews several different methods for rating amplitude modulation in wind turbine noise and subsequently released a recommended method (Institute of Acoustics, 2016) by which to characterise the peak to trough level in any given 10-minute period.

Although this document provides a definitive approach for the quantification of amplitude modulation, it does not provide any comment on what could be defined as an unacceptable level of AM nor any kind of penalty scheme, such as for tonal content, by which the overall turbine noise level should be corrected to account for its presence.

This has subsequently been covered by a DECC commissioned project looking at human response to the amplitude modulated component of wind turbine noise, results were presented, prior to the publication of the final report, at the IOA Acoustics 2016 conference (Perkins, et al., 2016).

The combination of these two documents provides both a method of quantification of the level of amplitude modulation over a given 10-minute period and the appropriate penalty to apply if necessary.

The WEDG 2006 merely states that sound from wind turbines "*is generally broadband in nature and can display some "character" (swish)*". Whereas, the Draft Revised WEDG 2019 states: "*Where a complaint relates to amplitude modulated noise all wind directions associated with amplitude modulation shall be included in determining the rated noise level.*" The penalty scheme, reproduced in the Draft Revision WEDG 2019 is given as:

> "*[Amplitude Modulation rating levels with] an exceedance level above 3 dB, a 3 dB penalty is incurred. Between cumulative exceedance levels of 3 dB and 10 dB, a sliding scale of penalties is introduced, varying linearly from 3 dB to 5 dB which is the maximum penalty applied for amplitude modulation. No penalties are incurred at cumulative exceedance levels below 3 dB*".

It should be noted that most wind farms operate without significant AM, and that it is not possible to predict the likely occurrence of AM, but, like tonal noise, AM could be covered by a suitably worded planning condition if necessary.

One proposed wording for such a condition can be seen in an article jointly authored by a number of consultants working in the area in the November/December 2017 issue of the Institute of Acoustics' Acoustics Bulletin magazine (McKenzie, et al., 2017). However, the IoA GPG states that; "*…current practice is not to assign a planning condition to deal with AM*".

There are no standard or agreed methods by which to predict, with any certainty, the likelihood of amplitude modulation occurring at a level requiring a penalty at a particular development, only some indicators such as relatively high wind shear conditions under certain circumstances or particular turbine designs and/or dimensions for example.

Wind Shear

Wind shear, or more specifically vertical wind shear, is the rate at which wind speed increases with height above ground level. This has particular significance to wind turbine noise assessment where background noise measurements are referenced to measurements of wind speed at 10m height.

This is suggested as appropriate by ETSU-R-97, but which is not representative of wind at hub-height, which is what affects the noise generated by the turbines.

The preferred method of accounting for wind shear in noise assessments is by referencing background noise measurements to hub height wind speed.

Hub height wind speed may be determined directly by using a tall mast or remote sensing technology (i.e., LiDAR or SoDAR) or indirectly from measurements at a number of heights below hub height in order to calculate the hub height wind speed during the background noise survey period, as described in the GPG.

The hub height wind speeds are then converted to 'standardised 10m wind speeds', assuming standardised conditions as used by turbine manufacturers when specifying turbine sound power levels. This is the approach taken here.

Tonal Noise

ETSU-R-97 notes that, at the time the report was written, where complaints had been made over noise from existing wind farms, the tonal character of the noise from machinery in the nacelle had been the feature that had caused greatest annoyance.

The recommendation was, therefore, that any assessment carried out should include a correction to the predicted noise levels according to the level of any tonal components in the noise.

The audibility of any tones can be assessed by comparing the narrow band level of the tone with the masking level contained in a band of frequencies around it called the critical band.

The Draft Revised WEDG 2019 reference ISO 1996-2:2017 with regards to tonal noise analysis and assessment. It states "*The tonal adjustment to be applied in calculating the rated level shall be in 3 dB steps as follows:*"

$\Delta L \leq 2$ dB: $K_T = 0$ dB

2dB $< \Delta L \leq 9$ dB: $K_T = 3$ dB

9dB $< \Delta L$: $K_T = 6$ dB

Where K_T is the tonal penalty which applies and ΔL is the Tonal Prominence, as derived according to ISO 1996-2:2017.

The necessity of minimising tonal components in the noise output from the turbines is well understood by the turbine manufacturers and a guarantee will be procured to ensure that any tonal noise will be below that requiring a penalty under applicable schemes.

Infra-sound

Infra-sound is noise occurring at frequencies below that at which sound is normally audible, i.e., at less than about 20Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range it has to be at very high amplitude for sound to be perceptible and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance.

Wind turbines have been cited by some as producers of infra-sound. This has, however, been due to the high levels of such noise, as well as audible low frequency thumping noise, occurring on older 'downwind' turbines mainly installed in the USA.

Downwind turbines are configured with the blades downwind of the tower such that the blades pass through the wake left in the wind stream by the tower resulting in a regular audible thump, with infra-sonic components, each time a blade passes the tower. Virtually all modern larger turbines are of the upwind design; that is with the blades upwind of the tower, such that this effect is eliminated.

A study into low frequency noise from wind farms (UK Department of Trade and Industry, 2006) concluded that "infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range.

Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion".

It goes on to state that, based on information from the WHO, "there is no reliable evidence that infrasound below the hearing threshold produce physiological or psychological effects" and that "it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour".

A considerable amount of research has been conducted in respect of the levels of infrasound that wind turbines emit (UK Department of Trade and Industry, 1997) (Styles, et al., 2005) (Turnbull, 2012).

All reliable evidence suggests that at typical residential distances (e.g., at 500 m or more), the levels of infrasound from a wind farm are below accepted thresholds of perception. Even when measured in close proximity to a wind turbine, the measured levels of infrasound are below accepted thresholds of perception.

This suggests that infrasound is not an issue for neighbours in the vicinity of wind turbines.

Low Frequency Noise

Noise from modern wind turbines is essentially broad band in nature in that it contains similar amounts of noise energy in all frequency bands from low to high frequency. As distance from a wind farm site increases, the noise level decreases as a result of the spreading out of the sound energy and also due to air absorption which increases with increasing sound frequency.

This means that, although the energy across the whole frequency range is reduced, higher frequencies are reduced more than lower frequencies with the effect that as distance from the site increases the ratio of low to high frequencies also increases.

This effect is not specific to wind turbines and may be observed with road traffic noise or natural sources, such as the sea, where higher frequency components are diminished relative to lower frequency components at long distances.

At such distances, where residential properties are typically located in relation to wind farm developments, the overall noise level is so low, such that any bias in the frequency spectrum is insignificant.

Vibration

The ETSU study (International Oragnization for Standardization, 2016) found that vibration from wind turbines, as measured at 100m from the nearest machine, was well below the criteria recommended for human exposure in critical working areas such as precision laboratories (British Standards Institution, 2008).

At greater distances from turbines vibration levels are even lower. This has been confirmed by the Keele University study (Styles, et al., 2005), which showed vibration levels of around $10^{-8}m.s^{-2}$ at a distance of 2.4km from the Dun Law Wind Farm site under high wind conditions, orders of magnitude lower than the criteria referred to above which specify levels in the region of $0.005m.s^{-2}$.

Audibility

The potential audibility of noise from the proposed wind turbines depends to a large extent on the amount by which the predicted turbine noise level exceeds the noise from other sources (the baseline or background noise level) and the presence of any acoustical 'features' which distinguish it.

These other noise sources may be steady and unchanging but is more likely to be continuously variable depending on time of day and other factors including, particularly in rural areas, wind speed.

The results of baseline noise measurements are expressed in terms of the level exceeded for 90% of each 10-minute period which are shown plotted against wind speed.

The potential audibility of wind turbine noise from this site, for daytime and night-time hours and for worst case downwind propagation from the site towards the various measurement locations, can be determined by comparing the predicted turbine noise with the measured background noise level for each 10-minute measurement period (when including the effects of wind shear).

Where predicted noise levels are around the same level as the background noise this suggests that the noise source may be just audible, with perceived audibility increasing with margin above background and also when taking into account any significant acoustic features such as tonality or amplitude modulation.

Similarly, where predicted noise levels are lower than the existing background noise levels, audibility decreases as noise level reduces.

Sleep Disturbance

The potential for sleep disturbance depends on the average and maximum levels of noise in sleeping areas during the night-time period. The night-time noise limits in the DoEHLG Planning Guidelines aim to protect against sleep disturbance by limiting the amount of turbine noise external to dwellings assuming a worst case of inhabitants sleeping with the windows open for ventilation.

The internal noise levels in such circumstances can be calculated by assuming a 10-15dB reduction in noise from outside to inside. The WHO published recommendations (World Health Organization, 2009) in 1999 to the effect that average night-time noise levels in sleeping areas should not exceed 30dB L_{Aeq}.

Although this figure relates to overall noise level in sleeping areas, the potential for sleep disturbance specifically from turbine noise, for worst case downwind propagation with windows open, can be evaluated for each dwelling by subtracting 10-15dB from the predicted turbine noise level and comparing with this criterion, after also adding 2dB to convert the predicted turbine noise level to an L_{Aeq} value.

It should also be noted that potential difficulty in getting to sleep, either at the start of the night or once awoken by other sources, may be more related to audibility indoors under specific circumstances (see above) than by average noise level.

Guidance from the WHO on night noise levels is also provided in the form of the Night Noise Guidelines for Europe (World Health Organization, 2009), and recommends that the population is not exposed to average external night-time noise levels, over a whole year, of more than 40dB L_{Aeq}.

This average yearly noise level will depend on the variation in wind speed, wind direction and noise from other sources over each year period.

Further to the above, the latest guidance from the WHO (World Health Organization, 2018), conditionally recommends that turbine noise should not exceed an L_{den} of 45dB. L_{den} is the average noise level over one year, where noise during evening and night-time periods is penalised with a 5 and 10dB correction respectively.

In the case of wind turbine noise, which is continually varying from day to day, depending on the wind speed and direction, it will be almost impossible to establish compliance with this limit through measurement alone.

The Department of Housing, Local Government and Heritage is currently conducting a targeted review of WEDG 2006 in relation to noise, proximity and shadow flicker. It is proposed to update the relevant sections of the revised draft guidelines on these specific issues.

The noise limits provided in WEDG 2006 may be updated based on information contained within further guidelines which have yet to be published and a draft consultation document which has not yet been formally adopted as relevant planning policy.

The Department has invited submissions on the proposed revisions contained within the draft document and the period of consultation has now closed. Following consideration of the submissions made the Guidelines will be finalised and issued to planning authorities under Section 28 of the Planning and Development Act 2000 (as amended).

At the time of writing the local authorities were still under instruction from the Department that WEDG 2006, including the noise limit structure contained within, were to be followed in assessing planning applications. It is also understood that a contract has been let to re-consider the draft 2019 guidelines due to the level of criticism, on technical grounds, which was received.

Consequently, this assessment follows all existing and issued guidelines relevant to Wind Farm development, including the current WEDG 2006 .

13.2.3 Decommissioning Noise

No specific guidance exists in relation to decommissioning noise, however, it is considered that the same guidance is applicable to construction sites due to the similar types of activities.

13.3 Noise Sources

Noise is generated by wind turbines as they rotate to generate power. This only occurs above the 'cut-in' wind speed and below the 'cut-out' wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate electricity efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring.

The cut-in speed at proposed turbine hub-height is approximately 3 metres per second (m/s) and the cut-out wind speed is approximately 25m/s.

The principal sources of noise are from the blades rotating in the air (aerodynamic noise), internal machinery, normally the gearbox and, to a lesser extent, the generator (mechanical noise). However, the blades are carefully designed to minimise noise whilst optimising power transfer from the wind.

13.3.1 Noise in the Environment

The majority of wind turbines are situated in rural environments, where there are few other sources of noise. This is unlikely to be a problem at high wind speeds as any noise is generally masked by wind induced noise effects, particularly that of the trees being blown.

At lower wind speeds or in particularly sheltered locations the wind induced background noise may not be sufficient to mask any noise from the turbines. However, under these conditions, potential turbine noise levels may be so low as to generate very little impact.

Noise levels are normally expressed in decibels (dB). Noise in the environment is measured using the dB(A) scale, which includes a correction for the response of the human ear to noises with different frequency content.

It is generally accepted that, for noise of a similar character a change of 3dB(A) is the minimum perceptible under normal conditions, and a change of 10dB(A) corresponds roughly to halving and doubling the loudness of a sound.

Table 13-1 (transcribed from "Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)") (Kelly & Dilworth, 2016) shows indicative noise levels associated with different activities.

Table 13-1: Examples of Indicative Noise Levels

Source/Activity	Indicative Noise Levels LpA (dB)
Threshold of pain	120
Disco or Rock Concert	100
Very Busy Pub (voice has to be raised to be heard)	85
Car (60km/hr) at 7m	70
Busy General Office	60
Rural Setting (no wind)	35
Quiet Bedroom	30
Threshold of hearing	0

13.4 Consultation

The consultation undertaken in connection with this assessment is shown in Table 13-2 below together with responses and the section of this Chapter where their requirements have been addressed.

Table 13-2: Consultation

Consultee	Summary of Consultee Response	Where addressed within this Report
Environmental Health Service	Assessment of the predicted impacts during both the construction phase and the operational phase, detailing the change in noise environment.	13.4.2 Construction Effects
Environmental Health Service	The EIAR must also consider the appropriateness and effectiveness of all proposed mitigation measures to minimise noise and vibration.	13.5.1 Proposed Mitigation/Monitoring – Construction Noise
Environmental Health Service	Establish existing background noise levels by undertaking baseline noise monitoring surveys whilst excluding contribution from any existing turbines in the area.	13.2.3 Assessment Methodology – Operational Noise – Assessment Approach and at Appendix 13.2
Environmental Health Service	Consideration given to The Draft Revised Wind Energy Development Guidelines, published in December 2019.	13.2.1 Legislation, planning policy and guidance
Transport Infrastructure Ireland	The EIAR/EIS should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the relevant competent authority.	13.4.5 Cumulative Effects
Transport Infrastructure Ireland	The developer may need to consider the incorporation of noise barriers to reduce noise impacts (see Guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev., National Roads Authority, 2004)),	13.5.1 Proposed Mitigation/Monitoring – Construction Noise

13.5 Assessment Methodology

13.5.1 Construction and Decommissioning Noise

Construction and decommissioning noise impacts have been assessed with reference to relevant guidance in the form of BS 5228 'Code of Practice for Noise and Vibration Control on Construction and Open Sites' (BSI, 2014 + 2019) since there is no specific Irish Guidance for this type of noise.

The construction noise limits prescribed within BS 5228:2009 are designed to offer residents a reasonable level of protection with the regard to the typical shot-term duration and typical noise levels associated with construction noise.

In this case 65dB $L_{Aeq,12hr}$ daytime significance criterion has been adopted for the purposes of the assessment. However, noise associated with construction may be controlled through planning condition or through discussions with the relevant authorities.

Due to the temporary nature of construction works, including the excavation and filling works associated with turbine bases, and the typically large distances between turbines and neighbouring receptors, noise levels associated with the erection of wind turbines are relatively low at receptor locations, and are rarely a cause for concern.

A construction noise assessment has been carried out at the closest residential property. It is assumed that if no impact occurs there, then no impact would occur at properties further away.

13.5.2 Operational Noise

Operational noise associated with the Proposed Development has been assessed in accordance with the requirements of the Department of the Environment, Heritage and Local Government Planning Guidelines on wind farm development (WEDG 2006).

It also incorporates the best practice described within the UK Institute of Acoustics document, 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (GPG) (IOA, 2013).

This section describes the procedures used to determine the relevant noise limits, including the collection of baseline noise data at measurement locations described herein, and the methodology to predict the expected turbine noise levels resulting from the Proposed Development. The predicted turbine noise levels are then compared with the applied limits at surrounding dwellings.

Predictions have been carried out for a range of turbine types to identify a worst-case candidate turbine where noise immissions (noise level received at receptor locations) are highest. Each candidate turbine emits different noise spectra which are attenuated by different amounts with distance from the source. Therefore, the turbine with the highest noise emission (noise level from the source) does not always necessitate the highest noise immissions.

The following candidate turbines have been assessed:

- Nordex N163 5.7MW with a 118.5 m hub height;
- Vestas V162 6.0MW with a 119 m hub height;
- SG 6.0-155 6.0MW with a 122.5 m hub height;
- Nordex N149 5.XMW with a 125.5 m hub height;

For each candidate turbine, tip heights are modelled as 200m with the hub heights dependent on the rotor diameter.

Noise predictions have been made for all the candidate turbines and the Nordex N163 5.6MW was found to have the highest noise emissions and immissions at *all* receptor locations and for *all* wind speeds so provides the most conservative candidate for the noise assessment. As such, it is not necessary to further assess the other candidate turbines.

Noise predictions have been carried out using ISO 9613 (International Oragnization for Standardization, 1996), as referred to within the IOA GPG. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e., worst case) conditions or long-term overall averages. The long-term averages have not been used here.

A supplementary term has been added to the methodology to allow for the effects of wind direction as discussed in the IOA GPG.

The propagation model calculates the predicted sound pressure level by taking the source sound power level for each turbine in separate octave bands and subtracting a number of attenuation factors according to the following:

Predicted Octave Band Noise Level = $L_W + D - A_{geo} - A_{atm} - A_{gr} - A_{bar} - A_{misc}$

These factors are discussed in detail below. The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

L_W - Source Sound Power Level

The assumed turbine locations for the Proposed Development are shown in Table 13-3.

Table 13-3: Turbine Locations

Turbine	Easting	Northing
T1	521909	583645
T2	521820	584122
T3	521304	583200
T4	521164	583642
T5	521201	584214
T6	520493	583186
T7	520532	583692
T8	520312	584085
T9	519746	582997
T10	519828	583554
T11	519030	582721
T12	519079	583259
T13	518641	583554
T14	518274	582399
T15	518326	582965
T16	517622	581933
T17	517644	582502

Table 13-4 shows octave band sound power levels at various integer standardised 10m height wind speeds (corrected from hub height using the reference ground roughness length of 0.05m) at a hub height of 118m for the Nordex N163 5.6MW turbine with +2dB uncertainty added.

Table 13-4: Source Sound Power Levels

Standardised 10m Height Wind Speeds (m/s)	Octave Band Centre Frequency (Hz)								
	63	125	250	500	1k	2k	4k	8k	Overall
4	83.5	91.0	94.9	96.5	96.2	93.0	87.0	77.8	102.0
5	86.6	93.9	98.8	101.3	101.9	98.8	88.8	80.8	106.8
6	90.7	98.0	102.9	105.4	106.0	102.9	92.9	84.9	110.9
7	91.0	98.3	103.2	105.7	106.3	103.2	93.2	85.2	111.2

Standardised 10m Height Wind Speeds (m/s)	Octave Band Centre Frequency (Hz)								
	63	125	250	500	1k	2k	4k	8k	Overall
8	91.5	97.7	101.9	105.2	106.6	104.2	95.4	86.6	111.2
9	91.5	97.7	101.9	105.2	106.6	104.2	95.4	86.6	111.2
10	91.5	97.7	101.9	105.2	106.6	104.2	95.4	86.6	111.2
11	91.5	97.7	101.9	105.2	106.6	104.2	95.4	86.6	111.2
12	91.5	97.7	101.9	105.2	106.6	104.2	95.4	86.6	111.2

The ETSU-R-97 noise limits assume that the wind turbine noise contains no audible tones. Where tones are present, a correction should be added to the measured or predicted noise level before comparison with the recommended limits.

D - Directivity Factor

The directivity factor allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measured in a downwind direction, corresponding to the worst-case propagation conditions considered here and needs no further adjustment except where this is covered by wind direction factors (see below).

Ageo - Geometrical Divergence

The geometrical divergence accounts for spherical spreading in the free-field from a point sound source resulting in an attenuation which depends on distance, according to:

$$A_{geo} = 20 \times \log(d) + 11$$

where d = distance from the turbine

A wind turbine may be considered as a point source beyond distances corresponding to one rotor diameter.

Aatm - Atmospheric Absorption

The atmospheric absorption accounts for the frequency dependant linear attenuation with distance over the frequency spectrum according to:

$$A_{atm} = d \times a$$

where a = the atmospheric absorption coefficient for the relevant frequency band

Published values of ‘a’ from ISO 9613 Part 1 have been used, corresponding to a temperature of 10°C and a relative humidity of 70%, which give relatively low levels of atmospheric attenuation, as given at Table 13-5 and according to the requirements of the IOA GPG.

Table 13-5: Atmospheric Absorption Coefficients

Octave Band Centre Frequency (Hz)	63	125	500	1k	2k	4k	8k
Atmospheric Absorption Coefficient (dB/m)	0.0001	0.0004	0.0010	0.0019	0.0037	0.0097	0.0328

Agr - Ground Effect

Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions.

The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete, and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation).

The IOA GPG recommends that the use of G = 0.5 and a receptor height of 4m in rural areas are appropriate assumptions for the determination of noise emission levels at receptor locations downwind of wind turbines, provided that an appropriate margin for uncertainty has been included within the source levels for the proposed turbine.

Accordingly, predictions in this report are based on G = 0.5 with a receptor height of 4m due to the conservatism in the sound power levels assumed here.

Abar - Barrier Attenuation

The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions.

The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of 2dB(A) should be allowed where the direct line of sight between the source and receiver is just interrupted and that 10dB(A) should be allowed where a barrier lies within 5m of a receiver and provides a significant interruption to the line of sight.

The effect of barrier attenuation has been included within the prediction model. A summary of the barrier attenuations assumed in the prediction are given at Table 13-6.

Table 13-6: Barrier Attenuation Corrections (dB)

Turbine	Property								
	R04	R06	R54	R56	R59	R64	R65	R72	R73
T1	-2	-2	-2	-2	-2	-2	-2	-2	0
T2	-2	-2	-2	-2	-2	-2	-2	-2	0
T3	-2	-2	-2	-2	-2	-2	-2	0	0
T4	-2	-2	-2	-2	-2	-2	-2	-2	0
T5	-2	-2	-2	-2	-2	-2	-2	-2	0
T6	-2	-2	-2	-2	-2	-2	-2	0	0
T7	-2	-2	-2	-2	-2	-2	-2	-2	0
T8	-2	-2	-2	-2	-2	-2	-2	-2	0
T9	0	0	0	-2	-2	-2	-2	0	0
T10	-2	-2	-2	-2	-2	-2	-2	-2	0
T11	0	0	0	-2	-2	-2	-2	0	0
T12	0	0	-2	-2	-2	-2	-2	0	0

Turbine	Property								
	R04	**R06**	**R54**	**R56**	**R59**	**R64**	**R65**	**R72**	**R73**
T13	-2	0	-2	-2	-2	-2	-2	-2	0
T14	0	0	0	-2	-2	0	-2	0	0
T15	0	0	0	-2	-2	-2	-2	0	0
T16	0	0	0	0	-2	0	-2	0	0
T17	0	0	0	-2	-2	0	-2	0	0
Turbine	**Property**								
	R93	**R109**	**R110**	**R115**	**R122**	**R129**	**R132**	**R144**	**R153**
T1	-2	-2	-2	-2	-2	-2	-2	-2	0
T2	-2	-2	-2	-2	-2	-2	-2	-2	0
T3	-2	-2	-2	-2	-2	-2	-2	-2	0
T4	-2	-2	-2	-2	-2	-2	-2	-2	0
T5	-2	-2	-2	-2	-2	-2	-2	-2	0
T6	-2	-2	-2	-2	-2	-2	-2	-2	0
T7	-2	-2	-2	-2	-2	-2	-2	-2	0
T8	-2	-2	-2	-2	-2	-2	-2	-2	0
T9	-2	0	0	-2	0	-2	-2	-2	0
T10	-2	-2	-2	-2	-2	-2	-2	-2	0
T11	-2	0	0	-2	0	-2	-2	-2	0
T12	-2	-2	0	-2	-2	-2	-2	-2	0
T13	-2	-2	-2	-2	-2	-2	-2	-2	0
T14	0	0	0	0	0	0	0	0	0
T15	-2	0	-2	-2	0	-2	-2	-2	0
T16	0	0	0	0	0	0	0	0	0
T17	-2	0	-2	0	0	0	0	0	0

Amisc - Miscellaneous Other Effects

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

Wind Direction Effects

Wind direction effects have not been included in these predictions. Properties are considered simultaneously downwind of all the turbines which, whilst not possible in practice, represents the most conservative approach in this regard.

Concave Ground Profile

Studies have shown that sound propagation across a valley or 'concave ground profile' can result in noise levels which are higher than predicted due to a reduced ground effect and/or the focussing effect of the ground shape.

Calculating the precise effect of this phenomenon is particularly difficult. However, a simplified approach to allow for it has been suggested in the IOA GPG. Paragraph 4.3.9 in the IOA GPG states that:

> *"A further correction of +3dB (or +1.5dB if using G=0.0) should be added to the calculated overall A-weighted noise level for propagation "across a valley", i.e. a concave ground profile, or where the ground falls away significantly, between the turbine and the receiver location. The following criterion of application is recommended:*
>
> $hm \geq 1.5.(abs\ (h_s - h_r)/2)$
>
> *where hm is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver respectively."*

The guidance also notes that:

> *"Care needs to be exercised when evaluating this condition, as small changes in distances and height may trigger (or not) the criterion when the actual situation has not changed significantly."* It is also evident that the criterion may also be triggered in situations where there is more than one valley between a particular source and receiver, where, in reality, the stated causes of the 'concave ground profile' effect could not occur.

An analysis of the ground profile between the proposed turbines and the neighbouring dwellings has been carried out and it was found that no such corrections were identified.

Assessment Approach – Operational Noise

Noise limits for wind energy developments are set out in WEDG 2006. Where cumulative noise levels from the Proposed Development acting together with the neighbouring proposed, consented, or operational developments are predicted to be above 35dB L_{A90} at 'rated' power at noise sensitive locations, baseline noise measurements are required to derive appropriate noise limits.

In this respect, baseline measurements have been undertaken at four locations as discussed in Appendix 13-3. The purpose of the background noise survey, described at Appendix 13-3, is to determine the existing noise environment at locations which are representative of the noise environment at properties neighbouring the Proposed Development.

Additional baseline noise data has been taken from Knocknamork EIA chapter which is the only site which presented background noise data for any of the relevant properties. The combination of these baseline noise datasets form the basis of the noise assessment in accordance with the guidance described in WEDG 2006 and ETSU, and are presented at 13.6 Baseline Conditions.

Where the limits are set relative to background noise levels, the background noise must not contain any contribution from existing wind turbines, and although not expressly stated, it is assumed that the relevant noise limits apply to cumulative noise from all wind turbines in the vicinity.

The derived prevailing background noise levels, over a range of wind speeds, are used to determine daytime and night-time noise limits according to the requirements of the WEDG 2006. Operational noise predictions are then compared with these derived noise limits. Since all the noise sensitive locations identified are residential properties, they are referred to as 'properties' in this chapter.

The neighbouring Knocknamork Wind Farm has a noise limit of 43dB L_{A90} or a maximum increase of +5dB above background noise, which applies daytime and night-time.

During the night-time (23:00 to 07:00), for the Proposed Development acting in combination with all existing and consented wind farms, the same noise limit which is imposed on the Knocknamork Wind Farm has been applied, which is also in accordance with WEDG 2006.

During the daytime (07:00 to 23:00), for the Proposed Development in combination with all existing and consented wind farms , background noise levels are all above 30dB L_{A90} and therefore a noise limit of 45dB L_{A90} has been applied in accordance with the noise limits stated in WEDG 2006.

Since the lowest cumulative noise limit for day or night-time is 43dB L_{A90}, any property with a predicted noise level from the Proposed Development less than 33dB L_{A90} is scoped out of assessment since the contribution from the Proposed Development will be at least 10dB below the noise limit, and this is considered negligible.

Table 13-1-1 of Technical Appendix 13-1 lists all the receptors which were considered and states whether they can be scoped out due to having a predicted noise level from the Proposed Development of less than 33dB L_{A90}.

For the properties not scoped out, noise limits which apply to the Proposed Development acting alone have been derived using the "Remaining Noise Budget" approach.

Using this methodology, the noise immisions from neighbouring wind farms are taken into account by subtracting (logarithmically) the predicted noise contribution from all neighbouring wind farms from the noise limit at each standardised 10m height integer wind speed from the cumulative noise limit.

The remaining values are the noise limit for Proposed Development acting alone, which ensure that cumulative predicted noise levels remain within the cumulative limits described above if the Proposed Development were to operate up to the remaining noise budget limit.

Predicted noise levels resulting from the Proposed Development over a range of wind speeds can then be compared with the derived remaining noise budget limits in order to assess significance.

Cumulative schemes in the area which have been assessed are Caherdowney, Clydaghroe, Coomacheo, Curragh, Gneeves (1 & 2), and Knocknamork. Details of the turbines and locations assumed for these cumulative schemes is given at Appendix 13-2.

Assessment Approach – Road Traffic Noise

In respect of road traffic noise, a doubling of road traffic would see a 3dB increase in the noise level at receptor locations, and it is considered that if the increase in road traffic noise during the construction phase is below 3dB, then no significant impacts will occur.

An assessment of changes in traffic noise on the wider road network has been undertaken by comparing existing road usage with planned vehicle use during the busiest three months of the construction period (months 1-3).

13.5.3 Significance Criteria

Construction (and Decommissioning Noise)

The noise limits prescribed within BS 5228 are designed to offer residents a reasonable level of protection with the regard to the typical short-term duration and typical noise levels associated with construction noise. In this case an assumed 65dB $L_{Aeq,12hr}$ daytime significance criterion has been adopted for the purposes of assessment.

Such assessments are applicable where properties are near to the construction site or access tracks.

At properties along the N22 near to the Proposed Development, road traffic and the associated change in noise level has been assessed in terms of the increase in noise levels over existing traffic flows. Increases of more than 3dB are described as significant, otherwise the noise levels will be described as not significant.

Operational Noise

For the purposes of this noise chapter significance is assessed in terms of whether the noise limits are met. For properties where noise from the Proposed Development is below the remaining noise budget noise limits, noise is considered to be not significant. Where noise exceeds these noise limits, the noise impact is considered to be significant.

The noise limits which apply to the Proposed Development are derived at 13.7.3 according to the approach described at 13.5.

13.6 Baseline Conditions

A noise survey to determine the existing noise environment at four measurement locations neighbouring the Proposed Development has been carried out according to the guidance within ETSU-R-97 and the IOA GPG. Details of this survey are provided at Appendix 13-3. The derived baseline noise data is given at Table 13-7 for night and daytime respectively.

Table 13-7: Derived Prevailing Background Noise, dB LA90

Location		Standardised 10 m Height Wind Speed (m/s)						
	Period	3	4	5	6	7	8	>9
NML1	Day	32.3	33.0	34.0	35.2	36.4	37.5	38.2
	Night	32.8	33.2	33.8	34.4	35.2	36.2	37.5
NML2	Day	36.1	36.3	36.9	37.6	38.4	39.1	39.7
	Night	37.1	36.8	36.7	36.8	37.3	38.4	40.3
NML3	Day	35.5	36.1	36.5	36.9	37.1	37.3	37.4
	Night	29.2	28.8	28.2	27.9	28.5	30.5	34.6
NML4	Day	32.5	33.2	34.4	35.9	37.6	39.5	41.3
	Night	32.9	33.2	33.7	34.4	35.6	37.5	40.3

In addition to this noise survey, baseline noise data has been taken from data provided from Knocknamork EIAR which describes measured background noise levels at H01, H05, H11. These are presented at Table 13-8.

Table 13-8: Derived Prevailing Background Noise, dB L_{A90}, as presented in Knocknamork EIAR

Location	Period	Standardised 10 m Height Wind Speed (m/s)							
		4	5	6	7	8	9	10	11
H01	Day	36.7	36.9	37.3	37.9	38.8	39.9	41.2	42.8
	Night	35.8	35.8	36.0	36.3	36.9	37.8	39.0	40.5
H05	Day	33.6	35.0	36.5	37.9	39.4	41.0	42.6	44.2
	Night	30.5	30.6	31.1	32.2	33.9	36.2	38.7	41.2
H11	Day	38.8	39.3	40.1	41.0	42.1	43.4	44.9	46.5
	Night	29.2	29.8	30.8	32.0	33.6	35.6	37.9	40.5

13.7 Assessment of Effects and Mitigation

13.7.1 Do-Nothing Scenario

If the development did not go ahead, residential properties assessed in this chapter would be subject to the same noise levels as at present. For the majority, wind farm noise is already a feature of the noise environment.

13.7.2 Construction Effects

Noise during the construction period will arise from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks.

Noise from vehicles on local roads and access tracks will also arise resulting from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

Increase in Traffic

The potential effect the increase in traffic has been assessed in terms of the increase in traffic noise at roadside locations, except where there is little traffic movement, in which case it has been assessed against the criteria in *BS 5228 Code of Practice for Noise and Vibration Control on Construction & Open Sites*.

According to the transport assessment undertaken as part of this EIA (presented in Chapter 7 of this EIAR), the overall increase in traffic volumes as a result of the construction of the Proposed Development would be less than 5% along the existing road network, with a corresponding increase in HGV traffic of 5%. Therefore, the contribution to the overall noise environment would be negligible and Non-Significant.

Access Track Construction

Property R52 is recessed from the road and is only 90m from the proposed access track at its closest point and has therefore been assessed against the ABC method in BS 5228. Predictions have been made of noise immissions at this location, using the methods prescribed in BS 5228.

This is on the basis of all construction works will occur during daytime hours (0700-1900) including Saturdays (0700-1300). The outline CEMP confirms that construction activities will be restricted to these hours and that if it is required to work outside of these hours, this will be agreed in advance with the Planning Authority.

In carrying out the predictions, it has been assumed that all plant involved with track construction is located at the nearest possible point to the property and is all operating at the same time. It should be noted that this is unlikely to occur in practice but gives worst case noise levels.

The plant assumed for access track construction is shown at Table 13-9 with assumed octave band sound power levels for each item. For the calculations, 100% soft ground attenuation has been used throughout with no topography or barrier attenuation.

Table 13-9: Sound Pressure Levels at 10m for Construction Plant, dB(Z)

Plant (BS 5228 Ref.)	Total (dBA)	Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Dozer 104kW (C.5_12)	77	80	78	71	70	74	68	65	61
Wheeled Backhoe Loader 62kW (C.2_8)	68	74	66	64	64	63	60	59	50
Tracked Excavator 27kW (C.5_35)	74	82	72	71	69	69	70	61	54
Dump Truck 669kW (C.9_16)	91	86	89	88	88	86	83	76	70
Road Roller (C.5_19)	80	87	85	75	73	75	73	69	63

The cumulative noise level from these plant at R52 is 69dB L_{Aeq} which is more than the daytime criterion of 65dB L_{Aeq} prescribed in BS 5228.

The track construction activities would be above this level for around 100m of track construction from the existing road towards the turbines. Track construction is usually completed at a rate of approximately 150m per 8-hour day, meaning that the levels would be above the criterion for only 5-6 hours.

The short duration of exposure results in an impact which is negligible and not significant in relation to the overall construction duration, and therefore this is not considered further.

Turbine Construction

The closest residential location (R153) is 550m to the nearest turbine, 400m to the nearest borrow pit, and 300m to the nearest access track. The second closest residential location (R34) is 1km from the nearest access track and at least 1.3km to the nearest borrow pit and turbine.

At these distances construction activities associated with turbine construction are unlikely to breach typical construction noise limits suggested within BS 5228 at the nearest noise sensitive receptor locations. This, combined with the temporary nature of the works, means that a detailed assessment of the construction noise impacts is not considered necessary.

As a result, this aspect of the Proposed Development is considered not significant. Noise barriers are not considered necessary.

Blasting at Borrow Pits

There may be a need for blasting in the process of creating borrow pits for the construction activities. In respect blasting and its potential effect on neighbours to site BS 5228 states that:

> *"Vibration and air overpressure from blasting operations is a special case and can under some circumstances give rise to concern or even alarm to persons unaccustomed to it. The adoption of good blasting practices will reduce the inherent and associated impulsive noise: prior warning to members of the public, individually if necessary, is important."*

BS 5228 also states that practical measures, including good blast design have been found to reduce air overpressure and/or vibration. Specifically:

- Ensuring appropriate burden to avoid over or under confinement of the charge;
- Accurate setting out and drilling;
- Appropriate charging;
- Appropriate stemming with appropriate material such as sized gravel or stone chippings;
- Using delay detonation to ensure smaller maximum instantaneous charges (mics);
- Using decked charges and in-hole delays;
- Blast monitoring to enable adjustment of subsequent charges;
- Designing each blast to maximize its efficiency and reduce the transmission of vibration; and
- Avoiding the use of exposed detonating cord on the surface to minimize air overpressure – if detonating cord is to be used in those cases where down-the-hole initiation techniques are not possible, it should be covered with a reasonable thickness of selected overburden.

The above factors will be included in the noise management plan for the construction works and a combination of minimising blasting activities and ensuring nearby residents are fully warned should mitigate any adverse impact from these activities which are high in sound and vibration energy but of very short duration.

Grid Connection Construction

The grid connection will consist entirely of underground cabling (UGC) with the majority of the UGC to be installed within internal forestry road networks.

The UGC works will consist of the installation of six ducts in an excavated trench to accommodate three power cables, two fibre communications cables to allow communications between the Proposed Developments substation and Ballyvouskil 220kV substation and one earth continuity conductor. Excavation, installation, and reinstatement takes approximately 1 day per 100 m section.

The equipment used is a 360° tracked excavator (13 ton normally, 22 ton for rock breaker) and a tracker dumper or tractor and trailer. The primary noise associated with the grid connection construction site is likely to come from machinery digging trenches for the high voltage cables to be laid into the ground.

The closest property to the grid construction route is located at 525463 583614 (ITM) which is approximately 700m from the grid connection construction site at its closest point. At this distance the predicted noise from the construction plant is 36dB which is well below the 65dB LAeq construction noise limits given in BS5228.

Table 13-10: Sound Pressure Levels at 10m for Grid Connection Plant, dB(Z)

Plant (BS 5228 Ref.)	Total (dBA)	Octave Band Centre Frequency (Hz) 63	125	250	500	1k	2k	4k	8k
360º tracked excavator 22 ton (C.4_64)	75	74	80	75	73	69	66	60	51
Tracked dumper (C.4_3)	76	84	81	74	73	72	68	61	53

13.7.3 Operational Effects

Derivation of Noise Limits

Since the results of all the baseline monitoring yielded background noise levels greater than 30dB L_{A90}, the fixed lower limit of 45dB L_{A90} or background +5dB applies during the daytime, and 43dB L_{A90} or background +5dB applies during the night-time.

The noise limits, stated at Table 13-11, take into account the existing noise levels from all other wind farms in the area (as described at 13.5) and ,thereby, show the noise limits that apply to the Proposed Development acting in isolation.

Table 13-11: Derived Remaining Noise Budget Limits

Location		Standardised 10 m Height Wind Speed (m/s)								
	Period	4	5	6	7	8	9	10	11	12
NML1	Day	44.9	44.8	44.5	44.3	44.1	44.0	44.0	44.0	44.0
	Night	42.9	42.7	42.1	41.7	41.4	41.3	41.3	41.3	41.3
NML2	Day	45.0	44.9	44.8	44.8	44.7	44.7	44.7	44.7	44.7
	Night	42.9	42.9	42.7	42.6	43.0	45.0	45.0	45.0	45.0
NML3	Day	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
	Night	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
NML4	Day	45.0	45.0	44.9	44.9	44.9	46.2	46.2	46.2	46.2
	Night	43.0	42.9	42.9	42.8	42.8	45.2	45.2	45.2	45.2
H01	Day	44.7	44.1	42.6	41.7	41.4	41.3	43.7	46.2	46.2
	Night	42.5	41.4	38.1	34.7	33.4	32.4	38.4	42.4	42.4
H05	Day	44.8	44.5	43.8	43.4	43.3	44.7	46.7	48.6	48.6
	Night	42.7	42.2	40.9	40.2	40.0	39.9	41.2	45.0	45.0

The noise limits which apply at each of the remaining properties are given at Table 13-12.

Table 13-12: Noise Limit which applies at each Property

Receptor	Easting	Northing	Limit which applies
R04	515824	583688	NML4
R06	517407	583968	NML2
R54	518425	580045	H05

Receptor	Easting	Northing	Limit which applies
R04	515824	583688	NML4
R06	517407	583968	NML2
R56	519150	580459	NML3
R59	519006	580401	NML3
R64	519554	580194	NML3
R65	519334	580811	H01
R72	516100	583529	NML4
R73	516133	583627	NML4
R93	517197	580297	NML3
R109	518519	579871	H05
R110	518227	579904	H05
R115	519190	580030	NML3
R122	518471	580092	H05
R129	517148	580188	NML3
R132	519290	580313	NML3
R144	519387	580106	NML3
R153	519142	583765	NML1

Table 13-13 and Table 13-14 present the remaining noise budget limits for each property.

Table 13-13: Daytime Remaining Noise Budget Limits, dB L_{A90}

Property	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R04	45.0	45.0	44.9	44.9	44.9	46.2	46.2	46.2	46.2
R06	45.0	44.9	44.8	44.8	44.7	44.7	44.7	44.7	44.7
R54	44.8	44.5	43.8	43.4	43.3	44.7	46.7	48.6	48.6
R56	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R59	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R64	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R65	44.7	44.1	42.6	41.7	41.4	41.3	43.7	46.2	46.2
R72	45.0	45.0	44.9	44.9	44.9	46.2	46.2	46.2	46.2
R73	45.0	45.0	44.9	44.9	44.9	46.2	46.2	46.2	46.2
R93	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R109	44.8	44.5	43.8	43.4	43.3	44.7	46.7	48.6	48.6
R110	44.8	44.5	43.8	43.4	43.3	44.7	46.7	48.6	48.6
R115	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R122	44.8	44.5	43.8	43.4	43.3	44.7	46.7	48.6	48.6
R129	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R132	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R144	44.9	44.8	44.5	44.4	44.4	44.4	44.4	44.4	44.4
R153	44.9	44.8	44.5	44.3	44.1	44.0	44.0	44.0	44.0

Table 13-14: Night-time Remaining Noise Budget Limits, dB LA90

Property	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R04	43.0	42.9	42.9	42.8	42.8	45.2	45.2	45.2	45.2
R06	42.9	42.9	42.7	42.6	43.0	45.0	45.0	45.0	45.0
R54	42.7	42.2	40.9	40.2	40.0	39.9	41.2	45.0	45.0
R56	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R59	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R64	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R65	42.5	41.4	38.1	34.7	33.4	32.4	38.4	42.4	42.4
R72	43.0	42.9	42.9	42.8	42.8	45.2	45.2	45.2	45.2
R73	43.0	42.9	42.9	42.8	42.8	45.2	45.2	45.2	45.2
R93	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R109	42.7	42.2	40.9	40.2	40.0	39.9	41.2	45.0	45.0
R110	42.7	42.2	40.9	40.2	40.0	39.9	41.2	45.0	45.0
R115	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R122	42.7	42.2	40.9	40.2	40.0	39.9	41.2	45.0	45.0
R129	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R132	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R144	42.9	42.7	42.3	42.1	42.0	42.0	42.0	42.0	42.0
R153	42.9	42.7	42.1	41.7	41.4	41.3	41.3	41.3	41.3

Noise Predictions

Table 13-15 shows the downwind predicted noise levels associated with the Proposed Development acting in isolation. Figure 13-1 shows the predicted noise contours for the Proposed Development at 7m/s where the maximum noise emissions occur for the candidate turbine. Figure 13-2 shows the predicted noise contours for the Proposed Development acting cumulatively with the other sites in the area at 7m/s.

It should be noted that the predicted noise levels are presented for downwind propagation conditions, and that for conditions other than downwind, operational noise levels would be lower.

Table 13-15: Predicted Noise Levels from the Proposed Development, dB LA90

Receptor	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R04	24.9	29.1	33.2	33.5	33.0	33.0	33.0	33.0	33.0
R06	31.1	35.6	39.7	40.0	39.6	39.6	39.6	39.6	39.6
R54	25.4	29.7	33.8	34.1	33.6	33.6	33.6	33.6	33.6
R56	25.7	29.9	34.0	34.3	33.8	33.8	33.8	33.8	33.8
R59	25.2	29.5	33.6	33.9	33.3	33.3	33.3	33.3	33.3
R64	24.7	28.9	33.0	33.3	32.7	32.7	32.7	32.7	32.7
R65	26.7	31.0	35.1	35.4	34.9	34.9	34.9	34.9	34.9
R72	26.4	30.7	34.8	35.1	34.6	34.6	34.6	34.6	34.6
R73	26.7	31.0	35.1	35.4	34.9	34.9	34.9	34.9	34.9
R93	25.3	29.6	33.7	34.0	33.5	33.5	33.5	33.5	33.5

Receptor	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R109	24.7	28.9	33.0	33.3	32.7	32.7	32.7	32.7	32.7
R110	24.6	28.8	32.9	33.2	32.7	32.7	32.7	32.7	32.7
R115	24.4	28.6	32.7	33.0	32.4	32.4	32.4	32.4	32.4
R122	25.6	29.9	34.0	34.3	33.8	33.8	33.8	33.8	33.8
R129	25.0	29.3	33.4	33.7	33.2	33.2	33.2	33.2	33.2
R132	25.4	29.6	33.7	34.0	33.5	33.5	33.5	33.5	33.5
R144	24.5	28.7	32.8	33.1	32.5	32.5	32.5	32.5	32.5
R153	39.4	44.1	48.2	48.5	48.2	48.2	48.2	48.2	48.2

Comparison of Noise Limits and Predictions

Table 13-16 and Table 13-17 show the margin of compliance between the Proposed Development and the noise limits given at Table 13-13 and Table 13-14. Where there are exceedances of the noise limits they are shown as negative numbers with red text.

Table 13-16: Margin of Compliance of the Proposed Development with Daytime Noise Limits, dB

Receptor	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R04	20.1	15.8	11.7	11.4	11.9	13.2	13.2	13.2	13.2
R06	13.9	9.3	5.1	4.8	5.2	5.1	5.1	5.1	5.1
R54	19.4	14.8	10.0	9.4	9.8	11.2	13.2	15.1	15.1
R56	19.3	14.9	10.5	10.1	10.6	10.6	10.6	10.6	10.6
R59	19.7	15.3	11.0	10.6	11.1	11.1	11.1	11.1	11.1
R64	20.3	15.9	11.6	11.2	11.7	11.7	11.7	11.7	11.7
R65	18.0	13.1	7.5	6.2	6.5	6.4	8.8	11.3	11.3
R72	18.6	14.3	10.1	9.8	10.3	11.6	11.6	11.6	11.6
R73	18.3	14.0	9.8	9.5	10.0	11.3	11.3	11.3	11.3
R93	19.6	15.2	10.8	10.4	10.9	10.9	10.9	10.9	10.9
R109	20.2	15.6	10.8	10.2	10.6	12.0	14.0	15.9	15.9
R110	20.2	15.7	10.9	10.2	10.7	12.0	14.1	15.9	15.9
R115	20.5	16.2	11.9	11.4	11.9	11.9	11.9	11.9	11.9
R122	19.2	14.6	9.8	9.2	9.6	11.0	13.0	14.9	14.9
R129	20.0	15.5	11.2	10.8	11.2	11.2	11.2	11.2	11.2
R132	19.5	15.2	10.8	10.4	10.9	10.9	10.9	10.9	10.9
R144	20.4	16.1	11.8	11.3	11.8	11.8	11.8	11.8	11.8
R153	5.5	0.7	-3.7	-4.2	-4.1	-4.2	-4.2	-4.2	-4.2

Table 13-17: Margin of Compliance of the Proposed Development with Night-time Noise Limits, dB

Receptor	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R04	18.1	13.8	9.6	9.3	9.8	12.2	12.2	12.2	12.2
R06	11.8	7.3	3.0	2.6	3.4	5.5	5.5	5.5	5.5

Receptor	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
R54	17.3	12.5	7.1	6.1	6.4	6.3	7.7	11.4	11.4
R56	17.2	12.7	8.2	7.7	8.2	8.2	8.2	8.2	8.2
R59	17.7	13.2	8.7	8.2	8.7	8.7	8.7	8.7	8.7
R64	18.2	13.8	9.3	8.8	9.3	9.3	9.3	9.3	9.3
R65	15.8	10.4	3.0	-0.7	-1.6	-2.5	3.5	7.5	7.5
R72	16.6	12.2	8.1	7.7	8.2	10.6	10.6	10.6	10.6
R73	16.3	11.9	7.8	7.4	7.9	10.3	10.3	10.3	10.3
R93	17.6	13.1	8.5	8.0	8.5	8.5	8.5	8.5	8.5
R109	18.1	13.3	7.9	6.9	7.2	7.1	8.5	12.2	12.2
R110	18.1	13.4	7.9	7.0	7.3	7.2	8.5	12.3	12.3
R115	18.5	14.1	9.6	9.1	9.5	9.5	9.5	9.5	9.5
R122	17.1	12.3	6.9	5.9	6.2	6.1	7.5	11.2	11.2
R129	17.9	13.4	8.9	8.4	8.8	8.8	8.8	8.8	8.8
R132	17.5	13.0	8.5	8.0	8.5	8.5	8.5	8.5	8.5
R153	3.5	-1.4	-6.1	-6.7	-6.8	-7.0	-6.9	-6.9	-6.9

During the daytime, predicted operational noise levels comply with the noise limits at all properties, except R153 where noise limits are exceeded at wind speeds greater than or equal to 6m/s and by up to 4.2dB.

During the night-time, predicted operational exceedances occur for wind speeds greater than or equal to 5m/s at R153 and at 7-9m/s at R65. Exceedances at R153 are up to 7dB.

Operational noise impacts are considered to be not significant where the derived noise limits are not exceeded. Operational noise is therefore only significant at R65 during the night-time and R153 during the day and night-time.

Road Traffic Noise

There will be no significant noise impacts from road traffic noise during the operational phase of the wind farm.

There will be a wind farm access track near to R52. Whilst the wind farm is operational, service vehicles can be expected to use this track to access the wind farm. The effect on the property could be considered negligible as it would only occasionally be audible outside the property as vehicles infrequently pass, generally only during working hours.

13.7.4 Decommissioning Effects

Noise will arise during decommissioning from the removal of the turbines and breaking of the exposed part of the concrete bases. Noise associated with these activities will have high peak levels, like the blasting described in construction effects, but these levels will be brief and occur at large distances from properties where the effects are considered to be negligible.

The potential short-term breaches of the BS 5228 noise level at R52 during the construction phase due to construction of the access track will not occur during the decommissioning phase since the track will remain after decommissioning. Other than this, road traffic and construction traffic noise levels will be expected to increase to the same degree as during the construction phase which will have negligible impact on any of the properties.

13.7.5 Cumulative Effects

There are no other known construction projects in the area which would add cumulatively to noise levels at the properties in the vicinity of the Proposed Development during construction.

The derived noise limits have taken into account cumulative operational noise levels such that a cumulative operational noise impact assessment is inherent in the assessment, as required by the guidance, which assumes that limits apply to cumulative noise.

13.8 Proposed Mitigation

13.8.1 Construction Noise

No significant effects have been identified in respect of construction noise; therefore, no mitigation is required. However, the following section presents best practice control measures for construction noise that will be implemented during the construction phase.

Best Practice Control Measures for Construction Noise

In accordance with established best practice voluntary control measures are proposed including the use of quiet plant, work within defined hours, and timing of construction traffic/deliveries.

BS 5228 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authorities will be required along with providing information to residents on intended activities.

The construction works on-site will be carried out in accordance with:

- EC noise limits for certain items of construction equipment as listed in BS5228 that limit noise emissions from a variety of construction plant; and
- The guidance set out in BS 5228: 2009;

Potential breaches of the BS 5228 noise limit may occur for 4-5 hours (during the whole project) at R52. The small timeframe means that the breaches are not considered significant.

The use of construction plant with quieter noise levels than those assumed as part of this assessment would be considered to further reduce the risk of disturbance.

A noise control plan will be produced that includes:

- Procedures for ensuring compliance with statutory or other identified noise control limits;
- Procedures for minimising noise from construction related traffic on the existing road network;
- Procedures for ensuring that all works are carried out in accordance with the principle of "Best Practicable Means"; and

- General induction training for site operatives, and specific training for staff having responsibility for particular aspects of controlling noise from the site.

A pre-blasting noise management programme to be prepared (in the event that blasting is required) which would identify the most sensitive receptors that could be potentially affected by blasting noise. The programme will contain details of the proposed frequency of blasting, and proposed monitoring procedures.

The operator will inform the nearest residents of the proposed times of blasting and of any deviation from this programme in advance of the operations. The programme will also contain contact details which will be provided to local residents should concerns arise regarding construction and blasting activities.

In addition, each blast will be designed carefully to maximise its efficiency and to reduce the transmission of noise.

Any planned deliveries during night-time and/or other sensitive hours have the potential to wake or disturb the residents of neighbouring properties. As a result, any such events, if unavoidable, will be agreed with the local authority dealing with the development and residents will be kept informed of these activities prior to any night-time deliveries taking place.

Use of noise barriers is not considered necessary for reducing the noise impact for any of these activities as the relevant limits are predicted to be met.

In planning the construction site layout the contractor will ensure that a 'good housekeeping' policy is applied at all times and as far as reasonably practicable.

This includes utilising existing hedges, tree screens and the topography to screen construction sites. Temporary earth mounding or other temporary screening will also be included, where appropriate, within the confines of land take for construction sites.

13.8.2 Operational Noise

Mitigation is required as predicted noise levels from the Proposed Development, when assuming unrestricted operation, do not meet the derived limits at R65 during the night-time and at R153 during day and night-time. It should be noted that, for the candidate turbine considered, it is possible to mitigate the turbines to meet the noise limits without requiring any turbines to be shut down, but by use of noise reduced operation modes.

A curtailment strategy which ensures predicted noise levels meet the noise limits is given at Table 13-18 and Table 13-19 for daytime and night-time respectively. The sound power levels associated with these reduced noise operation modes are given at Appendix 13-4.

The curtailment strategy is specific to this model of turbine. If a different candidate turbine is built, a different curtailment strategy would need to be derived.

Table 13-18: Curtailment Modes Required to Meet Daytime Noise Limits

Turbine	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
T9	0	0	3	5	4	5	5	5	5
T10	0	0	10	10	10	10	10	10	10
T11	0	0	2	4	3	3	3	3	3
T12	0	0	14	15	15	15	15	15	15

Turbine	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
T13	0	0	13	14	14	14	14	14	14
T15	0	0	0	1	0	1	1	1	1

Table 13-19: Curtailment Modes Required to Meet Night-time Noise Limits

Turbine	Standardised 10m Height Wind Speed								
	4	5	6	7	8	9	10	11	12
T6	0	0	2	4	4	5	5	5	5
T7	0	0	4	6	6	6	6	6	6
T8	0	0	7	9	9	10	10	10	10
T9	0	0	10	10	10	11	11	11	11
T10	0	0	15	16	17	18	18	18	18
T11	0	0	10	10	10	10	10	10	10
T12	0	12	18	18	18	18	18	18	18
T13	0	12	18	18	18	18	18	18	18
T14	0	0	0	2	1	2	2	2	2
T15	0	0	9	10	10	10	10	10	10

13.8.3 Decommissioning Noise

No significant effects have been identified in respect of noise associated with the decommissioning of the Proposed Development.

13.8.4 Residual Effects

Construction Noise

Construction noise and associated traffic will be audible at some of the residential receptors neighbouring the site and located along the proposed access routes for certain periods during the construction phase.

However, even during the most intensive periods of deliveries to the construction site it is unlikely that noise limits (i.e., those specified within BS 5228) would be breached at distances greater than 250m, particularly for typical daytime periods, due to the sporadic and intermittent nature of the noise from vehicles passing the neighbouring properties and the slow speeds at which HGVs will pass the properties.

At the property less than 250m from the construction access track there is potential for a breach of the BS 5228 noise limit but only for a short period of up to one working day. Therefore, the residual effect of construction noise on all sensitive receptors is considered to be not significant.

Due to the large distances between the grid connection cabling route and the nearest properties.

Operational Noise

The potential impacts that could arise from the Proposed Development during the operational phase relates to increases in noise caused by the operational wind turbines.

This chapter has considered a range of candidate turbines as described at 13.5.2. The noisiest turbine was identified, and this model was used for the assessment. Predicted wind farm operational noise levels for the Proposed Development are below the derived daytime and night-time noise limits at all properties except for R153 for day and night-time and at R65 for night-time.

Provided the noise limits are met, by implementation of a suitable mitigation scheme tailored to the specific turbine, there will be no change to the potential impacts or predicted effects, irrespective of the candidate turbine selected.

Since all other candidate turbines have lower predicted noise levels than the Nordex N163 which was assessed, the exceedances of the noise limits for other candidate turbine will be lower. Therefore, the other candidate turbines in the range would require less noise mitigation to meet the noise limits.

13.9 Summary and Statement of Significance

Noise from construction works related to the Proposed Development are assessed as being not significant due to the large separation distances between properties and the construction site.

Although noise from access track construction may temporarily breach limits prescribed in BS 5228 at one property, the duration over which it may do so and would not result in a significant impact.

With an appropriate mitigation scheme, operational noise from the Proposed Development is not considered significant at any of the properties assessed as the relevant derived noise limits will be met.

13.10 References

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