12. NOISE AND VIBRATION

12.1 INTRODUCTION

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impacts and effects associated with the proposed project.

The proposed project is subject to two planning applications, one for the Ballyfasy Wind Farm and onsite substation and a separate planning application for two grid connection options. The first application is for the proposed wind farm and on-site 110 kV substation along with the works on private lands along the proposed TDR. The second application is for the proposed grid connection. This EIAR assesses the project as a whole and will be presented with both planning applications which will be submitted in parallel to An Coimisiún Pleanála. The proposed project comprises:

- a wind farm of 10 no. turbines and ancillary infrastructure such as turbine foundations, hardstanding areas, borrow pits and access roads;
- An onsite 110 kV substation;
- Grid Connection Options (GCO) (two options being considered); and
- Works on the proposed Turbine Delivery Route (TDR).

A full description of the proposed project is provided in Chapter 2 (Description of the Proposed Project).

Noise and vibration impact assessments have been prepared for the operational, construction, and decommissioning phase of all options and ranges of the proposed project to the nearby noise sensitive locations (NSLs). To inform this assessment noise levels have been surveyed at six representative NSLs in the receiving environment. Noise predictions for the nearest NSLs have been prepared for all key elements of the proposed project that have the potential for noise and vibration impacts and effects.

12.1.1 Statement of Authority

This chapter of the EIAR has been prepared by the following staff of AWN Consulting Ltd:

Dermot Blunnie (Associate (Acoustics)) holds a BEng (Hons) in Sound Engineering, MSc in Applied Acoustics and has completed the Institute of Acoustics (IOA) Diploma in Acoustics and Noise Control. He has been working in the field of acoustics since 2008 and is a member of the Institute of Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA). He has extensive knowledge and experience in relation to commissioning noise monitoring and impact assessment of wind farms as well as a detailed knowledge of acoustic standards and proprietary noise modelling software packages. He has commissioned noise surveys and completed noise impact assessments for numerous wind farm projects within Ireland.

Miguel Cartuyvels (Acoustic Consultant) holds a BEng (Hons) in Industrial Engineering and is a member (TechIOA) of the Institute of Acoustics. Miguel has worked in the field of acoustics since 2021, where he has contributed to numerous projects related to environmental surveying, noise modelling, and impact assessment for various sectors, including wind energy, industrial, commercial, and residential.

Donogh Casey (Senior Acoustic Consultant) has been working in the field of acoustics since 2018. He has completed the Institute of Acoustics Diploma in Acoustics and Noise Control and is currently a member of the Institute of Acoustics. has extensive experience in all aspects of building acoustic design, as well as acoustic commissioning testing and environmental surveying. Mike Simms (Principal Acoustic Consultant) holds a BE and MEngSc in Mechanical Engineering and is a member of the Institute of Acoustics (MIOA) and of the Institution of Engineering and Technology (MIEI). Mike has worked in the field of acoustics for over 20 years. He has extensive experience in all aspects of environmental surveying, noise modelling and impact assessment for various sectors including, wind energy, industrial, commercial, and residential.

12.1.2 Fundamentals of Acoustics

A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. To take account of the enormous range of pressure levels that can be detected by the ear, it is widely accepted that sound levels are measured and expressed using a decibel scale i.e., a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels (SPL) in decibels (dB).

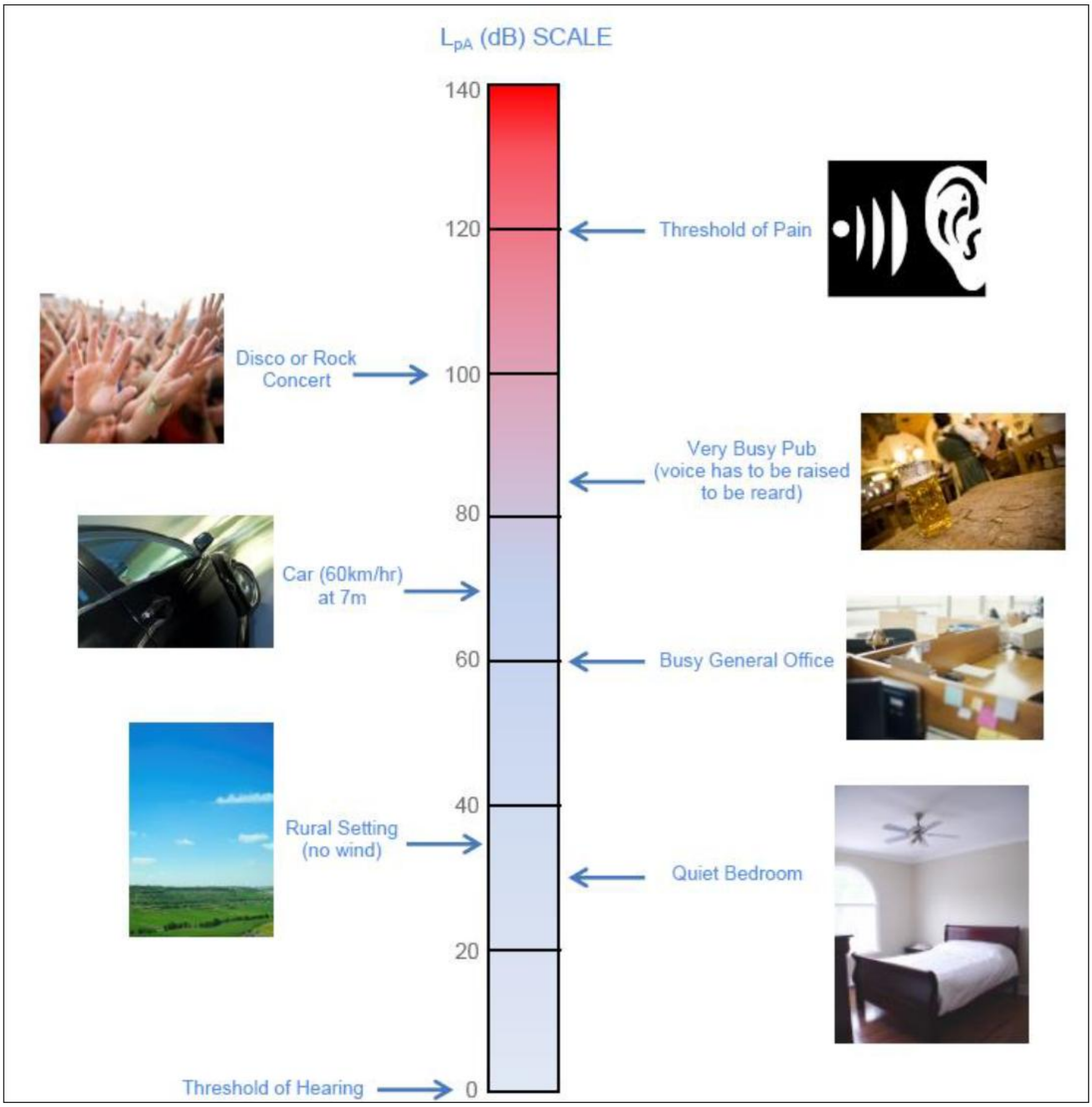
The audible range of sounds expressed in terms of Sound Pressure Levels is 0 dB (for the threshold of hearing) to 120 dB (for the threshold of pain). In general, a subjective impression of a doubling of loudness corresponds to a tenfold increase in sound energy, which equates to a 10 dB increase in SPL. It should be noted that a doubling in sound energy, such as may be caused by a doubling of traffic flows, will increase the SPL by 3 dB. This results in the subjective impression of a slight increase in noise level.

The frequency of sound is the rate at which a sound wave oscillates is expressed in Hertz (Hz). The sensitivity of the human ear to different frequencies in the audible range is not uniform. For example, hearing sensitivity decreases markedly as frequency falls below 250 Hz. To rank the SPL of various noise sources, the measured level must be adjusted to give comparatively more weight to the frequencies that are readily detected by the human ear. The 'A-weighting' system defined in the international standard, BS ISO 226:2003 Acoustics. Normal Equal-loudness Level Contours has been found to provide the best correlations with human response to perceived loudness. SPLs measured using 'A-weighting' are expressed in terms of dB(A).

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 12-1.

For a glossary of terms used in this chapter please refer to Appendix 12-1 (Glossary of Acoustic Terminology).

Figure 12-1: dB(A) Scale & Indicative Noise Levels – (EPA NG4 – 2016))



12.1.3 Consultation

During the consultation process, feedback regarding the assessment of noise and vibration was noted by Kilkenny Council County, HSE, and Transport Infrastructure Ireland (TII). The points relating to noise and vibration in each of these submissions was general and they have been covered in the assessment and preparation of the Noise and Vibration Chapter for this EIAR. No changes to the standard assessment methodology were required to address the consultation feedback received. Refer to Chapter 1 (Introduction) for full details of consultations.

12.1.4 Difficulties Encountered During Preparation of This Chapter

There were no difficulties or limitations encountered when undertaking this assessment.

12.1.5 Legislation, Policy and Guidance

The assessment of effects for the proposed project has been undertaken in compliance with the applicable guidance documents relating to environmental noise and vibration. The following guidance documents have been consulted when preparing this chapter of the EIAR:

- *EPA Guidelines on the Information to be contained in Environmental Impact Statements, (EPA, 2022);*
- *Wind Energy Development Guidelines for Planning Authorities, Department of the Environment, Heritage, and Local Government (2006);*
- *The Assessment and Rating of Noise from Wind Farms, Department of Trade, and Industry (UK) Energy Technology Support Unit (ETSU) (1996);*
- *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise and its Supplementary Guidance Notes (IOA GPG) (2013);*
- *Guidelines for the Treatment of Noise and Vibration in National Road Schemes, Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA) (2004).*
- *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes, Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA) (2014);*
- *British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise;*
- *British Standard BS 5228-2:2009+A1:2014 Code of practice for vibration control on construction and open sites – Vibration;*
- *British Standard BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (BSI, 1993);*
- *Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (National England (now National Highways) 2020);*
- *Calculation of Road Traffic Noise (CRTN, UK Department of Transport, 1988)*
- *ISO 1996: 2017: Acoustics – Description, measurement, and assessment of environmental noise;*
- *EPA document Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) (EPA, 2011);*
- *EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (EPA, 2016);*

General context guidance has also been considered although not directly applied:

- *World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018);*
- *Draft Revised Wind Energy Development Guidelines 2019 Department of Housing, Local Government and Heritage (2019 draft WEDGs);*
- *Department for Business, Energy & Industrial Strategy Wind Turbine AM Review: Phase 2 Report Project Number: 3514482A Issue: 3 Issued August 2016; and,*
- *International Electrotechnical Commission (IEC) Technical Specification 61400-11-2 (Edition 1.0, 2024) Wind Energy Generation Systems – Part 11-2: Acoustic noise measurement techniques – Measurement of wind turbine sound characteristics in receptor position.*

12.1.6 Description of Effects

The significance of effects of the proposed project are described in the relevant sections of this chapter in accordance with the EPA guidance document *Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EIAR), (2022). Details of the methodology for describing the significance of the effects associated with the proposed project are provided in Chapter 1 (Introduction) of the EIAR.

12.1.7 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to wind energy developments and confirms the proposed criteria and assessment thresholds for the noise and vibration.

12.1.7.1Construction and Decommissioning Phase – Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction or decommissioning phase of a project. Local authorities normally control construction activities by imposing limits on the hours of operation and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels for a development of this scale may be found in the British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise (BS5528-1). This standard is commonly accepted and used in Ireland.

The approach adopted here calls for the designation of an NSL into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. A threshold noise value is applied to each category. Exceedances (construction noise only) of the threshold value, at the facade of a noise-sensitive location (NSL) during construction, indicates a potential significant noise impact associated with the construction activities. The threshold values recommended by BS5228-1 are depicted in Table 12-1. The threshold values are applicable to both construction and decommissioning noise. It should be noted that this assessment method is only valid for residential properties.

Table 12-1: Threshold of Potential Significant Effect at Dwellings

Assessment category and threshold value period (T)	Threshold value, in $L_{Aeq,T}$ dB		
	Category A [Note A]	Category B [Note B]	Category C [Note C]
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends [Note D]	55	60	65
Daytime (07:00 – 19:00hrs) and Saturdays (07:00 – 13:00hrs)	65	70	75

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.
Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.
Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.
Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The following method has been applied in the assessment.

For each period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5 dB. At some properties, particularly those located close to busy roads, the ambient noise levels are expected to be relatively high. However, given the rural nature of the site in general, reference has been made to the quietest properties near the development which have daytime ambient noise levels typically in the range of 30 to 55 dB $L_{Aeq,1hr}$. Therefore, for the purposes of this assessment, as a worst case, all properties will be afforded a Category A designation.

If the specific construction noise level exceeds the category threshold value (e.g., 65 dB $L_{Aeq,T}$ during daytime periods) then a significant effect is considered to occur. To determine the significance of the effects it is important to consider the duration of the impacts, which is discussed in Section 12.1.7.3.

12.1.7.1.1 Linear Activities – Noise

Due to the linear progressive nature of the construction works associated with access road and, cabling and grid connection route, a fixed noise limit is proposed for the purpose of the assessment. This is deemed appropriate in that noise from associated construction activities is variable and typically occurs for a short period of time only and is at its highest when closest to the NSL. As the works progress, construction noise levels at the NSL will reduce due to the works taking place at greater distances, resulting overall in a shorter duration of exposure to noise impacts.

In relation to an appropriate fixed noise limit value, BS 5228-1 paragraph E.2 states:

"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut."

Paragraph E.2 goes on to state:

"*Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:*

- *70 decibels (dBA) in rural, suburban areas away from main road traffic and industrial noise;*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas*".

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004) proposes daytime period (Monday to Friday 0700 – 1900 hrs) construction noise limits of 70 dB $L_{Aeq,1hr}$.

Considering the above guidance, a construction noise limit of 70 dB $L_{Aeq,1hr}$ is proposed for linear construction activities (i.e. access road and, cabling and grid connection route). Noise levels above 70 dB $L_{Aeq,1hr}$ would indicate a significant impact depending on the duration and frequency of occurrence.

12.1.7.2Additional Traffic on Public Roads - Construction Phase

There are no specific guidelines or limits relating to traffic related sources along the local or surrounding roads. Given that traffic from the proposed project will make use of existing roads already carrying traffic volumes, it is appropriate to assess the calculated increase in traffic noise levels that will arise because of vehicular movements associated with the proposed project.

In the absence of any national guidelines in Ireland for the assessment of potential noise impacts from construction related traffic along public roads, it is proposed to adopt UK guidance from National Highways (formerly Highways England) Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA 111 Noise and Vibration (Revision 2) (DMRB).

Table 12-2 taken from DMRB LA 111 2020 offers guidance as to the likely short-term impact associated with any change in traffic noise level.

Table 12-2: Likely Impacts Associated with Change in Traffic Noise Level

Change in Sound Level (dB)	Magnitude of Impact
Less than 1 dB	No change
1 – 2.9	Minor
3 – 4.9	Moderate
≥5	Major

The DMRB guidance will be used to assess the predicted increases in traffic levels on public roads associated with the proposed project (this includes the Turbine Delivery Route) and comment on the likely 'short-term' impacts during the construction phase. Where a major or moderate impact is identified due to the change in traffic noise level, reference will be made to the overall predicted noise level from construction traffic in the context of the construction noise threshold values outlined previously in this section.

12.1.7.3Consideration of Duration When Assessing Effects

Section 3.19 of LA 111, DMRB states that construction noise and construction traffic noise shall constitute a significant effect where it is determined that a major or moderate magnitude of impact will occur for a duration exceeding:

- 10 or more days or nights in any 15 consecutive days or nights; or,
- A total number of days exceeding 40 in any 6 consecutive months.

12.1.7.4Construction and Decommissioning Phase – Vibration

Vibration standards distinguish between two key areas: those concerned with human comfort and those addressing cosmetic or structural damage to buildings. With respect to this proposed project, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

Guidance relevant to acceptable vibration within buildings is contained in the following standards:

- BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration (BSI, 1993) (BS7385).
- BS 5228-2:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration (BSI, 2014) (BS5228-2).

BS7385 states that there should typically be no cosmetic damage if transient vibration does not exceed 15 mm/s at 4 Hz rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These guidelines relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS5228-2 recommends that, for soundly constructed residential properties and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e., non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above 15 Hz. Below these vibration magnitudes minor damage is unlikely, although the standard notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are excited within structures the limits discussed above may need to be reduced by 50%.

The Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) publication *Guidelines for the Treatment of Noise and Vibration in National Road Schemes* (2004) also contains information on the permissible construction vibration levels during the construction phase as shown in Table 12-3.

Table 12-3: Allowable Vibration at Sensitive Properties (NRA, 2004)

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of:		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Following review of the suggested vibration criteria discussed above from BS7385, BS5228-2 and the NRA Guidelines, the values in Table 12-3 from the NRA Guidelines are appropriate for this assessment.

12.1.7.5Operational Phase Noise – Wind Turbines

The noise assessment documented in this chapter complies with guidance relating to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines for Planning Authorities* (WEDG) published by the Department of the Environment, Heritage and Local Government in 2006. The WEDG are broadly in line with the recommendations set out in the Department of Trade and Industry (UK) Energy Technology Support Unit (ETSU) publication *The Assessment and Rating of Noise from Wind Farms* (1996) (ETSU-R-97). The ETSU document has been used to supplement the guidance contained within the WEDGs, where appropriate and necessary.

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

The core of the noise guidance contained within the WEDGs is broadly based on the ETSU publication ETSU-R-97 however the turbine noise limits values are slightly different.

ETSU-R-97 advises regulating wind turbine noise by establishing noise limits at the properties most sensitive to noise. The document suggests that applying fixed noise limits across all wind speeds may not be appropriate for wind turbine projects. Instead, it recommends setting noise limits in relation to the prevailing background noise levels at sensitive locations. A crucial step in assessing noise for wind energy projects involves identifying the existing background noise levels through on-site surveys.

Page 58 of ETSU-R-97 states: "*…absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question…*". Therefore, the noise contribution from all wind turbine development in the area should be included in the assessment.

The ETSU-R-97 guidance allows for a higher level of turbine noise operation at properties that have an involvement in the development, both as a higher fixed level of 45 dB L_{A90} and/or a higher level above the prevailing background noise level.

12.1.7.5.2 Institute of Acoustics Good Practice Guide (IOA GPG)

The original ETSU-R-97 concepts underwent a thorough standardisation and modernisation in 2013 with the Institute of Acoustics publication of the *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* (IOA GPG) including 6 Supplementary Guidance Notes. These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described including the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG is considered to represent best practice and has been adopted for this assessment.

The IOA GPG states, that at a minimum continuous background noise monitoring should be carried out for typically a two-week period and should capture a representative sample of wind speeds in the area (i.e., from cut in speeds to the wind speed that generate the highest sound power output from the proposed turbine(s)). Background noise measurements (i.e., $L_{A90,10min}$) should be related to wind speed measurements that are collated at the site of the wind turbine development. Regression analysis is used on the data sets to calculate background noise levels at different wind speeds; the resulting background noise curve can be used to establish appropriate turbine noise criteria at each location.

The noise levels associated with the wind turbines are predicted in accordance with ISO 9613-2:2024: *Acoustics — Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors* (Hereafter ISO 9613-2). This is a noise prediction standard that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. Noise predictions and contours are typically prepared for various wind speeds, and the predicted levels are compared against the relevant noise criterion curve to demonstrate compliance with the appropriate noise criteria.

Where noise predictions indicate that reductions in noise emissions are required to satisfy any adopted criteria, consideration can be given to detailed downwind analysis and operating turbines in low noise mode, which is an option on modern wind turbines.

For guidance on the methodology for the background noise survey and operation impact assessment for wind turbine noise, the IOA GPG has been adopted.

The IOA GPG states that cumulative noise exceedances should be avoided and where existing or permitted development is at the noise limit, any new turbine noise sources should be designed to be 10 dB below the limit value. This guidance will be applied when considering potential cumulative impacts from any other existing permitted or proposed wind farms in the surrounding environment. In the first instance, to determine if they need to be included in the wind turbine noise assessment or if they can be scoped out of the cumulative assessment.

Section 5.1 of the IOA GPG provide criteria to determine if a cumulative turbine noise assessment is necessary:

> *"5.1.4 During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.*
>
> *5.1.5 Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary."*

An appraisal of the study area to determine whether a cumulative turbine noise impact assessment is required is presented in Section 12.4.4.1.

12.1.7.5.3 Wind Energy Development Guidelines for Planning Authorities

Section 5.6 of the *Wind Energy Development Guidelines for Planning Authorities* published by the Department of the Environment, Heritage and Local Government (2006) (WEDG06) addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

This following statement from WEDG06 represents the commonly adopted daytime noise criterion curve in relation to wind farm developments.

> *"In general, a lower fixed limit of 45dB(A) 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, an important caveat should be noted as detailed in the following extract.

> *"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 30dB(A), it is recommended that the daytime level of the $L_{A90, 10min}$ of the wind energy development be limited to an absolute level within the range of 35 – 40dB(A)."*

In relation to night periods the following guidance is given:

> *"A fixed limit of 43dB(A) will protect sleep inside properties during the night."*

This limit is defined in terms of the $L_{A90,10min}$ parameter. This represents the commonly adopted night time noise criterion curve in relation to wind farm developments.

In summary, the WEDGs outlines the following guidance to identify appropriate wind turbine noise criteria curves at NSLs:

- An appropriate absolute limit level in the range of 35 – 40 dB L_{A90} for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels of not less than 30 dB $L_{A90,10min}$ and;
- 43 dB $L_{A90,10min}$ for night time periods or a maximum increase of 5 dB above background noise (whichever is higher).

While the caveat of an increase of 5dB(A) above background for night-time operation is not explicit within the WEDGs, an allowance for same is commonly applied in noise assessments prepared and is accepted as detailed in numerous examples of planning conditions issued by An Coimisiún Pleanála (formerly An Bord Pleanála).

12.1.7.5.4 Future Potential Guidance Changes

In December 2019, the Draft Revised Wind Energy Development Guidelines (Draft Revised WEDGs (2019)) were published for consultation. During the public consultation on the Draft Revised WEDGs (2019), several concerns relating to the proposed methodology for the assessment of noise in the Draft Revised WEDGs (2019) have been expressed by various parties. Specific concerns expressed by a group of acoustic professionals working in the field are most relevant. The group was made up of acousticians who act for wind farm developers, Councils, Government bodies and residents' groups (all of whom are members of the Institute of Acoustics, IOA). The group contained several of the authors / contributors to ETSU-R-97, the IOA Good Practice Guide (IOA GPG) and the IOA Amplitude Modulation Working Group, which are all referenced extensively in the draft guidelines. A statement from the group can be reviewed at:

https://www.ioa.org.uk/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community-and

A copy of the group's consultation response can be viewed at:

https://tneigroup-com.stackstaging.com/wp-content/uploads/2022/05/WEDG-consultation-joint-response-R0.pdf

The following statement is of note from the response:

> "*a number of acousticians working in the field have raised serious concerns over the significant amount of technical errors, ambiguities and inconsistencies in the content of the draft WEDG and these were highlighted during the consultation process by a group of acousticians*"

The following statement was submitted by the Minister for Housing, Local Government and Heritage during a Dail Eireann Debates on 13 June 2023[1]

> "*My Department is currently undertaking a focused review of the 2006 Wind Energy Development Guidelines. The review is addressing a number of key aspects including noise, setback distance, shadow flicker, community obligation, community dividend and grid connections.*
>
> *Guidance on the noise aspect, which is highly technical in nature, is currently being finalised by my Department in conjunction with the Department of the Environment, Climate and Communications (DECC), which has primary responsibility for environmental noise matters. Both Departments are engaging on proposals regarding the measurement and assessment of noise from wind turbines to ensure they are robust and fit for purpose having regard to, inter alia, the revised 2030 target to generate up to 80% of our electricity from renewable sources.*
>
> *In this connection, DECC has recently appointed an acoustic expert, who has commenced work to inform any amendments to the noise aspect of the Guidelines. My Department in conjunction with DECC will make any further changes to the draft Guidelines which are deemed necessary or appropriate in the wake of this work, with a view to bringing the review of the Guidelines to a conclusion. My Department will be in a better position to provide an update on the expected publication date of the revised Guidelines once this process has concluded.*
>
> *It should be noted that Action EL/23/4 of the Climate Action Plan 2023 Annex of Actions contains a commitment to having new draft Guidelines prepared by the end of Q4 2023, with revised Guidelines to be published in 2024.*
>
> *When finalised, the revised Guidelines will be issued under section 28 of the Planning and Development Act 2000, as amended. Planning authorities and, where applicable, An Bord Pleanála, must have regard to guidelines issued under section 28 in the performance of their functions generally under the Planning Acts. In the meantime, the current 2006 Wind Energy Development Guidelines remain in force.*"

At the time of writing this EIAR chapter, no new draft guidelines have been published, and no confirmed timeframe for their release has been provided. The assessment of wind turbine noise presented in this EIAR chapter is based on the guidance outlined in the 2006 WEDGs and has been supplemented with best practice guidance from ETSU-R-97 and the IOA GPG. If updated Wind Energy Guidelines are published during the application process for the proposed project it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

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[1] https://www.oireachtas.ie/en/debates/question/2023-06-13/780/

12.1.7.5.5 World Health Organization (WHO) Noise Guidelines for the European Region

The WHO Environmental Noise Guidelines for the European Region (2018) provide guidance on protecting human health from exposure to environmental noise. They set health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise. Recommendations are rated as either 'strong' or 'conditional'.

A strong recommendation, "*can be adopted as policy in most situations*" whereas a conditional recommendation, "*requires a policy-making process with substantial debate and involvement of various stakeholders. There is less certainty of its efficacy owing to lower quality of evidence of a net benefit, opposing values and preferences of individuals and populations affected or the high resource implications of the recommendation, meaning there may be circumstances or settings in which it will not apply*".

The objective of the WHO Environmental Noise Guidelines for the European Region is to provide recommendations for protecting human health from exposure to environmental noise from transportation, wind farm and leisure sources of noise. The guidelines present recommendations for each noise source type in terms of L_{den} and L_{night} levels above which there is risk of adverse health risks.

In relation to wind turbine noise, the WHO Guideline Development Group (GDG) state the following:

> *"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB L_{den}, as wind turbine noise above this level is associated with adverse health effects.*
>
> *No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.*
>
> *To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."*

The quality of evidence used for the WHO research is stated as being 'Low', the recommendations are therefore conditional.

The WHO Environmental Noise Guidelines aim to support the legislation and policy-making process on local, national, and international level, thus shall be considered by Irish policy makers for any future revisions of Irish National Guidelines.

There is potential for increased uncertainty due to the parameter used by the WHO for assessment of exposure (i.e., L_{den}), which it is acknowledged may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes, as stated below, from within Environmental Noise Guidelines:

"Even though correlations between noise indicators tend to be high (especially between L_{Aeq}-like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in Lden is converted from original sound pressure level values. The conversion requires, as variable, the statistical distribution of annual wind speed at a particular height, which depends on the type of wind turbine and meteorological conditions at a particular geographical location. Such input variables may not be directly applicable for use in other sites. They are sometimes used without specific validation for a particular area, however, because of practical limitations or lack of data and resources. This can lead to increased uncertainty in the assessment of the relationship between wind turbine noise exposure and health outcomes. Based on all these factors, it may be concluded that the acoustical description of wind turbine noise by means of L_{den} or L_{night} may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes."

"…Further work is required to assess fully the benefits and harms of exposure to environmental noise from wind turbines and to clarify whether the potential benefits associated with reducing exposure to environmental noise for individuals living in the vicinity of wind turbines outweigh the impact on the development of renewable energy policies in the WHO European Region."

Based upon the review set out above, and in our professional opinion, the conditional WHO recommended average noise exposure level (i.e. 45 dB L_{den}), should not currently be applied as target noise criteria for an existing or proposed wind turbine development in Ireland.

12.1.7.5.6 Low Frequency Noise and Infrasound

Low Frequency Noise is noise that is dominated by frequency components less than approximately 200 Hz whereas infrasound is typically described as sound at frequencies below 20 Hz. In relation to infrasound, the following extract from the EPA document *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)* (EPA, 2011) is noted here:

"There is similarly no significant infrasound from wind turbines. Infrasound is high level sound at frequencies below 20 Hz. This was a prominent feature of passive yaw "downwind" turbines where the blades were positioned downwind of the tower which resulted in a characteristic "thump" as each blade passed through the wake caused by the turbine tower. With modern active yaw turbines (i.e. the blades are upwind of the tower and the turbine is turned to face into the wind by a wind direction sensor on the nacelle activating a yaw motor) this is no longer a significant feature."

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[2] found that the level of infrasound from wind turbines is insignificant and no different to any other source of noise, and that the worst contributors to household infrasound are air-conditioners, traffic and noise generated by people.

2 EPA South Australia, 2013, Wind farms https://www.epa.sa.gov.au/files/477912_infrasound.pdf

The EPA's study concluded that the level of infrasound at houses near wind turbines was no greater than in other urban and rural environments, and stated that:

> *"The contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment."*

These conclusions have been reinforced by more recent studies and reviews. For example, a study for the National Institute for Public Health and the Environment (RIVM) in the Netherlands[3] published in 2020 concluded in this regard that:

> *"Although low frequency sound and infrasound might have other effects than 'normal' sound has, these effects are highly unlikely at sound levels typical for wind turbines. Brain studies show that low frequency and infrasound are processed in the same parts of the brain as 'normal' sound and there is no evidence that infrasound elicits any reaction at sub-audible levels."*

An Australian study funded by the National Health and Medical Research Council of Australia (NHMRC), was also recently published in the Environmental Health Perspectives (EHP) journal, published[4] by the United States National Institute of Environmental Health. The study considered the effects, including in particular on sleep, to exposing people to 72 hours of infrasound (designed to simulate a wind turbine infrasound signature). The study was based on a highly robust double-blind randomised controlled study and concluded that:

> *"Our findings did not support the idea that infrasound causes WTS [Wind Turbine Syndrome][5]. High level, but inaudible, infrasound did not appear to perturb any physiological or psychological measure tested in these study participants."*

An IOA statement in Respect of Wind Farm Noise Assessment dated December 2024 and published on the IOA website[6] stated the following in relation to Infrasound and Low Frequency noise:

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

"*The IOA is aware that there is some information presented at planning inquiries suggesting the potential for physiological health effects from low frequency noise from wind turbines. It is current*

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3 Health effects related to wind turbine sound: an update, I. van Kamp, G.P. van den Berg, National Institute for Public Health and the Environment (RIVM), RIVM report 2020-0150, October 2020.

4 Marshall et. al., The Health Effects of 72 Hours of Simulated Wind Turbine Infrasound: A Double-Blind Randomized Crossover Study in Noise-Sensitive, Healthy Adults. Environmental Health Perspectives (EHP), 131(3) March 2023.

5 The publication explains that some authors "have proposed that people who live in the vicinity of wind turbines suffer from wind turbine syndrome [WTS] with dizziness, sleep disturbance, and other symptoms. The causes of this syndrome have been the subject of substantial international controversy. Proponents have contended that the symptoms that compose this syndrome are caused by low frequency sub audible infrasound generated by wind turbines."

6 https://www.ioa.org.uk/publications/wind-turbine-noise

advice to members that there is no need to assess low frequency noise as part of the noise impact assessment process, as the absolute levels, whilst potentially audible at typical receptor distances, are well below those reported to trigger physiological health effects based on peer reviewed research to date."

In conclusion, low frequency noise and infrasound associated with wind turbines is expected to be below perceptibility thresholds and are not likely to result in any significant effects at NSLs. There are no criteria proposed for assessing low-frequency noise or infrasound as part of the EIAR; this approach is standard practice in Ireland when assessing wind turbine noise at planning stage.

12.1.7.5.7 Tonality

A tone is the concentration of acoustic energy into a very narrow frequency range, with a noticeable character (such as a "hum" or "whine" for example). The audibility of any tones can be assessed by comparing the narrow band level of such tones with the masking level contained in a band of frequencies around the tone. Several objective methodologies to assess tonal audibility are available, such as the one included in ETSU-R-97 or that of ISO 1996-2 (2017)[7].

Mechanical noise may emanate from components within the nacelle of a wind turbine. This is a less natural sounding noise which can be characterised in some cases by its tonal content, particularly if resonances in the mechanical noise are not suitable controlled. However, modern turbine designs have evolved to minimise mechanical noise radiation from wind turbines and resonances are normally minimised through design.

Wind farm noise guidelines such as those of ETSU-R-97 assume that the wind turbine noise contains no clearly audible tones. However, it not possible to predict the occurrence of tonality on a project as this would not normally be expected from standard wind turbine designs. The unlikely occurrence of tonality in the wind turbines of the proposed project will be managed through the commitments provided by the Applicant in Section 12.5.3.2.

12.1.7.5.8 Amplitude Modulation

In the context of this assessment, amplitude modulation (AM) is defined in the IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document *A Method for Rating Amplitude Modulation in Wind Turbine* (IOA, 2016) as:

> *"Periodic fluctuations in the level of audible noise from a wind turbine (or wind turbines), the frequency of the fluctuations being related to the blade passing frequency (BPF) of the turbine rotor(s)."*

It is now generally accepted that there are two mechanisms which can cause amplitude modulation:

- 'Normal' AM, and;
- 'Other' AM (sometimes referred to 'Excessive' AM).

[7] International Organization for Standardization (ISO), ISO 1996-2 (2017), Acoustics — Description, measurement and assessment of environmental noise, Part 2: Determination of sound pressure levels.

In both cases, the result is a regular fluctuation in amplitude at the Blade Passing Frequency (BPF) of the wind turbine blades (the rate at which the blades of the turbine pass a fixed point). For a three-bladed turbine rotating at 20 rpm, this equates to a modulation frequency of 1 Hz.

'Normal' AM — An observer at ground level close to a wind turbine will experience 'blade swish' because of the directional characteristics of the noise radiated from the trailing edge of the blades as it rotates towards and then away from the observer.

This effect is reduced for an observer on or close to the turbine axis and therefore would not generally be expected to be significant at typical separation distances, at least on relatively level sites.

The RenewableUK AM project (RenewableUK, 2013) has coined the term 'normal' AM (NAM) for this inherent characteristic of wind turbine noise, which has long been recognised and was discussed in ETSU-R-97 in 1996.

'Other' AM — In some cases AM is observed at large distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' at relatively low frequencies.

On sites where it has been reported, occurrences appear to be occasional, although they can persist for several hours under some conditions, dependent on atmospheric factors, including wind speed and direction.

It was proposed in the RenewableUK 2013 study that the fundamental cause of this type of AM is transient stall conditions occurring as the blades rotate, giving rise to the periodic thumping at the blade passing frequency.

Transient stall represents a fundamentally different mechanism from blade swish and can be heard at relatively large distances, primarily downwind of the rotor blade.

The RenewableUK AM project report adopted the term 'Other AM' (OAM) for this characteristic. The terms 'enhanced' or 'excess' AM (EAM) have been used by others, although such definitions do not distinguish between the source mechanisms and presuppose a 'normal' level of AM, presumably relating back to blade swish as described in ETSU-R-97.

Frequency of Occurrence of AM

UK Research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report 'Research into Aerodynamic Modulation of Wind Turbine Noise' (2007). The conclusions of this report were that aerodynamic modulation was only considered to be an issue at four, and a possible issue at a further eight, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the four sites where AM was confirmed as an issue, it is likely based on the descriptions made that this was excess AM or OAM (although these terms were not in use at the time). It was considered that conditions associated with this OAM might occur between about 7 and 15% of the time. It also emerged that for three out of the four sites the complaints have subsided, in one case due to the introduction of a turbine control system.

It is not possible to predict an occurrence of AM at the planning stage. The RenewableUK Research Document states the following in relation to matter:

Page 68 Module F *"even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."*

Page 6 Module F *"It has also been the experience of the project team that, even at those wind farm sites where AM has been reported or identified to be an issue, its occurrence may be relatively infrequent. Thus, the capture of time periods when subjectively significant AM occurs may involve elapsed periods of several weeks or even months."*

Page 61 Module F *"There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."*

Concluding Comments on AM

It is essential to recognise that amplitude modulation (AM) is an intrinsic feature of wind turbine noise. A distinction must be made between 'Normal' AM, which is generated by all wind turbines, generally limited in magnitude and reduces with separation distance, and 'Other' or 'Excessive' AM, which can be more pronounced and potentially intrusive. As normal AM is assumed to be part of normal wind turbine noise, the noise limits set out in applicable guidelines discussed in this section take this into account and are relatively stringent as a result. Excessive AM, should it occur, may lead to additional impacts at sensitive receptors in some cases. The term AM is commonly used without these descriptions; however, where AM is referenced in this chapter, it should be understood to refer to unacceptable or excessive AM with the potential to result in additional adverse impacts, unless otherwise stated.

Research and guidance in the field of wind turbine noise AM is ongoing with the most notable recent publications discussed here.

The Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) published, A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016) (The Reference Method). The document proposes an objective method for measuring and rating AM. The AMWG however does not propose what level of AM is likely to result in adverse community response or propose any limits for controlling AM. The purpose of the AMWG was to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation.

A 2016 report was commissioned by the UK government Wind turbine AM review: Phase 2 report. 3514482A Issue 3. Department of Energy and Climate Change (DECC) prepared by WSP Parsons Brinckerhoff. The objective of this report was to recommend how excessive AM might be controlled through the use of a planning condition. The report recommended the use of a penalty scheme as a potential planning condition for AM to cover periods of complaints due to unacceptable AM. This penalty scheme is based on the AMWG method and other potential AM rating methods were dismissed as not sufficiently robust. The report included the following caveat:

"*Any condition developed using the elements proposed in this study should be subject to a period of testing and review. The period should cover a number of sites where the condition has been implemented and would be typically in the order of 2-5 years from planning approval being granted*."

It is noted that the WSP report recommended that excessive AM be controlled specifically during period of complaints. The key point is that while excessive amplitude modulation (AM) may occur during the operation of the wind farm, it may not necessarily result in any adverse impacts. As per the discussion on the research presented previously in this Section, excessive/other AM is considered an atypical phenomenon, and the duration, conditions and specific location or locations at which it presents cannot be predicted in the planning stage. For these reasons, the assessment of AM is typically triggered in response to complaints where the contributing factors aligning to the period of the complaint such as meteorological conditions and turbine operations can be investigated.

The International Electrotechnical Commission (IEC) published Technical Specification 61400-11-2 (Edition 1.0, 2024) Wind Energy Generation Systems – Part 11-2: Acoustic noise measurement techniques – Measurement of wind turbine sound characteristics in receptor position, in 2024. This document introduces a standardised methodology for measuring and rating AM at receptor locations. The method broadly aligns with the AMWG approach but includes some minor differences.

To date there is no clear industry consensus on how AM should be regulated or managed through the planning stage. In the absence of clear policy in Ireland to control AM from wind turbines, the commitments outlined in the Section **Error! Reference source not found.** are c onsidered to represent best practice and will be adopted in the event that an complaint relating excessive AM is reported.

The assessment and mitigation of AM at post-commissioning stage is discussed in Section **Error! R eference source not found.**. AM from the proposed project will be managed through the commitments provided by the Applicant in Section **Error! Reference source not found.**.

12.1.7.6 Operational Phase Noise – Fixed Plant Items

There is no published statutory Irish guidance relating to the maximum permissible noise level from fixed mechanical and electrical plant that would be associated with substation. In the absence of specific noise limits, appropriate criteria relating to fixed mechanical and electrical plant reference is made to best practice guidance contained in the following published guidelines and standards.

12.1.7.6.1 EPA NG4

To establish whether the NSLs would be considered 'low background noise' areas as defined in the EPA publication, Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities 2016 (NG4) guidance, the noise levels measured during the environmental noise survey need to satisfy the following criteria:

- Arithmetic Average of L_{A90} During Daytime Period ≤40 dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Evening Period ≤35 dB L_{A90}, and;
- Arithmetic Average of L_{A90} During Night-time Period ≤30 dB L_{A90}.

Table 12-4 outlines the noise criteria detailed in the NG4 for areas of low background noise and all other areas.

Table 12-4: NG4 Approach for Determining Appropriate Noise Criteria

Scenario	Daytime Noise Criterion, dB $L_{Ar,T}$ (07:00 to 19:00hrs)	Evening Noise Criterion, dB $L_{Ar,T}$ (19:00 to 23:00hrs)	Night Noise Criterion, dB $L_{Aeq,T}$ (23:00 to 07:00hrs)
Areas of Low Background Noise	45	40	35
All other Areas	55	50	45

It is important to consider the likelihood of adverse noise impacts when assessing noise from fixed plant. The NG4 guidance refers to the assessment method prescribed in BS 4142:2014: Methods for rating and assessing industrial and commercial sound that can be used to assess the likelihood of complaints from specific plant noise sources.

12.1.7.6.2 BS 4142

BS 4142:2014: Methods for rating and assessing industrial and commercial sound is the industry standard method for analysing fixed plant sound emissions to residential receptors. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

For a BS 4142 assessment it is necessary to compare the measured external background sound level (i.e. the $L_{A90,T}$ level measured in the absence of plant items) to the rating level ($L_{Ar,T}$) of the various plant items, when operational. Where sound emissions are found to be tonal, impulsive, intermittent or to have other sound characteristics that are readily distinctive against the residual acoustic environment, BS 4142 recommends that penalties be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal sound characteristics outlined in BS 4142 recommends the application of a 2 dB penalty for a tone which is just perceptible at the receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible. In relation to intermittency, BS 4142 recommends that If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied. The following definitions as discussed in BS 4142 as summarised below:

"ambient sound level, $L_{Aeq,T}$	*equivalent continuous A-weighted sound pressure level of the totally encompassing sound in a given situation at any given time, usually from many sources near and far, at the assessment location over a given time interval, T.*
residual sound level, $L_{Aeq,T}$	*equivalent continuous A-weighted sound pressure level of the residual sound (i.e. ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound) at the assessment location over a given time interval, T.*

specific sound level, $L_{Aeq, T}$	*equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr.*
Rating level, $L_{Ar,T}$	*specific sound level plus any adjustment for the characteristic features of the sound.*
background sound level, $L_{A90,T}$	*A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels."*

To establish an initial estimate of impact, BS 4142 states the following:

"*Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following.*

a. *Typically, the greater this difference, the greater the magnitude of the impact.*

b. *A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

c. *A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.*

d. *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

Note Adverse impacts include, but are not limited to, annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact."

BS4142 contains the following pertinent factors that must be considered with respect to the context of the sound, which is relevant to this assessment as the background noise levels are typically low at NSLs during periods of low wind speeds:

> "*The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low.*
>
> *Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."*

12.1.7.7Operational Phase Vibration

Any vibration generated from the operation of a wind turbine unit will decrease significantly over distance. A report from Germany published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016, "*low frequency noise incl. infrasound from wind turbines and other sources*" conducted vibration measurements study for an operational Nordex N117 – 2.4 MW wind turbine. The report concluded that at distances of less than 300m from the turbine vibration levels had dropped so far that they could no longer be differentiated from the background vibration levels.

The shortest distance from any turbine in the proposed project to the nearest NSL is greater than 700 m. At that distance, the level of vibration will be significantly below any thresholds for perceptibility. As vibration effects are not perceptible, vibration limits are not studied further for the operational phase of the proposed project.

12.1.7.8 *Human Health Effects*

There is currently no credible evidence to link wind turbine noise exposure in the environment to adverse direct physiological health impacts. For further details of potential health impacts effects associated with the proposed project, refer to Chapter 5 (Population and Human Health).

12.2 METHODS

The outline methodology adopted for this assessment is summarised as follows:

- Review of best practice guidance to identify appropriate noise and vibration criteria for the construction, operational and decommissioning phases;
- Characterise the receiving environment through noise surveys at selected NSLs in the vicinity of the proposed project;
- Undertake predictive calculations to assess the potential effects associated with the construction and decommissioning phases of the proposed project;
- Undertake predictive calculations to assess the potential effects associated with the operation of the proposed project at NSLs;
- Specify mitigation measures to reduce, where necessary, the identified potential outward effects relating to noise and vibration from the proposed project; and,
- Describe the significance of the residual noise and vibration effects associated with the proposed project and the cumulative wind farms in the area.

12.2.1 Study Area

The study area for the noise and vibration impact assessment was defined by the area where there is potential for noise and vibration impacts at NSLs associated with the proposed project during the construction, decommissioning, and operational phases.

12.2.1.1 Operational Phase Noise

For the operational phase, the initial study area covered the area where turbine noise levels are predicted to exceed 35 dB L_{A90} from all existing, permitted, and proposed wind turbines. Due to potential cumulative effects with other wind farm developments, the final study area for the operational phase of the proposed project is defined by the areas where predicted turbine noise levels from the proposed project in isolation are predicted to be above 30 dB L_{A90} at the maximum noise emission level for the proposed turbines. Refer to Appendix 12-5 which displays the relevant noise contours maps and identifies the operation phase study area.

The NSLs identified within this study area have also been considered in the assessment of operational noise from proposed fixed plant items, namely the onsite substation.

12.2.1.2Construction and Decommissioning

During the construction and decommissioning phases, noise could occur at any location within the redline boundary and along public roads where there are increases in traffic associated with the proposed project. There is also a potential for noise impacts from Heavy Goods Vehicles (HGVs) along the proposed turbine delivery route (TDR).

NSLs in proximity to specific construction activities and those situated along haul routes have the most potential to experience noise and vibration from the proposed project. Taking account of the works associated with the construction and decommissioning phases, the study area is based on the nearest NSLs to the working areas, these distances are confirmed in the relevant sections of this chapter and representative of the closest identified NSLs, or at defined set back distances (in metres) from the proposed works.

12.2.2 Background Noise Survey

A summary outlining key information of the of the background survey is presented in this section; full details of the background noise survey methodology instrumentation and results is provided in Appendix 12.4.

A background noise survey was undertaken to establish typical background noise levels at representative NSLs surrounding the proposed wind farm site. The background noise survey was conducted through installing unattended sound level meters at 6 no. representative locations in the surrounding area.

All measurement data collected during the background noise surveys has been carried out in accordance with the IOA GPG and accompanying *Supplementary Guidance Note 1: Data Collection* (2014) discussed in the following sections.

12.2.2.1Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at the early stages of the assessment and reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps). Any locations that fell inside the predicted 35 dB L_{A90} noise contour was considered for noise monitoring in line with current best practice guidance outlined in the IOA GPG. The selected noise monitoring locations are considered robust to capture the typical representative background noise levels at NSLs surrounding the proposed wind farm.

The co-ordinates for selected locations for the noise monitoring locations are outlined in Table 12-5 and identified in the context of the receiving area on a map in Figure 12-2.

Table 12-5: Noise Measurement Coordinates

Location Reference	Co-ordinates (ITM)	
	Easting	Northing
A (H177)	660,042	624,364
B (H346)	663,827	627,125
C (H555)	662,424	625,138
D (H357)	663,258	626,079
E (H618)	662,435	623,080
F (H262)	658,987	626,062

Site visits by survey personnel were carried out during morning and afternoon periods; during these visits, primary noise sources contributing to noise build-up were noted. In respect of night-time periods, when noise due to traffic on local roads, agricultural activities and other sources tend to reduce, there was no indication of any significant local night-time sources of noise at any location. No sources of vibration were noted at any of the survey locations.

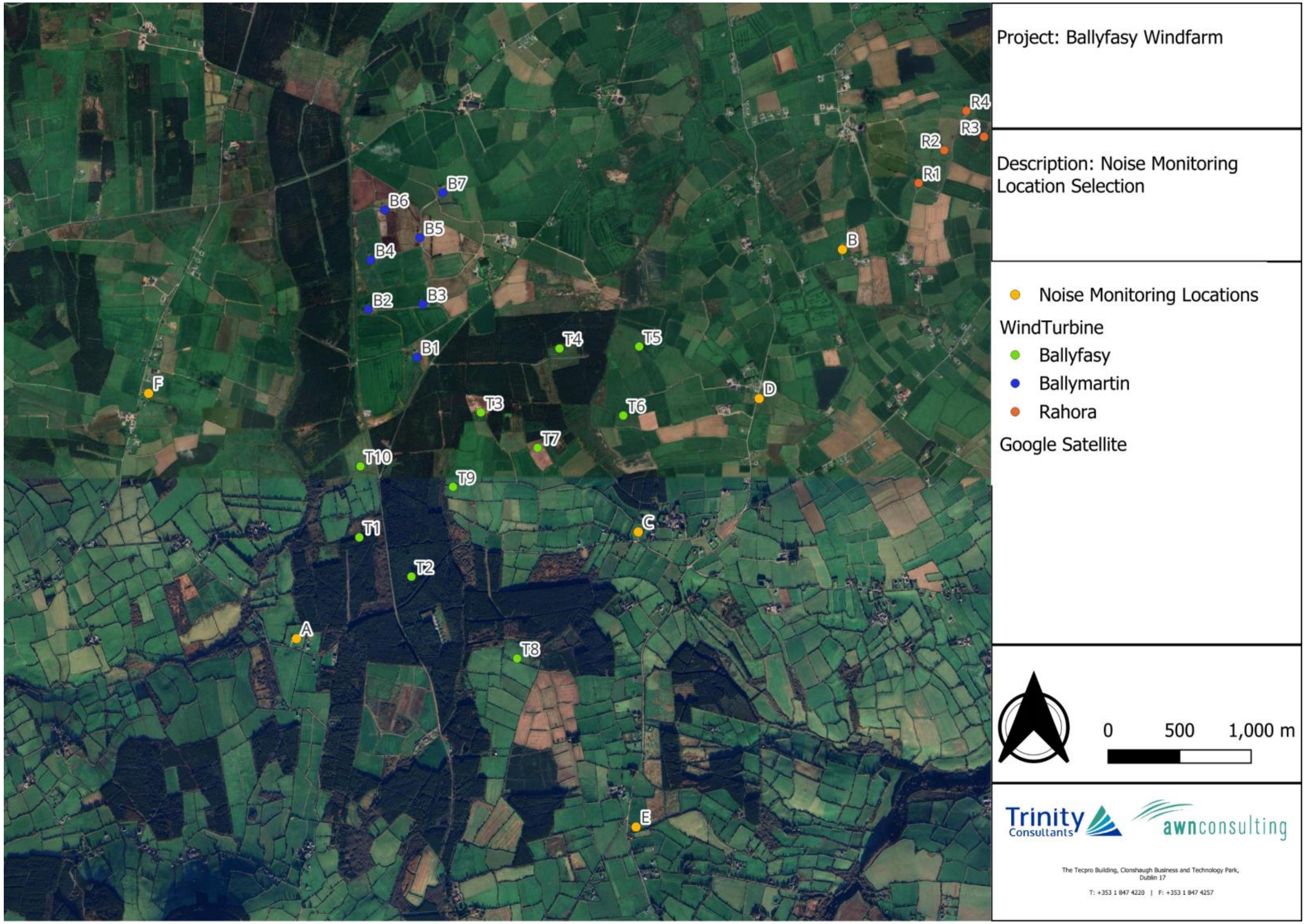
In general, the significant noise sources in the area were noted to be local and distant traffic movements, activity in and around the residences, wind generated noise from local foliage and other typical anthropogenic sources typically found in such rural settings.

At some locations noise from the operation of existing turbines located at Ballymartin Smithstown, and Rahora wind farms were noted to be audible to varying degrees during site visits. It should be noted that the level of wind turbine noise is variable, it is dependent on the operational condition of the turbine, wind speed and direction, distance from the turbines, and the levels of background noise at the location. Any noise from the existing wind turbines in the area should not form part of the 'background' noise level at noise sensitive locations, the background noise is used to derive noise limits in line with the guidance of section 12.1.7. In contrast, the terms 'baseline noise level' or the 'existing noise levels', will incorporate any current noise contributions from the operation of the existing turbines. To derived suitable background noise levels in the presence of exiting turbine noise, the methodology from the IOA GPG has been applied to the assessment.

Additional information is included in Appendix 12.2 (Copies of Calibration Certificates).

Section 12.3.1 of this chapter presents the results of the background noise survey and Section 12.3.2 presents the derived noise criteria for the operational wind farm.

Figure 12-2: Map of Noise Monitoring Locations



12.2.2.2Wind Data Measurements

Wind speed measurements were obtained from an onsite met mast. A copy of the met mast installation report is included in Appendix 12.8.

Table 12-6: Met Mast Location

Met Mast Reference	Co-ordinates (ITM)	
	Easting	Easting
Ballyfasy Upper, Co. Kilkenny	661,369	625,723

12.2.2.3Analysis of Survey Data

As well as the location-specific filtering, the data sets have been filtered to remove issues such as the dawn chorus and the influence of other atypical noise sources. An example of atypical sources would be short, isolated periods of raised noise levels attributable to local sources, agricultural activity, boiler flues, operation of gardening equipment etc. In addition, sample periods affected by rainfall or when rainfall resulted in prolonged periods of atypical noise levels have also been screened from the data sets. The assessment methods outlined above are in line with the guidance contained in the IOA GPG.

The results presented Appendix 12-4 and summarised in the following sections refers to the noise data collated during 'quiet periods' of the day and night as defined in the IOA GPG.

12.2.2.4Consideration of Wind Shear

Wind shear is defined as the change of wind speed with height above ground. Site specific wind shear is captured in the background noise assessment through simultaneously measurement of deriving wind speeds adjust to hub height using the one of three methods described in the IOA GPG.

To ensure clearly and consistently defined wind speeds it is standard industry practice to convert and reference wind speeds to the 'Standardised Wind Speed'. The Standardised Wind Speed is a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m in accordance with the IEC 61400-11 standard. The standardised equations used to determine the wind speed at standardised 10m above ground is presented in Appendix 12-3.

Any reference to wind speed in this chapter should be understood to be standardised wind speed at a height of 10 m height unless otherwise stated.

12.2.3 Construction Noise Calculations

A variety of items of plant will be used for the purposes of site preparation, construction, and site works. There will be vehicular movements to and from the site that will make use of existing roads. There is the potential for generation of significant levels of noise from these activities.

In the absence of specific details on the plant items and methods to be employed during the construction stage, a set of assumptions must be made in order to predict and assess the likely noise emissions from construction activities. The standard best practice approach is to predict typical noise levels at the NSLs using guidance set out in British Standard *BS 5228-*

1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

The methodology adopted for the assessment of construction noise is to analyse the various elements of the construction phase in isolation. For each element, the typical construction noise sources are assessed along with typical sound pressure levels and spectra referenced in BS 5228-1 at various distances from these works.

12.2.4 Operational Noise Calculations

A series of computer-based prediction models have been prepared to quantify the potential noise level associated with the operational phase of the proposed project on the receiving environment. This section discusses the methodology behind the noise modelling process and presents the results of the modelling exercise.

12.2.4.1Noise Prediction Software

The selected software, DGMR *iNoise Enterprise (Version 2024 v3.0)* can be configured to calculate noise levels in accordance with ISO 9613-2 as recommended in the IOA GPG.

iNoise is a proprietary noise calculation package for computing noise levels and propagation of noise sources. iNoise calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated considering a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (LWA);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impacts at distances greater than approximately 400 m).

12.2.4.2Noise Prediction Model - Input Data and Assumptions

The calculation settings, input data and any assumptions made in the assessment are described in the following sections. Additional information relating to the noise model inputs, calculation settings and technical assumptions is provided in Appendix 12-3.

12.2.4.2.1 Proposed Turbine Details

To assess all scenarios within the range of turbine types and specification being considered, the following list of turbines have been included in this assessment:

- Vestas V150 at 95 and 105 m hub heights;
- SGRE SG6.6-155 at 102.5 m hub height;
- Vestas V162 at 99 m hub height;
- Nordex N149 at 95.5 and 105.5 m hub heights;
- Nordex N163 at 98.5 m hub height;
- GE GE5.5-158 at 101 m hub height.

The dimensions of the above turbines all vary but are all within the proposed range of dimensions as described in Chapter 2 of this EIAR (Description of the Proposed Project). These turbines are considered representative of the type of turbine that would be installed on the site taking into consideration the proposed dimensions and the nominal generation capacity.

In terms of predicting noise levels at noise-sensitive locations the turbine noise emission levels can be defined by two parameters:

- The hub height (HH), and
- The sound power noise emissions at various wind speeds.

Sound power levels for each of the turbines listed above referenced to wind speeds at standardised 10m height (calculated in accordance with the IOAGPG), are presented in Table 12-7.

Table 12-7: L_{WA} Levels for various hub heights (HH)

Wind Speed	dB L_{WA} of Turbine Model at Stated Hub Height (m)							
	V150	SG6.6		V162	N149		N163	GE5.5
	105 m	95 m	102.5 m	99 m	105.5 m	95.5 m	98.5 m	101 m
4	96.3	97.8	97.8	95.7	95.2	95.1	97.8	96.8
5	100.5	102.7	102.7	99.6	99.8	99.5	102.3	101.5
6	104.0	105.0	105.0	103.3	104.2	103.9	106.6	105.2
7	104.8	105.0	105.0	104.3	105.6	105.5	107.2	106.0
≥8	104.9	105.0	105.0	104.3	105.6	105.6	107.2	106.0

Figure 12-3 presents a graph of the noise emissions for each turbine.

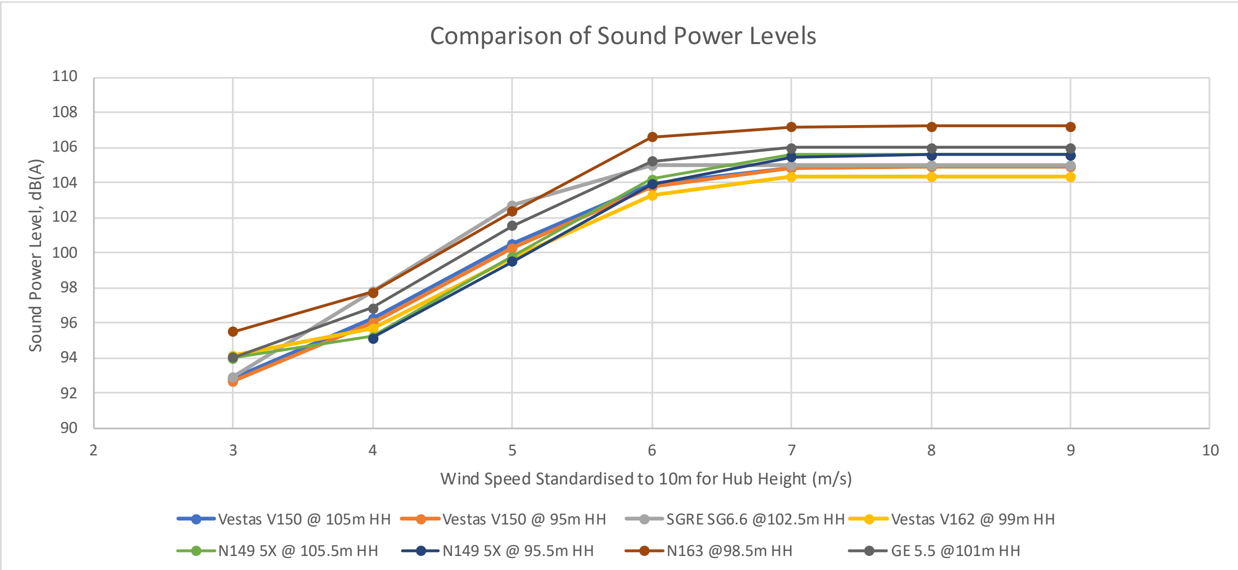


Figure 12-3: Sound Power Levels for Eight Turbine Types and Specifications Consideration

The appraisal of the turbine range considered sound energy across the frequency spectrum, noting that low-frequency energy experiences less attenuation over distance. Therefore, it is not appropriate to compare only the overall L_{WA} for the various turbines. To validate the conclusions in this assessment, all of turbines listed in Table 12-7 have been modelled. The result of the turbine noise prediction modelling have been reviewed as it was confirmed that:

- the turbine model with the highest predicted emissions at NSLs over the range of operational wind speeds is the N163; and,
- the turbine model with the lowest predicted emissions at NSLs over the range of operational wind speeds is the SG6.6-155.

The noise emissions at NSLs from all of the other turbines types listed in Table 12-7 fall with the range between the turbine model with the highest predicted noise emissions the N163 (98.5 m HH) and the turbine model with the lowest predicted noise emissions, the SG6.6-155 (102.5 m HH). The EIAR will present the assessment for these two turbine models. This assessment will provide a robust evaluation of all the turbines being considered. Hence the noise impact assessment is representative of all of the candidate turbine types listed in Table 12-7.

The manufacturer's turbine sound power levels are presented in terms of the L_{Aeq} parameter. As per best practice guidance contained within the IOA GPG, an allowance for uncertainty in the measurement of turbine source levels is applied to in the noise prediction modelling. An uncertainty factor of +2 dB has been applied in the calculation to all turbine types listed in Table 12-7. In line with the manufacturers[8] technical data for the installed turbine types at Ballymartin Smithstown and Rahora wind farms a +1 dB uncertainty has been applied in noise prediction calculations. Hence, a conservative uncertainty factor has been applied to noise prediction assessment to all wind turbines in line with IOAGPG guidance.

As explained below in Section 12.3.2, the criteria are couched in terms of a L_{A90} criterion. Best practice guidance in the IOA GPG states that "*L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB*". A 2 dB reduction has therefore been applied in the noise model calculation. All predicted noise levels in this chapter are presented in terms of L_{A90} parameter, i.e., this reduction of 2 dB is applied in the noise prediction modelling.

Best practice dictates that if any tonal component is present, a penalty must be applied to the predicted noise levels. The magnitude of this penalty, as outlined in ETSU-R-97, corresponds to the extent by which the tonal component exceeds the threshold of audibility. In this assessment, no tonal penalty has been applied to the predicted noise levels. However, the selected turbine manufacturer will provide a warranty confirming that the turbine's noise output will not necessitate a tonal correction under best practice guidance.

12.2.4.2.2 Consideration Turbine Hub Height

The turbine and parameter being considered as part of this noise assessment have a hub height range of between 95 m up to 105.5 m. The background noise levels, and turbine noise criteria are influenced by the assessment hub height. The principles are demonstrated in the discussion of wind shear described in Section 12.2.2.4, consequently, the lowest background noise levels will correspond to the highest hub height, which in this case is 105.5 m.

The background noise levels corresponding to a hub height of 105.5 m (the highest hub height in the range) have been used in the assessment as they represent a worst case. This approach represents a conservative assessment, as it will result in the lowest turbine noise criteria for the range of turbine hub heights under consideration. Hence the noise impact assessment is representative of all candidate turbines in terms of the highest potential turbine noise impact.

[8] Enercon (see Appendix 12.3)

12.2.4.2.3 Modelling Calculation Parameters

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613-2. Appendix 12-3 provides comprehensive details of noise prediction calculation settings, the list of NSLs and turbine co-ordinates, and the turbine sound power emissions used in the assessment.

12.2.4.2.4 Cumulative Noise from Other Turbines

An appraisal of the wider study area identified three additional wind turbine developments to be included in the turbine noise assessment. These developments are the operational Ballymartin Smithstown and Rahora Wind Farms, as well as the permitted Castlebanny Wind Farm. All turbines associated with these developments have been included in the cumulative turbine noise assessment, following best practice guidance discussed in Section 12.1.7.5. It was confirmed that, in accordance with the IOAGPG guidance, no other turbines needed to be included in the cumulative turbine noise assessment for the EIAR.

The details and coordinates of the other wind farms considered in the assessment are presented in Appendix 12-3.

12.2.4.2.5 Wind Direction and Noise Propagation

When considering noise impacts of wind turbines, the effects of propagation in different wind directions have been considered. The day-to-day operations of the optimised development will not result in a worst-case condition of all noise locations being downwind of all turbines at the same time i.e. omni-directional predictions. Therefore, to address this issue, a review of expected noise levels downwind of the turbines has been prepared for various wind directions in accordance with the IOA GPG Guidance.

For any given wind direction, a property can be assigned one of the following classifications in relation to turbine noise propagation:

- Downwind (i.e. 0° ±80°): no reduction in noise levels;
- Crosswind (i.e. 90° ±10° and 270° ±10°): reduction of 2 dB, and;
- Upwind (i.e. 180° ±80°): typically, up to 10 dB reduction depending on distance from turbine.

Table 12-8 presents the directivity attenuation factor that has been applied to turbines when considering noise propagation in downwind conditions (full downwind is represented by 0° and full upwind is 180°).

Table 12-8: Turbine Directivity Attenuation with Consideration of Wind Direction

Wind Direction Sector	Degrees (˚)	Attenuation (dB)
Downwind	280 – 360 & 0 - 80	0
Crosswind	260 – 280 & 80 - 100	2
Upwind	230 - 250	5
	220	5.5
	210	6
	200	6.5
	190	7
	180	7.5

12.3 EXISTING ENVIRONMENT

This section of the chapter documents the typical background noise levels measured in the vicinity of the NSLs in closest proximity to the proposed wind farm site. Appendix 12-4 presents the results of the background noise surveys as analysed in accordance with the methodology in Section 12.2.2.

12.3.1 Summary of Derived Background Noise Levels

Table 12-9 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night-time periods. These levels have been derived using regression analysis carried out on the data sets measured in line with best practice guidance contained in the IOA GPG and its SGN No. 2 Data Collection.

Values in parenthesis are used where, for higher wind speeds during day and night-time periods, the measurement obtained during the survey did not have sufficient data points at these wind speeds. In accordance with IOA GPG Supplementary Guidance Note 2: Data Processing & Derivation of ETSU-R-97 Background Curves, paragraph 2.9.1: "*Where background noise data has not been collected for higher wind speeds it may be appropriate to cap the background noise curve (and therefore the associated noise limit)*".

Table 12-9: Derived Background Noise Levels of $L_{A90,10\text{-}min}$ for Various Wind Speeds

Location	Period	Derived L_{A90}, 10min Levels (dB) at Various Standardised 10m Height Wind Speeds							
		3	4	5	6	7	8	9	≥10
A (H177)	Day	28.1	28.8	29.8	31.0	32.6	34.4	36.5	38.9
	Night	26.7	26.7	26.9	27.6	28.5	29.8	31.4	33.4
B (H346)	Day	28.2	30.0	30.9	32.5	35.3	39.0	42.6	(42.6)
	Night	22.1	24.8	26.8	29.1	32.3	36.3	40.8	(40.8)
C (H555)	Day	26.9	28.4	30.1	32.2	34.5	37.0	39.9	43.0
	Night	20.1	21.3	23.2	25.7	28.8	32.3	36.1	40.0
D (H357)	Day	25.2	26.8	28.4	30.2	32.1	34.1	36.3	(36.3)
	Night	18.6	19.9	21.7	24.1	27.0	30.5	34.6	(34.6)
E (H618)	Day	26.5	26.9	28.4	30.6	33.4	36.4	39.3	41.8
	Night	19.9	20.4	21.9	24.2	27.2	30.6	34.3	38.1
F (H262)	Day	28.1	28.0	29.0	30.8	33.1	35.5	37.7	39.3
	Night	23.0	24.3	25.0	25.9	27.6	30.8	36.0	(36.0)

12.3.2 Wind Turbine Noise Criteria

With respect to the relevant guidance documents outlined in Section 12.1.7.5, noise criteria curves have been established for the proposed project. The criteria curves have been derived following a detailed review of the background noise data conducted at representative NSLs described in Section 12.2.2.

The criteria adopted is in line with the applicable WEDG06 and is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála (now An Coimisiún Pleanála) and local planning authorities in Ireland[9]. For the proposed project, it is considered that a lower daytime threshold of 40 dB $L_{A90,10min}$ for low noise environments where the background noise is less than 30 dB(A) is appropriate in respect of the following point:

- The EPA document *'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)'* proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. Turbine noise limits are detailed in terms of the L_{A90} parameter while the NG4 daytime limit is detailed in terms of the L_{Aeq}. The accepted difference between the L_{Aeq} and L_{A90} for wind turbine noise assessments is 2 dB, i.e., 45 dB L_{Aeq} equates to 43 L_{A90}. This approach infers a 3 dB difference when accounting for difference parameters between the NG4 limits and the WEDG06 limits. The proposed lower threshold daytime criterion for wind turbine noise here is 3 dB more stringent than the equivalent daytime noise limit for areas of low background noise outlined in NG4.

Best practice for setting wind turbine noise limits at NSLs is that the limits should relate to the cumulative turbine noise level from all turbines. It is not uncommon for older wind farm developments in Ireland to have conditioned noise limits that conflict with best practice guidance and may often conflict with neighbouring wind farm developments.

The proposed noise limits shall be cumulative, accounting for all operational wind turbines. When setting appropriate turbine noise limits in accordance with the criteria following the applicable WEDG06 guidelines and best practice guidance, it is important to bear in mind that where an existing wind turbine development is the dominant source of turbine noise at a given NSL, this must be considered in the context of the planning condition for noise under which other development operate.

The proposed turbine noise criteria should apply to the nearest NSLs where it can be reasonably determined that the noise contribution from the operation of proposed project is the dominant wind turbine source or has a significant contribution to the cumulative turbine noise level at a given NSL. The operational noise limits proposed for the proposed project at are:

Noise levels generated by the windfarm following commissioning by itself or in combination with other existing or permitted wind energy development in the vicinity when measured externally at noise sensitive locations, shall not exceed

- *For the daytime period 0700 to 2300 hrs, in quiet environments, where background noise is less than 30 dB $L_{A90,10min}$, 40 dB $L_{A90, 10 min}$*
- *For daytime periods, 0700 to 2300, where the background noise level exceeds 30 dB $L_{A90,10min}$, the greater of 45 dB $L_{A90,10min}$, or 5 dB(A) above background levels, whichever is greater; and*

[9] A lower threshold of 40 dB is commonly adopted in planning conditions for wind energy developments that have been granted planning permission by An Bord Pleanála (now An Coimisiún Pleanála) and local planning authorities in recent years for example, Derrinlough Wind Farm (Planning Ref: 306706-20), Coole Wind Farm (Planning Ref: PL25M.300686) Cloncreen Wind Farm (Planning Ref: PA0047), Borrisbeg Wind Farm (Planning Ref: 318704-23), Castlebanny Wind Farm (Planning Ref: 309306-21), Ballivor Wind Farm (Planning Ref: 316212-23) and Carrig Renewables Wind Farm (Planning Ref: 318689-23.

- *For the nighttime period 2300 to 0700, for all noise environments, the greater of 43 dB $L_{A90,10min}$, or 5 dB(A) above background levels, whichever is greater.*

12.3.2.1 *Assigning Representative Background Noise Levels*

The derived turbine noise limits have been assigned to the various NSLs where noise monitoring has been undertaken. Where background noise measurements have been conducted in the vicinity and/or are judged to be typical/indicative of the background noise levels at other locations, these can be assigned to the nearby representative location for the purposes of setting appropriate turbine noise limits for the assessment. That approach is in line with best practice guidance set out in the IOA GPG.

Table 12-10 confirms where representative background noise levels have been assigned to each of the relevant NSL's for the purpose of setting noise limits or where the existing noise conditions for turbine noise are in place for existing and permitted developments. Assigned the noise limits is based on professional judgement in line with best practice guidance of representative background noise levels that were measured as part of the survey.

Table 12-10: Representative Background Noise Levels

Derived Background Noise Levels measured at NSL:	Representative Background Noise Levels for NSL:
B (H346)	H346 & H347
C (H555)	H548, H549, H550, H551, H552, H553, H554, H555 & H556
A (H177), D (H357), E (H618) & F (H262)	The turbine noise limits derived in accordance with the criteria based on the background noise levels are location A, D, E & F are the same, and therefore the background noise levels at these locations applied at all other NSLs for the purpose of this assessment.

Table 12-11 outlines the operational noise criteria that will apply to this assessment. The derived criteria at 9m/s have been applied to higher wind speeds for the purpose of this assessment. It should be noted that as wind speed increases so too will the background noise levels, this approach to the assessment is therefore conservative.

Table 12-11: Derived Turbine Noise Limited for a Hub Height at 105.5 m

Location	Period	Turbine Noise Limits L_{A90}, 10min Levels (dB) at Various Standardised 10m Height Wind Speeds)						
		3	4	5	6	7	8	≥9
A	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
B	Day	40.0	45.0	45.0	45.0	45.0	45.0	47.6
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
C	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
D	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
E	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0
F	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0

In line with ETSU-R-97 guidance (Section12.1.7.5.1), a fixed lower threshold of 45 dB L_{A90} or a maximum increase of 5 dB above background noise (whichever is the higher) is proposed for any NSLs identified as being involved in the proposed project.

12.3.2.1.1 Comment on Cumulative Turbine Noise at H270 and H271

Locations H270 and H271 are situated in proximity to the Ballymartin Smithstown wind farm. These locations were referenced as R049 and R050 respectively in the Ballymartin Wind Farm Environmental Report (ER)[10]. These locations can be seen in **Error! Reference source not found.** f or context. R049 and R050 are identified as 'landowners' for the Ballymartin Wind Farm. The Ballymartin ER specifies a threshold of 45 dB L_{A90} or 5 dB above the background whichever is the higher for both day and night time periods at these properties. This approach adopted in the ER is in line with the ESTU-R-97 guidance and considered best practice. In these scenarios the landowner threshold would apply as a cumulative turbine noise limit of 45 dB L_{A90} or 5 dB above the background whichever is the higher for both day and night time periods at Locations H270 and H271.

In the scenario where Ballymartin Smithstown wind farm were decommissioned, the increased cumulative turbine noise of 45 dB L_{A90} for both day and night time periods at Locations H270 and H271 would no longer apply.

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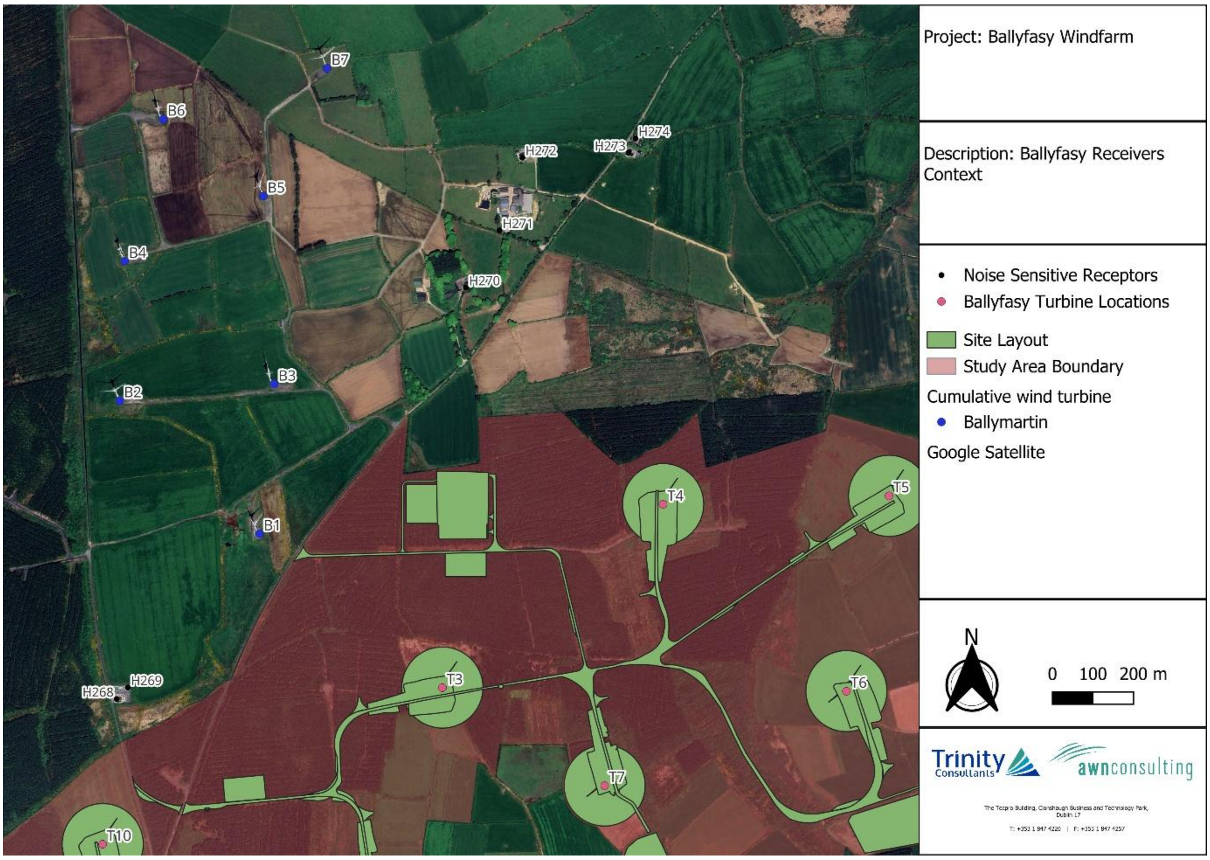
10 Ballymartin Windfarm Environmental Report Document No. RPS/MCE0650RP001F01 dated 23 September 2010.

Figure 12-4: Contextual Location of H270 and H271



12.3.3 Noise Limits for Fixed Plant

Based on a review of the measured noise from the background noise survey (Section 12.2.2 and 12.3), the NSLs in the vicinity of the site are defined as areas of low background noise as per the NG4 guidance. As the proposed substation will operate on a 24-hour basis, the potential impact during night-time periods governs the assessment. A night time criterion of 35 dB $L_{Aeq,T}$ is considered appropriate for the operation of the substation. 35 dB $L_{Aeq,T}$ is considered a low level of noise.

In accordance with to the guidance from the BS4142 standard, discussed in Section 12.1.7.6, it is considered that the proposed absolute criterion of 35 dB $L_{Aeq,T}$ for noise from the substation is robust and should prevent adverse impacts at NSLs.

12.4 Potential Effects

12.4.1 Do-nothing Scenario

If the proposed project does not proceed, the existing noise environment is expected to remain unchanged. The likely future receiving environment is anticipated to experience a gradual increase in traffic volumes on the local road network; however, this is not expected to result in a significant change to the overall ambient or background noise levels within the receiving environment.

12.4.2 Construction Phase

Construction noise prediction calculations have been conducted using the assessment methodology outlined and discussed in Sections 12.1.7.1. The source noise levels referred to in this section are indicative of the type of plant items and activities associated with the construction of the proposed project.

The highest predicted noise levels are expected to occur for short periods of time at a limited number of properties. Construction noise levels will be lower than these levels for most of the time at most properties in the vicinity of the proposed project.

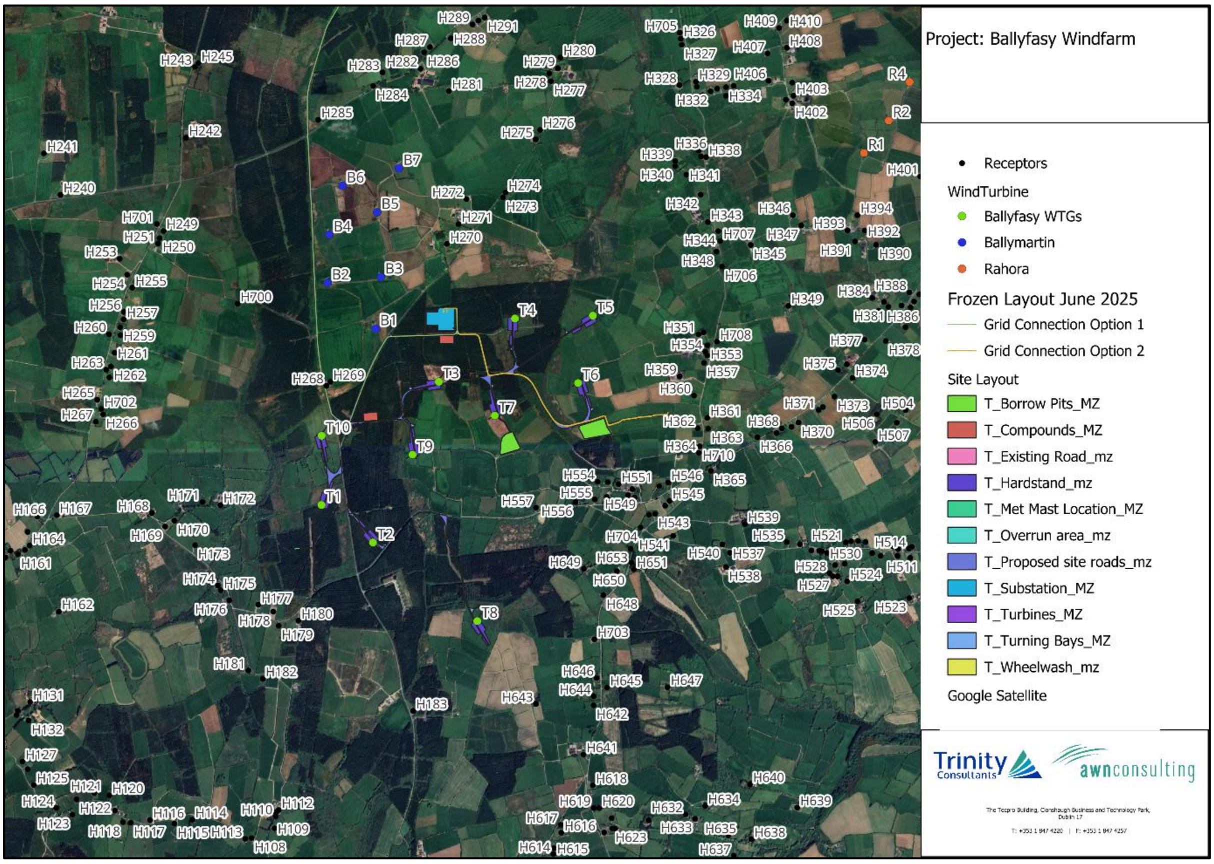
There are several stages and elements associated with the construction phase of the proposed project which will include but are not limited to the following:

- Construction and upgrade of site entrances.
- Construction and upgrade of internal site roads including site entrances.
- Directional Drilling for watercourse crossings
- Opening and operation of borrow pits.
- Construction of turbines and hardstand areas.
- Construction of 110kV electrical substation; and
- Grid Connection Options (GCO One & GCO Two).

Chapter 2 (Description of the Proposed Project) has detailed information on each of these elements.

In general, the distances between the construction activities associated with the proposed project and the nearest NSLs are such that there will be no significant noise, and vibration impacts at the NSLs. Figure 12-5 shows the construction layout in relation to the NSLs. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration effects, all other stages and elements are considered unlikely to have any significant noise and vibration effects namely, temporary construction compounds, meteorological mast, onsite span bridges, parking, security fencing, onsite cabling and site drainage works.

Figure 12-5: Construction Layout in relation to Noise Sensitive Locations



Construction activities will be carried out during normal daytime working hours (i.e., weekdays 08:00hrs – 20:00hrs and Saturdays 08:00hrs – 13:00hrs). However, to ensure that optimal use is made of good weather periods or at critical periods within the programme (e.g., concrete pours) or to accommodate delivery of large turbine components along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the Local Authority.

12.4.2.1General Construction of Turbines and Hardstand Areas

12.4.2.1.1 Noise

Several noise sources that would be expected on a construction site of this nature have been identified and predictions of the potential noise emissions have been calculated at the nearest NSL. In this instance the closest noise sensitive receptor is Location H554 which is situated approximately 720 m from the proposed turbine T06. The construction assessment will be conducted based on the worst-case scenario to the nearest receiver H554 situated 720 m from the constructions works.

Table 12-12 outlines the anticipated construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 12-12: Anticipated Wind Farm Turbine Construction Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)11	Predicted Noise Level (dB $L_{Aeq,T}$) at distance (m) 720 m
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	29
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	27
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	35
General Construction (Various)	All general activities plus deliveries of materials and plant	84	34
Concrete Mixer Truck and Concrete Pump (C.4.27)	Foundations	75	25
Dumper Truck (C.4.4)	Removing spoil and transporting fill and other materials.	76	26
Mobile Telescopic Crane (C.4.39)	Installation of nacelles	77	27
JCB (D.8.13)	Road surfacing.	82	32
Vibrating Rollers (D.8.29)	For services, drainage and landscaping.	77	27
Cumulative Construction Noise Level		--	40

At the nearest NSL (H554) the predicted noise levels from construction activities are in the range of 25 to 35 dB $L_{Aeq,T}$ with a total cumulative construction level of the order of 40 dB $L_{Aeq,T}$.

The predicted noise levels at the nearest NSLs are below the adopted significance threshold outlined in Table 12-1 (Category A – 65 dB $L_{Aeq,T}$ during daytime periods). This assessment is considered representative of worst-case construction noise levels at NSLs.

There is no item of plant that would be expected to give rise to noise levels that would be considered out of the ordinary or in exceedance of the thresholds outlined in Table 12-1 and this finding is valid should all items of plant operate simultaneously. No specific mitigation measures are required.

12.4.2.1.2 Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

12.4.2.1.3 Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case

[11] All plant noise levels are derived from BS5228: Part 1

associated effects at the nearest noise sensitive locations associated with construction of turbines and hardstanding areas are described as follows:

Quality	Significance	Duration
Negative	Not Significant	Short Term

The above effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.4.2.2Construction of Site Roads

It is proposed to upgrade existing site roads and construct new site roads to access the various parts of the development. Review of the road layout has identified that the nearest NSL to any point along the proposed layout is approximately 210 m to H360. All other locations are at greater distances with the majority at significantly greater distances. The full description of the new road is outlined in Chapter 2 (Description of the Proposed Project).

12.4.2.2.1 Noise

Table 12-13 outlines the typical construction noise levels associated with the proposed works for this element of the construction. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period.

Table 12-13: Indicative Noise Levels from Construction Plant at Various Distances from Site Roads

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)[12]	Highest Predicted Noise Level at Stated Distance from Edge of Works (dB $L_{Aeq,T}$) at 210 m
Tracked Excavator (C.4.64)	77	40
HGV Movement (C.2.30)	79	42
Vibrating Rollers (D.8.29)	77	39
Dumper Truck (C.4.4)	76	40
Cumulative Total	--	46

The table shows that at 210 m, noise levels are 19 dB below the construction noise thresholds in Table 12-1 and therefore the impact is not significant. As these works will progress along the road the worst-case predicted impacts will reduce. Works will therefore be in proximity to the closest NSL's for limited period.

There are no items of plant or construction activities that are likely to give rise to noise levels that would be considered out of the ordinary or in exceedance of the thresholds outlined in Section 12.1.7.1. No specific mitigation measures are required.

12.4.2.2.2 Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

12 All plant noise levels are taken from BS5228: Part 1

12.4.2.2.3 Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of site roads are described below.

Quality	Significance	Duration
Negative	Not Significant	Temporary

The above effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential effect.

12.4.2.3Borrow Pits

12.4.2.3.1 Noise

To inform this aspect of the proposal, a noise assessment has been based on the following assumptions:

- 1 mobile crusher and 1 rock breaker will be used at each borrow pit location;
- The plant will operate simultaneously in the vicinity of all proposed borrow pit location indicated in Table 12-14;
- Table 12-15 outlines the assumed noise levels for the plant items as extracted from BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

Table 12-14: Proposed Borrow Pit Locations

Borrow Pit Ref	Co-ordinates (ITM)	
	Easting	Northing
BP-01	661,811	625,506
BP-02	662,423	625,620

Table 12-15: Plant Noise Emissions

Item	dB L_W Levels per Octave Band (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Crusher	95	98	98	106	103	100	95	86	108
Rock Breaker	93	101	104	114	115	116	113	106	121
HGV Movement	77	88	95	93	93	92	86	76	98
Dump Truck	87	92	99	97	102	99	94	85	105
Semi-mobile screen/stockpiler	69	82	96	99	103	101	99	88	107
Tracked Excavator (3 no. in each pit)	77	88	95	93	93	92	86	76	98

A noise model prediction model has been prepared to consider the expected noise emissions from the proposed construction works at borrow pits as outlined above. A percentage on-time of 66% has been used for the noise calculations.

The nearest NSL to any of the borrow pit locations is situated at approximately 319 m from the nearest borrow pit. The predicted levels at the ten NSLs with the highest predicted noise levels assuming all borrow pits operate simultaneously are presented in Table 12-16.

Table 12-16: Prediction Noise Levels from Borrow Pit Activity at Nearest NSLs

Location Ref.	dB $L_{Aeq,T}$
H554	55
H553	55
H551	53
H555	52
H556	52
H552	52
H557	52
H550	51
H549	51
H548	50

Review of the results contained in Table 12-16 confirms that the predicted construction noise levels are 10 dB below or more than the relevant daytime construction noise criteria (65 dB $L_{Aeq,T}$). It is expected that construction works at the borrow pits will only occur during daytime periods.

12.4.2.3.2 Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

12.4.2.3.3 Description of Effects

The predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with operation of borrow pits are described follows:

Quality	Significance	Duration
Negative	Not Significant	Short Term

12.4.2.4Substation Construction

12.4.2.4.1 Noise

The nearest NSL to the proposed substation is H270, which is approximately 445 m to the closest point of the substation. As a worst-case example assuming the same construction activities as outlined in Table 12-12, the predicted noise levels from construction activities associated with the substation will be in the order of 55 dB $L_{Aeq,T}$ at the nearest NSL. This level of noise is well below the significance threshold of 65 dB $L_{Aeq,T}$, therefore no specific mitigation measures are required.

12.4.2.4.2 Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

12.4.2.4.3 Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of substation are described below.

Quality	Significance	Duration
Negative	Not Significant	Short Term

The above effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential effect.

12.4.2.5 Grid Connections Options

Two proposed Grid Connection Options (GCO) are being considered for the proposed project to connect to the national grid.

Proposed GCO One, proposes to install an underground 110 kV cable will run from the proposed onsite electrical substation to the consented Castlebanny Wind Farm 110 kV substation, approximately 12 km to the north.

Proposed GCO Two, proposes to connect the substation to the existing 110 kV Great Island-Kilkenny overhead line which passes to the east of the proposed Ballyfasy Wind Farm site. This option would require the following works:

- Removal of an existing 110kV pole set on the Great Island-Kilkenny overhead line.
- 2 new 110kV Overhead Line Cable Interface Masts.
- 2 circuits of 110kV underground cable (approximately 4.6 km of cable (2 cables x 2.3 km)) from line cable interface mast to the proposed Ballyfasy 110kV loop in substation.
- Access road to allow permanent access to the underground cable from line cable interface mast to the proposed loop in substation.
- All related site works, drainage and ancillary works.

The full description of the cable routes options is outlined in Chapter 2 (Description of the Proposed Development) of this EIAR.

12.4.2.5.1 Noise

Table 12-17 outlines the typical construction noise levels associated with the proposed works for both GCOs. Calculations have assumed an on-time of 66% for each item of plant i.e., that the item is operational for 8 hours over a 12-hour assessment period. Note the plant items and activities are indicative and based on assumption to be representative of a reasonable conservative assessment.

Table 12-17 presents outline noise calculations, considering the typical anticipated methods of construction, at varying distances from the construction works. The calculations assume that there is no acoustic screening (i.e. barriers) in place between the site works and the NSL and that plant items are operating at nominal on-times noted.

Table 12-17: Indicative Noise Levels for Typical Construction Plant at Various Distances from the Grid Connection Works

Item (BS 5228 Ref.)	Plant Noise Level at 10m Distance (dB $L_{Aeq,12hr}$)	Assumed % on-time	Calculated Construction Noise Level dB $L_{Aeq,T}$ at distance from works (m)			
			20 m	25 m	50 m	100 m
Tracked Excavator (C.2.7)	70	45%	61	55	48	40
Vibratory Plate (C.2.41)	80	25%	68	61	54	46
Dump Truck (C.2.32)	76	30%	63	59	52	44
Wheeled Loader (C.2.8)	68	25%	56	53	46	38
HDD (Directional drilling - C.4.96)	77	30%	66	64	58	52
HGV (C.6.19)	76	45%	67	58	51	43
Total Construction Noise	--	--	73	68	61	54

The nearest NSL to any point along proposed GCO One is H285 which is approximately at 76 m. The nearest NSL to any point along proposed GCO Two is H360, located approximately at 220 m. Table 12-17 shows that at these distances, the predicted construction noise levels at the nearest NSLs are below the adopted significance threshold outlined in Section 12.1.7.1 and no specific mitigation measures are required.

12.4.2.5.2 Vibration

Due to the distance of the proposed works from sensitive locations vibration effects are not likely at any NSL.

12.4.2.5.3 Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest noise sensitive locations associated with construction of the grid connection and underground cabling are described below.

Quality	Significance	Duration
Negative	Not significant	Temporary

The above effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential effect.

12.4.2.6 Construction Traffic

This section has been prepared to review potential noise impacts associated with construction traffic on the local road network. The information presented in Chapter 16 (Traffic and Transportation) has been used to inform the assessment presented in this chapter.

Changes in the traffic noise levels associated with the construction traffic for 'peak' and 'average' construction have been calculated based on information contained in Chapter 16.

The peak percentage increase along any of the construction haul routes due to construction generated traffic is 18%. Assuming 3% of the Do-Nothing Traffic Flows (2028) are heavy goods vehicles the calculated maximum increase in traffic noise during the 3-month peak construction period, is 1.5 dB. With reference to the DMRB magnitude of impact set out in Table 12-2, the potential impact is classified as a 'minor' impact change.

The off-peak percentage increase along any of the construction haul routes due to construction generated traffic is 4%. The calculated maximum increase in traffic noise during the 21-month off-peak construction period, is 0.4 dB. With reference to the DMRB magnitude of impact set out in Table 12-2, the potential impact is classified as 'no change'.

For concrete pours for turbine foundations, it is expected that there will be 12 two HV trips per hour. The calculated maximum increase in traffic noise during the 10 days expected for thee works is 5 dB. With reference to the DMRB magnitude of impact set out in Table 12-2, the potential impact is classified as 'Major', however as the total duration of this impact does not exceed the 15-day threshold (see Section 12.1.7.3) the associated increase in noise will not constitute a significant effect.

It is concluded that there will be no significant noise impacts associated with the additional traffic generated during the construction phase.

12.4.2.6.1 Description of Effects

The likely predicted effects are below the limits and/or thresholds identified for a significant effect to occur. With respect to the EPA's criteria for description of effects, the potential associated effects at the nearest NSLs associated with additional traffic generated during the construction phase are described below.

Quality	Significance	Duration
Negative	Not Significant	Short Term

12.4.3 Decommissioning Phase

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment will be used. The noise and vibration impacts associated with any decommissioning of the proposed project can be considered comparable to those outlined in relation to the construction phase (as per Section 12.4.2) albeit less works will be required as only above ground structures will be removed.

It is proposed that the turbine hardstands, met mast foundations, internal roads, substation, underground cabling and cable ducting remain in situ and will not be decommissioned. Refer to Chapter 2 (Description of Proposed Project) for full details. The predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB $L_{Aeq,T}$) at all NSLs for the decommissioning phase, the impact is not significant.

12.4.3.1.1 Description of Effects

The likely predicted noise and vibration impacts are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential associated effects at the nearest noise sensitive locations associated with construction of turbines and hardstanding areas are described below.

Quality	Significance	Duration
Negative	Not significant	Short Term

12.4.4 Operational Phase

12.4.4.1Assessment of Wind Turbine Noise

Using the assessment methodology described in Section 12.2.4, the predicted turbine noise levels have been calculated at all NSLs within the study area of the proposed project for the range of turbine types under consideration as described in Section 12.2.4.2.1. The results for the following scenarios are presented in this section:

- The predicted turbine noise levels for the Nordex N163 turbine, i.e., the turbine with the highest predicted noise levels at NSLs over the range of operational wind speeds; and,
- the predicted turbine noise levels for the SG6.6-155 turbine i.e. the turbine with the lowest predicted noise levels at NSLs over the range of operational wind speeds.

As described in Section 12.2.4.2.1, the assessment results are presented for two turbine types within the considered range. This approach ensures a robust evaluation of all turbine models listed in Table 12-7.

The first step of the noise prediction assessment is to present a worst-case omni-directional turbine noise prediction assessment using the ISO 9613-2 calculation standard and best practice guidance for turbine noise prediction calculations contained in the IOA GPG.

Omni-directional noise predictions are considered a worst-case scenario because the calculation method assumes uniform propagation with respect to wind direction. It models a situation where all NSLs are simultaneously downwind of all turbines, which cannot occur all locations.

The noise prediction calculations are based on worst-case conditions that favour sound propagation, such as wind blowing from the source to the receiver (downwind) and temperature inversions that cause sound to bend downward (downward refraction).

The results of the noise prediction models have been compared against the turbine noise limits that have been assigned to each of the NSL's for the purpose of this assessment as presented in Section 12.3.2, which have been derived in accordance with the criteria set out in Section 12.1.7.5.

Appendix 12-6 and Appendix 12-7 presents the predicted omni-directional turbine results at all NSLs in tabulated form.

Noise contours for the omni-directional rated power wind speed for the proposed project and the cumulative assessment are presented in Appendix 12-5 for the N163 and SG6.6 turbine options.

12.4.4.1.1 Predicted Levels – Nordex N163

This section presents the assessment of the N163 turbine, which represents the worst-case scenario for turbine noise emissions at NSLs among the range of turbine specifications considered.

With the exception of three NSLs, H270, H272 (both situated north of T04) and H557 (situated south of T07) the worst omni-directional cumulative turbine noise levels are below the turbine noise limits at all NSLs as described in Section 12.3.2.

Table 12-18 confirms that the potential exceedances identified at H270, H272, and H557 in the predicted omni-directional cumulative turbine noise levels range from 0.2 to 2.3 dB at wind speeds of 6 m/s or higher.

Table 12-18: Predicted Turbine Noise Levels with Potential Cumulative Exceedances (N163)

NSL Ref.	Description	Predicted Noise Level dB L_{A90} at Standardised Wind Speed at 10m height						
		3	4	5	6	7	8	9
H270	Omni-Directional Cumulative Turbine Noise	37.3	37.3	39.4	43.7	44.9	45.2	45.3
	Daytime Criterion	45	45	45	45	45	45	45
	Daytime Excess	--	--	--	--	--	0.2	0.3
	Night-time Criterion	45	45	45	45	45	45	45
	Night-time Excess	--	--	--	--	--	0.2	0.3
H272	Omni-Directional Cumulative Turbine Noise	35.6	35.6	37.5	41.8	43.1	43.4	43.5
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	0.4	0.5
H557	Omni-Directional Cumulative Turbine Noise	34.4	34.4	38.7	43.2	43.8	43.8	43.8
	Daytime Criterion	40	40	45	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	0.2	0.8	0.8	0.8

The next stage of the assessment is to consider the effects of wind direction. As described in Section 12.2.4.2.5 the directional nature of noise emissions from wind turbines means that, depending on the wind direction, noise levels at a given noise-sensitive location may be lower than or equal to those shown in **Error! Reference source not found.**, since locations situated b etween the wind farms will not be downwind of all turbines at the same time.

The result of the directional noise prediction model at the three NSLs with potential exceedance identified in the omni-direction turbine noise review are presented in Table 12-19 to Table 12-21. The tables present the predicted cumulative noise levels at each NSL across a range of wind speeds and directions and compare these levels against the applicable daytime and night-time noise criteria. The tables include a summary of the magnitude of any exceedances, along with the corresponding wind direction sector.

12.4.4.1.1.1Location H270 Results considering Wind Direction with Turbine N163

The result of the directional noise prediction model at H270 are presented in Table 12-19. It is confirmed that there are no exceedances of the turbine noise limits predicted at location H270 once consideration is given to wind direction and its effect on noise propagation.

Table 12-19: Review of Predicted Exceedances in Various Wind Direction Sectors – H270

NSL Ref.	Description	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.			
		6	7	8	9
N270	Omni-directional	43.7	44.9	45.2	45.3
	North (N)	40.5	41.7	42.0	42.1
	Northeast	40.1	41.3	41.6	41.7
	East	41.0	42.2	42.5	42.6
	Southeast	41.7	42.9	43.2	43.3
	South	42.7	43.9	44.2	44.3
	Southwest	42.9	44.1	44.4	44.5
	West	42.3	43.5	43.8	43.9
	Northwest	41.5	42.7	43.0	43.1
	Daytime Criterion	45.0	45.0	45.0	45.0
	Daytime Excess Accounting for Wind Direction	--	--	--	--
	Night-time Criterion	45.0	45.0	45.0	45.0
	Night-time Excess Accounting for Wind Direction	--	--	--	--

12.4.4.1.1.2 Location H272 Results considering Wind Direction with Turbine N163

The result of the directional noise prediction model at H272 are presented in Table 12-20.

Table 12-20: Review of Predicted Exceedances in Various Wind Direction Sectors – H272

NSL Ref.	Description	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.			
		6	7	8	9
H272	Omni-directional	41.8	43.1	43.4	43.5
	North (N)	38.7	40.0	40.3	40.4
	Northeast	37.0	38.3	38.6	38.7
	East	38.8	40.1	40.4	40.5
	Southeast	39.8	41.1	41.4	41.5

NSL Ref.	Description	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.			
		6	7	8	9
	South	40.7	42.0	42.3	42.4
	Southwest	41.6	42.9	43.2	43.3
	West	40.6	41.9	42.2	42.3
	Northwest	39.8	41.1	41.4	41.5
	Daytime Criterion	45.0	45.0	45.0	45.0
	Daytime Excess Accounting for Wind Direction	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0
	Night-time Excess Accounting for Wind Direction	--	--	0.2 (SW)	0.3 (SW)

As shown in Table 12-20 some marginal exceedances of the turbine noise criteria are predicted for location H272. The magnitude of these exceedances is between 0.2 and 0.3 dB, and they are predicted to occur in the Southwest wind directions sectors at ≥8 m/s wind speeds.

Predicted exceedances that are less than or equal to 0.5 dB are considered negligible in the context of this assessment. A change of this magnitude would not be perceptible to the human ear and falls within the typical range of measurement and calculation uncertainty.

As the turbine noise is predicted to exceed the noise criteria albeit by a very small margin, it can be concluded that in the absence of mitigation the N163 turbine has the potential for some exceedances at Location H272.

The noise emissions from the turbine can be reduced through the curtailment applied to the turbine via embedded controls. If required curtailment can ensure that the residual turbine noise levels at H272 will be within the applicable noise limits. Mitigation measures in the form of a turbine curtailment strategy are described in Section 12.5.3.1.

12.4.4.1.1.3Location H557 Results considering Wind Direction with Turbine N163

The result of the directional noise prediction model at H557 are presented in Table 12-21.

Table 12-21: Review of Predicted Exceedances in Various Wind Direction Sectors – H557

NSL Ref.	Description	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.			
		6	7	8	9
H557	Omni-directional	43.2	43.8	43.8	43.8
	North (N)	42.5	43.1	43.1	43.1
	Northeast	41.5	42.1	42.1	42.1
	East	39.4	40	40	40
	Southeast	38.7	39.3	39.3	39.3
	South	39.3	39.9	39.9	39.9
	Southwest	41.1	41.7	41.7	41.7
	West	42.6	43.2	43.2	43.2
	Northwest	42.8	43.4	43.4	43.4
	Daytime Criterion	45.0	45.0	45.0	45.0
	Daytime Excess Accounting for Wind Direction	--	--	--	--
	Night-time Criterion	43.0	43.0	43.0	43.0
	Night-time Excess Accounting for Wind Direction	--	0.1 (N), 0.2 (W), 0.4 (NW)	0.1 (N), 0.2 (W), 0.4 (NW)	0.1 (N), 0.2 (W), 0.4 (NW)

As shown in Table 12-21 some marginal exceedances of the turbine noise criteria are predicted for location H557. The magnitude of these exceedances is between 0.1 and 0.4 dB, and they are predicted in the West, Northwest, and North wind direction sectors at ≥7 m/s wind speeds.

Predicted exceedances that are less than or equal to 0.5 dB are considered negligible in the context of this assessment. A change of this magnitude would not be perceptible to the human ear and falls within the typical range of measurement and calculation uncertainty.

As the turbine noise is predicted to exceed the noise criteria albeit by a very small margin, it can be concluded that in the absence of mitigation the N163 turbine has the potential for exceedances at Location H557.

Mitigation measures in the form of a turbine curtailment strategy are described in Section 12.5.3.1.

12.4.4.1.2 Predicted Levels – SG6.6

This section presents the assessment of the SG6.6 turbine, which represents the turbine with the lowest noise emissions at NSLs among the range of turbine specifications considered.

The worst omni-directional cumulative turbine noise levels are below the turbine noise limits as described in Section 12.3.2 at all NSLs.

Appendix 12-6 and Appendix 12-7 presents the predicted omni-directional turbine results at all NSLs in tabulated form.

Noise contours for the omni-directional rated power wind speed for the proposed project and the cumulative assessment are presented in Appendix 12-5 for the N163 and SG6.6 turbine options.

12.4.4.1.3 Summary of Turbine Noise Assessment

The assessment of operational turbine noise has been carried out for two turbine models corresponding to the range outlined in Table 12-7 and discussed in Section 12.2.4.2.1. These models, the Nordex N163 and the SG6.6 represent the turbines with the highest and lowest predicted noise emissions NSLs within the study area. This approach ensures a robust evaluation of all turbine models listed in Table 12-7.

The N163 turbine produced in the highest turbine noise emissions. Negligible exceedances of the turbine noise limits are predicted at two NSLs. If required, exceedances can be addressed by mitigation through the application of a turbine curtailment strategy which is applied through embedded control within the wind turbines. At all other NSLs the predicted turbine noise levels are within the proposed turbine noise criteria and there are no likely significant effects anticipated.

The exceedances that are predicted are limited to specific wind speeds and wind directions. To ensure compliance with the turbine noise criteria and address the exceedances, mitigation measures in the form of a turbine curtailment strategy are described in Section 12.5.3.1.

The SG6.6 turbine resulted in the lowest turbine noise emissions. At all NSLs the predicted turbine noise levels are within the proposed turbine noise criteria when considering the SG6.6 turbine.

12.4.4.1.4 Description of Effects

12.4.4.1.4.1N163 Turbine

With the exception of locations H272 and H557, there are no significant effects are associated with the operation of proposed project, as the predicted cumulative turbine noise levels are within the turbine noise criteria.

While noise levels at low wind speeds will increase due to the development, specifically the operation of the turbines, the predicted levels will remain low, albeit a new source of noise will be introduced into the soundscape. At some other locations, there is currently noise from existing turbines at neighbouring wind farms. This assessment has considered the cumulative contribution from all turbines in the area with the potential cumulative noise effects.

With respect to the EPA's criteria for description of effects, the likely noise effects for the N163 turbine in the absence of mitigation are described below.

The exceedances at locations H272 and H557 are slightly above the applicable wind turbine noise criteria; on that basis, the significance of the effect before mitigation can be described as significant.

Quality	Significance	Duration
Negative	Significant	Long-term

The above effect should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

At all other NSLs, the effect associated with operation of the wind turbine of the development are described as follows:

Quality	Significance	Duration
Negative	Not Significant	Long-term

12.4.4.1.4.2SG6.6 Turbine

There are no significant effects are associated with the operation of proposed project, as the predicted cumulative turbine noise levels are within the turbine noise criteria.

While noise levels at low wind speeds will increase due to the development, specifically the operation of the turbines, the predicted levels will remain low, albeit a new source of noise will be introduced into the soundscape. At some other locations, there is currently noise from existing turbines at neighbouring wind farms. This assessment has considered the cumulative contribution from all turbines in the area with the potential cumulative noise effects.

With respect to the EPA's criteria for description of effects, the likely noise effects for the SG6.6 turbine in the absence of mitigation are described below.

Quality	Significance	Duration
Negative	Not Significant	Long-term

12.4.4.2Fixed Plant Noise

12.4.4.2.1 Substation

Details of the proposed 110 kV substation are described in Chapter 2 (Description of the Proposed Project). The substation is likely to be operating continuously, and the noise impact at the nearest NSL has been assessed to identify the potential greatest impact associated with the operation of the substation at the nearest NSL.

Based on experience with similar developments the likely noise emissions associated with a typical substation that would support a development of this nature is the order of 92 dB(A) L_w.

Noise prediction model calculations for the operation of the substation have been undertaken in accordance with ISO 9613-2. The predicted noise level from the operation of the substation at the nearest NSL H270 at approximately 540 m is 24 dB $L_{Aeq,T}$. This level of noise is low, and it is concluded that there will be no significant noise emissions from the operation of the substation at any NSL. Furthermore, the predicted noise level is well below the criterion for fixed mechanical plant outlined in Section 12.3.2.1.1 and is not expected to result in any adverse impacts at nearby NSLs. During the detailed design, acoustic features such as tonality, impulsivity and intermittency, will be considered in the context of the character assessment framework contained in BS-4142. Where these acoustic features are present, the Rating Level should be controlled to avoid adverse impacts at NSLs in accordance with BS-4142. Given the distances to the nearest NSLs, the occurrence of any acoustic features is unlikely.

12.4.4.2.2 Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the fixed mechanical and electrical plant at the proposed substation and battery storage facility is described below.

Quality	Significance	Duration
Negative	Not Significant	Long-term

12.5 Mitigation Measures

The assessment of potential effects has demonstrated that the proposed project is expected to comply with the identified criteria for the construction, operational and decommissioning phases and therefore no specific mitigation measures are required. However, the mitigation measures detailed below will be implemented for good practice

12.5.1 Embedded Mitigation

At project design stage all noise sensitive locations in the vicinity of the proposed wind farm were identified. In order to minimise potential effects on residential properties, it was decided early in the design process that a minimum set-back of 720 m would be appropriate (4 x the highest potential tip height of 180 m). This is in line with the setback requirements in the 2006 and Draft Revised WEDGs (2019).

Any turbine used in the proposed project will have embedded controls that can be programmed to reduce the noise output of the individual turbines. These can be applied during specific periods, wind speeds and/or wind directions. Operating a turbine in reduced noise mode, referred to as curtailment, typically results in a corresponding reduction in energy generation capacity for the turbine. The application of curtailment to the turbines can ensure that the proposed project will operate within the relevant noise limits.

12.5.2 Construction and Decommissioning Phases

The contract documents will specify that the Contractor undertaking the construction works will be obliged to adopt best practice noise abatement measures contained in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise and BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration.

To ameliorate any potential noise impacts that may present during the construction phase, a schedule of noise control measures has been formulated in accordance with best practice guidance, and the contract documents will require the Contractor to implement these measures. These are outlined in the Construction and Environmental Management Plan (CEMP) that has been prepared for the proposed project (see Appendix 2-6).

12.5.3 Operational Phase

12.5.3.1 Wind Turbine Noise

An assessment of the operational wind turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 12.1.7.5. The findings of the assessment, presented in Section 12.2.4, has confirmed that the predicted operational noise levels associated with the proposed project will be within best practice turbine noise criteria at most locations with no significant cumulative impacts or effects. However, in the worst-case scenario of the N163 turbine, which results in the highest turbine noise at NSLs, there are slight exceedance at two locations (H272 and H557) in the absence of mitigation. Mitigation in the form of turbine curtailment can ensure the residual turbine noise levels will be within the turbine noise criteria.

As mentioned in Section 12.5.1, the turbines can be programmed to run in reduced modes of operation (or low noise modes) to achieve the required attenuation in specific wind conditions (i.e., wind speed and direction).

To address the potential exceedances predicted, the Nordex N163 turbine in this assessment can be programmed to operate in low noise modes for specific wind speed bins and periods. The N163 turbines can be configured for up to 18 different operating modes and all modern wind turbines will have similar controls to reduce the noise emission of the turbine in certain conditions.

For any turbine curtailment strategy that is developed, consideration must be given to the practical benefits. This is particularly the case with cumulative turbine noise, where two or more wind farm developments contribute to the overall turbine noise level. In these instances, curtailment of the non-dominant turbines[13] may only achieve an imperceptible and unmeasurable change in the total wind turbine noise level at a given receptor. Such curtailment may unnecessarily reduce the electrical power generating capacity of a wind farm, for an imperceptible change to the overall turbine noise levels. When curtailing for exceedance of the night time criterion consideration should be given to the background noise at the specific NSL to avoid unnecessarily curtailing turbine noise when the result would yield an imperceptible change to the overall turbine noise levels.

Wind Speed	Period	Predicted exceedance in Noise Level dB LA90 at Standardised Wind Speed at 10 m A.G.L.							
		N	NE	E	SE	S	SW	W	NW
3	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
4	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--

[13] When the contribution of the non-dominant wind farm is 10 dB or more below the cumulative turbine noise level of neighbouring site it is considered to be no longer contributing to the overall turbine noise, and no further mitigation would be required.

Wind Speed	Period	Predicted exceedance in Noise Level dB LA90 at Standardised Wind Speed at 10 m A.G.L.							
		N	NE	E	SE	S	SW	W	NW
5	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
6	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
7	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
8	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	0.2	--	--
9	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	0.3	--	--

Table 12-22 and Table 12-23 present an overview of the extent of the potential exceedances to be mitigated through curtailment of turbine operation for the N163 turbine. The following points are reiterated:

- Predicted exceedances that are less than or equal to 0.5 dB are considered negligible in the context of this assessment. A change of this magnitude would not be perceptible to the human ear and falls within the typical range of measurement and calculation uncertainty.

Table 12-22: Extent of Potential Maximum Exceedance for N163 Turbine at H272

Wind Speed	Period	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.							
		N	NE	E	SE	S	SW	W	NW
3	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
4	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
5	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--

Wind Speed	Period	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.							
		N	NE	E	SE	S	SW	W	NW
6	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
7	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
8	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	0.2	--	--
9	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	0.3	--	--

Table 12-23: Extent of Potential Maximum Exceedance for N163 Turbine at H557

Wind Speed	Period	Predicted exceedance in Noise Level dB L_{A90} at Standardised Wind Speed at 10 m A.G.L.							
		N	NE	E	SE	S	SW	W	NW
3	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
4	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
5	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
6	Day	--	--	--	--	--	--	--	--
	Night	--	--	--	--	--	--	--	--
7	Day	--	--	--	--	--	--	--	--
	Night	0.1	--	--	--	--	--	0.2	0.4
8	Day	--	--	--	--	--	--	--	--
	Night	0.1	--	--	--	--	--	0.2	0.4
9	Day	--	--	--	--	--	--	--	--
	Night	0.1	--	--	--	--	--	0.2	0.4

The following outline curtailment strategy, applied in this assessment, demonstrates that the proposed wind farm can operate within the relevant best practice noise criteria. The mitigation strategy is based on a wind speed of 9 m/s, which represents the worst-case scenario, and illustrates the principle that can be applied during the design phase to address any exceedances of the turbine noise criteria.

The outline curtailment strategy presented in Table 12-24 demonstrates the extent of turbine curtailment required for the N163 for the worst-case scenario that would apply during night time periods at windspeeds ≥9 m/s during night time periods only in the south west wind director.

Table 12-24: Curtailment Strategy for N163 Turbine to Address Potential Exceedances at 9 m/s

Wind Speed	Period	N163 Turbine Operating Mode in Various Wind Direction Sectors (Turbine Number, TXX – Turbine Operating Mode, MXX)							
		N	NE	E	SE	S	SW	W	NW
9	Day	--	--	--	--	--	--	--	--
	Night	T7 (M01)	--	--	--	--	T4 (M04)	T7 (M01)	T7 (M02)

The principles outlined in this section for addressing potential exceedances at a limited range of operational wind speeds and directions will be applied to all turbines considered in this assessment, if required, to ensure compliance with noise limits. Table 12-24 represents the worst-case scenario in terms of both the number and magnitude of exceedances to be addressed through mitigation in the form of turbine curtailment.

Any curtailment strategy would need to be verified by the turbine manufacturer and will be designed with consideration of the physical limitations and controls of the turbine. With curtailment in place the operation of proposed project will be within the proposed turbine noise limits at all locations.

This would be controlled in practice through a planning condition imposing noise limits on operational noise from the wind turbines at neighbouring residential properties, in line with the noise criteria outlined in Section 12.3.2 and/or the relevant operational criteria associated with the grant of planning for the proposed project.

12.5.3.2Fixed Plant

The assessment of noise from the operation of fixed plant at the substation is predicted to comply with the proposed criteria in Section 12.1.7.6. Therefore, no specific mitigation measures are required.

12.5.3.3Monitoring

Prior to the commissioning of the wind farm, the developer will submit a Noise Complaint Monitoring Programme (NCMP) to the planning authority for written agreement. The NCMP will include a detailed methodology for noise measurement procedures for recording results and a protocol for managing complaints.

Compliance noise surveys will be undertaken to verify compliance with any noise conditions applied to the development. It is common practice to commence surveys within six months of a wind farm being commissioned. The guidance outlined in the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014) will be taken into account.

In the unlikely event that an exceedance of the noise criteria is identified as part of the commissioning assessment and relevant corrective actions taken. For example, implementation of noise reduced operational modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure turbine noise levels are within the relevant noise criterion or conditions turbine noise limits. Such curtailment can be applied using the wind farm SCADA system with a marginal reduction of the wind turbine performance.

12.5.3.3.1 Amplitude Modulation and tonality

In the event of a complaint indicating potential excessive amplitude modulation or tonality associated with the proposed project, the operator will fully investigate the complaint in collaboration with the turbine manufacturer, through review of the meteorological periods and conditions during which the reported AM or tonality occurs. A noise monitoring protocol would be established, in consultation with the local authority, which would set out the location and analysis methodology to be employed for the noise monitoring. This can be secured via a planning condition.

If an ongoing issue with excessive AM is established, a mitigation strategy to reduce the level of AM will be implemented through engineering methods, operational changes and/or curtailment of specific turbines. The operator would first appoint a qualified acoustic consultant to objectively assess the level of AM in accordance with the methods outlined in the Institute of Acoustics IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report: A Method for Rating Amplitude Modulation in Wind Turbine Noise (9 August 2016) or subsequent revisions.

The measurement method outlined in the IOA AMWG document, known as the ‘Reference Method’, provide a robust and reliable indicator of AM and yield important objective information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including methods[14], determined in liaison with the turbine manufacturer, to minimise the occurrence of excessive AM. Examples of mitigation measures which could be considered include turbine blade modifications, the implementation of specific operational controls for the relevant turbine type or operating turbines in different operational modes or turbine curtailment under specific operational conditions. The aim of the mitigation would be to minimise adverse impacts from excessive AM associated with the proposed project as much as is reasonably practicable.

Similarly, if the complaints suggest the potential occurrence of clearly audible tonality in the wind turbine noise, the audibility of the tones will be investigated from measured data with a robust, objective method such as that included in ISO 1996-2:2017. If persistent occurrence of

[14] See for example: Cand M. and Bullmore A. (2015), Measurements demonstrating mitigation of far-field AM from wind turbines. 6th International Meeting on Wind Turbine Noise Glasgow, 2015.

clearly audible tonality is identified, then the operator would liaise with the turbine manufacturer to investigate and implement measures to mitigate or minimise the occurrence of tonality as much as is reasonably practicable. This may also involve engineering methods or turbine operational changes for example.

The commitment outlined to control amplitude modulation (AM) from wind turbines are considered best practice. The proposed approach provides a clear commitment that additional adverse impacts from excessive amplitude modulation (AM) or tonality associated with the operation of the proposed project will be effectively managed and minimised by the operator.

12.6 Residual Effects

This section summarises the likely residual noise and vibration effects associated with the proposed project following the implementation of mitigation measures.

12.6.1 Construction Phase

During the construction phase of the proposed project, there will be some impacts on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and the NSLs, the short-term duration of the construction phase, and the assessment's findings that the expected noise and vibration emissions will be below the identified threshold and limit values, the impacts will not be significant.

With respect to the EPA's criteria for description of effects, in terms of these construction activities, the potential worst-case associated effects at the nearest NSLs associated with the various elements of the construction phase are described below.

12.6.1.1General Construction – Turbines and Hardstand Areas

Quality	Significance	Duration
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.1.2Construction of Site Roads

Quality	Significance	Duration
Negative	Not Significant	Temporary

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.1.3Borrow Pits

Quality	Significance	Duration
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.1.4Substation Construction

Quality	Significance	Duration
Negative	Not Significant	Short Term

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.1.5 Grid Connection Options

Quality	Significance	Duration
Negative	Not Significant	Temporary

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. The described effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.1.6Construction Traffic

Quality	Significance	Duration
Negative	Not Significant	Short Term

12.6.2 Operational Phase

12.6.2.1Wind Turbine Noise

The residual turbine noise levels associated with the proposed project will be within best practice noise criteria curves recommended in line with Irish guidance 'Wind Energy Development Guidelines for Planning Authorities', it is not considered that a significant effect is associated with the project.

While noise levels at low wind speeds will increase due to the development and specifically the operation of the turbines, the predicted levels will remain low, albeit new sources of noise will be introduced into the soundscape.

The predicted residual operational turbine noise effects are summarised as follows at the nearest NSLs.

Quality	Significance	Duration
Negative	Not Significant	Long-term

The above effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.6.2.2Substation Operation

Quality	Significance	Duration
Negative	Not Significant	Long-term

The above effects consider the locations of the greatest potential impact.

12.7 CUMULATIVE EFFECTS

A review of the planning applications submitted in the area in proximity to the site (as detailed in Chapter 1 Introduction) has been undertaken and these projects have been considered in the noise and vibration cumulative assessments

12.7.1 Wind Turbine Noise

Existing permitted and proposed wind farm developments with the potential for cumulative impacts have been considered as part of the turbine noise impact assessment. A review of existing, proposed and permitted wind turbine developments in the wider study area has been undertaken in accordance with the guidance contained in the IOA GPG. Therefore, Section 12.4.4 provides a full cumulative noise assessment in accordance with the IOA GPG, considering Ballymartin Smithstown, Rahora and Castlebanny Wind Farms.

It is therefore considered that the effect on the noise environment associated with the proposed project in combination with other wind farm developments is not significant.

12.7.2 Noise from Fixed Plant Operation

The predicted noise from the operation of the substation at the nearest NSL is of such low magnitude that the potential for any cumulative noise effects is not significant.

12.7.3 Construction and Decommissioning

It is not anticipated that there will be any other activities that would give rise to significant cumulative effects during the construction or decommissioning phases. The predicted noise and vibration emissions for the proposed project are not of enough magnitude to cause an increase in the cumulative construction noise emissions exceeding the threshold for significant impacts at any NSL.

In order for cumulative noise levels to increase, the contribution of noise from the proposed project must be within 10 dB of the other source of noise. The predicted noise levels from construction activity would therefore need to be well in excess of 55 dB $L_{Aeq,T}$ at an NSL in order for a potential cumulative construction noise increase to exceed the noise thresholds outlined in Section 12.1.7.1. The assessment in Section 12.4.2 and 12.4.3 confirms that the predicted noise levels from activities at any NSL are ≤55 dB $L_{Aeq,T}$ and therefore the potential for any cumulative noise effect from all of the proposed activities occurring simultaneously or with construction activities from other developments is unlikely and not significant.

12.8 CONCLUSION

When considering a development of this nature, the potential noise and vibration effects on the surroundings must be considered for three stages: the short-term construction phase and decommissioning phases, and the long-term operational phase.

The assessment of construction noise and vibration and has been conducted in accordance with best practice guidance contained in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration*.

Residual noise associated with the construction and decommissioned phases have been predicted to be below the proposed threshold values. The associated noise and vibration levels are not likely to cause significant effect at any NSL.

Based on the proposed site layout and the details of turbine noise emissions, hub height, and tip height for the range of turbine types considered in the assessment, turbine noise levels have been predicted at NSLs across a range of operational wind speeds.

The assessment found that the N163 turbine, which produces the highest noise levels among the options considered, has the potential to marginally exceed the turbine noise criteria at two locations.

However, the assessment has demonstrated that turbine noise emissions can be reduced through curtailment measures applied via embedded controls within the turbines. The application of mitigation in the form of turbine curtailment will ensure that residual noise levels associated with the proposed project remain within the best practice noise limits recommended in WEDGs.

Therefore, it is not considered that the proposed project will result in a significant noise effect.

A commitment has been provided that prior to the commissioning of the wind farm; the developer will submit a Noise Compliance Monitoring Programme (NCMP) to the planning authority for written agreement. The NCMP will include a detailed methodology for all noise measurements, the frequency of monitoring, procedures for recording results and a protocol for managing complaints.

Operational noise from the proposed substation has been assessed and found to be within the adopted criteria.

No significant vibration effects are associated with the operation of the site.

It is not considered that a significant effect is associated with the proposed project.

12.9 References

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022)
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise. (BS5228-1)
- Transport Infrastructure Ireland (TII) (formerly National Roads Authority (NRA)) document Guidelines for the Treatment of Noise and Vibration in National Road Schemes (NRA, 2004)
- Design Manual for Roads and Bridges, Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (National England (now National Highways) 2020) (DMRB)
- BS 7385 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration (1993) (BS77385)
- BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration. (BS5528-2)
- Department of the Environment, Heritage and Local Government Wind Energy Development Guidelines 2006 (WEDGs)
- Department of Trade & Industry (UK) Energy Technology Support Unit (ETSU) publication The Assessment and Rating of Noise from Wind Farms (1996) (ETSU-R-97)
- Institute of Acoustics (IOA) document A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013) including six Supplementary Guidance Notes (IOA GPG)
- World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018)
- ISO 9613-2:2024: Acoustics — Attenuation of sound during propagation outdoors Part 2: Engineering method for the prediction of sound pressure levels outdoors
- EPA Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) (2011)
- EPA Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4), 2016 (NG4)
- Draft Revised Wind Energy Development Guidelines 2019 Department of Housing, Local Government and Heritage (2019 draft WEDGs)
- World Health Organisation (WHO) document Community Noise (WHO, 1995)
- South Australian Environment Protection Authority namely, Infrasound levels near windfarms and in other environments (EPA, 2013)
- State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg Low Frequency Noise incl. Infrasound from Wind Turbines and Other Sources (2016)
- IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document A Method for Rating Amplitude Modulation in Wind Turbine Noise (IOA, 2016)
- RenewableUK AM project (RenewableUK 2013)
- Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of

Communities and Local Government (CLG) Research into Aerodynamic Modulation of Wind Turbine Noise (2007)
- Wind turbine AM review: Phase 2 report. 3514482A Issue 3. Department for Business, Energy & Industrial Strategy (2016)
- ISO 1996: 2017: Acoustics — Description, measurement, and assessment of environmental noise.
- International Electrotechnical Commission (IEC) Technical Specification 61400-11-2 (Edition 1.0, 2024) Wind Energy Generation Systems – Part 11-2: Acoustic noise measurement techniques – Measurement of wind turbine sound characteristics in receptor position.