12.0 NOISE AND VIBRATION

12.1 INTRODUCTION

This chapter of the EIAR describes the assessment undertaken of the potential noise and vibration impact on local residential amenity from the proposed project.

The proposed project will be the subject of two planning applications: one to An Bord Pleanála under section 37E of the Planning and Development Act 2000 as amended, and another separate application will be made to the An Bord Pleanála for the proposed onsite substation and grid connection under section 182A of the Planning and Development Act 2000. The entire proposed project is assessed in this EIAR. Any references to the "proposed development" or "proposed project" in the EIAR would equally relate to the entire project (i.e. wind farm, grid connection and all temporary/permanent works along the proposed turbine delivery route (TDR), unless otherwise stated. A full description of the proposed project is provided in Chapter 2 of this EIAR.

The proposed project consists of 15 wind turbines with an overall blade tip height of 179.5-185 m inclusive, a rotor diameter range of 149 m to 163 m inclusive, a hub height range of 102.5 m to 110.5 m inclusive.

Noise and vibration impact assessments have been prepared for the operational, construction, and decommissioning phases of the proposed project to the nearest Noise Sensitive Locations (NSLs). To inform this assessment, baseline noise levels have been surveyed at four representative NSLs surrounding the proposed wind farm site. Noise predictions to the nearest NSLs have been prepared for all key elements of the proposed project with the potential for noise and vibration impacts and effects.

A separate proposed wind farm development with potential for cumulative noise impacts has been identified and reviewed as part of this assessment. In line with best practice guidance, the cumulative impact of this development has been included in the operational noise impact assessment. Further details on the projects considered as part of the cumulative assessment are provided in Chapter 4 of this EIAR.

For a glossary of terms used in this chapter please refer to Appendix 12.1.

12.1.1 Statement of Authority

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

Dermot Blunnie (Principal Acoustic Consultant) 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.

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.

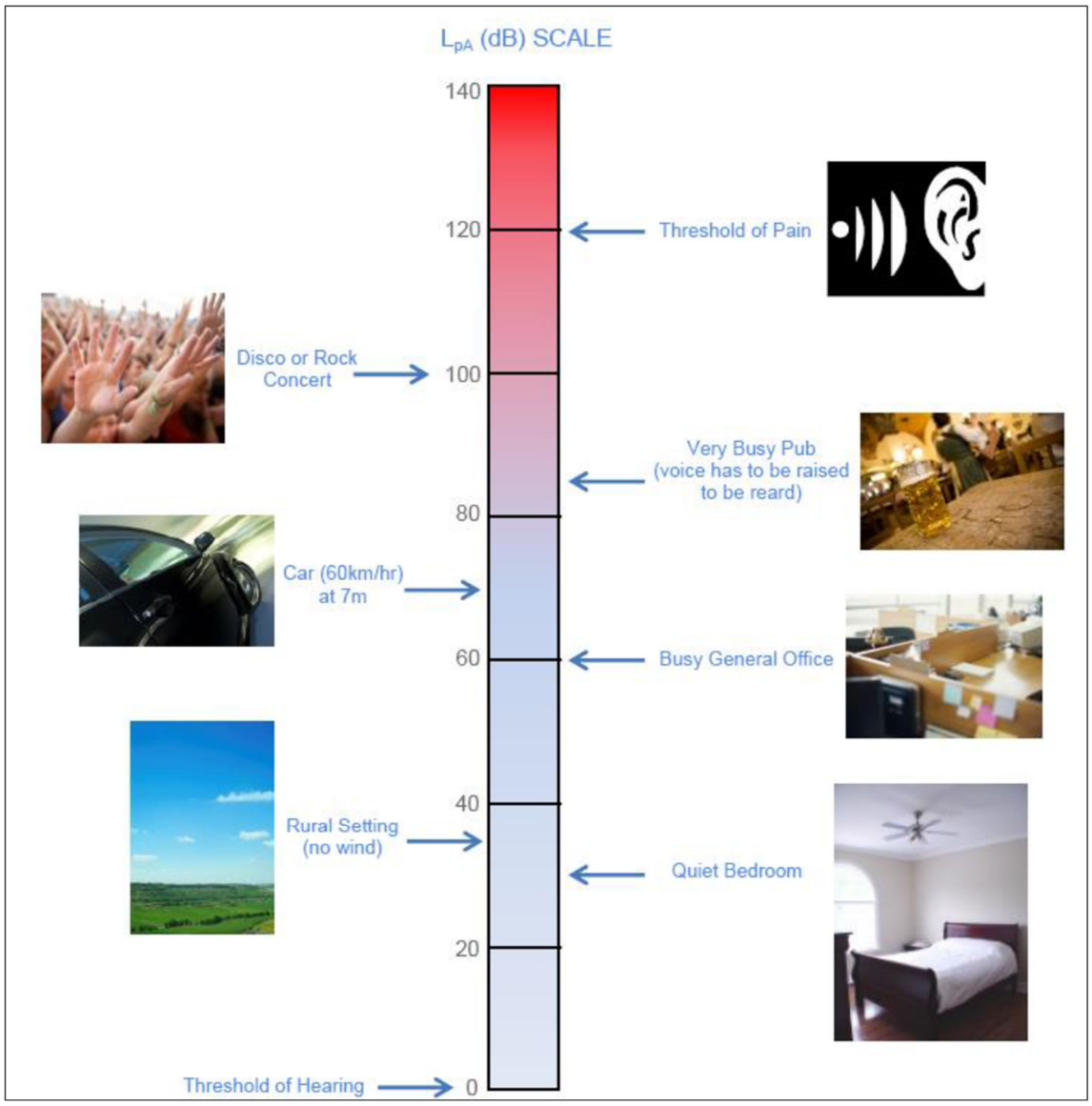

Figure 12-1: dB(A) Scale & Indicative Noise Levels – (EPA: Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4 – 2016))

12.2 LEGISLATION, POLICY AND GUIDANCE

The assessment of impacts for the proposed project has been undertaken with reference to the most relevant guidance documents relating to environmental noise and vibration, in addition to specific guidance documents that 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) (WEDGs).
- *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)
- *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).
- 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*

12.2.1 Environmental Protection Agency (EPA) Description of Effects

The significance of effects of the proposed project shall be described in accordance with the Environmental Protection Agency (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 are provided in Chapter 1 – Introduction.

The effects associated with the proposed project are described in the relevant sections of this chapter in accordance with the EPA guidance set out in Chapter 1 of the EIAR.

12.2.2 Guidance Documents and Assessment Criteria

The following sections review best practice guidance that is commonly adopted in relation to developments such as the one under consideration here.

12.2.2.1 Construction Phase – Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction 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).

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: Example 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 ABC-method should be applied as described below to determine appropriate threshold values at NSLs.

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 $L_{Aeq,1hr}$ during daytime periods) then a significant effect is considered to occur. In order to determine the significance of the effects it is important to consider the duration of the impacts.

12.2.2.1.1 Linear Construction Works

Due to the linear progressive nature of the construction works associated with proposed grid connection route (GCR), internal underground cabling, and construction of new site access roads and upgrade on existing site roads, a fixed noise limit is proposed. 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 shorter periods 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 $L_{Aeq,1hr}$.

In light of the above guidance, a construction noise limit of 70 dB $L_{Aeq,1hr}$ is proposed for linear construction activities (i.e. the proposed GCR, internal underground cabling, construction of new site access roads and upgrades to the existing site roads). Noise levels above 70 dB $L_{Aeq,1hr}$ would indicate a significant impact depending on the duration and frequency of occurrence.

12.2.2.1.2 Additional Vehicular Activity on Public Roads Construction Phase

There are no specific guidelines or limits relating to traffic related noise 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 development.

For the assessment of potential noise impacts from construction related traffic along public roads it is proposed to adopt guidance from Highways England (now National Highways) Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA 111 Noise and Vibration (Revision 2) (DMRB).

Table 12-2**Error! Reference source not found.** taken from DMRB LA 111 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 (Source LA 111 DMRB, 2020).

Change in Baseline Noise Level (dB)	DMBR Magnitude of Impact (Short Term)
Less than 1 dB	No change
1 – 2.9	Minor
3 – 4.9	Moderate
≥5	Major

Section 3.19 of LA 111, DMRB states that construction traffic noise shall constitute a significant effect where it is found 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.

The DMRB guidance will be used to assess the predicted increases in traffic levels on public roads associated with the proposed project 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.

12.2.2.2 Construction Phase – Vibration

Vibration standards come in two varieties: those dealing with human comfort and those dealing with cosmetic or structural damage to buildings. With respect to this development, 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).
- B*S 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 be no cosmetic damage if transient vibration does not exceed 15 mm/s at low frequencies rising to 20 mm/s at 15 Hz and 50 mm/s at 40 Hz and above. These values relate to relatively modern buildings and should be reduced to 50% or less for more critical buildings.

BS5228-2 recommends that, for a 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 than 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 considered appropriate for this assessment.

12.2.2.3 Operational Phase Noise – Wind Turbines

The noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the WEDGs. These guidelines are in turn based on detailed 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). The ETSU document has been used to supplement the guidance contained within the WEDGs where necessary.

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

The core of the noise guidance contained within the WEDGs is based on the 1996 ETSU publication *The Assessment and Rating of Noise from Wind Farms* (ETSU-R-97).

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.

ETSU-R-97 states on page 58, "*…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 considered 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.

12.2.2.3.2 Institute of Acoustics Good Practice Guide

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* including six Supplementary Guidance Notes (IOA GPG)[1]. 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 in Ireland and have 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: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation* (1996). 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 typically offered by modern wind turbine units.

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. Reference will be made to this guidance 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 relevant IOA GPG states the following:

> *"Cumulative impact assessment necessary:*

[1] Accessible at https://www.ioa.org.uk/publications/wind-turbine-noise

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 Section 12.3.112.3.1.

12.2.2.3.3 Wind Energy Development Guidelines for Planning Authorities (2006)

Section 5.6 of the Wind Energy Development Guidelines (WEDGs) addresses noise and outlines the appropriate noise criteria in relation to wind farm developments.

The following extracts from this document should be considered:

> *"An appropriate balance must be achieved between power generation and noise impact."*

While this comment is noted it should be stated that the WEDGs give no specific advice in relation to what constitutes an 'appropriate balance'. In the absence of specific guidance in the WEDGs, reference has been made to the guidance contained in ETSU-R-97, IOAGPG and recent planning conditions for noise issued by An Bord Pleanála on similar developments.

> *"In the case of wind energy development, a noise sensitive location includes any occupied house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational importance. Noise limits should apply only to those areas frequently used for relaxation of activities for which a quiet environment is highly desirable. Noise limits should be applied to external locations and should reflect the variation in both turbine source noise and background noise with wind speed."*

The issues identified in this extract have been incorporated into our assessment and are addressed in Section 12.4.2.

> *"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."*

This represents the commonly adopted daytime noise criterion curve in relation to wind farm developments. 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 time 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 and represents the commonly adopted night time noise criterion curve in relation to wind farm developments.

In summary, the WEDGs outline 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 LA90 for quiet daytime environments with background noise levels of less than 30 dB LA90,10min;
- 45 dB LA90,10min 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 LA90,10min and;
- 43 dB LA90,10min for night time periods.

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 Bord Pleanála.

12.2.2.3.4 Future Potential Guidance Changes

In December 2019, the Draft Revised Wind Energy Development Guidelines (2019 draft WEDGs) were published for consultation and at the time of writing, the final guidelines have yet to be published. It is important to note that during the public consultation on the 2019 draft WEDGs, several concerns relating to the proposed approach of the 2019 draft WEDGs 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 cross party group can be reviewed at:

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

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 statements was submitted by the Minister for Housing, Local Government and Heritage during a Dail Eireann Debates on 13 June 2023[2]:

> "*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.*"

The assessment of wind turbine noise presented in this EIAR is based on the guidance outlined in the 2006 WEDGs and has been supplemented with best practice guidance from ESTU-R-97 and the IOA GPG.

If the updated and final 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.

12.2.2.3.5 World Health Organisation (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

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

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 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."

It is considered that the conditional WHO recommended average noise exposure level (i.e. 45 dB L_{den}) if applied, as target noise criteria for an existing or proposed wind turbine development in Ireland, should be done with caution. The conditional WHO recommendation for average noise exposure level (i.e., 45 dB L_{den}) may be a poor characterisation of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.

12.2.2.4 Operational Phase Noise - Substation

For the proposed substation which forms part of the proposed project, it is proposed to set fixed noise limits in accordance with the following best practice guidance.

12.2.2.4.1 EPA NG4

In order 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}.*

Determining Appropriate Noise Criteria

Table 12-4 12-4**Error! Reference source not found.** outlines the noise emission limit criteria detailed in the NG4 document.

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.

12.2.2.4.2 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 factor 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."*

12.2.2.5 Operational Phase Noise - Special Characteristics of Turbine Noise

12.2.2.5.1 Low Frequency Noise/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."*

With respect to infrasonic noise levels below the hearing threshold, the World Health Organisation (WHO) document *Community Noise* (WHO, 1995) has stated that:

> *"There is no reliable evidence that infrasounds below the hearing threshold produce physiological or psychological effects."*

In 2010, the UK Health Protection Agency published a report entitled *Health Effects of Exposure to Ultrasound and Infrasound, Report of the independent Advisory Group on Non-ionising Radiation*. The exposures considered in the report related to medical applications and general environmental exposure. The report notes:

> *"Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies.*
>
> *For infrasound, aural pain and damage can occur at exposures above about 140 dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects."*

The UK Institute of Acoustics Bulletin in March 2009 included a statement of agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments (IAO JS2009). The intent of the article was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. The article notes the following with respect to infrasound:

> *"Infrasound is the term generally used to describe sound at frequencies below 20 Hz. At separation distances from wind turbines which are typical of residential locations the levels of infrasound from wind turbines are well below the human perception level. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.*

Sounds at frequencies from about 20 Hz to 200 Hz are conventionally referred to as low-frequency sounds. A report for the DTI in 2006 by Hayes McKenzie concluded that neither infrasound nor low frequency noise was a significant factor at the separation distances at which people lived. This was confirmed by a peer review by a number of consultants working in this field. We concur with this view."

The article concludes that:

"from examination of reports of the studies referred to above, and other reports widely available on internet sites, we conclude that there is no robust evidence that low frequency noise (including 'infrasound') or ground -borne vibration from wind farms, generally has adverse effects on wind farm neighbours".

A report released in January 2013 by the South Australian Environment Protection Authority namely, *Infrasound levels near windfarms and in other environments* (EPA, 2013)[3] 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.

The study included several houses in rural and urban areas, both adjacent to and away from a wind farm, and measured the levels of infrasound with the wind farms operating and switched off.

There were no noticeable differences in the levels of infrasound under all these different conditions. In fact, the lowest levels of infrasound were recorded at one of the houses closest to a wind farm, whereas the highest levels were found in an urban office building.

The 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."

A German report[4], titled "*low frequency noise incl. infrasound from wind turbines and other sources*" presents the details of a measurement project which ran from 2013. The report was published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in 2016 and concluded the following in relation to infrasound from wind turbines:

"The measured infrasound levels (G levels) at a distance of approx. 150 m from the turbine were between 55 and 80 dB(G) with the turbine running. With the turbine switched off, they were between 50 and 75 dB(G). At distances of 650 to 700 m, the G levels were between 55 and 75 dB(G) with the turbine switched on as well as off.

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

4 Report available at https://www4.lubw.baden-wuerttemberg.de/servlet/is/262445/low-frequency_noise_incl_infrasound.pdf?command=downloadContent&filename=low-frequency_noise_incl_infrasound.pdf

> *"For the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013 Draft)[5]"*
>
> *"The results of this measurement project comply with the results of similar investigations on a national and international level."*

There is a significant body of evidence to show that the infrasound associated with wind turbines will be below perceptibility thresholds and typically in line with existing baseline levels of infrasound within the environment. In conclusion, there are no impacts expected from infrasound from the operation of the proposed project.

12.2.2.5.2 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).

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.

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5 DIN 45680:2013-09 – Draft "Measurement and assessment of low-frequency noise immissions" November 2013

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

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 was considered that conditions associated with AM 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. While OAM can occur it is noted that the research has shown that it is a rare event associated with a limited number of wind farms.

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

Research and Guidance in the field of wind turbine noise AM is ongoing with recent publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *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 does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation.

A 2016 report commissioned by the UK government *Wind turbine AM review: Phase 2 report. 3514482A Issue 3. Department for Business, Energy & Industrial Strategy c*ompleted by WSP Parsons Brinckerhoff recommended the use of a penalty.

There is no clear industry consensus on how AM should be regulated or managed at the planning stage. Consequently there is no methodology that can be applied to predict the likelihood of AM at a particular wind farm site. Any site specific assessment would need to be undertaken at post commissioning stage. The assessment of AM at post commissioning stage is discussed in Section 12.6.3.1.

12.2.2.6 Operational Phase - Vibration

Vibration generated from the operation of a wind turbine unit will decrease rapidly with distance. Typically, at 100 m from a 1 MW turbine unit the level of vibration associated with a turbine is the order of 10^{-5} mm/s.

A recent 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 300 m 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 in approximately 820 m (being the distance from turbine T01 to NSL ref. H090). At that distance, the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria are not specified for the operational phase of the proposed project.

12.2.2.7 Comment on Potential Health Impacts from Wind Turbine Noise

The peer-reviewed research outlined in the subsequent sections supports that there are no direct negative health effects on people with long term exposure to wind turbine noise in the environment. For further details of potential health impacts associated with the proposed project refer to Chapter 5 Population and Human Health of the EIAR.

12.2.2.7.1 The National Health and Medical Research Council

The relevant Australian authority on health issues, the National Health and Medical Research Council (NHMRC), conducted a comprehensive independent assessment of the scientific evidence on wind farms and human health. The findings are contained in the NHMRC Information Paper: Evidence on Wind Farms and Human Health 2015, which concluded:

"After careful consideration and deliberation, NHMRC concluded that there is no consistent evidence that wind farms cause adverse health effects in humans. This finding reflects the results and limitations of the direct evidence and also takes into account the relevant available parallel evidence on whether or not similar noise exposure from sources other than wind farms causes health effects".

12.2.2.7.2 Health Canada

Health Canada, Canada's national health organisation, released preliminary results of a study into the effect of wind farms on human health in 2014[6]. The study was initiated in 2012 specifically to gather new data on wind farms and health. The study considered physical health measures that assessed stress levels using hair cortisol, blood pressure and resting heart rate, as well as measures of sleep quality. More than 4,000 hours of wind turbine noise measurements were collected and a total of 1,238 households participated.

No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses. Additionally, the study's results did not support a link between wind turbine noise and stress, or sleep quality (self-reported or measured). However, an association was found between increased levels of wind turbine noise and individuals reporting of being annoyed.

12.2.2.7.3 New South Wales Health Department

In 2012, the New South Wales (NSW) Health Department provided written advice to the NSW Government that stated existing studies on wind farms and health issues had been examined and no known causal link could be established.

NSW Health officials stated that fears that wind turbines make people sick are 'not scientifically valid'. The officials wrote that there was no evidence for 'wind turbine syndrome', a collection of ailments including sleeplessness, headaches and high blood pressure that some people believe are caused by the noise of spinning blades.

12.2.2.7.4 The Australian Medical Association

The Australian Medical Association put out a position statement, *Wind Farms and Health* 2014[7]. The statement said:

"The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects

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6 Health Canada 2014, Wind Turbine Noise and Health Study: Summary of Results. Available at https://www.canada.ca/en/health-canada/services/environmental-workplace-health/noise/wind-turbine-noise/wind-turbine-noise-health-study-summary-results.html

7 Australian Medical Association, 2014, Wind farms and health. Available at https://ama.com.au/position-statement/wind-farms-and-health-2014

occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects."

12.2.2.7.5 Journal of Occupational and Environmental Medicine

The review titled, Wind Turbines and Health: A Critical Review of the Scientific Literature was published in the Journal of Occupational and Environmental Medicine, 2014. An independent review of the literature was undertaken by the Department of Biological Engineering of the Massachusetts Institute of Technology (MIT). The review took into consideration health effects such as stress, annoyance and sleep disturbance, as well as other effects that have been raised in association with living close to wind turbines. The study found that:

"No clear or consistent association is seen between noise from wind turbines and any reported disease or other indicator of harm to human health."

The report concluded that living near wind farms does not result in the worsening of the quality of life in that particular region.

12.3 ASSESSMENT METHODOLOGY

The assessment of impacts has been undertaken with reference to the most appropriate guidance documents relating to noise and vibration for both the construction, operational and decommissioning associated with the proposed project.

The 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 baseline noise surveys at representative NSLs surrounding the proposed project.
- Undertake predictive calculations to assess the potential impacts associated with the construction and decommissioning phases of the proposed project at NSLs within the defined study area.
- Undertake predictive noise calculations to assess the potential impacts associated with the operation of the proposed project at NSLs.
- Specify mitigation measures to reduce or avoid, where necessary, the identified potential outward impacts relating to noise and vibration from the proposed project.
- Describe the significance of the residual noise and vibration effects associated with the proposed project.

12.3.1 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.

12.3.1.1 Wind Turbine Noise

For the operational phase the study area should cover, at a minimum, the area predicted to exceed 35 dB L_{A90} from all existing, permitted, and proposed wind turbines.

An appraisal has identified that the only other wind turbine development (existing, permitted or proposed) identified with the potential for cumulative turbine noise impacts is the proposed Dyrick Hill wind farm (Planning Ref. No ABP-312434-22). There are no other wind turbine developments within 12 km of the proposed project. At this distance, there is no potential for cumulative turbine noise impacts as per the guidance discussed in Section 12.2.2.3.2. Therefore, no other wind farms are required to be included in the operational noise assessment.

As outlined due to the potential for cumulative impact with the proposed Dyrick Hill wind farm, the study area for the operational phase of the proposed project covers the area where the cumulative turbine noise levels are predicted to exceed 35 dB L_{A90} at the maximum predicted noise emission level. Refer to Appendix 12.7 which shows the relevant turbine noise contour maps.

12.3.1.2 Construction and Decommissioning

During the construction and decommissioning phases, noise could occur at any location within the proposed wind farm site and along public roads where there are increases in traffic associated with the proposed project. There is also a potential for noise impacts from HGVs along proposed TDR during the proposed project.

NSLs in proximity to specific construction sites and those situated along haul routes have the most potential to experience noise and vibration impacts. 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 and representative of the closest identified NSL or at defined set back distances from the proposed works.

12.3.2 Background Noise Survey

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 4 no. representative locations in the surrounding area. These locations are indicated in Figure 12-2: Map of Noise Monitoring Locations.

All measurement data collected during the background noise surveys has been carried out in accordance with the IOA GPG discussed is the following sections.

12.3.2.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. Any locations that fell inside the predicted 35 dB L_{A90} noise contour were considered for noise monitoring in line with current best practice guidance outlined in the IOA GPG. The selection of the noise monitoring locations was informed by a site visit and supplemented by reviewing aerial images of the study area and other online sources of information (e.g., Google Earth and OSI Maps - access between 3 to October 2022 and 15 February 2023).

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

Table 12-5: Noise Measurement Coordinates

Location Reference (ID)	Co-ordinates (ITM)	
	Easting	Northing
NML 1 (H012)	610,406	605,977
NML 2 (H086)	613,196	604,296
NML 3 (H101)	615,921	603,832
NML 4 (H157)	615,160	601,562

The site was visited by AWN survey personnel were carried out during the morning and afternoon time; 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 significant sources of vibration were noted at any of the survey locations.

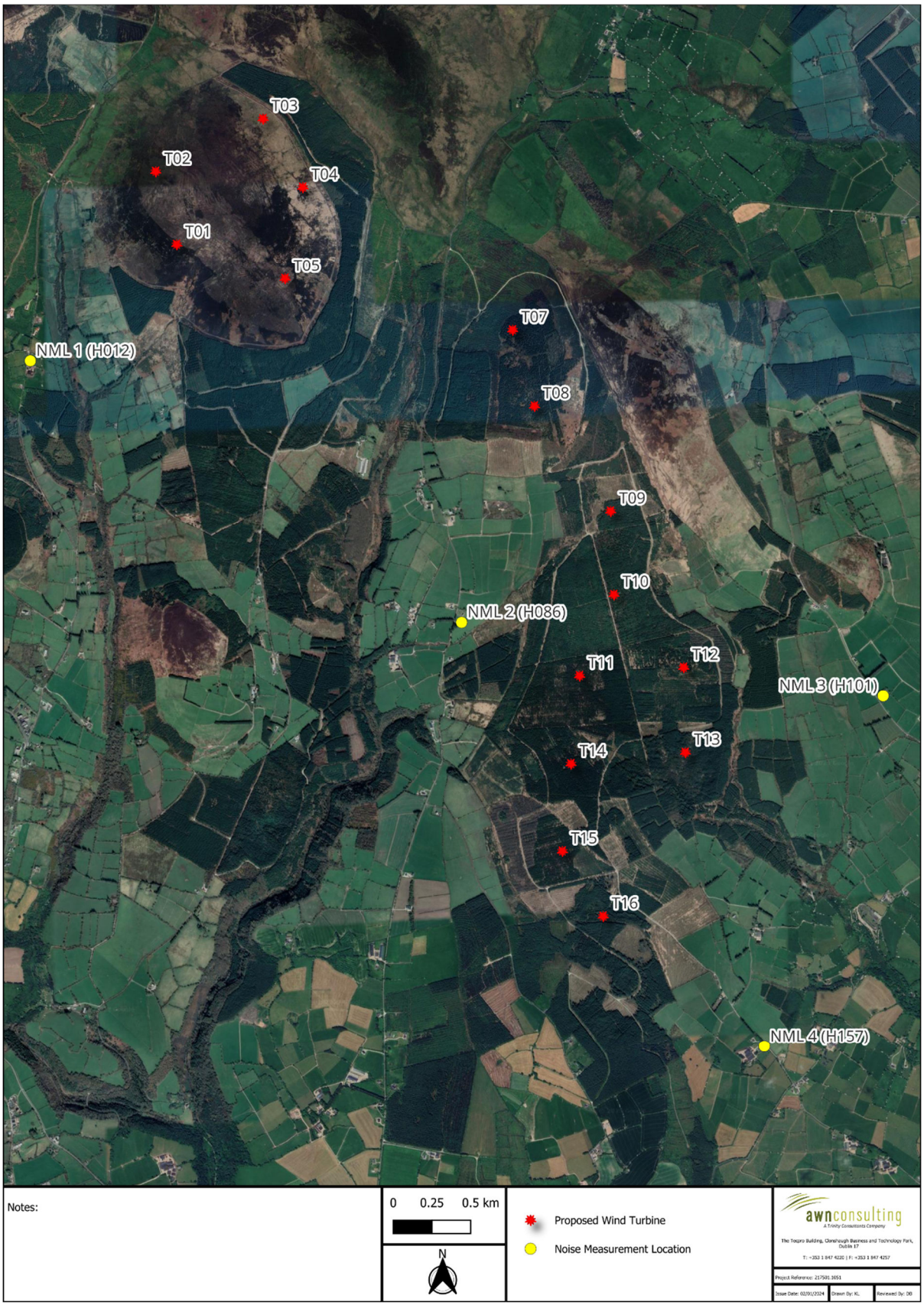

Figure 12-2: Map of Noise Monitoring Locations

12.3.2.1.1 NML 1

The sound meter at NML 1 was installed in a field to the rear of the property. The dominant noise source at this location was noted to be cattle in a shed close to the home at the time of the installation.

12.3.2.1.2 NML 2

At NML 2, the monitoring equipment was installed in the garden to the front of the property. Birdsong, distant tractor noise and aircraft flying above were listed as notable noise sources. A rain gauge was also installed at this location.

12.3.2.1.3 NML 3

The meter at NML 3 was installed in a field to the right of the property. Birdsong was noted as being a dominant noise source at the time of installation.

12.3.2.1.4 NML 4

The sound meter installed at NML 4 was set up in the front garden of the property. At the time of the install, a distant beeping noise could be heard as well as a chainsaw nearby, but otherwise birdsong was listed as the dominant noise source during further visits.

12.3.2.2 Survey Periods

The measuring equipment was installed on site until such time that enough data points were captured at each survey locations. Refer to Table 12-6 for dates. Section 2.9.1 of the IOA GPG states:

> *"The duration of a background noise survey is determined only by the need to acquire sufficient valid data over the range of wind speeds (and directions, if relevant). It is unlikely that this requirement can be met in less than 2 weeks."*

An ongoing review of the survey data was conducted at regular intervals to establish when adequate data had been captured. Noise measurements were undertaken at relevant monitoring locations over the periods outlined in Table 12-6: Noise Measurement Periods

AWN personnel visited the site on 16 February 2023 to install the equipment, 8 March 2023 to check equipment and carry out field calibrations on sound levels meters and 24 March 2023 to collect the equipment.

Table 12-6: Noise Measurement Periods

Location Reference	Survey Period	
	Start Date	End Date
NML 1 (H012)	16/02/2023 12:10 hrs	23/03/2023 01:10 hrs
NML 2 (H086)	16/02/2023 11:20 hrs	24/03/2023 16:00 hrs
NML 3 (H101)	16/02/2023 10:20 hrs	23/03/2023 07:20 hrs
NML 4 (H157)	16/02/2023 10:40 hrs	24/03/2023 15:20 hrs

A variety of wind speed and weather conditions were encountered over the survey periods. Figure 12-3 shows the distribution of wind speed and direction recorded on the ZephIR LIDAR unit for all periods of day and night between 16 February 2023 and 24 March 2023. The wind speed data presented below relates to a turbine hub height of 110.5 m which relates to the highest turbine hub height being considered in the assessment.

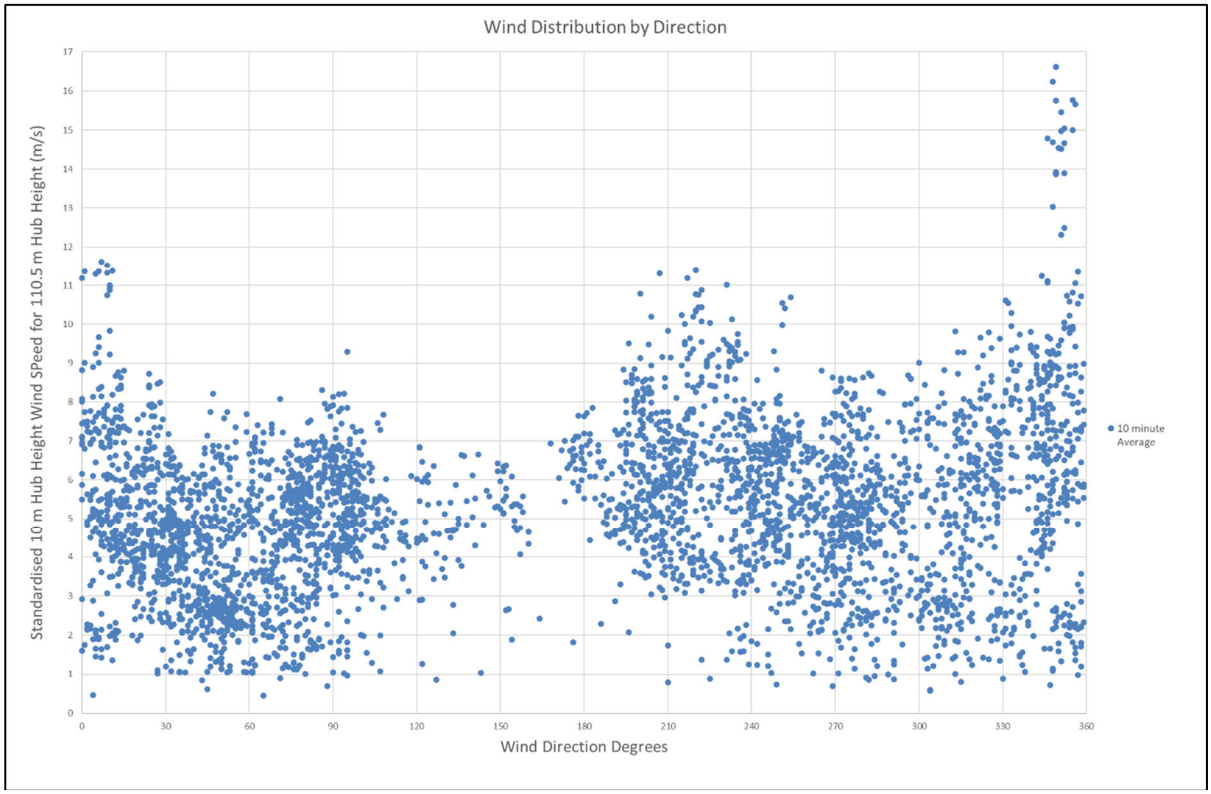

Figure 12-3 Distribution of Wind Speeds and Direction Measured during Survey Period

It is confirmed that survey periods were of sufficient duration to measure adequate data to derive a suitable representation of typical background at all locations in accordance with guidance contained within the IOA GPG.

12.3.2.3 Instrumentation

Table 12-7 confirms the details of the instrumentation installed at each location.

Table 12-7: Details of Noise Measurement Instrumentation

Location Reference (ID)	Equipment Make and Model	Serial Number
NML 1 (H012)	Rion NL-52	186668
NML 2 (H086)	Rion NL-52	564809
NML 3 (H101)	Rion NL-52	186667
NML 4 (H157)	Rion NL-52	976162

Before, after and during each survey period, the measurement instrument was checked and calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator. All calibration drifts were less than +/- 0.5 dB. Copies of the relevant calibration certificates are included in Appendix 12.2.

Rainfall was logged and recorded using rain gauges installed at two locations NML 2 and NML 3. The rainfall data allows for the identification of periods of rainfall so that they can be removed from the noise monitoring data sets, in line with best practice, when calculating the prevailing background noise levels at the various locations.

12.3.3 Analysis of Survey Data

12.3.3.1 Measurement Procedure

Measurements were conducted at all locations over the survey periods outlined in Table 12-6. Data samples for all measurements (noise, rainfall, and wind) were logged continuously at 10-minute interval periods for the duration of the survey. The $L_{Aeq,10min}$ and $L_{A90,10min}$ noise parameters were measured in this instance and the results were saved to the instrument memory for later analysis.

Survey personnel noted potential primary noise sources contributing to noise build-up during the installation and removal of the sound level meters from site. Description of the observed noise environment at each of the monitoring locations is presented in Section 12.3.2.

12.3.3.2 Atypical Noise Data

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 removed from the data sets.

12.3.3.3 Assessment Periods

The results presented in the following sections refer to the noise data collated during 'quiet periods' of the day and night as defined in the IOA GPG. These periods are defined as follows:

- Daytime Amenity hours are:

  - all evenings from 18:00 to 23:00hrs;
  - Saturday afternoons from 13:00 to 18:00hrs, and;
  - all day Sunday from 07:00 to 18:00hrs.
- Night time hours are 23:00 to 07:00hrs.

The assessment methods outlined above are in line with the guidance contained in the IOA

12.3.3.4 Wind Shear

The effects of wind shear must be considered as part of a robust wind turbine noise assessment, and it is standard procedure to reference wind data to standardised 10 metre wind speed. Wind shear has been considered in this assessment in accordance with the guidance contained in the IOA GPG, specifically in Supplementary *Guidance Note (SGN) 4: Wind Shear*. This guidance presents the following equations in relation to the derivation of a standardised hub height wind speed to 10 m height:

Equation A this uses the following equation:

Shear Exponent Profile:

$$U = U_{ref}\left[\frac{H}{H_{ref}}\right]^{m}$$

Where:

U	calculated wind speed.
U_{ref}	measured wind speed.
H	height at which the wind speed will be calculated.
H_{ref}	height at which the wind speed is measured.
m	shear exponent.

Equation B this uses the following equation:

Roughness Length Shear Profile:

$$U_1 = U_2 \frac{\ln(H_1/z)}{\ln(H_2/z)}$$

Where:

H_1 the height of the wind speed to be calculated (10m)

H_2 the height of the measured wind speed.

U_1 the wind speed to be calculated.

U_2 the measured wind speed.

z the roughness length.

Note: A roughness length of 0.05m is used to standardise hub height wind speeds to 10m height in the IEC 61400-11:2003 standard, regardless of what the actual roughness length seen on a site may have been. This 'normalisation' procedure was adopted for comparability between test results for different turbines.

Wind speed measurements were obtained from an ZephIR Lidar unit that was installed on site measuring wind speeds at various heights. The location of the Lidar unit is provided in Table 12-8. Appendix 12.8 contains a copy of the Lidar unit installation report.

Table 12-8: Lidar Unit Location

Lidar Unit Reference	Co-ordinates (ITM)	
	Easting	Northing
ZephIR 755	614,102	603,679

The derived background noise level at integer wind speeds (standardised 10 m height) is dependent on the specific hub height. Any reference to wind speed in the following sections of this chapter should be understood to be the standardised 10 m height wind speed reference unless otherwise stated.

Section 12.3.5.212.3.5.2.1 presents a discussion on the candidate turbine type and parameter being considered as part of the proposed project. Full details can be found in Chapter 2. The candidate turbines represent a range of typical turbine models that would be suitable for the proposed project. The turbines under consideration for the proposed project have a hub height range of between 102.5 m up to 110.5 m.

The background noise levels, and turbine noise criteria are influenced by the hub height. The principles are demonstrated in the discussion of wind shear described above, consequently, the

lowest background noise levels will correspond to the highest hub height, which in this case is 110.5 m.

The background noise levels corresponding to a hub height of 110.5 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.

12.3.4 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.

Due to the nature of construction activities, it is difficult to calculate the actual magnitude of emissions to the local environment in the absence of a detailed construction programme. 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*. Construction noise predictions have been carried out using guidance set out in BS 5228-1.

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 from BS 5228-1 at various distances from these works.

12.3.5 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.

12.3.5.1 Noise Prediction Software

The selected software, DGMR *iNoise Enterprise (Version 2023.02)* calculates noise levels in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation*, (ISO, 1996).

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).

12.3.5.2 Noise Prediction Model - Input Data and Assumptions

Information available for the site was input into the iNoise noise modelling software using the ISO 9613:1996. The input data and assumptions made are described in the following sections.

12.3.5.2.1 Proposed Turbine Details

In order to assess all scenarios within the range of turbine types and dimensions, the following list of turbines have been considered:

- Vestas V150 at between 105 and 110 m hub height;
- SGRE SG155 at between 102.5 and 107.5 m hub height;
- Nordex N149 at between 105 and 110.5 m hub height;
- Vestas V162 at 104 m hub height;
- Nordex N163 at 103.5 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 10 m height (calculated in accordance with the IOAGPG), are presented in Table 12-9.

Table 12-9: L_{WA} Levels for various hub heights (HH)

Wind Speed	dB L_{WA}							
	V150 @ HH		SG155 @ HH		N149 @ HH		V162	N163
	110 m	105 m	107.5 m	102.5 m	110.5 m	105 m	104 m	103.5 m
3	92.8	92.8	92.9	92.9	94.0	94.0	94.0	95.0
4	96.3	96.3	97.9	97.8	95.3	95.0	94.8	96.4
5	100.6	100.5	102.8	102.6	100.4	100.3	99.0	100.8
6	104.1	104.0	105.0	105.0	104.4	104.3	103.2	105.2
7	104.8	104.8	105.0	105.0	106.1	106.1	104.6	106.5
8	104.9	104.9	105.0	105.0	106.1	106.1	104.8	106.6
9	104.9	104.9	105.0	105.0	106.1	106.1	105.0	106.6

Wind Speed	dB L_{WA}							
	V150 @ HH		SG155 @ HH		N149 @ HH		V162	N163
	110 m	105 m	107.5 m	102.5 m	110.5 m	105 m	104 m	103.5 m
10	104.9	104.9	105.0	105.0	106.1	106.1	105.4	106.6
11	104.9	104.9	105.0	105.0	106.1	106.1	105.5	106.6

Figure 12-4 presents a graph of the noise emissions for each turbine. When considering a range of hub heights for a specific turbine, the lower hub height has been omitted from the figure as the upper hub height in the range yields the highest noise emissions.

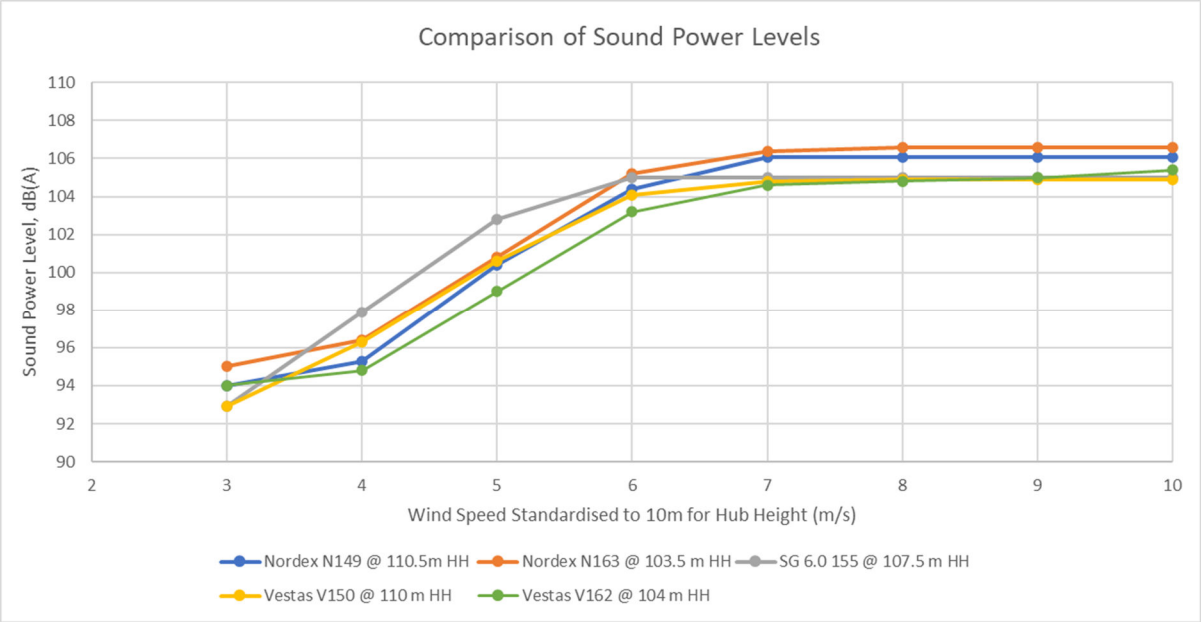

Figure 12-4 Sound Power Levels of Each of Five Turbine Types Under Consideration

The turbine with the highest sound power level at lower wind speeds (4-5 m/s) is the SG155 at 107.5m hub height.

The turbine with the highest sound power level over the remainder of the wind speed range (3 & ≥6 m/s) is the N163 at 103.5 m hub height. For this assessment all turbine options listed in Table 12-9 have been modelled. The result of this exercise confirmed that the highest turbine noise level occurred at all NSLs for the following scenario:

- 4-5 m/s a mix of the N163 and the SG155 turbines. The highest noise level from either these scenarios is reported in the results; and,
- ≥6 m/s the N163.

Since all other candidate turbines exhibit lower noise emissions across their operational range, this assessment will offer a robust evaluation, encompassing the highest potential noise emissions among all the turbines being considered. Hence the noise impact assessment is representative of all candidate turbines in terms of the highest potential turbine noise impact

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 of +2 dB is applied in modelling to all turbine sound power levels presented in the tables above.

As explained below in Section 12.2.2.312.2.2.3, 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 specifies that should any tonal component be present, a penalty shall be added to the predicted noise levels. The level of this penalty is described in ETSU-R-97 and is related to the level by which any tonal components exceed audibility. In this assessment, we have not included a tonal penalty in the predicted noise levels. A warranty will be provided by the manufacturers of the selected turbine to ensure that the noise output will not require a tonal noise correction under best practice guidance.

12.3.5.2.2 Modelling Calculation Parameters

Prediction calculations for turbine noise have been conducted in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation, 1996*. Appendix 12.3 provides comprehensive details of noise prediction calculation settings, the NSL and turbine co-ordinates, and the turbine sound power emissions used in for the Proposed Wind Farm and in terms of the cumulative assessment, the proposed Dyrick Hill wind farm.

12.4 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 project.

12.4.1 Summary of Derived Background Noise Levels

Table 12-10 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.

Table 12-10 Derived Background Noise Levels of $L_{A90,10-min}$ for Various Wind Speeds at 110.5 m hub height

Location	Period	Derived $L_{A90,10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds (m/s)							
		3	4	5	6	7	8	9	10
NML 1	Day	29.8	31.0	32.5	34.1	35.9	37.8	39.8	42.0
	Night	27.7	29.1	30.7	32.5	34.3	36.3	38.3	40.4
NML 2	Day	26.0	27.8	30.1	32.8	35.7	38.7	41.8	44.7

Location	Period	Derived $L_{A90,10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds (m/s)							
		3	4	5	6	7	8	9	10
	Night	24.6	26.6	29.0	31.6	34.4	37.1	39.6	41.8
NML 3	Day	25.7	28.0	30.4	33.0	35.8	38.6	41.6	44.7
	Night	22.5	25.4	28.2	30.8	33.4	35.8	38.2	40.4
NML 4	Day	27.9	29.0	30.6	32.5	34.6	36.9	39.2	41.4
	Night	23.8	25.6	27.8	30.2	32.8	35.3	37.7	39.7
Envelope	Day	25.7	27.8	30.1	32.5	34.6	36.9	39.2	41.4
	Night	22.5	25.4	27.8	30.2	32.8	35.3	37.7	39.7

A conservative 'envelope', based on the lowest derived background levels at the various wind speeds for both day and night-time is also presented in Table 12-10. Full background noise level details are provided in Appendix 12.4.

12.4.2 Wind Turbine Noise Limits

With respect to the relevant guidance documents outlined in Section 12.2.2.3 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 12.3.2.112.3.2.

This set of criteria adopted is in line with the intent of the applicable WEDGs and is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála and local planning authorities in Ireland. 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) would be appropriate in respect of the following points:

- 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 WEDG 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.
- A lower threshold of 40 or 43 dB is commonly adopted in planning conditions for similar developments that have been granted planning permission by An Bord Pleanála and local planning authorities in recent years for example, Derrinlough Wind Farm (ABP Ref: 306706-20) Derryadd Wind Farm (ABP Ref: PL14.303592), Coole Wind Farm (ABP Ref:

PL25M.300686) Cloncreen (ABP Ref: PA0047) and Meenbog (ABP Ref: PL05E.300460).

The proposed turbine noise criteria summarised below should apply at all NSLs within the study area. The proposed turbine noise limits shall be cumulative and relate to noise from the contribution of all operational wind turbines.

In summary, the operational turbine noise limits proposed for the proposed project are:

- 40 dB $L_{A90,10min}$ for daytime in quiet environments with typical background noise of less than 30 dB $L_{A90,10min}$.
- 45 dB $L_{A90,10min}$ for daytime in environments with typical background noise greater than or equal to 30 dB $L_{A90,10min}$ or a maximum increase of 5 dB(A) above background noise (whichever is the higher); and
- 43 dB $L_{A90,10min}$ for night-time periods or a maximum increase of 5 dB(A) above background noise (whichever is the higher).

Day and night time noise criteria curves have been determined from review of the derived background noise levels at 4 no. NSLs surrounding the proposed project and are presented in the relevant sections of this chapter.

12.4.2.1 Assigning Turbine Noise Limits

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. This approach is in line with best practice guidance set out in the IOA GPG.

To rationalise the assessment, a conservative 'envelope review' will be applied to all non-surveyed locations. The envelope review is a conservative approach that adopts the lowest noise criteria derived from the measured background noise levels and applies it to all non-surveyed locations for the purpose of the assessment.

Table 12-11 outlines the operational noise criteria that will apply to this assessment. The derived criteria at 10 m/s have been applied to higher wind speeds for the purpose of this assessment it should be noted that as wind speed increase so too will the background noise levels, this approach to the assessment is therefore conservative.

Table 12-11: Proposed Noise Criteria Curves

Location (ID)	Period	Turbine Noise Limits $L_{A90,10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds (m/s)							
		3	4	5	6	7	8	9	≥10
A	Day	40.0	45.0	45.0	45.0	45.0	45.0	45.0	47.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.3	45.4
B	Day	40.0	40.0	40.0	45.0	45.0	45.0	46.8	49.7

Location (ID)	Period	Turbine Noise Limits $L_{A90,10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds (m/s)							
		3	4	5	6	7	8	9	≥10
	Night	43.0	43.0	43.0	43.0	43.0	43.0	44.6	46.8
C	Day	40.0	40.0	45.0	45.0	45.0	45.0	46.6	49.7
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.2	45.4
D	Day	40.0	40.0	45.0	45.0	45.0	45.0	45.0	46.4
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.7
Envelope	Day	40.0	40.0	40.0	45.0	45.0	45.0	45.0	46.4
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.7

12.4.2.2 Comments on Proposed Turbine Noise Criteria in Dyrick Hill Wind Farm EIAR

To inform the cumulative turbine noise assessment presented in this chapter, reference has been made to information presented in the proposed Dyrick Hill Wind Farm EIAR Noise and Vibration Chapter (Planning Ref. No ABP-312434-22 available through the An Bord Pleanála planning portal). The following items are noted as they are pertinent to the assessment presented in this chapter for the proposed project.

The Dyrick Hill turbine noise assessment was based on the 2006 WEDGs. The assessment has identified specific properties as being 'financially involved' with the project. These locations have been assigned lower threshold turbine noise limit of 45 dB $L_{A90,10\text{-}min}$ for both day and night time periods.

The Dyrick Hill EIAR referenced turbine noise emissions for the Vestas V162 turbine assessed at a hub height of 104 m. These details have been used in the cumulative assessment presented in this chapter. Full details of the noise modelling input data are outlined in Appendix 12.3. Some key points in relation to the cumulative assessment are outlined here:

- Location H095 is not included as a NSL in the Dyrick Hill wind farm noise assessment, it is understood in the event that the proposed wind farm was consented, this property would no longer be considered an NSLs. Therefore, the predicted cumulative turbine noise levels at H095 must be considered in this context.
- Locations H096 and H097 (referred to as H92 and H93 respectively in the Dyrick Hill EIAR are identified as 'financially involved' and a lower threshold of 45 dB $L_{A90,10\text{-}min}$ is proposed for cumulative turbine noise for both day and night time periods.
- The WEDGs confirms that a daytime lower threshold of 45 dB L_{A90} is appropriate for areas when the background noise is 30 dB L_{A90} or higher,, however the Dyrick Hill assessment proposes a threshold of 43 dB L_{A90} for both daytime and night-time periods, (with an allowance for + 5 dB above the background noise levels), as opposed to 45 dB L_{A90} for daytime periods, and 43 dB L_{A90} for night-time periods.
- This is not considered to be best practice because, as addressed in Section 12.2.2.312.2.2.3, the WEDGs proposes a daytime lower threshold of 45 dB L_{A90} where

background noise levels are 30 dB L_{A90} or greater. The approach taken in the Dyrick Hill EIAR is noted to be slightly more conservative, however, it deviates slightly from best practice guidance set out in the WEDGs.

- The adopted turbine noise limits for the proposed project during daytime periods in environments where the typical background noise level is greater than or equal to 30 dB L_{A90} is 45 dB L_{A90} or a maximum increase of 5 dB(A) above background noise (whichever is the higher); refer to Section 12.4.212.4.2 for full details.
- It should be noted that the proposed project will be assessed assuming the same operational turbine noise emissions for both day and night time periods. Therefore the predicted turbine noise level must demonstrate compliance with the night time criteria of 43 dB L_{A90} with an allowance for + 5 dB above background noise level, which correspond to the criteria proposed in the Dyrick Hill EIAR assessment. This approach will facilitate a simple comparison of the predicted turbine noise levels from the proposed Dyrick Hill wind farm and the proposed project and in the context of the cumulative assessment presented in this chapter, as the same turbine noise thresholds apply to all properties.

12.4.3 Substation Noise Limits

Based on a review of the measured noise from the background noise survey (Section **Error! Reference source not found.**12.4.1), 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. The substation design will ensure that the noise emissions do not contain audible tones or impulsive characteristics at the nearest NSLs. 35 dB $L_{Aeq,T}$ is considered a low level of noise.

With respect to the guidance from the BS4142 standard, discussed in Section 12.2.2.4.2, 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.

12.5 POTENTIAL EFFECTS

12.5.1 Do-nothing Scenario

If the proposed project is not progressed, the existing noise environment will remain unchanged. Traffic noise is currently a noise source in the vicinity of some road networks in the area. In the absence of the proposed project, any increases in traffic volumes on the local road network over time would not be expected to result in a significant change to the overall ambient and background noise levels in the receiving environment.

12.5.2 Construction Phase

Construction noise prediction calculations have been conducted using the assessment methodology outlined in Section 12.3.412.3.4. The noise levels referred to in this section are indicative only and are intended to demonstrate that it will be possible for the contractor to comply with current best practice guidance. The highest predicted noise levels are expected to occur for only short periods of time at a very 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 the following:

- Construction of turbines, hardstands, and meteorological mast.
- Construction of substation.
- Internal access roads.
- TDR works areas.
- Borrow pits activities.
- Proposed GCR.
- Watercourse and HDD

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 NSL's are such that there will be no significant noise and vibration impacts at NSL's. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration impacts, all other stages and elements are considered unlikely to have any significant noise and vibration impacts.

Construction activities will be carried out during normal daytime working hours (i.e., weekdays 0700 – 1800 hrs and Saturdays 0700 – 1400 hrs). However, to ensure that optimal use is made of good weather period or at critical periods within the programme (e.g., concrete pours, erection of turbines) 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.

12.5.2.1 Construction of Turbines and Hardstands

12.5.2.1.1 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 calculated at the closest sensitive receptor. In this instance the closest NSL is Location H090 which is situated approximately 820 m from the proposed turbine T01. The following construction calculations have been completed for both properties.

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

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)[8]	Predicted Noise Level (dB $L_{Aeq,1hr}$) at 820 m
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	79	33
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	31
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	39
Piling Operations (C.12.14)	Piling Foundations (if required).	88	42
General Construction (Various)	All general activities plus deliveries of materials and plant	84	38
Concrete Mixer Truck and Concrete Pump (C.4.27)	-	75	29
Dumper Truck (C.4.4)	-	76	30
Mobile Telescopic Crane (C.4.39)	-	77	31
Dewatering Pumps (D.7.70)	If required.	80	34
JCB (D.8.13)	For services, drainage and landscaping.	82	36

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

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)[8]	Predicted Noise Level (dB $L_{Aeq,1hr}$) at 820 m
Petrol-drive Chainsaw (D.2.14)	-	86	40
Vibrating Rollers (D.8.29)	Road surfacing.	77	31
Total		--	47

At 820 m, the distance to the nearest NSL to the proposed works the predicted noise levels from construction activities are in the range of 29 to 42 dB $L_{Aeq,1hr}$ with a total 'worst-case' cumulative construction level of the order of 47 dB $L_{Aeq,1hr}$. In all instances the predicted noise levels at the nearest NSLs are below the adopted significance threshold outlined in Table 12-1 (Category A – 65 dB $L_{Aeq,1hr}$ during daytime periods). This assessment is considered representative of highest construction noise levels predicted at the nearest in habited NSL.

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.

12.5.2.1.2 Vibration

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

12.5.2.1.3 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 NSLs 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.

12.5.2.2 Construction of Substation

12.5.2.2.1 Noise

The substation is to be located at coordinates (ITM: 614656, 602077). The nearest NSL to the proposed substation is H155, , which is approximately 270 m south-east to the substation. However, this is a derelict property, and the closest residential NSL, H154, is located 380 m away from the proposed substation. As a conservative assessment assuming the same construction activities as outlined in Table 12-12, it is predicted that the likely potential noise levels from construction activities associated with the substation will be in the order of 58 dB $L_{Aeq,1hr}$ at the nearest NSL, H155. This level of noise is well below the significance threshold of 65 dB $L_{Aeq,1hr}$, therefore no specific mitigation measures are required.

12.5.2.2.2 Vibration

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

12.5.2.2.3 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 (see Chapter 1 – Introduction for further details), the potential associated effects at the nearest NSLs 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 impact.

12.5.2.3 Construction of Internal Site Roads

It is proposed that new internal roads will be constructed to access the various parts of the proposed project. The nearest NSLs to any point along the proposed internal roads are H071, H069 and H070 which are located 47 m, 107 m and 150 m respectively. All other locations are at greater distances. The full description of the internal access roads is outlined in Chapter 2 of the EIAR, Description of the proposed project.

12.5.2.3.1 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 the New Internal Site Roads

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)[9]	Highest Predicted Noise Level at Stated Distance from Edge of Works(dB $L_{Aeq,1hr}$)		
		47 m	107 m	150 m
HGV (C.2.30)	79	61	53	49
Tracked Excavator (C.4.64)	77	59	51	47
Dumper Truck (C.4.4)	76	58	50	46
Petrol-drive Chainsaw (D.2.14)	86	68	60	56
Vibration Rollers (D.8.29)	77	59	51	47
Total	--	70	62	58

The table shows that at the closest NSL at 47 m, the predicted noise levels do not exceed the threshold of 70 dB. The assessment is based on all plant at the likely closest distance to the property during the works, however, these are linear works and as works progress along the route, the noise emissions will decrease. The predicted levels in Table 12-13 this figure is considered to be the conservative and as they represent the scenario for the highest predicted impact to occur over a brief period. Therefore, it is concluded that the impact is not significant.

There are no items of plant or construction activities that are likely to give rise to noise levels that are expected the exceed the thresholds outlined in Section 12.2.212.2.2.1.1 for linear works, therefore no specific mitigation measures are required.

12.5.2.3.2 Vibration

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

12.5.2.3.3 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 potential associated effects at the nearest NSLs associated with construction of internal site roads are described below.

[9] All plant noise levels are taken from BS5228: Part 1

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 impact.

12.5.2.4 TDR Works Areas

It is proposed that TDR works areas will be constructed in order to transport the turbines safely to the site. A total of three of these works that have been identified as having likely noise and vibration impacts and are located at a distance greater than 10 km from the site of the proposed wind farm, including roundabouts which will involve temporary hardcore surfacing. The locations identified are as follows:

Table 12-14: Proposed TDR Works Locations

TDR works area Refs	Co-ordinates (ITM)	
	Easting	Northing
A	651,370	610,245
B	663,876	615,181
C	664,083	615,872

It has been identified that the nearest NSL, is located 90 m west from TDR works area B, as pictured in Figure 12-5. The full description of the TDR works is outlined in Chapter 2 of the EIAR, Description of the Proposed Project.

Figure 12-5 TDR Works on the N29 (green outline)

12.5.2.4.1 Noise

Table 12-15 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 12-15: Indicative Noise Levels from Construction Plant at Various Distances from the New Internal Site Roads

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)[10]	Highest Predicted Noise Level at Stated Distance from Edge of Works(dB $L_{Aeq,1hr}$) at 90 m
HGV (C.2.30)	79	55
Tracked Excavator (C.4.64)	77	53
Dumper Truck (C.4.4)	76	52
Vibration Rollers (D.8.29)	77	53
Total	--	59

The table shows that at 90 m, noise levels are within the construction noise thresholds in Table 12-1 and therefore the impact is not significant. As these works will progress along the route the predicted impacts will reduce.

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 Table 12-1. No specific mitigation measures are required.

12.5.2.4.2 Vibration

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

12.5.2.4.3 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 potential associated effects at the nearest NSLs associated with construction of internal site roads are described below.

[10] All plant noise levels are taken from BS5228: Part 1

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 impact.

12.5.2.5 Proposed GCR Construction

The proposed GCR from the proposed onsite substation will connect via a 110 kV underground cable to an existing substation near Dungarvan. The overall length of the GCR between the proposed substation and the existing substation is approximately 15.5km, with approximately 13.3 km located within the public road corridor with a short section being within the site of the proposed wind farm, and the remainder being located within Coillte lands and other private lands. Chapter 2 of the EIAR, presents the full description of the proposed project.

12.5.2.5.1 Noise

Table 12-16 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. Note the plant items and activities are indicative and based on assumption to be representative of a reasonable conservative assessment.

The associated construction works will occur for short durations (rolling construction method, average 50 m per day over an estimated 7 - 10 days) at varying distances from NSLs. Table 12-16 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 12-16: Indicative Noise Levels for Typical Construction Plant at Various Distances from the Proposed GCR 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

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
Wheeled Loader (C.2.8)	68	25%	56	53	46	38
HGV (C.6.19)	76	45%	67	58	51	43
Total Construction Noise	--	--	72	65	58	50

Calculations indicate that the impact noise criteria may be exceeded in the event where all construction assumed activity occurs within approximately 20 m if an NSL. There is a total of 9 NSLs that are located within 20 m. As described, construction activity will vary and will not be continuous in nature. The assessment sets out that the various activities that will contribute noise levels that, over a standard working day will be above the threshold for potential significant effects, the noise levels are not expected to exceed the threshold over a significant period of time as the works are linear and only at the closet point to the NSL's for 1-2 days. As the assessment has identified a potential brief significant effect at up to 9 NSL's mitigation will be specified.

12.5.2.5.2 Vibration

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

12.5.2.5.3 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 potential associated effects at the nearest NSLs associated with construction of the proposed GCR and internal underground cabling are described below.

Quality	Significance	Duration
Negative	Significant	Brief

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 as described at up to 9 number NSL's.

12.5.2.6 HDD Drilling

12.5.2.6.1 Noise

There are a total of three watercourses associated with the proposed GCR where Horizontal Directional Drilling (HDD), will be employed. HDD will take place in order to install cable ducts under the watercourses. Each watercourse is located to the south-east of the site. The coordinates are as follows:

Table 12-17: Proposed GCR Watercourse Locations

Proposed GCR Watercourse Ref	Co-ordinates (ITM)	
	Easting	Northing
A	617,043	600,073
B	617,521	599,354
C	621,742	596,525

It has been identified that the closest NSL is located 36m south of proposed GCR Watercourse A. Table 12-18 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 12-18: Construction Noise Levels associated with HDD

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,1hr}$)[11]	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)
			36 m
Directional drill (generator) (C.4.96)	Drilling under obstacles for installing cable ducts	77	62

The table shows that at 36 m, noise levels are within the construction noise thresholds in Table 12-1 and therefore the impact is not significant. As these works will only be operational for 1-2 days, this impact is short term.

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 Table 12-1. No specific mitigation measures are required.

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

12.5.2.6.2 Vibration

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

12.5.2.6.3 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 potential associated effects at the nearest NSLs associated with construction of internal 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 impact.

12.5.2.7 Borrow Pits

It is proposed that 2 no. borrow pits will be constructed, in order to provide a source of stone material required for the construction of the proposed project. These are located north of T14 and northeast of T15, Refer to chapter 2 of the EIAR for full details on the borrow pits, the approximate locations are outlined in Table 12-19 below.

Table 12-19: Approximate Borrow Pit Locations

Borrow Pit Ref	Co-ordinates (ITM)	
	Easting	Northing
A	613,880	603,050
B	614,370	602,660

12.5.2.7.1 Noise

To inform this aspect of the proposal, a comparative noise assessment has been prepared and is outlined in the following paragraphs. Two situations have been considered as follows:

- Scenario A Blasting operation
- Scenario B Rock Breaking Operation

The assessment has been based on the following assumptions:

- Works at the borrow pit will only occur during daytime periods only (07:00 to 19:00hrs).
- That plant is operating simultaneously in the vicinity of all proposed borrow pit location indicated in Table 12-19**Error! Reference source not found.Error! Reference source not found.**.
- A rock crusher will operate on site for both scenarios.
- The rock breaker will not operate in scenario A

- Table 12-20**Error! Reference source not found.** 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.
- For Scenario A, it is assumed that 1 – 2 blasts per week will be required over a specified period and it is expected that no more than 1 blast would occur per day.

Table 12-20: Plant Noise Emissions Assumed for Borrow Pit Works

Item	dB L_w Levels per Octave Band (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Rock Crusher	121	114	107	109	103	99	94	87	109
Tracked Excavator (each of 6 no)	77	88	95	93	93	92	86	76	98
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	95	98	105	103	103	100	98	89	107
Rock Breaker	119	117	113	117	115	115	112	108	121

A noise prediction model has been prepared using proprietary software package iNoise to calculate the expected noise emissions from the two scenarios outlined above for operation of the borrow pit. A percentage on-time of 66% has been assumed for the noise calculations. A percentage on-time of 66% has been used for the noise calculations. The predicted levels at the 10 no. NSL's, with the highest predicted noise levels are presented in Table 12-21**Error! Reference source not found.**.

Table 12-21: Prediction Noise Levels from Borrow Pit Activity at Nearest NSLs

Scenario A		Scenario B	
Location Ref.	dB $L_{Aeq,T}$	dB $L_{Aeq,1hr}$	dB $L_{Aeq,T}$
H154	40	H154	47
H076	38	H076	43
H153	36	H153	42
H075	35	H075	40
H165	35	H155	40
H155	34	H165	40
H077	34	H077	40

Scenario A		Scenario B	
Location Ref.	dB $L_{Aeq,T}$	dB $L_{Aeq,1hr}$	dB $L_{Aeq,T}$
H079	33	H079	39

Review of the results contained in Table 12-21**Error! Reference source not found.** confirms the following:

- Predicted construction noise levels for both Scenario A and B at the borrow pit are well within the relevant construction noise criteria (65 dB $L_{Aeq,T}$).
- The blasting proposal results in lower levels of construction noise as the rock breaking plant is not required to operate to the same extent in this scenario. Predicted noise levels are lower at all assessed locations for Scenario A.
- It is accepted that the individual blast events will be audible at certain locations. Blast events will be designed and controlled such that the best practice limits values outlined in the mitigation section of this chapter are not exceeded.

At all NSLs the predicted construction noise levels are well within the relevant construction noise criteria (65 dB $L_{Aeq,1hr}$). It is proposed that construction works at the borrow pit will only occur during daytime periods and only during the construction phase which will last up to 24 months.

12.5.2.7.2 Vibration

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

12.5.2.7.3 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 potential associated effects at the nearest NSLs associated with operation of borrow pits are described follows:

Quality	Significance	Duration
Negative	Not Significant	Temporary

12.5.2.8 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 here.

Changes in the traffic noise levels associated with the construction traffic for 'peak' and 'average' construction have been calculated on based on information in Chapter 16. The results are presented in Table 12-22

Table 12-22: Increase in Noise Level Due to Construction Traffic

Road	Scenario	Construction Traffic			Increase in Noise Levels dB $L_{Aeq,T}$
		ADT	%HGV	HGV	
L1027	Baseflow 2027	1,251	5.4%	68	--
	Peak Construction	1,421	6.9%	98	+1.1
	Average Construction	1,321	6.7%	88	+0.6
N72 E	Baseflow 2027	5,702	7.3%	416	--
	Peak Construction	5,828	7.6%	446	+0.1
	Average Construction	5,756	7.6%	436	+0.1

The results indicate that the increase in traffic noise levels range from +0.1 to +1.1 dB. With reference to the DMRB magnitude of impact set out in Table 12-2 the potential impacts are classified as 'no change' to 'minor' change. It is concluded that there will be no significant noise impacts associated with the additional traffic generated during the construction phase.

12.5.2.8.1 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 potential associated effects at the nearest NSLs associated with decommissioning 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 impact.

12.5.3 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. Considering that in all aspects of the construction and decommissioning, the predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB $L_{Aeq,1hr}$) at all NSLs for the decommissioning phase, the impact is not significant. therefore no specific mitigation measures are required.

12.5.3.1.1 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 potential associated effects at the nearest NSLs associated with decommissioning 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 impact.

12.5.4 Operational Phase

12.5.4.1 Assessment of Wind Turbine Noise

Using the assessment methodology described in Section 12.3.5, the predicted turbine noise levels have been calculated at all NSLs within the study area of the proposed project. A conservative omni-directional turbine noise prediction assessment has been carried out using the ISO 9613-2 calculation standard and best practice guidance for turbine noise prediction contained in the IOA GPG. These calculations are based on conditions favourable to noise propagation, i.e. downwind propagation from source to receiver and/or downward refraction under temperature inversions.

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 as presented in Section 12.4.2 which in turn have been derived in accordance with the assessment criteria set out in Section 12.2.2.3.

The assessment is presented for two scenarios:

1. Wind turbine noise from the proposed project only; and
2. Cumulative assessment of the proposed project with the proposed Dyrick Hill Wind Farm.

12.5.4.1.1 Assessment of Proposed Project

At all NSL's the omni-directional cumulative turbine noise levels from the proposed project are well below the noise criterion curves for all turbine options and scenarios considered in the assessment (see Table 12-11 Section 12.3.512.4.2).

Appendix 12.5 presents the predicted omni-directional turbine noise results at all NSL's in tabulated form for the proposed project in isolation.

12.5.4.1.2 Description of Effects

The predicted noise levels associated with the proposed project will be within best practice noise criteria recommended in the WEDGs, therefore it is not considered that a significant effect is associated with the development.

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 to the soundscape.

With respect to the EPA's criteria for description of effects, the potential associated effects at the most impacted NSLs associated with operation of the wind turbines of the proposed project are described as follows:

Quality	Significance	Duration
Negative	Not 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.

12.5.4.1.3 Cumulative Assessment of the Proposed Project with the Proposed Dyrick Hill Wind Farm

At all NSL's the omni-directional cumulative turbine noise levels from the proposed project along with Dyrick Hill wind farm are below the noise criterion curves for the proposed project (See Table 12-11), with the exception of potential exceedances of the 43 dB $L_{A90,10\text{-}min}$ night time criterion in the following scenarios:

- ≥7 m/s at locations H096 and H097 with Nordex N163;
- ≥9 m/s at locations H096 with Nordex N149;
- ≥9 m/s at locations H096 with Vestas V150;

The two locations identified, H096 and H097, are noted as being 'financially involved' in the proposed Dyrick Hill Wind Farm project development. Referenced as H92 and H93 respectively in the Dyrick Hill Wind Farm EIAR. In accordance with ETSU-R-97 guidance the Dyrick Hill EIAR proposed a cumulative lower turbine noise threshold of 45 dB $L_{A90,10\text{-}min}$ for day and night time periods at these properties. Applying these lower thresholds of 45 dB $L_{A90,10\text{-}min}$ to H097 and H096 in the cumulative assessment, the predicted omni-directional turbine noise levels are below the noise criterion curves for all turbine options and scenarios considered in the assessment.

Appendix 12.6 presents the predicted cumulative omni-directional turbine results at all NSL's in tabulated form for the proposed project with the proposed Dyrick Hill Wind Farm.

12.5.4.1.4 Description of Effects

The predicted cumulative noise levels from the proposed project with the proposed Dyrick Hill Wind Farm will be within best practice noise criteria described in Section 12.2.2.3 therefore it is not considered that a significant effect is associated with the development.

With respect to the EPA's criteria for description of effects, the potential associated effects at the most impacted NSLs associated with operation of the wind turbines of the proposed project in combination with the proposed Dyrick Hill Wind Farm are described as follows:

Quality	Significance	Duration
Negative	Not 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.

12.5.4.2 Assessment of Substation Noise

Details of the proposed substation are described in Chapter 2 of the EIAR (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.

The noise emission level associated with a typical substation that would support a development of this nature is the order of 92 dB(A) L_w.

Noise prediction calculations for the operation of the substation have been undertaken in accordance with ISO 9613: *Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (1996)*. The predicted noise level from the operation of the substation at the nearest NSL (H165 at approximately 320 m from the noise source at the substation) is 30 dB $L_{Aeq,T}$. This level of noise is considered low, and it is concluded that there will be no significant noise emissions from the operation of the substation at any NSL. At the detailed design stage plant will be selected to ensure that there are no tonal or impulsive characteristics form the plant audible at any NSLs during night time periods.

The predicted noise level is well below the criterion for fixed machinal plant outlined in Section **Error! Reference source not found.**12.2.2.4, and unlikely to result in any adverse impacts at nearby NSLs.

12.5.4.2.1 Description of Effects

With respect to the EPA's criteria for description of effects, the potential associated effects at the nearest NSLs associated with the operation of the proposed substation is described below.

Quality	Significance	Duration
Negative	Not Significant	Long-term

12.6 MITIGATION MEASURES

12.6.1 Construction Phase

Due to the potential for significant noise impact effects at receptors within 25 m of the proposed GCR construction works, specific mitigation measures are provided in section 12.6.1.1.

For all other elements of the construction phase the assessment of potential impacts has demonstrated that the proposed project is expected to comply with the criteria and therefore no specific mitigation measures are required.

The contract documents will specify that the Contractor undertaking the construction works will be obliged to take specific noise abatement measures and comply with the recommendations of 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 and vibration control measures has been formulated in accordance with best practice guidance. These are outlined in the Construction and Environmental Management Plan (CEMP) that has been prepared for the proposed project.

12.6.1.1 Proposed GCR Construction Works Mitigation

In respect of the GCR construction, a temporary solid hoarding may be employed where there are NSL's within 25 m to the activity. This can be expected to reduce noise at the NSL by 5 - 10 dB. With this mitigation measure in place, noise levels at 20 m distance from construction activity are expected to be within the criterion for linear construction works in Section 12.2.2.1.1. With respect to the EPA's criteria for description of effects, the potential residual effects post mitigation will be negative, not significant and brief to temporary.

Additional or alternative mitigation measures include:

- Monitoring typical levels of noise and vibration during critical periods and at sensitive locations;
- Selection of plant with low inherent potential for generation of noise and/ or vibration, and;
- Placing of noisy / vibratory plant as far away from sensitive properties as permitted by site constraints.

It is noted that the assessment presented in Section 12.5.2.5 is conservative, and the assessment has identified a potential exceedance of the noise criteria at two number NSL's with 25 m of the works. If the appointed contractor can demonstrate through onsite monitoring or other means that mitigation measures are not required to meet the relevant construction noise criteria, then works can proceed without specific mitigation measures in place.

12.6.1.2 Comments on Blasting

In blasting is undertaken as part of the proposed project, a detailed assessment will be undertaken by a specialist blast design engineer to determine the blast design parameters; all mitigation measures specified by the blast design engineer to keep vibration values within the criteria in Section 12.2.2.2 will be implemented.

Air overpressure from a blast is difficult to control, however, because of its variability much can be done to reduce the effect. A reduction in the amount of primer cord used, together with the adequate burial of any that is above the ground, can give dramatic reduction to air overpressure intensities especially in the audible frequency range. Should complaints arise, they are likely to be received from an area downwind of the blast site, and therefore, blasting will be postponed during unfavourable weather conditions. Furthermore, as air blast intensity is a function of total charge weight, then a reduction in the total amount of explosives used can also reduce the air overpressure value.

Further guidance will be obtained from the recommendations contained within BS 5228: Part 1 and the European Communities (Construction Plant and Equipment) (Permissible Noise Levels) Regulations 1988 in relation to blasting operations.

The methods used to minimise complaints could consist of some or all of the following:

- Restriction of hours within which blasting can be conducted (e.g. 09:00 – 18:00hrs).
- Notification to nearby residents before blasting starts (e.g. 24-hour written notification).
- The firing of blasts at similar times to reduce the 'startle' effect.
- On-going circulars informing people of the progress of the works.
- The implementation of an onsite documented complaints procedure.
- The use of independent monitoring by external bodies for verification of results.

- Trial blasts in less sensitive areas to assist in blast designs and identify potential zones of influence.

12.6.2 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 to be comparable to those outlined in relation to the construction phase (as per Section 12.5.2), albeit less works will be required as only above ground structures will be removed. Turbine and mast foundations would remain underground and cable ducting will remain in situ. The GCR, underground cabling and on-site substation will remain in place. Refer to Chapter 2 for full details.

12.6.3 Operational Phase Mitigation Measures

An assessment of the operational turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in Section 12.2.2.312.2.2.3 of this Chapter.

The findings of the assessment have confirmed that the predicted operational noise levels from the proposed project in isolation, and the predicted cumulative turbine noise level from the proposed project with the proposed Dyrick Hill Wind Farm both wind turbine developments will be within the noise criteria. Therefore, no specific mitigation measures are required.

If alternative turbine models within the proposed specifications are considered for the proposed project, an updated noise assessment will be prepared to confirm that the noise emissions will comply with the noise criteria as per best practice guidance outlined in Section 12.4.212.4.2 and/or the relevant operational criteria associated with the grant of planning for existing/permitted developments. A suitable curtailment strategy will be designed and implemented for alternative technologies to ensure compliance with the relevant noise criteria, should detailed assessment conclude that this is necessary.

12.6.3.1 Amplitude Modulation

In the event of a complaint that indicates potential amplitude modulation (AM) associated with turbine operation, the operator will employ a qualified acoustic consultant to 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 (AMWG) namely, 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', will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions including mitigation.

These mitigation measures, if required, will consist of the implementation of operational controls for the relevant turbine type, which may include curtailment of turbines under specific operational conditions.

12.6.4 Monitoring

Commissioning noise surveys will be undertaken to ensure compliance with any noise conditions applied to the development. It is common practice to commence surveys within six months of a proposed wind farm being commissioned. If an exceedance of the noise criteria is identified as part of the commissioning assessment, the guidance outlined in the IOA GPG and Supplementary Guidance Note 5: *Post Completion Measurements* (July 2014) will be followed, 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 curves/planning conditions limits. Such curtailment can be applied using the wind farm SCADA system without undue effect on the wind turbine performance. Following implementation of these measures, noise surveys will be repeated to confirm compliance with the noise criteria.

12.7 RESIDUAL EFFECTS

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

12.7.1 Construction Phase

During the construction phase of the proposed project there will be some effect on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and nearby NSLs and the fact that the construction phase of the development is temporary in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that the noise effects are kept to a minimum.

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

12.7.1.1 Turbines and Hardstands

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

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

12.7.1.2 Substation Construction

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

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

12.7.1.3 Construction of Internal Site Roads

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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

12.7.1.4 TDR Works

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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

12.7.1.5 Proposed GCR Route

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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

12.7.1.6 HDD Drilling

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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

12.7.1.7 Borrow Pits

Quality	*Significance*	*Duration*
Negative	Not Significant	Temporary

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

12.7.1.8 Construction Traffic

Quality	*Significance*	*Duration*
Negative	Not Significant	Short Term

The likely predicted construction traffic noise impacts are below the thresholds identified. The described residual effects should be considered in terms that the effect is variable, and that this assessment considers the locations of the greatest potential impact.

12.7.2 Operational Phase

12.7.2.1 Wind Turbine Noise

The predicted noise levels associated with the proposed project will be within best practice noise criteria curves recommended in line with guidance in the WEDGs, it is not considered that a significant effect is associated with the development.

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.

12.7.2.2 Substation Operation

Quality	*Significance*	*Duration*
Negative	Not Significant	Long-term

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

12.8 CUMULATIVE EFFECTS

12.8.1 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 has been undertaken in accordance with the guidance contained in the IOA GPG. A cumulative wind turbine noise assessment has been undertaken which considered the cumulative turbine noise impact of the proposed Dyrick Hill Wind Farm.

The proposed Dyrick Hill Wind Farm (ABP Ref. 317265), the site of which is located directly adjacent to the currently proposed Scart Mountain Wind Farm site, was recently (October 2024) refused planning permission by An Bord Pleanála. As there is still a potential for judicial review at the time of writing this EIAR chapter (November 2024), it has been decided to include the project in the cumulative impact assessments. In the event that the refusal of the Dyricck Hill Wind Farm application is confirmed prior to the determination of the current application, then any discussions around cumulative impacts for this project in this EIAR can be ignored by ABP.

There was no other wind turbine developments identified within the study area that need to be considered in the cumulative assessment. Refer to Section 12.2.2.3.2 and 12.3.1 for discussion and definition of the study area.

12.8.2 Construction

It is not anticipated that there will be any other construction activities that would give rise to significant cumulative impacts during the construction phase. The predicted noise 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.

The predicted noise levels from construction activity would need to be in well in excess of 55 dB $L_{Aeq,T}$ in order for a potential cumulative construction noise increase to exceed the noise thresholds. The only elements of the construction phase where there may be potential for cumulative construction noise impacts are proposed GCR works occurring in proximity to an NSL. In any such instances, the contractor will adopt appropriate mitigation measures as required to ensure the noise impacts are minimised. It is concluded that, with the implementation of appropriate mitigation measures outlined in Section **Error! Reference source not found.**12.6.1, any potential cumulative impacts during the construction phase will not be significant.

12.8.3 Other Developments

12.8.3.1 Construction and Decommissioning

The list of cumulative projects detailed in Appendix 4.2 of the EIAR have been reviewed. It is not anticipated that there will be any other construction activities that would give rise to significant cumulative impacts during the construction and decommissioning phases. With the exception of proposed 'linear' construction works, the predicted noise 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.

For construction activities occurring in close proximity to NSL's, considering the distance to any other projects and the noise emissions associated with these activities, cumulative construction noise or vibration effects are unlikely.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest NSLs associated with cumulative impacts during the construction phase are described as follows:

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

12.8.3.2 Proposed GCR

It is not considered that any significant cumulative operational noise or vibration effects are in relation to the proposed GCR infrastructure (substation, internal underground cabling, and proposed GCR. The electrical cabling will not generate any noise during the operational phase, and the predicted operational noise levels at the nearest NSL from the operation of the substation are well below the noise criteria. Furthermore, the distance to any other developments will ensure that any contribution to cumulative noise will not be significant.

With respect to the EPA criteria for description of effects, the anticipated associated effects at the nearest NSLs associated with cumulative impacts from the proposed GCR are described as:

Quality	*Significance*	*Duration*
Negative	Not significant	Long-term

12.9 SUMMARY

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 and decommissioning phases, and the long-term operational phase.

The assessment of construction noise and vibration and has been conducted in accordance 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 expected to cause any likely significant effects at any NSL.

Based on detailed information on the site layout, and the proposed turbine specifications, turbine noise levels have been predicted at NSLs for a range of operational wind speeds. The predicted noise levels associated with the proposed project will be within best practice noise limits recommended in WEDGs regardless of which turbine is constructed within the turbine range, therefore it is not considered that the effects of the proposed project will not be significant.

Noise from the proposed substation has also been assessed and found to be well within the proposed noise criteria.

No significant vibration effects are associated with the operation of the proposed project.

12.10 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: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (1996)
- 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)
- UK Health Protection Agency published a report entitled Health Effects of Exposure to Ultrasound and Infrasound, Report of the independent Advisory Group on Non-ionising Radiation.
- 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)
- DIN 45680:2013-09 – Draft Measurement and Assessment of Low-frequency Noise Immissions (November 2013)
- 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)
- National Health and Medical Research Council (NHMRC) Evidence on Wind Farms and Human Health 2015
- Health Canada Wind Turbine Noise and Health Study: Summary of Results (2014)
- Journal of Occupational and Environmental Medicine Wind Turbines and Health: A Critical Review of the Scientific Literature (2014)
- ISO 1996: 2017: Acoustics — Description, measurement, and assessment of environmental noise.

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