



Cush Wind Farm Phase II

Environmental Impact Assessment Report

Chapter 12: Noise & Vibration

Cush Wind Limited

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12.1 INTRODUCTION

This chapter of the EIAR describes the assessment undertaken of the likely significant noise and vibration effects from the proposed project.

Noise and vibration impact assessments have been prepared for the operation, construction, and decommissioning phases of the proposed project on the nearby noise sensitive locations (NSLs). To inform this assessment, baseline noise levels were measured at four representative NSLs surrounding the proposed wind farm site (see **Section 12.4.2**). Noise predictions for the nearest NSLs have been prepared for all key elements of the proposed project that have the potential for noise and vibration impacts and effects in accordance with the guidance presented in this chapter.

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

This chapter is supported by the material presented in the following appendices:

- **Annex 12.1:** Glossary of Acoustic Terms;
- **Annex 12.2:** Noise Modelling Parameters;
- **Annex 12.3:** Operational Noise Study Area;
- **Annex 12.4:** Background Noise Survey;
- **Annex 12.5:** Sound Power Levels;
- **Annex 12.6:** Predicted Noise Levels for Proposed Development;
- **Annex 12.7:** Predicted Noise Contours for Proposed Development;
- **Annex 12.8:** Predicted Cumulative Noise Levels;
- **Annex 12.9:** Predicted Cumulative Noise Contours;

12.1.1 STATEMENT OF AUTHORITY

This chapter of the EIAR has been prepared by Mike Simms, with input from Miguel Cartuyvels and Dermot Blunnie of AWN Consulting.

Mike Simms (Principal Acoustic Consultant) holds a BE and MEngSc in Mechanical Engineering and is a member of the Institute of Acoustics (MIOA). 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.

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

Dermot Blunnie (Associate Director) 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. He has commissioned noise surveys and completed noise impact assessments for numerous

wind farm projects within Ireland.

12.1.2 DESCRIPTION OF THE PROJECT

The project site is located in rural Co. Offaly, approximately 4km north of the town of Birr and c. 28km south-west of Tullamore, Co. Offaly.

The project assessed within this EIAR comprises a 3 no. wind turbine extension to the permitted Cush Wind Farm Phase I, together with all associated and ancillary infrastructure and works. This includes turbine foundations, crane hardstanding areas, access tracks, internal wind farm underground cabling, site drainage and rehabilitation works, peat/spoil management, a proposed electrical switch room building, and c.5km of underground electricity line to connect the proposed wind farm to the national electricity network at the proposed Mullanafawnia 110kV substation.

The turbine component haul route and associated temporary and permanent upgrade works as described in **Chapter 3**, are located within Counties Galway, Roscommon, Westmeath and Offaly. It is envisaged that turbine components will be transported from the Port of Galway to the project site via the N6, M6, N52 and N62, before accessing the project site from the permitted construction phase site entrance from the N62 national road.

A full detailed description of the project is presented in **Chapter 3**.

12.1.3 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 and 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**.

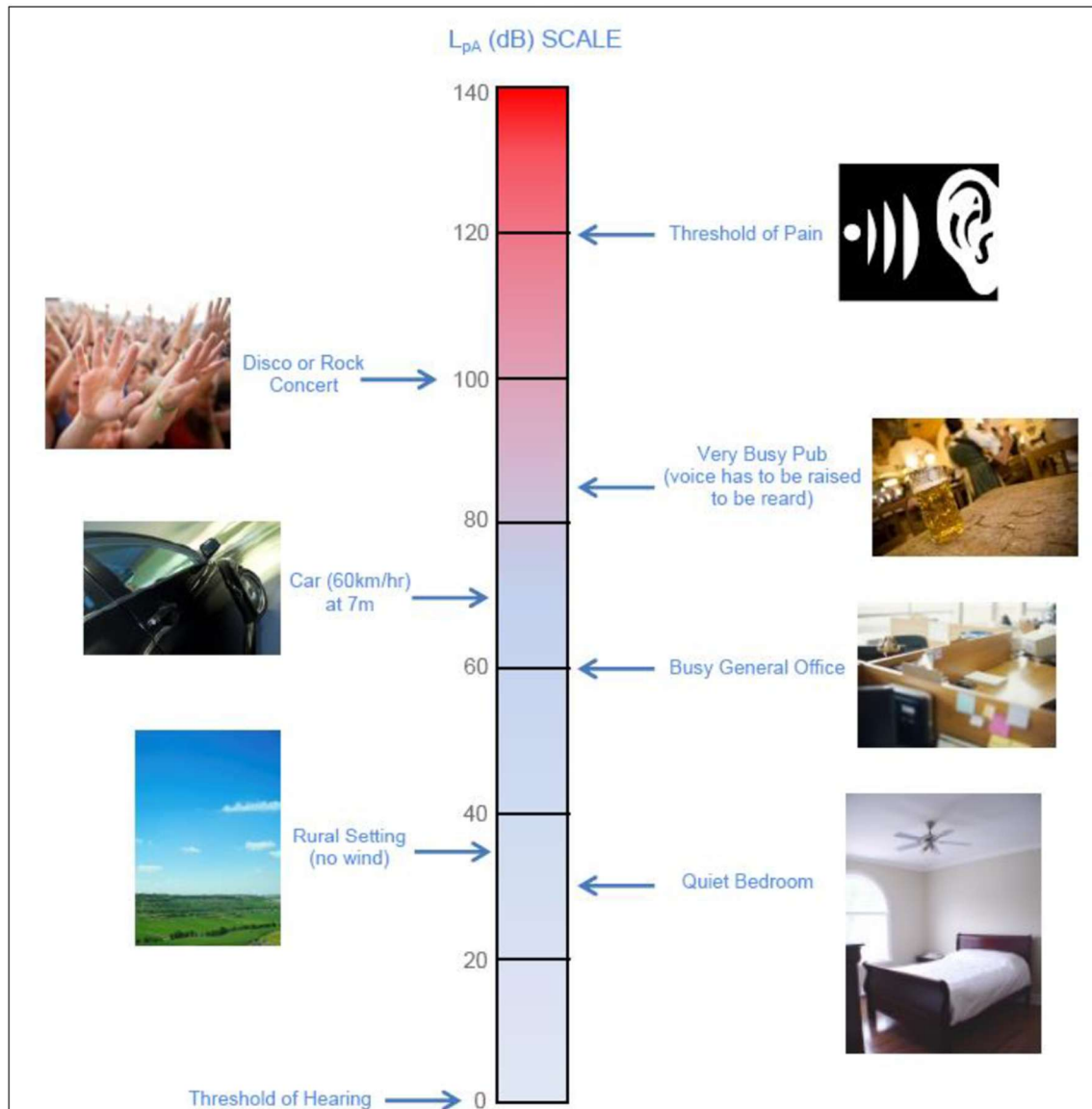


Figure 12.1: dB(A) Scale & Indicative Noise Levels (EPA NG4, 2016)

12.1.4 LIMITATION ENCOUNTERED DURING PREPARATION OF THIS CHAPTER

There were no difficulties or limitations encountered when assessing the likely noise and vibration effects of the project.

12.2 CONSULTATION

During the consultation process there were no concerns or issues in relation to noise raised by Local Authorities, Government Departments, NGOs or Stakeholders that affected the assessment and preparation of the Noise and Vibration assessment for this EIAR. National Office for Environmental Health Services ('EHS') responded to the Developer's consultation request on 25 February 2026 and made reference to a range

of guidance and information which they felt was applicable to the consideration of the project generally, including specific reference to noise related information. The assessment carried out in this chapter has been cognisant of the observations made by EHS and the information referred to therein.

Refer to **Chapter 1** for full details of consultations.

12.3 LEGISLATION, POLICY AND GUIDANCE

The assessment of effects for the project has been undertaken with reference to the guidance documents that are applicable to the development and/or considered to represent best practice for the assessment of environmental noise and vibration impacts.

The following guidance documents have been consulted when preparing this chapter of the EIAR and the specific details are presented where relevant in **Section 12.3.2:**

- *EPA Guidelines on the Information to be contained in Environmental Impact Statements*, Environmental Protection Agency, 2022 ('EPA 2022');
- *Wind Energy Development Guidelines for Planning Authorities*, Department of the Environment, Heritage, and Local Government 2006 ('WEDGs');
- Department for Energy Security and Net Zero (DESNZ) *Assessment and Rating of Wind Turbine Noise* ('ARWTN') ('DESNZ, 2026');
- *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise* 2013 and its *Supplementary Guidance Notes* 2024 ('IOA GPG');
- *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*, Transport Infrastructure Ireland (TII) (formerly National Roads Authority 2004 ('TII 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 ('TII 2014');
- *British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* ('BS5228-1');
- *British Standard BS 5228-2:2009+A1:2014 Code of practice for vibration control on construction and open sites – Vibration* ('BS5228-2');
- *British Standard BS 7385 – Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration* BSI, 1993 ('BS7385');
- *Design Manual for Roads and Bridges Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2* (National England (now National Highways)) 2020 ('DMRB');
- *ISO 1996: 2017: Acoustics – Description, measurement, and assessment of environmental noise* ('ISO-1996:2017');
- EPA document *Guidance Note for Noise Assessment of Wind Turbine Operations at EPA Licensed Sites* NG3 EPA, 2011 ('NG3');
- EPA document *'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* NG4 EPA, 2016 ('NG4');

- *BS 4142:2014: Methods for rating and assessing industrial and commercial sound ('BS4142');*
- *Institute of Acoustics Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) document A Method for Rating Amplitude Modulation in Wind Turbine 2016 ('IOA AMWG');* and
- *ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors - Part 2: General method of calculation ('ISO 9613-2, 1996');*
- *ISO 9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors - Part 2: Engineering method for the prediction of sound pressure levels outdoors ('ISO 9613-2, 2024');*

General context guidance in the following documents has also been considered but not directly applied:

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

12.3.1 ENVIRONMENTAL PROTECTION AGENCY (EPA) DESCRIPTION OF EFFECTS

The significance of effects of the proposed project shall be described in accordance with the EPA 2022 guidance document. Details of the methodology for describing the significance of the effects are provided in **Chapter 1**.

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.

12.3.2 GUIDANCE DOCUMENTS AND ASSESSMENT CRITERIA

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

12.3.2.1 Construction and Decommissioning Phase – Noise

There is no published statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. Local authorities typically control construction activities by restricting the hours during which construction activities can take place and may consider noise limits at their discretion.

In the absence of specific noise limits, appropriate criteria relating to permissible construction noise levels can be found in the British Standard BS5528-1. This standard is commonly accepted and used in Ireland.

An approach in BS5528-1 calls for the designation of receptors into a specific category (A, B or C) based on the existing ambient noise levels at the receptor in the absence of construction noise. A threshold noise value is applied to each category. An exceedance of the construction noise threshold (CNT) at the façade of a noise sensitive location (NSL) during construction may indicate a potentially significant noise impact associated with the construction activities. The CNT values recommended by BS5228-1 are included in **Table 12.1**. The CNT values are applicable to both construction and decommissioning noise. This assessment method is proposed for residential receptors only.

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

Table 12.1: Example Threshold of Potential Significant Effect at Dwelling

Note A Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.

Note B Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values.

Note C Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.

Note D 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

The following steps are applied to implement the A-B-C method from BS5228-1:

For each period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5 dB. At some NSLs, particularly those located close to a busy road network, the existing ambient noise levels are expected to be relatively high. However, given the rural nature of the site in general, the measured daytime ambient noise levels are generally in the range of 30 to 55 dB $L_{Aeq,1hr}$. Therefore, for the purposes of this assessment and to adopt a conservative approach, all properties will be assigned a Category A designation, setting the initial CNT for daytime periods at 65 dB $L_{Aeq,T}$.

BS 5228-1 states that:

"If the site noise level exceeds the appropriate category value [the CNT], then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect."

If the specific construction noise level exceeds the CNT, then a potential significant impact is identified. To determine the significance of effects, it is important to consider the duration and magnitude of the impacts as described in **Section 12.3.2.5**.

12.3.2.2 Linear Construction Works

A fixed noise limit is proposed for elements of the construction that are linear and progressive in nature including:

- Internal underground cabling, or underground electricity line as part of the grid connection, and
- Construction and upgrade of site access tracks.

This approach is deemed appropriate as noise from these activities is variable, typically short in duration, and only at its highest when closest to the NSL. As the works progress, the distance between the construction activities and the NSL increases, resulting in reduced noise levels and a shorter duration of exposure to noise impacts. To set an appropriate fixed noise limit, reference is made to paragraph E.2, BS 5228-1.

General Principle:

"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."

Recommended Daytime Limits (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; and*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas."*

TII 2004 guidance proposes a daytime period (Monday to Friday 0700 – 1900 hrs) with a construction noise limit of 70 dB $L_{Aeq,1hr}$.

Considering the above guidance, a construction noise limit of 70 dB $L_{Aeq,16hr}$ is proposed for linear construction activities.

Noise levels above 70 dB $L_{Aeq,16hr}$ may indicate a significant impact depending on the duration and frequency of occurrence.

12.3.2.3 Additional Construction Phase Vehicular Activity on Public Roads

There are no specific guidelines or limits relating to traffic-related sources along the local or surrounding roads. Given that traffic from the proposed project will make use of existing public 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.

In the absence of any national guidelines in Ireland, for the assessment of potential

noise impacts from construction related traffic along public roads, it is proposed to adopt guidance from DMRB. The DMRB guidance is considered appropriate and best practice as it provides a well-established, internationally recognised framework with objection criteria for assessing construction noise and vibration impacts, which align closely with the relevant significance of effects from EPA 2022. **Table 12.2** taken from DMRB offers guidance as to the likely short-term impact associated with any change in traffic noise level.

Change in Sound Level (dB LA10,18hr)	Magnitude of Impact	Initial Significance Rating
Less than 1.0	Negligible	Not significant
1 – 2.9	Minor	
3 – 4.9	Moderate	Significant
Greater than or equal to 5.0	Major	

Table 12.2: Likely Impacts Associated with Change in Traffic Noise Level

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 or an initial significance rating of 'Significant' is identified, reference will be made to the overall predicted noise level from construction traffic in the context of the construction noise threshold values outlined in this **Section 12.3.2.1**.

12.3.2.4 Construction Phase – Vibration

With respect to this project, the range of relevant criteria used for building protection is expressed in terms of Peak Particle Velocity (PPV) in mm/s.

In the absence of statutory Irish guidelines for the assessment of construction-related vibration, the following published standards and guidance have been considered in this assessment. These documents provide industry-recognised thresholds and assessment methodologies that align with EIAR requirements. Guidance relevant to acceptable vibration within buildings is contained in the following standards:

- BS 7385;
- BS 5228-2, and
- TII 2004.

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

BS5228-2 recommends that, for soundly constructed residential properties and similar structures that are generally in good repair, a threshold for minor or cosmetic (i.e., non-structural) damage should be taken as a peak particle velocity of 15 mm/s for transient vibration at frequencies below 15 Hz and 20 mm/s at frequencies above 15 Hz. Below these vibration magnitudes minor damage is unlikely, although the standard

notes that where there is existing damage these limits may be reduced by up to 50%. In addition, where continuous vibration is such that resonances are exceeded within structures, the limits discussed above may need to be reduced by 50%.

TII 2004 also contains information on the permissible construction vibration levels during the construction phase as shown in **Table 12.3**.

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

(Source: TII 2004)

Table 12.3: Allowable Vibration at Sensitive Properties

In accordance with the suggested vibration criteria discussed above from BS 7385, BS 5228-2 and TII 2004, the values in **Table 12.3** are considered appropriate for this assessment as they provide an nationally recognised, conservative PPV thresholds specifically developed for Irish infrastructure and construction works, ensuring a robust and defensible assessment in the absence of statutory Irish vibration limits.

12.3.2.5 Factors to Consider when Assessing Construction Noise Impacts

Interpretation of the Construction Noise Threshold

To assist with interpretation of a predicted construction noise level (CNL), relative to the construction noise threshold (CNT), reference is made to Table 3.16 in DMRB which forms the basis of the assessment and has been adapted by AWN to include the relevant significance effects from EPA 2022 to assess the likely magnitude of impact associated with construction activities is presented in **Table 12.4**.

Construction Noise Level (CNL)	Magnitude of Impact (DMRB)	Determined EPA Significance of Effect	Determination
Below or equal Baseline Noise Level	Negligible	Not Significant	Depending on range of the CNL, the baseline noise level and the duration of the impact
Above Baseline and below or equal to CNT	Minor	Not Significant to Slight	
Above CNT and below or equal to CNT + 5dB	Moderate	Moderate to Significant	
Above CNT + 5dB	Major	Significant to Very Significant	

(Adapted from DMRB Table 3.16)

Table 12.4: Description of the magnitude of Impacts

The DMRB guidance in conjunction with the EPA 2022 will be used to assess the predicted construction noise levels at NSLs and comment on the likely effects during

the construction stage.

Consideration of Duration When Assessing Effects

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

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

12.3.2.6 Operation Phase Noise – Wind Turbines

The noise assessment described in this chapter complies with Guidance in relation to acceptable levels of noise from wind farms as contained in *Wind Energy Development Guidelines* 2006 (DoEHLG, 2006) ('WEDGs'). The WEDGs are broadly in line with the recommendations set out in ETSU-R-97, which has been superseded by the Department for Energy Security and Net Zero (DESNZ) publication *Assessment and Rating of Wind Turbine Noise* (DESNZ, 2026), hereafter referred to as ARWTN. The ARWTN document has been used to supplement the guidance contained within the WEDGs, where appropriate and necessary.

Wind Energy Development Guidelines for Planning Authorities

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

This following statement from the WEDGs represents the widely accepted daytime noise criterion curve in relation to wind farm developments.

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

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 LA90, 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 $LA_{90,10min}$ parameter. This represents the commonly adopted night-time noise criterion curve in relation to wind farm developments.

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

- An appropriate absolute limit level in the range of 35 – 40 dB L_{A90} for quiet daytime environments with background noise levels of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB above background noise (whichever is higher), for daytime environments with background noise levels equal to or greater than 30 dB $L_{A90,10min}$; and
- 43 dB $L_{A90,10min}$ for night time periods or a maximum increase of 5 dB above background noise (whichever is higher).

While the caveat of an increase of 5 dB(A) above background for night-time operation is not explicit within the WEDGs, an allowance for same is commonly applied in noise assessments prepared and is accepted as detailed in numerous examples of planning conditions issued by An Coimisiún Pleanála. This is supported by the guidance in ETSU-R-97, ARWTN and the IOA GPG and is based on the principle that when background noise levels are sufficiently elevated, the potential impact of wind turbine noise is less significant, provided it does not exceed 5 dB above the background level. This approach is also consistent with the daytime criteria in WEDGs, which allow the limit to increase by up to 5 dB above background where this exceeds the fixed threshold level.

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

The core of the noise guidance contained within the WEDGs is broadly based on ETSU-R-97, however the turbine noise limits values vary.

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

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

The ETSU-R-97 and ARWTN guidance allow 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.

Key updates introduced by the Assessment and Rating of Wind Turbine Noise – ARWTN

The Assessment and Rating of Wind Turbine Noise (ARWTN) (2026) replaces ETSU-R-97 and provides updated technical guidance for the assessment and control of operational wind turbine noise. However, as the operational noise assessment for the project is based on the methodology set out in the Wind Energy Development Guidelines (WEDG) 2006, the ARWTN document is reviewed here primarily to identify

relevant updates and clarifications. The ARWTN retains the fundamental principles of ETSU-R-97, including the assessment of wind turbine noise at noise sensitive receptors, the use of background noise measurements to inform noise limits, and the requirement to consider cumulative noise from all acoustically relevant wind energy developments.

The guidance increases emphasis on the assessment of cumulative operational noise and confirms that the combined contribution from existing, permitted and proposed wind energy developments should be considered where relevant. ARWTN also provides updated procedures for operational compliance monitoring, including refined methodologies for the assessment of tonal noise and amplitude modulation (AM). These characteristics are intended to be addressed through post-construction compliance monitoring and planning conditions, rather than through the application of penalties at the planning assessment stage unless there is clear evidence that such characteristics are likely to occur.

A notable update within ARWTN is the confirmation that certain acoustical issues do not require specific assessment during the planning process: namely infrasound, ground-borne vibration and low-frequency noise. The guidance confirms that infrasound generated by modern wind turbines is below the threshold of perception at typical receptor distances, that ground-borne vibration levels are significantly below those detectable by humans, and that low-frequency noise is adequately controlled through the standard A-weighted noise assessment criteria and tonal assessment procedures. Consequently, assessment of these characteristics is scoped out of the operational noise assessment for the project.

Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts underwent a thorough standardisation and modernisation in 2013 with publication of the IOA GPG including six Supplementary Guidance Notes published in 2014. These documents bring together the combined experience of acoustic consultants in the UK and Ireland in the application of the assessment methods. Numerous improvements in the accuracy and robustness are described including the treatment of wind shear and the general adaptation to larger wind turbines. The guidance contained within IOA GPG is considered to represent best practice and has been adopted in this assessment.

Background Noise Surveys

The IOA GPG provided guidance on the duration and requirements for background noise surveys and 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.

For guidance on the methodology for the background noise survey, the IOA GPG has been adopted.

Noise Prediction Calculations

The noise levels associated with the wind turbines have been calculated in accordance with ISO 9613-2, 1996 including IOA's GPG parameter settings for wind turbine screening limit and wind turbine valley correction settings. A new version of ISO 9613 was published in 2024 that include a more generic definition of the parameters indicated. However, IOA GPG includes a more conservative approach for terrain screening and are only applicable when using the ISO 9613-2, 1996. Therefore, the noise prediction calculations are made with the ISO 9613-2, 1996 with the IOA parameters. The IOA is undertaking a review of the GPG to clarify the use of the superseded standard with respect to the newest revision.

This is a standardised methodology for noise prediction that considers noise attenuation offered, amongst others, by distance, ground absorption, directivity, and atmospheric absorption. The IOA GPG states that when considering cumulative noise impacts, the effects of propagation in different wind directions can be considered. Any such direction attenuation factors, if used, should be clearly stated in any assessment.

Additional details on the noise prediction calculation settings are provided in **Annex 12.2**.

Cumulative Assessment Screening

Existing, permitted and proposed wind turbine developments must be considered cumulatively in the noise impact assessment. To determine where a particular wind farm development needs to be included in the assessment or whether it can be scoped out, a '10 dB rule' is applied. The '10 dB rule,' is grounded in scientific principles and supported by best-practice guidance. It states that if the contribution from another noise source is 10 dB below the total noise level, its contribution is insignificant to the total cumulative noise level, therefore, the other source is not significant and can be scoped out of the cumulative assessment.

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

"5.1.4 During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary."

5.1.5 Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary."

In this instance, the following existing/permitted wind farms have been included in the noise modelling for the cumulative assessment:

- Cush Wind Farm Phase I: 8 no. turbines;
- Cloghan Wind Farm: 9 no. turbines;
- Derrinlough Wind Farm: 21 no. turbines and
- Meenwaun Wind Farm: 4 no. turbines.

Noise Study Area

In the first instance the noise study area must be defined, the IOA GPG states that the 'study area' for background noise surveys (and noise assessment) should, as a minimum, be the area within which noise levels from the proposed, consented and existing wind turbines is greater than 35 dB L_{A90} .

In some circumstances the cumulative 35 dB L_{A90} area may extend beyond the area where the proposed turbines will have any significant effect. This initial study area can be refined by applying the '10 dB rule' such that the following statement is true:

The study area for operational turbine noise can be defined as the area within which the predicted turbine noise levels from the proposed, consented, and existing wind turbines is greater than 35 dB L_{A90} , and the predicted noise from the proposed turbines in isolation is within 10 dB of the proposed fixed lower threshold for turbine noise.

For example, where a fixed lower threshold of 40 dB applies, the maximum extent of the study area for the proposed project will correspond to the 30 dB L_{A90} noise contour of the proposed turbines in isolation.

Comments on Planning Conditions for Noise for Permitted Cush Wind Farm Phase I

Condition 12 of the permitted Cush Wind Farm Phase I¹, is as follows:

12. The operation of the proposed development, by itself or in combination with any other permitted wind energy development, shall not result in noise levels, when measured externally at nearby noise sensitive locations, which exceed:

- (a) *Between the hours of 0700 and 2300:*
 - i. *the greater of 5dB(A) L_{90} , 10min above background noise levels, or 45 dB(A) L_{90} , 10min at standardised 10-meter height above ground level wind speeds of 5 m/s or greater.*
 - ii. *40 dB(A) L_{90} , 10min $a=$ [sic] at all other standardised 10-metre height above ground wind speeds[s].*
- (b) *43 dB(A) L_{90} , 10min at all other times:*

Prior to commencement of windfarm, the developer shall submit to and agree in writing with the planning authority a Noise Compliance Monitoring Programme (NMCP). The NMCP shall include a detailed methodology for all

¹ An Coimisiún Pleanála Reference: ABP-318816-24

sound measurements, including frequency of monitoring (initially six months, with confirmatory monitoring in the third year post commissioning) and recording of results, which shall be made publicly available. The NMCP shall also include any mitigation measures such as the de-rating of particular turbines if required and shall be fully implemented during the operation of the wind farm.

Reason: in the interest of residential amenity

Section 12.5.3 comments on the criteria derived from this planning condition.

Future Potential Guidance Changes

In December 2019, the *Draft Wind Energy Development Guidelines* (DoEHLG, 2019) were published for consultation and at the time of writing this EIAR Chapter, no updated guidelines have been published. It is important to note that during the public consultation on the 2019 *draft Wind Energy Development Guidelines* ('draft WEDGs'), several concerns relating to the proposed approach of the 2019 draft WEDGs were 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, ARWTN, the IOA Good Practice Guide (IOA GPG) and the IOA Amplitude Modulation Working Group, which are all referenced extensively in the draft Guidelines. Comment on the statement from the party group can be reviewed at:

<https://pub.ioa.org.uk/blogs/wind-energy-development-guidelines-wedg-consultation-irish-department-housing-planning-community>

Wherein it is stated that:

"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"

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

<https://awnconsulting.com/wp-content/uploads/2026/03/WEDG-consultation-joint-response-R0.pdf>

In a written answer to Parliamentary Question on 19 June 2025, the Minister for Housing, Local Government and Heritage stated that the review of the 2006 *Wind Energy Development Guidelines* is ongoing and that, when finalised, the revised Guidelines "will be issued under section 28 of the Planning and Development Act 2000, as amended or, subject to commencement of the Planning and Development Act 2024, as a National Planning Statement, as appropriate". The Minister further stated that "The current 2006 *Wind Energy Development Guidelines* remain in force, pending the finalisation of the review." The full written answer is available from the Houses of the Oireachtas: *Wind Energy Guidelines*, Dáil Éireann Debate, 19 June 2025.

The assessment of wind turbine noise presented in this EIAR is based on the guidance

outlined in WEDGs and has been supplemented with best practice guidance from ARWTN, ESTU-R-97 and the IOA GPG. If updated Wind Energy Guidelines are published during the application process for the proposed project it is anticipated that any relevant changes affecting the noise will be addressed through an appropriate planning condition, or where a supplementary assessment is necessary, through provision of additional information.

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

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

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

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

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

"For average noise exposure, the GDG conditionally recommends reducing noise levels produced by wind turbines below 45 dB L_{den} , as wind turbine noise above this level is associated with adverse health effects.

No recommendation is made for average night noise exposure L_{night} of wind turbines. The quality of evidence of night-time exposure to wind turbine noise is too low to allow a recommendation.

To reduce health effects, the GDG conditionally recommends that policy-makers implement suitable measures to reduce noise exposure from wind turbines in the population exposed to levels above the guideline values for average noise exposure. No evidence is available, however, to facilitate the recommendation of one particular type of intervention over another."

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

The World Health Organisation (WHO) Environmental Noise Guidelines for the European Region (2018) aim to support the legislation and policy-making process on local, national, and international level, thus shall be considered by Irish policy makers

for any future revisions of Irish National Guidelines.

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

"Even though correlations between noise indicators tend to be high (especially between L_{Aeq} -like indicators) and conversions between indicators do not normally influence the correlations between the noise indicator and a particular health effect, important assumptions remain when exposure to wind turbine noise in L_{den} 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."

The WHO-recommended average noise exposure level (i.e. 45 dB L_{den}) is not an appropriate target noise criterion for an existing or proposed wind turbine development in Ireland. It is not industry best practice to implement an L_{den} limit for wind turbine noise, as it is considered a poor characterisation of wind turbine noise. The WHO 2018 recommendation for average noise exposure of 45 dB L_{den} is conditional, meaning that the available scientific data for wind turbine noise was not sufficient to justify a strong recommendation.

Low Frequency Noise and Infrasound

As stated in the ARWTN and discussed in above, low frequency noise and infrasound do not require specific assessment as they are generally below the threshold of perception at typical receptor distances and are not expected to result in any significant effect at the NSLs. Consequently, no assessment criteria for low-frequency noise or infrasound have been adopted as part of this EIAR.

Tonality

A tone is the concentration of acoustic energy into a very narrow frequency range,

with a noticeable character (such as a “hum” or “whine” for example). The audibility of any tones can be assessed by comparing the narrow band level of such tones with the masking level contained in a band of frequencies around the tone. Several objective methodologies to assess tonal audibility are available, such as the one included in ARWTN or that of ISO 1996-2 (2017) .

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

Wind farm noise guidelines such as ARWTN assume that the wind turbine noise does not normally contain clearly audible tones. It is not possible to predict the occurrence of tonality on a project reliably at the planning stage. The unlikely occurrence of tonality in the wind turbines of the proposed project will be managed through the commitments provided by the Applicant in **Section 12.8**.

Amplitude Modulation

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

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

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.

Previous definitions for AM distinguished between two distinct types:

‘Normal’ AM - An inherent characteristic of wind turbine noise, often described as “blade swish.” This effect is typically observed relatively close to the turbine and is produced as the trailing edge of the blade rotates toward and then away from the observer.

‘Other’ AM - A more pronounced form of AM, generally observed at greater distances from the turbine or turbines. It is often perceived as a periodic low-frequency “thumping” or “whoomphing.”

While AM is acknowledged as an intrinsic feature of wind turbine noise, the earlier terms Normal AM and Other AM were used to distinguish between the typical (expected AM), and the more pronounced form that may cause disturbance. Normal AM is accounted for in noise impact assessments, whereas Other AM may require additional mitigation if it presents at NSL during turbine operation.

The IOA AMWG now provides a clear, objective definition and rating method for AM,

reducing the need for the older terminology.

Frequency of Occurrence of Amplitude Modulation

UK research by Salford University commissioned by the Department of Environment Food and Rural Affairs (DEFRA), the Department of Business, Enterprise and Regulatory Reform (BERR) and the Department of Communities and Local Government (CLG) investigated the issue of AM associated with wind turbine noise. The results were reviewed and published in the report 'Research into Aerodynamic Modulation of Wind Turbine Noise' (2007). The conclusions of this report were that aerodynamic modulation was only considered to be an issue at four, and a possible issue at a further eight, of 133 sites in the UK that were operational at the time of the study and considered within the review. At the four sites where AM was confirmed as an issue, it was considered that conditions associated with this 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. The RenewableUK Research Document states the following in relation to the 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 Amplitude Modulation

Current research and guidance relating to wind turbine noise AM are ongoing. Among the most recent notable contributions is the IOA AMWG's 2016 publication, which outlines an objective measurement and rating approach known as the Reference Method. The IOA AMWG does not propose thresholds for adverse community response or recommend specific limits for AM. The purpose of the group is to consolidate existing research and to establish a consistent methodology for the objective measurement and rating of AM.

A 2016 report commissioned by the UK government BEIS AM Review Phase 2, completed by WSP Parsons Brinckerhoff, recommended the use of a penalty scheme as a potential planning condition for AM to cover periods of complaints due to unacceptable AM. This penalty scheme is based on the AMWG method and other potential AM rating methods were dismissed as not sufficiently robust and was not adopted by the UK or devolved Governments. The report included the following

caveat:

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

It is noted that the WSP report recommended that AM be controlled specifically during period of complaints. The key point is that while excessive amplitude modulation (AM) may occur during the operation of the wind farm, it may not necessarily result in any adverse impacts. The WSP report states *"at present it is not possible to predict whether AM will or will not be prevalent on a site"*.

As per the discussion on the research presented previously in this Section, excessive/other AM is considered an atypical phenomenon, and the duration, conditions and specific location or locations at which it presents cannot be predicted in the planning stage. For these reasons, the assessment of AM is typically triggered in response to complaints where the contributing factors aligning to the period of the complaint such as meteorological conditions and turbine operations can be investigated.

ARWTN confirms that the Reference Method as the relevant methodology for quantifying AM and describes the application on of a noise level rating to account for the presence of AM in line with that developed in the WSP Parsons Brinckerhoff document. This rating level is applied in the context of compliance monitoring only. There is no requirement in ARTWN to assess AM at the planning stage.

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

To date there is no clear industry and Governmental consensus on how AM should be regulated or managed through the planning and operational stage. Planning conditions imposing AM limits are therefore not considered best practice. In the absence of clear policy in Ireland to control AM from wind turbines, the commitments outlined in the **Section 12.8** are considered to represent best practice to control AM and will be adopted in the event that a complaint relating to excessive AM is reported.

12.3.2.7 Operation Phase Noise – Electrical Switch Room Building

The project does not include a substation or any other source of operational noise other than the wind turbines. The proposed electrical switch room building does not contain any component likely to emit noise to the surrounding environment. As such, no operational noise or vibration criteria are set for this element of the project.

12.3.2.8 Operation Phase Vibration

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

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

The shortest distance from any turbine in the proposed project to the nearest NSL is more than 713m (distance from turbine T09 to NSL ref. H057). At that distance, the level of vibration will be significantly below any thresholds for perceptibility. Therefore, vibration criteria are not specified for the operation phase of the proposed project.

An IOA statement in Respect of Wind Farm Noise Assessment dated December 2024 and published on the IOA website stated the following in relation to Vibration:

"Vibration from operational wind turbines has been measured by extremely sensitive measurement equipment such as seismic arrays but in terms of human perception, measured vibration levels are well below perception thresholds even on the actual wind turbine sites. There is, therefore, no need to assess vibration affecting people for operational wind turbine developments."

There are no other sources likely to give rise to any perceptible vibration at NSLs during the operation of the proposed project. The assessment of operation phase vibration has therefore been scoped out of this assessment as there are no likely significant vibration effects associated with the development.

12.3.2.9 Factors to Consider when Assessing Operational Noise Effects

Wind Turbine Noise

The applicable guidelines (WEDGs), along with additional best practice guidance discussed in **Section 12.3.2.6**, provide a framework for identifying appropriate noise limits at nearby NSLs. The turbines to be installed will be selected and designed to operate within these limits during the operation phase of the proposed project. Where predicted turbine noise levels remain within best practice thresholds, the effect can be considered not significant.

Baseline noise levels at low wind speeds are expected to increase at certain Noise Sensitive Locations (NSLs) with the operation of the proposed project. It is acknowledged that the introduction of turbines will contribute new sound sources to the existing soundscape. However, provided that operational noise levels remain within the applicable WEDGs limits and relevant best practice guidance, the resulting operational noise effects are considered not significant.

12.4 ASSESSMENT METHODOLOGY

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

- Review of best practice guidance to identify appropriate noise and vibration criteria for the construction, operation and decommissioning phases;
- Characterise the receiving environment through baseline noise surveys at various NSLs surrounding the proposed project;
- Undertake predictive calculations to assess the likely significant effects associated with the construction phase of the proposed project;
- Undertake predictive calculations to assess the likely significant effects associated with the operation of the proposed project at NSLs, including the wind farm developments in the cumulative assessment;
- Undertake predictive calculations to assess the likely significant effects associated with the decommissioning of the proposed project at NSLs;
- Specify mitigation measures to reduce, where necessary, the identified likely significant effects relating to noise and vibration from the proposed project; and
- Assess the significance of the cumulative residual noise and vibration effects associated with the proposed project.

12.4.1 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 operation phases, and the turbine component haul route.

12.4.1.1 Construction and Decommissioning

This section defines the study area for the assessment of construction and decommissioning noise and vibration, based on the potential for effects at nearby NSLs.

Based on a review of typical construction plant noise levels derived from BS 5228-1, including high noise-generating activities such as rock breaking, which at 300m is more than 10dB below the lowest noise threshold, a study area of 300m has been defined as the 'Construction Study Area' and applied for general construction activities and decommissioning occurring within the project Site. Taking account of the '10 dB rule' described in **Section 12.3.2.6**, it is unlikely that a cumulative impact can occur beyond 300m.

The Construction Study Area presented represents the combined spatial extent of all construction activities. However, in practice, each discrete construction activity is assessed based on a 300m buffer from the location of the works, reflecting the distance over which significant effects may arise.

For linear and short-duration activities associated with the proposed turbine haul route and proposed construction haul routes, a reduced study area of 200m has been adopted and is defined as the 'Traffic Study Area'. This reflects the transient nature of these works, whereby noise levels are only elevated for short periods at any given NSL.

Construction activities where the nearest NSLs are located beyond these defined

distances are unlikely to result in significant noise effects, having regard to BS 5228 threshold criteria and the attenuation of noise with distance, and are therefore scoped out of detailed assessment. Construction elements scoped out of the assessment are listed in **Section 12.6.2**.

12.4.1.2 Operation Phase Noise

Wind Turbines

The method to define the study area is described in **Section 12.3.2.6**. The operation phase noise study area is based on the fixed lower threshold for turbine noise. Wind turbine noise criteria for this project are presented in **Section 12.5.2-12.5.4**, where the lower fixed limit is set 40dB L_{A90} . The study area for the operation phase is therefore determined as the area predicted to exceed 30dB L_{A90} at the maximum predicted turbine noise emission level from the proposed project in isolation, i.e. the predicted noise from the proposed turbines in isolation is within 10dB below the proposed fixed lower threshold for turbine noise.

Annex 12.3, displays the relevant noise contours maps which identify this area. There are 131 no. noise-sensitive locations are included in the assessment.

Electrical Switch Room Building

There are no significant noise emissions expected from the proposed electrical switch room building.

The nearest NSL to the proposed switch room building, which is located to the south of the proposed wind turbines, is H057 at a distance of 140m.

Taking the above into account, environmental noise from the operation of the electrical switch room Building is **scoped out** of this assessment.

12.4.2 BACKGROUND NOISE SURVEY

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

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 between 22 December 2022 and 24 January 2023. A review of the study area has been undertaken to establish whether any material changes have occurred since completion of the survey which could significantly affect the prevailing background noise environment. The review considered changes in land use, new or altered roads and traffic sources, industrial or commercial development, new energy infrastructure, and other potentially significant noise sources in the vicinity of the surveyed receptors. No material changes have been identified which would be expected to significantly alter the background noise environment. The background noise levels measured during the baseline survey are therefore considered to remain representative of the

existing baseline conditions and suitable for use in this assessment.

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

12.4.2.1 Choice of Measurement Locations

The noise monitoring locations were identified by preparing a preliminary noise model contour at an early stage of the assessment. 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).

The co-ordinates for the selected noise monitoring locations are outlined in **Table 12.5** and identified on a map in **Figure 12.2**.

Location Reference (Closest NSL)	Coordinates (ITM)	
	Easting	Northing
A (H057)	E609000	N710151
B (H032)	E608187	N712007
C (H014)	E606111	N711029
D (H084)	E607284	N709378

Table 12.5: Noise Measurement Location Details

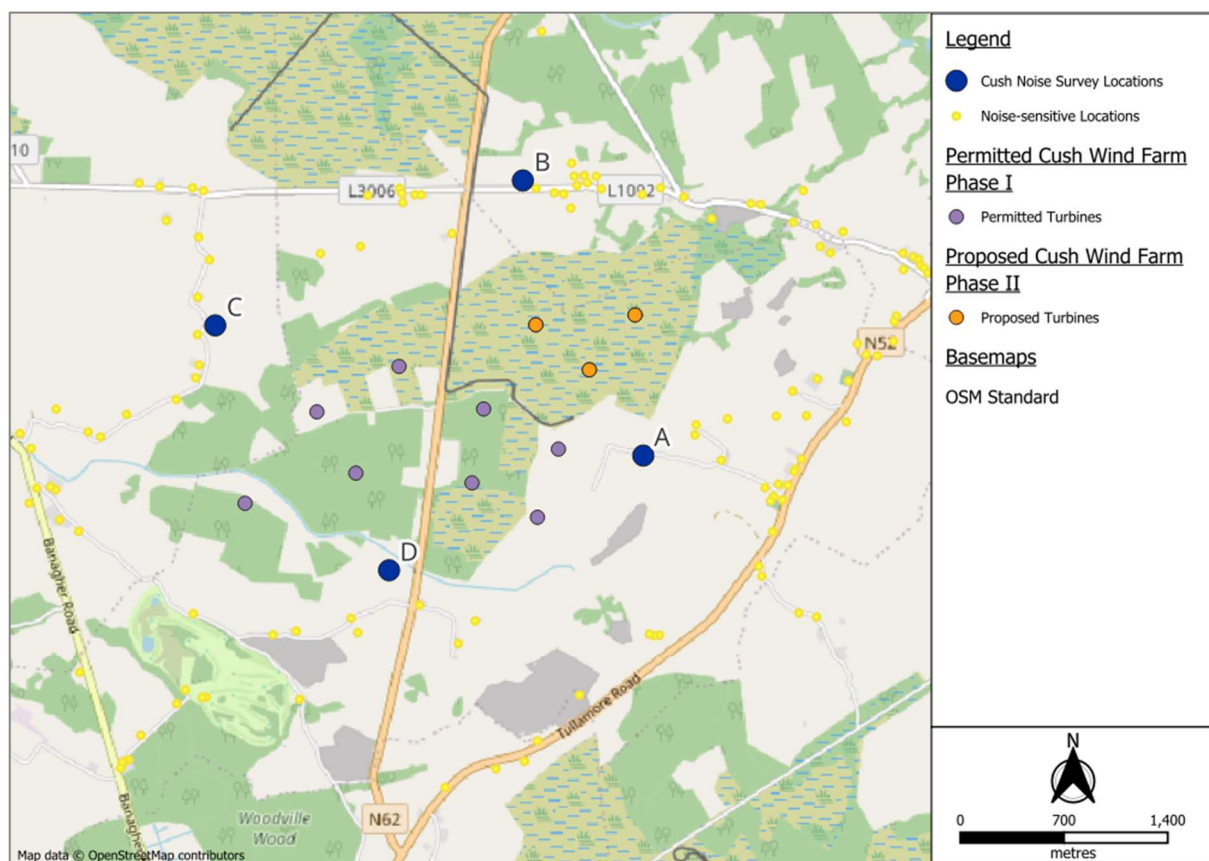


Figure 12.2: Noise Survey Locations

12.4.2.2 Wind Measurements

Average wind speed and direction was measured in 10-minute intervals at an on-site Met Mast and provided to AWN. Wind speed measurements made at 80m and 64.7m were used as per the Method B methodology described in the IOA GPG, the measured wind speeds were then corrected to the 'standardised' 10m wind speed. The 'standardised' wind speed is the industry standard in the UK and Ireland for referencing for wind speed with respect to wind turbines.

12.4.2.3 Rainfall Measurements

Rainfall loggers measured rainfall levels in 10-minute intervals for the duration of the survey. Additional details are provided in **Annex 12.4** of this EIAR.

12.4.3 ANALYSIS OF SURVEY DATA

As well as the location-specific filtering, the data sets have been filtered to remove issues such as the dawn chorus and the influence of other atypical noise sources. An example of atypical sources would be short, isolated periods of raised noise levels attributable to local sources, agricultural activity, boiler flues, operation of gardening equipment etc. In addition, sample periods affected by rainfall or when rainfall resulted in prolonged periods of atypical noise levels have also been screened from the data sets. In this instance, periods comprising 10 minutes before and after the rain was logged have been excluded. The assessment methods outlined above are in line with the guidance contained in the IOA GPG.

The results presented **Annex 12.4** and summarised in the following sections refers to the noise data collated during 'quiet periods' of the day and night as defined in the IOA GPG.

12.4.3.1 Noise from Existing Turbines

In line with the guidance outlined in **Section 12.3.2.6**, contributions to measured noise levels from existing, permitted and proposed wind turbines must be considered from the dataset when determining background noise levels. This ensures that the noise criteria are correctly applied to establish the permissible noise limits for the new wind turbine development.

At the time of the baseline noise survey, Meenwaun wind farm was operational but Cloghan and Derrinlough were not yet operational. there were no other operational wind farms with the potential to affect baseline noise measurements located in proximity to the proposed wind farm site.

12.4.3.2 Consideration of Wind Shear

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

To ensure clearly and consistently defined wind speeds, it is standard industry practice to convert and reference wind speeds to the 'Standardised Wind Speed'.

The Standardised Wind Speed is a wind speed measured at a height different than 10m (generally measured at the turbine hub height) which is expressed to a reference height of 10m in accordance with the IEC 61400-11 standard. The standardised equations used to determine the wind speed at standardised 10m above ground is presented in **Annex 12.4**.

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

12.4.4 CONSTRUCTION NOISE CALCULATIONS

A variety of plant items will be used for site preparation, construction, and associated works. Vehicular movements to and from the site will make use of existing roads. These activities have the potential to generate significant levels of noise.

In the absence of specific details on the plant items and construction methods to be employed, a set of assumptions must be made to predict and assess the likely noise emissions from these activities. The standard best practice approach is to predict typical noise levels at the NSLs using the guidance set out in BS5228-1.

The methodology adopted for the assessment of construction noise involves analysing the various elements of the construction phase in isolation. For each of the elements assessed in **Section 12.6.2**, anticipated construction noise sources are assessed along with typical sound pressure levels from BS5228-1 at various distances from these works.

12.4.5 OPERATION PHASE NOISE CALCULATIONS

A series of prediction models have been prepared to quantify the potential turbine noise level associated with the operation phase of the proposed project on the receiving environment. This section discusses the methodology used in the noise prediction modelling process.

12.4.5.1 Noise Prediction Software

The selected software, DGMR iNoise Enterprise (Version 2024.3) calculates noise levels in accordance with ISO 9613-1996. iNoise is a proprietary noise calculation package for computing noise levels and propagation of noise sources.

12.4.5.2 Noise Prediction Model - Input Data and Assumptions

The settings applied in the calculations depend on the type of source under assessment. Full details of the calculation settings, input data and any assumptions made in the assessment are provided in **Annex 12.2**. The assumptions made are in accordance with the guidance do not prevent the assessment from reaching an accurate conclusion regarding the likely significant effects.

12.4.5.3 Proposed Wind Turbine Details

The operational turbine noise assessment has been undertaken having regard to the turbine dimension range described in **Chapter 1** and the design flexibility process

undertaken with Offaly County Council pursuant to Section 32H of the 2000 Planning Act. As the final turbine model has not yet been selected, the assessment considers acoustic data from a range of candidate turbine technologies within the proposed dimension range. A summary of the turbine details is presented in **Table 12.6**.

Turbine Make and Model	Rotor Diameter (m)	Hub Height (m)	Tip Height (m)
General Electric GE-158	158	120.9	199.9
Vestas V162 6.2 MW	162	119	200
Vestas V162 7.2 MW	162	119	200
General Electric GE-164	164	118	200
Vestas V172 7.2 MW	172	114	200
Enercon E175	175	111.6	199.1

Table 12.6: Details of turbine types considered in the assessment

The operational noise assessment does not rely on a single turbine model. Instead, a conservative assessment sound-power profile has been developed by reviewing the sound power levels of the candidate turbine technologies within the proposed turbine dimension range and selecting the highest sound power level at each assessed wind speed. Sound power levels for the candidate turbines, referenced to standardised 10m height wind speeds calculated in accordance with the IOA Good Practice Guide, are presented in **Table 12.7**. The highest sound power level at each wind speed is shown in bold.

Wind Speed (m/s)	dB L _{WA} of Turbine Model at Stated Hub Height (m)						Highest
	GE-158	V162 6.2 MW	V162 7.2 MW	GE-164	V172	E175	
3	94.1	95.9	96.0	94.6	97.6	94.5	97.6
4	97.2	97.3	97.7	98.7	98.9	97.6	98.9
5	102.0	101.0	101.2	103.2	102.3	102.6	103.2
6	105.8	103.9	104.6	106.1	106.0	106.4	106.4
7	107.0	104.8	106.3	106.5	107.7	106.9	107.7
8	107.0	104.8	106.3	106.5	107.8	106.9	107.8
9	107.0	104.8	106.3	106.5	107.8	106.9	107.8

Table 12.7: L_{WA} Levels for the proposed range of turbines

Figure 12.3 presents a graphical comparison of the noise emissions for the turbines listed in **Table 12.7**.

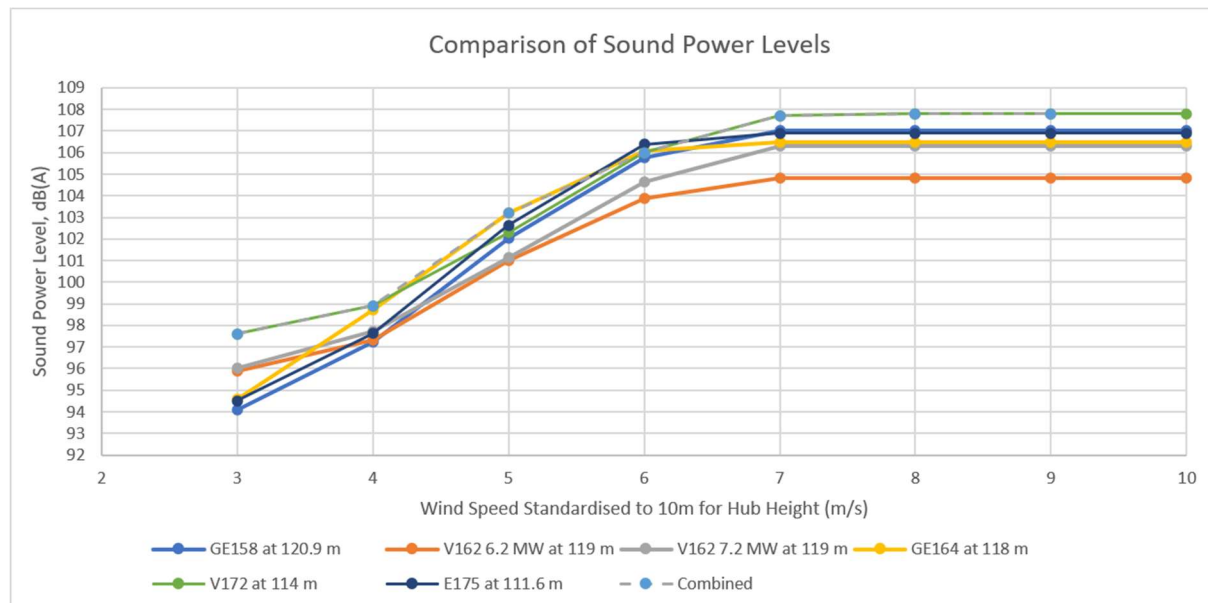


Figure 12.3: Comparison of Sound Power Levels

Considering each wind speed, the turbine models with the highest sound power levels are:

- 3 m/s: the Vestas V172 at 114m hub height;
- 4 m/s: the Vestas V172 at 114m hub height;
- 5 m/s: the General Electric GE164 at 118m hub height;
- 6 m/s: the Enercon E175 at 111.6m hub height;
- 7 m/s: the Vestas V172 at 114m hub height;
- 8 m/s: the Vestas V172 at 114m hub height and
- ≥ 9 m/s: the Vestas V172 at 114m hub height.

The noise levels at NSLs will be predicted using the above combination of sound power levels at each wind speed. Therefore, the noise impact assessment is representative of all candidate turbines in terms of the maximum potential turbine noise impact. This combination of turbines forms the input to the noise modelling and predictions and will be referred to in this chapter as the 'Assessment Turbine'. Sound power levels for the assessment turbine are presented in **Annex 12.5**.

The combined maximum sound power profile is derived from the highest relevant sound power level at each assessed wind speed across the candidate turbine range. It is derived principally from the Vestas V172 at a hub height of 114m, with the maximum sound power level at 5 m/s derived from the General Electric GE164 at a hub height of 118m, and the maximum sound power level at 6 m/s derived from the Enercon E175 at a hub height of 111.6m. The combined profile does not, therefore, represent a single candidate turbine or turbine-dimension permutation. The hub height adopted in the noise model has been selected having regard to the source heights associated with the candidate turbines and the predicted noise levels arising across the candidate range.

The relevant sound power levels and resulting comparison of predicted noise levels are presented in **Annex 12.5** and **Annex 12.6**.

The manufacturer's turbine noise emission data are provided in terms of sound power levels (dB L_{WA}) which allow L_{Aeq} values at NSLs to be predicted. However, turbine noise criteria are expressed in terms of the L_{A90} parameter. According to best practice guidance in the IOA GPG, "L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2 dB". This 2 dB adjustment is applied within the noise model calculations. All turbine noise predictions presented in this chapter are expressed using the L_{A90} parameter.

In accordance with guidance from the IOA GPG, an uncertainty factor should be considered in all turbine noise predictions. A +2 dB uncertainty correction has been applied in the modelling to all turbine sound power levels.

Best practice dictates that if any tonal component is present, a penalty must be applied to the predicted noise levels. The magnitude of this penalty, as outlined in ETSU-R-97, corresponds to the extent by which the tonal component exceeds the threshold of audibility.

Current good practice recommends that tonal issues at wind farms are best addressed through appropriate planning conditions. A tonal penalty has not been included in the predicted noise levels for this assessment. A warranty will be provided by the manufacturer of the selected turbine to ensure that the noise output, including tonality, is controlled.

12.4.5.4 Cumulative Noise from Other Wind Turbine Developments

An appraisal of the study area has identified the following permitted and operational wind turbine development with the potential for cumulative noise impacts within the study area:

- Cush Wind Farm Phase I (Permitted): Vestas V172 turbines² at 114m Hub Height ('HH');
- Derrinlough (Operational): Vestas V150 6MW turbines at 110m HH;
- Cloghan (Operational): Vestas V136 4.2MW turbines at 101m HH; and
- Meenwaun (Operational): GE 120 2.5MW turbines at 110m HH.

Sound power data and turbine coordinates for each development are presented in Annex 12.5. For the permitted Cush Wind Farm Phase I, the cumulative assessment considers both the turbine configuration authorised under the existing permission and the alternative configurations falling within the turbine dimension range proposed under the current section 146B alteration request. These configurations represent alternative forms of the same eight Phase I turbines and have not been modelled as separate developments operating concurrently. At each relevant NSL, the Phase I configuration giving rise to the highest combined predicted noise level has been used

² A section 146B alteration request has subsequently been submitted under An Coimisiún Pleanála Reference ACP-324405-26 seeking design flexibility in respect of the permitted turbine dimensions, including hub heights ranging from 111.6m to 120.9m.

in the cumulative assessment.

12.4.5.5 Effects of Propagation from Wind Directions

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

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

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

Table 12.8 presents the directivity attenuation factor that has been applied to turbines when considering noise propagation in downwind conditions (full downwind is represented by 0° and full upwind is 180°).

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

Table 12.8: Turbine Directivity Attenuation with Consideration of Wind Direction

12.5 EXISTING ENVIRONMENT

This section of the chapter documents the typical background noise levels measured at Noise Monitoring Locations (NMLs) representative of the nearest NSLs to the wind farm site. The NMLs locations are presented in **Table 12.5**. **Annex 12.4** presents the additional details and results of the background noise surveys undertaken in accordance with the methodology in **Section 12.4.2**.

12.5.1 DERIVED BACKGROUND NOISE LEVELS

The following section presents the various derived $LA_{90,10min}$ 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 and presented in **Section 12.4.2**. The scatter graphs of each location are displayed in **Annex 12.4**.

Table 12.9 presents the various derived $L_{A90,10min}$ noise levels for each of the monitoring locations for daytime quiet periods and night-time periods. These levels have been derived using regression analysis carried out on the data sets measured in line with guidance contained in the IOA GPG.

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

Location	Period	Derived $L_{A90, 10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds m/s for 114 m Hub Height							
		3	4	5	6	7	8	9	≥10
A (H057)	Day	32.7	33.0	33.7	34.7	36.1	37.8	39.9	42.3
	Night	24.9	25.9	27.7	30.1	33.0	36.2	39.6	42.9
B (H032)	Day	32.4	33.0	33.9	35.2	36.9	38.9	41.2	43.8
	Night	21.4	23.2	25.7	28.8	32.3	36.1	39.9	43.6
C (H014)	Day	27.2	28.1	29.3	30.8	32.5	34.4	36.6	39.0
	Night	21.9	22.6	24.1	26.3	29.0	32.1	35.4	38.7
D (H084)	Day	30.8	32.3	33.9	35.7	37.7	39.7	41.9	44.3
	Night	21.9	23.4	25.8	28.9	32.5	36.5	40.6	44.7

Table 12.9: Derived Background Noise Levels of $L_{A90,10-min}$ for Various Wind Speeds

12.5.2 WIND TURBINE NOISE LIMIT

With respect to the relevant guidance documents outlined in **Section 12.3.2.6**, 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 noise measurement locations described in **Section 12.4.2.1**.

The criteria adopted are in line with the applicable WEDGs and is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Coimisiún 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) is appropriate in respect of the following point:

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

proposed lower threshold daytime criterion for wind turbine noise here is 3 dB more stringent than the equivalent daytime noise limit for areas of low background noise outlined in NG4.

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

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

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

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

- 40 dB $L_{A90,10min}$ for daytime in quiet environments with typical background noise of less than 30 dB $L_{A90,10min}$;
- 45 dB $L_{A90,10min}$ or a maximum increase of 5 dB(A) above background noise (whichever is the higher), for daytime (0700 – 2300hrs) in environments with typical background noise greater than or equal to 30 dB $L_{A90,10min}$; and
- 43 dB $L_{A90,10min}$ for night-time periods (2300 – 0700hrs) or a maximum increase of 5 dB above background noise (whichever is higher).

In line with ETSU-R-97 and ARWTN guidance (see **Section 12.3.2.6**), a fixed lower threshold of 45 dB L_{A90} or a maximum increase of 5 dB above background noise (whichever is the higher) is proposed for NSLs involved in the project.

12.5.3 PROPOSED NOISE CRITERIA

Table 12.10 presents the operational noise limits derived for the assessment in accordance with applicable criteria. Turbine noise limits have been established for wind speeds between 3 and 9 m/s, covering the range from turbine cut-in up to the point where the turbine reaches its maximum sound power level.

In the absence of measured background noise data above 9 m/s, a conservative approach assumes that the background noise levels derived at 9 m/s apply at higher wind speeds, in line with guidance, and criteria set accordingly. However, it is expected that as wind speeds increase beyond 9 m/s, background noise levels will also rise.

Location	Period	Derived $L_{A90, 10min}$ Levels (dB) at Various Standardised 10m Height Wind Speeds (m/s) for 114 m Hub Height						
		3	4	5	6	7	8	≥ 9
A (H057)	Day	45	45	45	45	45	45	45
	Night	43	43	43	43	43	43	44.6
B (H032)	Day	45	45	45	45	45	45	46.2
	Night	43	43	43	43	43	43	44.9
C (H014)	Day	40	40	40	45	45	45	45
	Night	43	43	43	43	43	43	43
D (H084)	Day	45	45	45	45	45	45	46.9
	Night	43	43	43	43	43	43	45.6

Table 12.10: Wind Turbine Noise Criteria, $L_{A90,10-min}$, for Various Wind Speeds

It is noted that the limits derived using the guidance are broadly in line with the planning condition for the Permitted Cush Farm Phase I, as presented in **Section 12.3.2.6**. Application of the planning condition would result in similar noise criteria except at location C(H014) would increase from 40 to 45 dB $L_{A90,10min}$ at windspeeds of 5 m/s.

This assessment applies the best-practice guidance to derive the wind turbine noise criteria, as presented in the following section.

12.5.4 ASSIGNING TURBINE NOISE LIMITS

The derived background noise levels have been assigned to other NSL's which are deemed to be representative of the noise environment at the measurement locations. Where background noise measurements have been conducted in the vicinity and/or are judged to be typical/indicative of the background noise levels of the area at the measurement location, the background noise levels can be used for deriving turbine noise thresholds at other locations.

A noise criteria envelope, based on the lowest turbine noise limits derived across Locations A, B, C, and D at the various wind speeds has been derived for daytime and night-time and used as assessment criteria at all other non-surveyed Sensitive Receptors as a conservative approach to the assessment.

ETSU-R-97 guidance allows for a higher level of operation phase turbine noise at properties that have an involvement in the development, both as a higher fixed level of 45dB L_{A90} and/or a higher level above the prevailing background noise level. This approach continues to be supported in ARWTN. In line with the guidance, a higher threshold of 45dB $L_{A90,10min}$ is applicable to NSLs involved in the project. The set of NSLs corresponding to involved properties is as follows: H057, H082, H084, H085, H086, H087, and H088.

12.6 DESCRIPTION OF LIKELY EFFECTS

12.6.1 'DO NOTHING' SCENARIO

If the project is not progressed, the existing noise environment in the vicinity of the subject site and at noise sensitive receptors will remain largely unchanged.

12.6.2 CONSTRUCTION PHASE

Construction noise prediction calculations have been conducted using the assessment methodology outlined in **Section 12.4.4**. The source noise levels referred to in this section are indicative of the type of plant items and activities associated with the construction of the proposed project.

The highest predicted noise levels are expected to occur for 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 wind farm site.

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

- Construction of turbines and hardstand areas;
- Construction of the electrical switch room building;
- Construction of site entrances and internal site access tracks;
- Use of the spoil deposition areas; and
- Cabling and grid connection.

EIAR **Chapter 3** has detailed information on each of these elements.

In general, the distances between the construction activities associated with the proposed project and the nearest NSLs are such that there will be no significant noise, and vibration impacts at the NSLs. The following sections present an assessment of the main stages of the construction phase that have the potential for associated noise and vibration effects, all other stages and elements are considered unlikely to have any significant noise and vibration effects due to the distances to NSLs.

As discussed in **Section 12.4.1.1**, elements of the construction phase activities which have no NSLs within the Construction Study Area are scoped out of this assessment as no significant noise effects are likely. This applies to each of the construction stages referred to above.

Construction activities will generally be carried out during normal working hours of 07:00–19:00 Monday to Friday and 07:00–13:00 on Saturdays. It may be necessary to undertake works outside these hours to avail of favourable weather conditions, including periods of sufficiently low wind speed to facilitate turbine installation, or during extended concrete pours where works are required to continue beyond normal working hours. Where construction activities are necessary outside normal working hours, including on Sundays or public holidays, local residents and the Planning Authority will receive prior notification, where appropriate.

12.6.2.1 Electrical Switch Room Building

Noise

The nearest NSL to the proposed electrical switch room Building to the south of T9 is H057 at a distance of 140m.

Several noise sources that would be expected on a construction site of this nature

have been identified. **Table 12.11** outlines the expected construction noise levels associated with the proposed works for this element of the construction.

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)
			140 m
HGV Movement (C.2.30)	Removing spoil and transporting fill and other materials.	80	47
Tracked Excavator (C.4.64)	Removing soil and rubble in preparation for foundation.	77	44
Excavator Mounted Rock Breaker (C9.12)	Rock Breaking.	85	52
General Construction (Various)	All general activities plus deliveries of materials and plant	84	51
Concrete Mixer Truck and Concrete Pump (C.4.27)	Foundations	75	42
Dumper Truck (C.4.4)	Removing spoil and transporting fill and other materials.	76	43
Dewatering Pumps (D.7.70)	Pumping Water from Excavation	80	47
Vibrating Rollers (D.8.29)	Road surfacing.	84	51
Construction Noise Level			58

Table 12.11: Expected Switch Room Building Construction Noise Emission Level

On a precautionary basis, and assuming the construction activities outlined in **Table 12.11**, noise levels associated with construction of the proposed electrical switch room building are predicted to be of the order of 58 dB $L_{Aeq,1hr}$ at a distance of 140m. This is below the construction noise significance threshold of 65 dB $L_{Aeq,1hr}$. No additional specific mitigation measures are therefore required, other than adherence to the standard construction environmental management measures set out in the CEMP (**Annex 3.4**).

Having regard to the criteria set out in **Table 12.4**, the likely construction noise effects at the nearest NSL associated with the construction of the proposed electrical switch room building are assessed as **negative, not significant** and **short-term**.

Vibration

Rock breaking activity will likely generate the highest levels of vibrations through the ground. As set out in **Chapter 3**, preliminary site investigations indicate that the project site is predominantly underlain by peat/peaty topsoils and subsoils with a marl-type clay underlayer, with very little rock or rock outcrop identified. Accordingly, significant rock breaking is not anticipated to be a routine construction activity. Notwithstanding this, vibration from rock breaking has been assessed on a precautionary basis.

Empirical data for this activity is not provided in BS 5228-2, however the likely level of vibration from this activity is expected to be substantially below the vibration criteria for building damage based on experience from other sites. AWN Consulting Ltd (the author of this chapter) has previously conducted vibration measurements under controlled conditions, during trial construction works on a sample site where breaking was carried out. The trial construction works consisted of the use of the following plant and equipment when measured at various distances:

- Three tonne hydraulic breaker on small CAT tracked excavator; and
- Six tonne hydraulic breaker on large Liebherr tracked excavator.

Vibration measurements were conducted during various staged activities and at various distances. Peak vibration levels during staged activities using the three-tonne breaker ranged from 0.48 PPV (mm/s) to 0.25 PPV (mm/s) at distances of 10m to 50m respectively from the breaking activities. Using a six-tonne breaker, measured vibration levels ranged between 1.49 PPV (mm/s) to 0.24 PPV (mm/s) at distances of 10m to 50m respectively. While these measurements relate to breaking of concrete, the range of values recorded provides some context in relation to typical ranges of vibration generated by construction-breaking activity. The levels measured at up to 50m from the activity are significantly below the assessment threshold set out in **Table 12.3**.

Accounting for the distance from proposed works to the nearest NSLs, vibration effects are not likely at any NSL.

Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case associated effects at the nearest noise sensitive locations associated with the construction of the electrical switch room building is described as **negative, not significant to slight and temporary**.

12.6.2.2 Site Entrances and Access Tracks

Noise

During the construction phase it is proposed to use 1 no. construction phase and 1 no. operation phase access permitted as part of the permitted Cush Wind Farm Phase I, this includes; 1 no. construction phase site entrances from the N62 national road (eastern side) and 1 no. operation phase site entrance from the L300321 local road. In addition, a separate site entrance is proposed as part of the project, from the L300321 local road, in order to facilitate access to the proposed electrical switch room building. Access to the switch room will be required during both the construction and operation phases of the project. Full details are set out at **Chapter 3** and **Chapter 14**.

The nearest NSL to the proposed site entrance is H057 at a distance of 130 m to the proposed entrance. Several items of plant and machinery will be required during construction works associated with the construction/upgrade of the proposed site entrance and access tracks which are likely to generate noise at the nearest NSLs.

Table 12.12 presents, considering the likely construction activities, the noise levels associated with same at a reference distance of 10m. The typical sound pressure levels and spectra used in this assessment have been taken from BS 5228-1: 2009+A1:2014. The calculations assume that plant items are operating for 66% of the time, that the ground between the works and the NSL is soft and that there is no acoustic screening (i.e. barriers) in place between the site works and the NSL.

Item (BS 5228 Ref.)	Stage	Plant Noise Level at 10m Distance (dB LAeq,1hr)
Tracked Excavator (C.4.63)	Site Clearing/Excavating	77
HGV Movement (C.2.34)		80
Petrol driven chain saw (D.2.14)		86
Dumper Truck (C.4.4)		76
Tracked Excavator (C.4.63)	Entrance/Access Track Construction	77
HGV Movement (C.2.34)		80
Dumper Truck (C.4.4)		76
Vibrating Rollers (C.5.24)		84

Table 12.12: Typical Site Entrance/Access Track Construction Plant

Based on the assumptions outlined above, the predicted noise levels at each location, adopting a conservative assessment scenario, are presented in **Table 12.13**.

Location Ref	Stage	Predicted Noise Level (dB LAeq,1hr)
H057	Site Clearing / Excavating	56
	Entrance/Access Track Construction	54

Table 12.13: Predicted Site Entrance/Access Track Construction Noise Levels

The total construction noise levels are predicted to be below the appropriate Category A value (i.e. 65dB LAeq,1hr) and therefore a significant effect is not predicted in relation to the nearest NSLs. As all other NSLs are located at an increased distance from these construction activities, no significant effects are predicted as likely to arise.

Based on guidance for the description of effects in **Table 12.4**, the likely effects at the nearest NSL associated with the construction of the wind turbines are assessed to be **negative, not significant to slight and temporary**.

Vibration

With reference to the discussion on vibration presented in **Section 12.6.2.1** there will be no significant vibration impacts associated with the construction of internal site access tracks and therefore no specific mitigation measures are required.

Description of Effects

The predicted construction noise and vibration levels, adopting a conservative assessment scenario, are below the relevant limits and/or assessment thresholds identified above. Having regard to the EPA criteria for the description of effects, the

likely effects at the nearest noise sensitive locations associated with the construction of site entrances and access tracks are assessed as **negative, not significant** and **temporary**.

12.6.2.3 Internal Cabling & Underground Electricity Line

The associated construction works will occur for short durations at varying distances from NSLs. A review of the underground electricity line ('UGL') route has identified that the nearest NSLs to the proposed underground cable route are located at approximately 35m from the nearest point. There are jointing plinths proposed along the grid connection route, each comprising a concrete slab of 2m² installed within the trench. Crossings of public roads are discussed in the next section.

Noise

Table 12.13A outlines the expected 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. Note the plant items and activities are indicative and based on conservative assumption to be representative of typical construction activity.

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB L _{Aeq,T})	Predicted Noise Level (dB L _{Aeq,1hr}) at distance (m)				
		35 m	45 m	55 m	65 m	75 m
Tracked Excavator (C.2.7)	70	52	50	47	46	44
Vibrating Rollers (C.2.40)	73	55	53	50	49	47
Wheeled Loader (C.2.8)	68	50	48	45	44	42
Water Pump (C.2.44)	62	44	42	39	38	36
Cumulative Predicted Construction Noise Level (General)		58	56	53	52	50
Concrete Mixer Truck and Concrete Pump (C.4.27)	74	54	51	50	48	48
Cumulative Predicted Construction Noise Level (at joint plinths)		60	58	55	54	52

Table 12.13A: Predicted Construction Noise Levels for Internal Cabling and Underground Electricity Line Works

For standard grid connection (underground electricity line) works, any NSL set back at 35m or more from the proposed works is predicted to experience noise levels within the linear construction noise limit of 70 dB L_{Aeq,1hr} as set out in **Section 12.3.2.2**.

NSLs located closer than 15m to the works may experience construction noise levels slightly above the 70 dB L_{Aeq,1hr} construction noise limit for linear works. However, due to the progressive nature of the construction methodology, it is anticipated that works

will remain in close proximity to the nearest NSLs only for a limited duration. The predicted noise levels shown in **Table 12.13A** are expected to occur for less than two days at any individual receptor, with works typically progressing at a rate of approximately 150m per day along the route.

Based on the guidance in **Section 12.3.2.5**, the likely noise impacts are considered not significant, and no specific mitigation measures are required.

In line with the guidance in **Section 12.3.2.5**, the likely noise effects of the underground cabling construction are not considered significant, and no specific mitigation measures are required.

Vibration

With reference to the discussion on vibration presented in **Section 12.6.2.1** there will be no significant vibration impacts associated with the construction of grid connection and therefore no specific mitigation measures are required.

Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case associated effects at the nearest noise sensitive locations associated with the construction of the internal cabling and the underground electricity line are described as **negative, not significant** and **temporary**.

12.6.2.4 Horizontal Directional Drilling

Noise

Works along the proposed underground cable route include four locations where horizontal directional drilling will be used, this includes two crossings under the Rapemills River, and two crossings under roads, as set out below:

- The crossing under the N52 national road, where the nearest NSL is located at a distance of c. 80m, (NSL Ref. H068);
- The crossing under the L7006 local road, where the nearest NSL is located at a distance of c. 470m;
- The crossing under the Rapemills River (centrally located within the underground electricity line route), where the nearest NSL is located at a distance of c. 600m; and
- The crossing under the Rapemills River (close to the L7006 local road), where the nearest NSL is located at a distance of c. 440m.

Table 12.14 outlines the typical construction noise levels associated with the proposed works for this element of the construction, along with predicted noise levels at the nearest NSL to any of the HDD locations, i.e. H068. Calculations have again 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.

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dB $L_{Aeq,T}$)	Predicted Noise Level (dB $L_{Aeq,1hr}$) at distance (m)
		80 m
Tracked Excavator (C.2.7)	70	49
Directional drill (Vermeer D40x55 or similar)	76	55
Construction Noise Level	62	56

Table 12.14: Expected HDD Noise Levels

Noise levels at the nearest NSLs to the remaining HDD locations will be significantly less to our greater distances.

In line with the guidance in **Section 12.3.2.5**, the likely noise effects of the horizontal directional drilling are not considered significant, and no specific mitigation measures are required.

Vibration

With reference to the discussion on vibration presented in **Section 12.6.2.1** there will be no significant vibration impacts associated with the horizontal direction drilling and therefore no specific mitigation measures are required.

Description of Effects

The predicted construction noise and vibration levels, adopting a conservative assessment scenario, are below the relevant limits and/or assessment thresholds identified above. Having regard to the EPA criteria for the description of effects, the likely effects at the nearest noise sensitive locations associated with horizontal directional drilling are assessed as **negative, not significant** and **temporary**.

12.6.2.5 Haul Route Works

To facilitate the transport of larger turbine components, it is proposed to remove a 6m length of wall in Galway City. The nearest NSL to these works is at a distance of 33 m. as the duration of the works will be limited to 2 days. Assuming the same plant items as for the clearing activity assessed as part of Site Entrances and Access Tracks, the predicted noise level at the nearest NSL is 71 dB $L_{Aeq,1hr}$. This is slightly in excess of the linear construction noise limit of 70 dB $L_{Aeq,1hr}$ as set out in **Section 12.3.2.2**. In line with the guidance in **Section 12.3.2.5**, as the duration of these works is limited to 2 days, the likely noise effects of these haul route works are not considered significant, and no specific mitigation measures are required.

12.6.2.6 Construction Traffic

Noise

This section has been prepared in order to assess likely noise effects associated with

construction traffic using the local road network. Information presented at **Chapter 14**, regarding vehicle types and predicted traffic volumes, have been used to inform this assessment.

The likely noise effects of HGV movements are assessed through consideration of the cumulative noise level associated with a series of individual events. The noise level associated with an event of short duration, such as a vehicle drive-by, may be expressed in terms of its Sound Exposure Level (SEL; L_{Ax}). The SEL can be used to calculate the contribution of an event or series of events to the overall noise level in a given period. The appropriate formula is as follows:-

$$L_{Aeq,T} = L_{Ax} + 10\log_{10}(N) - 10\log_{10}(T) - 10\log_{10}(r_2/r_1) \text{ dB}$$

Where:

- $L_{Aeq,T}$ is the equivalent continuous sound level over the time period T (s).
- L_{Ax} is the "A-weighted" Sound Exposure Level of the event under consideration (dB).
- N is the number of events over the course of time period T.
- r_2 is the distance from the edge of the entrance road to the facade of nearest property.
- r_1 is the distance from vehicle to the point of original measurement.

The mean value of Sound Exposure Level for a HGV movement is of the order of 82dB L_{Ax} at a distance of 5m from the vehicle. This figure is based on a series of measurements conducted under controlled conditions.

Based on the construction traffic assessment presented in **Chapter 14**, the project is expected to generate an average of approximately 28 HGV deliveries per working day. As each delivery generates an inbound and an outbound vehicle movement, this equates to approximately 56 HGV movements per day or, assuming that the movements are distributed across the 12-hour weekday construction period, approximately 5 HGV movements per hour. Based on this traffic flow, the predicted noise level at a distance of 5m from the vehicle path is 53 dB $L_{Aeq,1hr}$, which is below the construction noise criterion of 65 dB $L_{Aeq,1hr}$.

The peak daily number of HGV deliveries will occur during the concrete pours for the turbine foundations. During each of the three turbine-foundation concrete-pour days, up to approximately 160 HGV deliveries are anticipated. This equates to approximately 320 two-way HGV movements per day or, when distributed across a 12-hour working period, approximately 27 HGV movements per hour. This is equivalent to approximately 13 concrete-delivery vehicles arriving per hour, with each vehicle subsequently leaving the project site. Based on this, the predicted noise level at a distance of 5m from the vehicle path is 61 dB $L_{Aeq,1hr}$, which is below the construction noise criterion of 65 dB $L_{Aeq,1hr}$.

Vibration

Significant levels of vibration are not expected to arise due to the types of vehicles to be used. In addition, the carriageways of local roads are paved and of a reasonably high standard (noted also that local roads in the vicinity of the project will be upgraded) and, consequently, significant levels of vibration are not assessed as likely.

With reference to the discussion on vibration presented in **Section 12.6.2.1** there will be no significant vibration impacts associated with construction traffic and therefore

no specific mitigation measures are required.

Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case associated effects with construction traffic are described as **negative, not significant** and **short-term**.

12.6.2.7 Cumulative Construction Noise and Vibration Effects

In respect of the potential for cumulative construction noise and vibration effects with the permitted Cush Wind Farm Phase I, considering that as discussed in **Section 12.4.1.1** the construction noise study areas are 300m from the activity for general works and 200m for linear works, the distances between construction activities are such that the construction of the permitted Cush Wind Farm Phase I are not likely to combine with those for the proposed project such that a significant noise or vibration effect occurs at any NSL.

Description of Cumulative Effects

With respect to the EPA's criteria for description of effects, the likely potential worst-case associated cumulative effects associated with the construction phase are described as **negative, not significant** and **short-term**.

12.6.3 DECOMMISSIONING PHASE

In relation to the decommissioning phase, similar overall noise levels as those calculated for the construction phase are 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 12.6.2**) albeit less works will be required as only above-ground structures will be removed.

The predicted noise levels are expected to be below the appropriate Category A value (i.e. 65 dB $L_{Aeq,T}$) at all NSLs for the decommissioning phase, therefore no likely significant effects arise.

12.6.3.1 Description of Effects

The likely predicted noise and vibration effects are below the limits and/or thresholds identified. With respect to the EPA's criteria for description of effects, the likely potential worst-case associated effects at the nearest noise sensitive locations associated with the decommissioning phase are described as **negative, not significant** and **short-term**.

12.6.4 OPERATION PHASE

12.6.4.1 Proposed Wind Turbines

Using the assessment methodology described in **Section 12.4.5**, the predicted noise levels due to the proposed 3 no. Cush Phase II turbines have been calculated at all

NSLs within the study area of the proposed wind farm site. The omni-directional turbine noise prediction assessment has been carried out on a conservative basis using the ISO 9613-2:1996 calculation standard and the best practice guidance for turbine noise prediction contained in the IOA GPG. Details of the wind turbine locations and sound power levels used for the other wind farm developments are provided in **Annex 12.5**.

The noise predictions have been undertaken using ISO9613 which calculates noise levels at receptors under conditions favourable to noise propagation, including 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 12.5.4** which in turn have been derived in accordance with the applicable criteria described in detail in **Section 12.3.2.6**.

Annex 12.6 presents the predicted omni-directional turbine results at all NSLs in tabulated form and noise contours for the omni-directional rated power wind speed (i.e., highest noise emission) are presented in **Annex 12.7**. In all cases, the predicted noise levels are within the criteria; therefore it is considered that no significant noise effects are associated with the operation of the proposed development.

The cumulative noise effects of the proposed development along with other wind energy developments including the permitted Cush Wind Farm Phase I.

Description of Effects

As all predicted noise levels are within the criteria the noise effects of the proposed development are considered **negative, not significant** and **long-term**.

12.6.4.2 Electrical Switch Room Building

An electrical switch room building is proposed along the underground cable route; the nearest NSL is H057 at a distance of approximately 140m. There are no significant noise or vibration sources associated with the control building.

Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operation of the proposed switch room is described as **neutral, imperceptible** and **long-term**.

12.6.4.3 Operation Phase Traffic Movements

There are no significant traffic volumes expected during the operation phase, with 1-2 visits to site by a light goods vehicle (LGV) per week. Therefore, there are no significant noise effects assessed as likely during the operation phase.

Description of Effects

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with the operational phase traffic movements is described as **neutral, imperceptible** and **long-term**.

12.6.4.4 Cumulative Effects with Other Wind Farms

The cumulative noise levels arising from the operation of the project along with the permitted Cush Wind Farm Phase I, and Cloghan, Meenwaun and Derrinlough developments have been calculated for the same set of NSLs. Details of the wind turbine locations and sound power levels used for the other wind farm developments are provided in **Annex 12.5**.

The results of the noise prediction models have again been compared against the turbine noise limits that have been assigned to each of the NSL's as presented in **Sections 12.5.2-12.5.4** which in turn have been derived in accordance with the applicable criteria described in detail in **Section 12.3.2.6**. Note that predicted noise levels are cumulative, i.e. the noise contributions from other wind farms discussed in **Section 12.4.5.4** are included in the predicted noise values.

Annex 12.8 presents the predicted cumulative omni-directional turbine results at all NSLs in tabulated form and cumulative noise contours for the omni-directional rated power wind speed (i.e., highest noise emission) are presented in **Annex 12.9**.

The predicted omni-directional cumulative turbine noise levels, adopting a conservative assessment scenario, are below the applicable noise criterion curves at all NSLs except for 15 locations: H019, H020, H023, H024, H031, H033, H034, H035, H036, H055, H056, H057, H081, H083, H084. At these locations, the modelling has identified the potential for exceedances during certain assessment periods, as presented in **Table 12.15**. At all other NSLs, predicted noise levels are within the daytime and night-time criteria.

NSL	Parameter	Predicted Noise Level, dB LA90, at wind speed at standardised 10m height, m/s						
		3	4	5	6	7	8	9
H019	Predicted	33.8	35.7	39.0	42.6	43.6	43.5	43.6
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.6	0.5	0.6
H020	Predicted	33.3	35.2	38.4	42.0	43.1	42.9	43.1
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	--	0.1
H023	Predicted	34.5	36.0	37.6	41.5	43.4	42.8	43.3
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.4	--	0.3
H024	Predicted	35.0	36.4	38.0	41.9	43.8	43.3	43.7
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--

NSL	Parameter	Predicted Noise Level, dB LA90, at wind speed at standardised 10m height, m/s						
		3	4	5	6	7	8	9
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.8	0.3	0.7
H031	Predicted	35.6	37.0	38.5	42.5	44.4	43.8	44.3
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	1.4	0.8	1.3
H033	Predicted	34.4	35.8	37.3	41.2	43.1	42.6	43.1
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.1	--	0.1
H034	Predicted	34.6	36.0	37.5	41.5	43.3	42.8	43.3
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.3	--	0.3
H035	Predicted	34.6	36.1	37.6	41.5	43.4	42.9	43.4
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.4	--	0.4
H036	Predicted	35.4	36.8	38.3	42.3	44.1	43.6	44.1
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	1.1	0.6	1.1
H055	Predicted	35.9	37.2	38.6	42.6	44.5	44.0	44.5
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	1.5	1.0	1.5
H056	Predicted	35.8	37.0	38.4	42.4	44.4	43.8	44.3
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	1.4	0.8	1.3
H057	Predicted	38.0	39.2	41.0	45.0	46.8	46.4	46.8
	Daytime Criterion	45	45	45	45	45	45	45
	Daytime Excess	--	--	--	--	1.8	1.4	1.8
	Night-time Criterion	45	45	45	45	45	45	45

NSL	Parameter	Predicted Noise Level, dB LA90, at wind speed at standardised 10m height, m/s						
		3	4	5	6	7	8	9
	Night-time Excess	--	--	--	--	1.8	1.4	1.8
H081	Predicted	35.2	36.4	37.6	41.7	43.7	43.1	43.6
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	0.7	0.1	0.6
H083	Predicted	35.4	36.7	37.8	41.9	44.0	43.3	43.9
	Daytime Criterion	40	40	40	45	45	45	45
	Daytime Excess	--	--	--	--	--	--	--
	Night-time Criterion	43	43	43	43	43	43	43
	Night-time Excess	--	--	--	--	1.0	0.3	0.9
H084	Predicted	36.9	38.1	39.6	43.7	45.6	45.0	45.5
	Daytime Criterion	45	45	45	45	45	45	45
	Daytime Excess	--	--	--	--	0.6	--	0.5
	Night-time Criterion	45	45	45	45	45	45	45
	Night-time Excess	--	--	--	--	0.6	--	0.5

Table 12.15: Predicted Noise Levels for Locations with exceedances

The next stage in the assessment is to consider the effects of wind direction adopting the methodology described in **Section 12.4.5.5**. Directional noise prediction models have been developed to identify the number and magnitude of exceedances of the noise criteria in different wind directions. **Table 12.16** presents the predicted noise levels for various wind speeds and direction sectors. Values in red indicate and exceedance of the day or night-time criteria. The number of remaining locations with exceedances is 10: namely, H019, H024, H031, H036, H055, H056, H057, H081, H083 and H084. Predicted noise levels for these locations, taking account of wind direction, are presented in **Table 12.16**, where (*) indicates an NSL involved in the proposed project.

NSL	Wind Direction	Exceedances of Wind Turbine Noise Criteria for Night-time Periods, dB LA90						
		3	4	5	6	7	8	9
H019	N	33.3	35.2	38.5	42.1	43.1	43.0	43.1
	NE	33.4	35.3	38.6	42.2	43.2	43.1	43.2
	E	32.1	34.0	37.3	40.9	41.9	41.8	41.9
	SE	29.9	31.8	35.1	38.7	39.7	39.6	39.7
	S	29.1	31.0	34.3	37.9	38.9	38.8	38.9
	SW	29.5	31.4	34.7	38.3	39.3	39.2	39.3
	W	31.6	33.5	36.8	40.4	41.4	41.3	41.4
	NW	33.1	35.0	38.3	41.9	42.9	42.8	42.9
H024	N	30.9	32.3	33.9	37.8	39.7	39.2	39.6
	NE	32.4	33.8	35.4	39.3	41.2	40.7	41.1

NSL	Wind Direction	Exceedances of Wind Turbine Noise Criteria for Night-time Periods, dB LA90						
		3	4	5	6	7	8	9
	E	33.9	35.3	36.9	40.8	42.7	42.2	42.6
	SE	34.4	35.8	37.4	41.3	43.2	42.7	43.1
	S	34.4	35.8	37.4	41.3	43.2	42.7	43.1
	SW	33.7	35.1	36.7	40.6	42.5	42.0	42.4
	W	32.0	33.4	35.0	38.9	40.8	40.3	40.7
	NW	30.8	32.2	33.8	37.7	39.6	39.1	39.5
H031	N	31.1	32.5	34.0	38.0	39.9	39.3	39.8
	NE	32.6	34.0	35.5	39.5	41.4	40.8	41.3
	E	34.0	35.4	36.9	40.9	42.8	42.2	42.7
	SE	35.1	36.5	38.0	42.0	43.9	43.3	43.8
	S	35.2	36.6	38.1	42.1	44.0	43.4	43.9
	SW	34.5	35.9	37.4	41.4	43.3	42.7	43.2
	W	33.5	34.9	36.4	40.4	42.3	41.7	42.2
	NW	31.2	32.6	34.1	38.1	40.0	39.4	39.9
H036	N	30.3	31.7	33.2	37.2	39.0	38.5	39.0
	NE	30.9	32.3	33.8	37.8	39.6	39.1	39.6
	E	33.1	34.5	36.0	40.0	41.8	41.3	41.8
	SE	34.9	36.3	37.8	41.8	43.6	43.1	43.6
	S	35.1	36.5	38.0	42.0	43.8	43.3	43.8
	SW	34.9	36.3	37.8	41.8	43.6	43.1	43.6
	W	33.8	35.2	36.7	40.7	42.5	42.0	42.5
	NW	31.2	32.6	34.1	38.1	39.9	39.4	39.9
H055	N	35.0	36.3	37.7	41.7	43.6	43.1	43.6
	NE	32.4	33.7	35.1	39.1	41.0	40.5	41.0
	E	29.9	31.2	32.6	36.6	38.5	38.0	38.5
	SE	30.2	31.5	32.9	36.9	38.8	38.3	38.8
	S	32.6	33.9	35.3	39.3	41.2	40.7	41.2
	SW	35.0	36.3	37.7	41.7	43.6	43.1	43.6
	W	35.9	37.2	38.6	42.6	44.5	44.0	44.5
	NW	35.8	37.1	38.5	42.5	44.4	43.9	44.4
H056	N	34.8	36.0	37.4	41.4	43.4	42.8	43.3
	NE	32.8	34.0	35.4	39.4	41.4	40.8	41.3
	E	29.8	31.0	32.4	36.4	38.4	37.8	38.3
	SE	30.0	31.2	32.6	36.6	38.6	38.0	38.5
	S	32.7	33.9	35.3	39.3	41.3	40.7	41.2
	SW	34.7	35.9	37.3	41.3	43.3	42.7	43.2
	W	35.8	37.0	38.4	42.4	44.4	43.8	44.3
	NW	35.8	37.0	38.4	42.4	44.4	43.8	44.3
H057*	N	36.7	37.9	39.7	43.7	45.5	45.1	45.5
	NE	34.6	35.8	37.6	41.6	43.4	43.0	43.4

NSL	Wind Direction	Exceedances of Wind Turbine Noise Criteria for Night-time Periods, dB LA90						
		3	4	5	6	7	8	9
	E	32.4	33.6	35.4	39.4	41.2	40.8	41.2
	SE	32.3	33.5	35.3	39.3	41.1	40.7	41.1
	S	35.1	36.3	38.1	42.1	43.9	43.5	43.9
	SW	37.0	38.2	40.0	44.0	45.8	45.4	45.8
	W	37.8	39.0	40.8	44.8	46.6	46.2	46.6
	NW	37.9	39.1	40.9	44.9	46.7	46.3	46.7
H081	N	35.2	36.4	37.6	41.7	43.7	43.1	43.6
	NE	34.9	36.1	37.3	41.4	43.4	42.8	43.3
	E	33.8	35.0	36.2	40.3	42.3	41.7	42.2
	SE	30.5	31.7	32.9	37.0	39.0	38.4	38.9
	S	28.9	30.1	31.3	35.4	37.4	36.8	37.3
	SW	30.5	31.7	32.9	37.0	39.0	38.4	38.9
	W	32.8	34.0	35.2	39.3	41.3	40.7	41.2
	NW	34.9	36.1	37.3	41.4	43.4	42.8	43.3
H083	N	35.4	36.7	37.8	41.9	44.0	43.3	43.9
	NE	35.1	36.4	37.5	41.6	43.7	43.0	43.6
	E	34.1	35.4	36.5	40.6	42.7	42.0	42.6
	SE	31.1	32.4	33.5	37.6	39.7	39.0	39.6
	S	29.5	30.8	31.9	36.0	38.1	37.4	38.0
	SW	30.1	31.4	32.5	36.6	38.7	38.0	38.6
	W	32.8	34.1	35.2	39.3	41.4	40.7	41.3
	NW	34.9	36.2	37.3	41.4	43.5	42.8	43.4
H084*	N	36.9	38.1	39.6	43.7	45.6	45.0	45.5
	NE	36.6	37.8	39.3	43.4	45.3	44.7	45.2
	E	35.1	36.3	37.8	41.9	43.8	43.2	43.7
	SE	33.4	34.6	36.1	40.2	42.1	41.5	42.0
	S	31.1	32.3	33.8	37.9	39.8	39.2	39.7
	SW	32.0	33.2	34.7	38.8	40.7	40.1	40.6
	W	34.9	36.1	37.6	41.7	43.6	43.0	43.5
	NW	35.9	37.1	38.6	42.7	44.6	44.0	44.5

(*) indicates an NSL involved in the proposed project

Table 12.16: Exceedances of Noise Criteria considering Wind Direction

It is reiterated that the noise prediction calculations have been made using the ISO 9613-2:1996 standard and relate to conditions favourable to noise propagation (typically downwind propagation from source to receiver and/or downward refraction under temperature inversions). Also allowances for uncertainties in the sound power levels as described in Section 12.4.5.3, in line with the IOA GPG.

Locations H020, H023, H033, H034 and H035

At these five locations, once wind direction is taken into account, the predicted noise

levels are within the criteria for day and night-time periods. The cumulative effects of the proposed Cush Wind Farm Phase II along with existing and permitted wind farms is therefore not significant at these locations.

Location H019

In respect of the +0.2 dB exceedances noted at H019, it is noted that this NSL is significantly closer to Meenwaun Wind Farm than the proposed Cush Wind Farm Phase II. The relative contributions from each wind farm in the north and northeast wind direction sectors are presented in **Table 12.17**. It is noted that the contribution from the proposed Cush Wind Farm Phase II is far below the total noise level, and the application of noise-reduction measures to the proposed wind farm would not materially reduce the overall noise level.

Wind Farm	Predicted Noise Level, dB L_{A90} , at wind speed of 9 m/s at standardised 10m height	
	North	Northeast
Meenwaun	41.8	41.5
Cloghan	21.1	21.1
Derrinlough	36.3	36.3
Cush Phase I	29.3	32.4
Cush Phase II	23.1	27.6
Total	43.1	43.2

Table 12.17: Noise Level Contribution from each wind farm at H019

In relation to exceedances of less than 0.5 dB such as this, in ARWTN Section 2.43, the following is stated:

It is acknowledged that changes of a fraction of a decibel would not be perceptible, and it is considered that changes of less than 0.5 dB are considered to be negligible. This is in line with the premise that where a development is 10 dB below an existing development its contribution is considered to be negligible but mathematically would result in a 0.4 dB increase in total noise level.

It is therefore considered that exceedances of up to 0.2 dB are not significant and not relevant as it is imperceptible in practice and as a change of this magnitude compared to a compliant noise level of 43 dB L_{A90} would not be perceptible to the human ear and falls within the typical range of measurement and calculation uncertainty.

Remaining Locations

As presented in **Table 12.16**, predicted exceedances are found the remaining 9 locations, H024, H031, H036, H055, H056, H057, H081, H083 and H084. As the noise levels at these locations are up to +1.7 dB above the noise criteria and these exceedances

are at least in part due to the proposed Cush Wind Farm Phase II, mitigation measures are required to reduce noise levels to within criteria. **Section 12.7.2** presents appropriate mitigation measures in the form of curtailment.

Description of Effects

At the majority of locations, there are no likely significant effects associated with the operation of the wind turbines of the proposed project, as the predicted cumulative turbine noise levels are within the turbine noise criteria presented in **Section 12.5.3**.

While noise levels at low wind speeds will increase due to the development, specifically the operation of the turbines, the predicted levels will remain low, nevertheless a new source of noise will be introduced into the soundscape. This assessment has considered the cumulative contribution from all turbines in the area with the potential cumulative noise effects including existing wind turbines.

Having regard to the EPA criteria for the description of effects, the potential operational noise effects at the most impacted noise sensitive locations, based on the conservative assessment scenario, are described below:

The predicted noise levels at 9 locations, (H024, H031, H036, H055, H056, H057, H081, H083 and H084) are slightly above the applicable wind turbine noise criteria; on that basis, the significance of the effect before mitigation can be described as **negative, significant and long-term**.

At all other NSLs, the effect associated with operation of the wind turbine of the development are described as **negative, not significant and long-term**.

The above effect is variable, and this assessment considers the locations of the greatest potential effect.

12.7 MITIGATION MEASURES

12.7.1 CONSTRUCTION PHASE MITIGATION

The assessment of potential impacts presented in Section 12.6.2 has demonstrated that construction noise and vibration effects are not predicted to be significant, taking account of the nature and duration of the works, including the two-day wall-removal works. The following mitigation measures will be implemented as a matter of best practice:

- The contract documents will specify that the Contractor undertaking the construction works will be obliged to adopt best practice noise abatement measures contained in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise and BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration.
- Evening, night-time, and Sunday working will be required during certain periods to facilitate large turbine component deliveries. The planning of such works will take consideration of sensitive receptors, in particular any nearby residential receptors. Construction activities will be scheduled in a manner

that reflects the location of the site and the nature of neighbouring properties. Construction activities / plant items will be considered with respect to their potential to exceed CNTs at NSLs and will be scheduled according to their noise level, proximity to NSLs, and possible options for noise control. In situations where an activity with the potential to exceed CNT is scheduled, other construction activities will be scheduled to not result in significant cumulative noise levels.

- To ameliorate any potential noise effects that may present during the construction phase, a schedule of noise control measures has been formulated in accordance with best practice guidance, and the contract documents will require the Contractor to implement these measures. These are outlined in the Construction and Environmental Management Plan (CEMP) that has been prepared for the proposed project (see **Annex 3.4**).

12.7.2 OPERATION PHASE

12.7.2.1 Curtailment Scheme

The permitted Cush Wind Farm Phase I and the proposed project comprise separate developments subject to separate planning permissions. Although it is anticipated that the construction of both developments will proceed concurrently, the operation of the permitted Phase I turbines will remain governed by the conditions attached to the Phase I permission, including the applicable noise limits.

The cumulative noise assessment takes account of the predicted noise contribution from the permitted Cush Wind Farm Phase I, including the alternative turbine configurations proposed under the current section 146B alteration request, on the basis that Phase I will operate in compliance with the conditions of its own permission. Where operational mitigation is required for the proposed project, it will be implemented solely through operational controls applied to the three proposed Phase II turbines, T09–T11.

Prior to the commencement of the operation phase, a turbine-specific curtailment strategy for T09–T11 will be prepared and verified by the manufacturer of the turbine model ultimately selected. The strategy will specify the operating modes and, where required, shutdown conditions necessary to ensure that the contribution from the proposed project, when considered cumulatively with the permitted Cush Wind Farm Phase I and the other relevant wind farm developments, remains within the applicable noise criteria. This commitment will apply regardless of the turbine model ultimately selected within the proposed turbine dimension range.

An assessment of the operational wind turbine noise levels has been undertaken in accordance with best practice guidelines and procedures as outlined in **Section 12.3.2.6**. The findings of the assessment, presented in **Section 12.6.4**, has determined that the predicted operational noise levels associated with the proposed project will be within best practice turbine noise criteria at all locations. However, when considered cumulatively, there are exceedances at 9 no. locations due to the

proposed Cush Wind Farm Phase II in the absence of mitigation. The illustrative turbine curtailment strategy and the resulting residual noise levels are presented below, including the remaining minor exceedances assessed as negligible.

For the purpose of demonstrating the technical feasibility of achieving the required noise reductions, an illustrative curtailment strategy has been developed using the noise reduced operating modes available for the Vestas V172. This does not prescribe or predetermine the turbine model ultimately selected for the proposed project.

Table 12.18 presents the sound power levels for normal operation and for the five noise-reduced modes.

Wind Speed (m/s)	Sound Power Level, dB L _{WA} for Operational Mode					
	Normal Operation	SO1	SO2	SO3	SO4	SO5
3	97.6	97.6	97.6	97.6	97.6	97.6
4	98.9	98.9	98.9	98.8	98.8	98.8
5	102.3	102.4	102.3	102.2	102	101
6	106.0	105.0	104.0	103.0	102	101
7	107.7	105.0	104.0	103.0	102	101
8	107.8	105.0	104.0	103.0	102	101
9	107.8	105.0	104.0	103.0	102	101

Table 12.18: Operational Modes for Vestas V172

For any turbine curtailment strategy that is developed, consideration must be given to the practical benefits. Such curtailment may unnecessarily reduce the electrical power generating capacity of a wind farm, for an imperceptible change to the overall turbine noise levels. When curtailing for exceedances, consideration should be given to the background noise at the specific NSL to avoid unnecessarily curtailing turbine noise when the result would yield an imperceptible change to the overall turbine noise levels. **Table 12.19** presents an illustrative curtailment strategy based on the noise reduced operating modes available for the Vestas V172.

Turbine	Turbine Mode at Wind Speed of 7m/s and higher							
	N	NE	E	SE	S	SW	W	NW
T09	SO1	--	--	--	--	SO1	SO4	SO5
T10	--	--	--	SO2	SO4	SO2	SO3	SO4
T11	SO2	--	--	--	--	--	SO3	SO4

Table 12.19: Curtailment Matrix for Daytime and Night-time Periods

12.7.2.2 Relative noise level contributions at H083

Prior to presenting the noise levels at NSLs with the mitigation measures applied, the noise levels at H083 are discussed here:

At H083, in the north and northeast wind direction sectors, the contribution from the proposed project is more than 10 dB below that of the permitted Cush Wind Farm

Phase I, thus there is no curtailment that can be applied to the proposed project to materially reduce the cumulative noise level. This is shown in **Table 12.20**.

Wind Farm	Predicted Noise Level, dB L _{A90} , at wind speed of 7 m/s at standardised 10m height		
	Northwest	North	Northeast
Meenwaun	20.2	20.2	<20
Cloghan	<20	<20	<20
Derrinlough	21.7	21.7	21.7
Cush Phase I	43.1	43.6	43.3
Cush Phase II	31.4	32.6	32.6
Total	43.5	44.0	43.7

Table 12.20: Noise Level Contribution from each wind farm at H083

However, the permitted project is assumed to comply with the Condition 12 in its grant of planning permission ABP-318816-24. The noise level due to Cush Phase I noise level is therefore set at 43 dB L_{A90} in **Table 12.21**, which presents the cumulative noise levels under these conditions. It is emphasised that due to the difference in noise contributions at this location, no curtailment of the proposed project is required in order to ensure that Cush Phase I wind farm achieves compliant noise levels.

Wind Farm	Predicted Noise Level, dB L _{A90} , at wind speed of 7 m/s at standardised 10m height		
	Northwest	North	Northeast
Meenwaun	20.2	20.2	<20
Cloghan	<20	<20	<20
Derrinlough	21.7	21.7	21.7
Cush Phase I	43.0	43.0	43.0
Cush Phase II	31.4	32.6	32.6
Total	43.3	43.4	43.4

Table 12.21: Noise Level Contribution from each wind farm at H083 with Cush Phase I designed to comply with Condition 12

12.7.2.3 Predicted Noise Levels with mitigation measures applied

Predicted noise levels at NSLs, H024, H031, H036, H055, H056, H057, H081, H083 and H084 with the curtailment applied are presented in **Table 12.22**.

In **Table 12.22**, all values are within the criteria for each location, except for H057 and H083 for certain wind direction sectors. Whilst curtailment has been applied, the remaining exceedances are less than 0.5 dB, and any further curtailment on the

proposed project does not result in any material reduction in the cumulative noise level due to contributions from other wind farms.

In accordance with the ARWTN guidance referenced in **Section 12.6.4.4**, the residual exceedances presented in **Table 12.22** are assessed as negligible and therefore not significant.

NSL	Wind Direction	Exceedances of Wind Turbine Noise Criteria for Night-time Periods, dB LA90						
		3	4	5	6	7	8	9
H024	N	30.9	32.3	33.9	37.8	39.7	39.2	39.6
	NE	32.4	33.8	35.4	39.3	41.2	40.7	41.1
	E	33.9	35.3	36.9	40.8	42.7	42.2	42.6
	SE	34.4	35.8	37.4	41.3	42.9	42.9	42.9
	S	34.4	35.8	37.4	41.3	42.7	42.7	42.7
	SW	33.7	35.1	36.7	40.6	42.5	42.0	42.4
	W	32.0	33.4	35.0	38.9	40.8	40.3	40.7
	NW	30.8	32.2	33.8	37.7	39.6	39.1	39.5
H031	N	31.1	32.5	34.0	38.0	39.9	39.3	39.8
	NE	32.6	34.0	35.5	39.5	41.4	40.8	41.3
	E	34.0	35.4	36.9	40.9	42.8	42.2	42.7
	SE	35.1	36.5	38.0	42.0	43.0	43.0	43.0
	S	35.2	36.6	38.1	42.1	43.0	43.0	43.0
	SW	34.5	35.9	37.4	41.4	42.5	42.5	42.5
	W	33.5	34.9	36.4	40.4	42.3	41.7	42.2
	NW	31.2	32.6	34.1	38.1	40.0	39.4	39.9
H036	N	30.3	31.7	33.2	37.2	39.0	38.5	39.0
	NE	30.9	32.3	33.8	37.8	39.6	39.1	39.6
	E	33.1	34.5	36.0	40.0	41.8	41.3	41.8
	SE	34.9	36.3	37.8	41.8	42.8	42.8	42.8
	S	35.1	36.5	38.0	42.0	42.8	42.8	42.8
	SW	34.9	36.3	37.8	41.8	42.4	42.4	42.4
	W	33.8	35.2	36.7	40.7	42.5	42.0	42.5
	NW	31.2	32.6	34.1	38.1	39.9	39.4	39.9
H055	N	35.0	36.3	37.7	41.7	42.2	42.2	42.2
	NE	32.4	33.7	35.1	39.1	41.0	40.5	41.0
	E	29.9	31.2	32.6	36.6	38.5	38.0	38.5
	SE	30.2	31.5	32.9	36.9	38.8	38.3	38.8
	S	32.6	33.9	35.3	39.3	41.2	40.7	41.2
	SW	35.0	36.3	37.7	41.7	42.8	42.8	42.8
	W	35.9	37.2	38.6	42.6	42.4	42.4	42.4
	NW	35.8	37.1	38.5	42.5	42.0	42.0	42.0
H056	N	34.8	36.0	37.4	41.4	42.1	42.1	42.1
	NE	32.8	34.0	35.4	39.4	41.4	40.8	41.3

NSL	Wind Direction	Exceedances of Wind Turbine Noise Criteria for Night-time Periods, dB LA90						
		3	4	5	6	7	8	9
	E	29.8	31.0	32.4	36.4	38.4	37.8	38.3
	SE	30.0	31.2	32.6	36.6	38.6	38.0	38.5
	S	32.7	33.9	35.3	39.3	41.3	40.7	41.2
	SW	34.7	35.9	37.3	41.3	42.5	42.5	42.5
	W	35.8	37.0	38.4	42.4	42.3	42.3	42.3
	NW	35.8	37.0	38.4	42.4	42.1	42.1	42.1
H057*	N	36.7	37.9	39.7	43.7	44.6	44.6	44.6
	NE	34.6	35.8	37.6	41.6	43.6	43.0	43.4
	E	32.4	33.6	35.4	39.4	41.2	40.8	41.2
	SE	32.3	33.5	35.3	39.3	41.1	40.7	41.1
	S	35.1	36.3	38.1	42.1	43.9	43.5	43.9
	SW	37.0	38.2	40.0	44.0	45.4 ^(A)	45.4 ^(A)	45.4 ^(A)
	W	37.8	39.0	40.8	44.8	45.4 ^(A)	45.4 ^(A)	45.4 ^(A)
	NW	37.9	39.1	40.9	44.9	45.2 ^(A)	45.2 ^(A)	45.2 ^(A)
H081	N	35.2	36.4	37.6	41.7	43.0	43.0	43.0
	NE	34.9	36.1	37.3	41.4	43.0	43.0	43.0
	E	33.8	35.0	36.2	40.3	42.3	41.7	42.2
	SE	30.5	31.7	32.9	37.0	39.0	38.4	38.9
	S	28.9	30.1	31.3	35.4	37.4	36.8	37.3
	SW	30.5	31.7	32.9	37.0	39.0	38.4	38.9
	W	32.8	34.0	35.2	39.3	41.3	40.7	41.2
	NW	34.9	36.1	37.3	41.4	43.0	43.0	43.0
H083	N	35.4	36.7	37.8	41.9	43.4 ^(B)	43.4 ^(B)	43.4 ^(B)
	NE	35.1	36.4	37.5	41.6	43.4 ^(B)	43.4 ^(B)	43.4 ^(B)
	E	34.1	35.4	36.5	40.6	42.7	42.0	42.6
	SE	31.1	32.4	33.5	37.6	39.7	39.0	39.6
	S	29.5	30.8	31.9	36.0	38.1	37.4	38.0
	SW	30.1	31.4	32.5	36.6	38.7	38.0	38.6
	W	32.8	34.1	35.2	39.3	41.4	40.7	41.3
	NW	34.9	36.2	37.3	41.4	43.3 ^(B)	43.3 ^(B)	43.4 ^(B)
H084*	N	36.9	38.1	39.6	43.7	45.0	45.0	45.0
	NE	36.6	37.8	39.3	43.4	45.0	45.0	45.0
	E	35.1	36.3	37.8	41.9	43.8	43.2	43.7
	SE	33.4	34.6	36.1	40.2	42.1	41.5	42.0
	S	31.1	32.3	33.8	37.9	39.8	39.2	39.7
	SW	32.0	33.2	34.7	38.8	40.7	40.1	40.6
	W	34.9	36.1	37.6	41.7	43.6	43.0	43.5
	NW	35.9	37.1	38.6	42.7	44.6	44.0	44.5

(*) indicates an NSL involved in the proposed project.

(A) Indicates an exceedance of the noise criteria, but of less than 0.5 dB LA90, which is

considered negligible as per the ARWTN guidance referenced in Section 12.6.4.4.

(B) indicates where noise levels are dominated by Cush Phase I and are assessed on the basis of compliance with the existing Condition 12 of ABP-318816-24, without introducing additional curtailment through the present application. The contribution from the proposed project is more than 10 dB below that of Cush Phase I, and exceedances are less than 0.5 dB L_{A90} and therefore negligible.

(C) All other values are numerically compliant with the adopted criteria.

Table 12.22: Predicted Noise Levels with implementation of Curtailment Matrix

Prior to the commencement of the operation phase, the manufacturer of the turbine model ultimately selected will verify the turbine-specific operating modes and curtailment settings required for T09–T11 to achieve the noise limits established for the proposed project. Only a turbine model capable of achieving those limits through verified operational controls will be selected. The final curtailment strategy will be implemented and maintained as necessary to ensure compliance with the applicable noise criteria. This commitment will apply regardless of the turbine model ultimately selected within the proposed turbine dimension range.

With the implementation of these mitigation measures, the residual exceedances are less than 0.5 dB, and negligible as per the ARWTN guidance referenced in Section 12.6.4.4, and therefore not significant.

12.7.3 DECOMMISSIONING PHASE

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

No specific mitigation measures are required for decommissioning. To ameliorate any potential noise impacts that may present during the decommissioning phase, a schedule of noise control measures has been formulated in accordance with best practice guidance. These are outlined in the CEMP (**Annex 3.4**) that has been prepared for the Proposed Project.

12.8 MONITORING MEASURES

12.8.1 NOISE COMPLIANCE MONITORING PLAN

Noise Compliance Monitoring refers to testing the wind turbine noise levels associated with the operation of the project against the terms of planning condition(s).

Prior to the commissioning of the wind farm, the developer will submit a Noise Complaint Monitoring Programme (NCMP) to the planning authority for written agreement. The NCMP will include a detailed methodology for the noise measurements, procedures for recording results and locations at which noise is to be

monitored.

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

In the unlikely event that an exceedance of the noise criteria is identified as part of the compliance assessment, a detailed investigation will be carried out and corrective actions taken. For example, 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 criteria or conditions on turbine noise. Such curtailment can be applied using the wind farm SCADA system with a marginal reduction of the wind turbine performance. After the implementation of the mitigation measures, the noise survey will be repeated to confirm compliance with the planning conditions.

12.8.2 IN THE EVENT OF A COMPLAINT

In the event of a complaint associated with noise for example, tonality or amplitude modulation from the proposed project, in line with the NCMP documents to be submitted and agreed with the local authority, the operator will fully investigate the complaint through review of the meteorological periods and conditions.

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

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

Similarly, if the complaints suggest the potential occurrence of clearly audible tonality in the wind turbine noise, the audibility of the tones will be investigated from measured data with a robust, objective method such as that included in ISO 1996-2:2017. If persistent occurrence of clearly audible tonality is identified, then the operator will liaise with the turbine manufacturer to investigate and implement measures to

mitigate or minimise the occurrence of tonality as much as is reasonably practicable. This may also involve engineering methods or turbine operational changes for example.

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

If the complaints suggest the potential occurrence of clearly audible tonality in the wind turbine noise, the audibility of the tones will be investigated from measured data with a robust, objective method such as that included in ISO 1996-2:2017. If persistent occurrence of clearly audible tonality is identified, then the operator will liaise with the turbine manufacturer to investigate and implement measures to mitigate or minimise the occurrence of tonality as much as is reasonably practicable. This may also involve engineering methods or turbine operational changes for example.

12.9 RESIDUAL EFFECTS

12.9.1 CONSTRUCTION PHASE

During the construction phase of the project, there will be some impacts on nearby NSLs due to noise emissions from site traffic and other construction activities. However, given the distances between the main construction works and the NSLs, and the nature and duration of the activities, including the two-day wall-removal works, the noise and vibration effects are not predicted to be significant.

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

Construction Element	Quality	Significance	Duration
Electrical Switch Room Building	Negative	Not Significant	Temporary
Site Entrances and Access Tracks	Negative	Not significant	Temporary
Underground Cabling	Negative	Not Significant	Temporary
Construction Traffic	Negative	Not Significant	Short-term

Table 12.23: Residual Effects in Construction Phase

12.9.2 OPERATION PHASE

The residual turbine noise levels associated with the proposed project will be within best practice noise criteria curves recommended in line with Irish guidance 'Wind Energy Development Guidelines for Planning Authorities' at 128 of the 131 locations assessed. It is acknowledged that with mitigation measures applied, noise levels at three NSLs (H019, H057 and H083) are in exceedance by less than 0.5 dB. However, in accordance with the guidance in ARWTN referred to in **Section 12.6.4.4**, these exceedances are negligible. Therefore, it is not considered that a significant effect is

associated with the project.

With respect to the EPA's criteria for description of effects, the potential worst-case associated effects at the nearest NSLs associated with operational turbine noise are summarised as **negative, not significant** and **long-term**.

There are no likely significant effects from the operation of the wind turbines of the proposed project.

12.10 SUMMARY

The noise environment at a set of representative noise-sensitive locations in the vicinity of the project has been quantified by an appropriate survey of background noise levels. The results of the background noise survey have been used to derive noise level criteria for these and other noise-sensitive locations.

Using the combined assessment sound power profile and an established noise-propagation model, operation phase noise levels have been predicted at 131 no. NSLs for the project in isolation and cumulatively with the permitted Cush Wind Farm Phase I and the other relevant operational wind farms. Predicted noise levels from the project in isolation are within the applicable noise criteria at all locations. The cumulative assessment identified potential exceedances at 9 no. locations (H024, H031, H036, H055, H056, H057, H081, H083 and H084) requiring mitigation to reduce noise levels from the proposed project.

With the implementation of the required turbine-specific curtailment strategy, the residual exceedances are less than 0.5 dB, and negligible as per the ARWTN guidance referenced in Section 12.6.4.4, and therefore the residual noise effects are not significant.

12.11 REFERENCES

- Environmental Protection Agency (EPA) Guidelines on the Information to be contained in Environmental Impact Assessment Reports (EPA, 2022)
- Department of the Environment, Heritage, and Local Government (DoEHLG) Wind Energy Development Guidelines (DoEHLG, 2006)
- Department for Energy Security and Net Zero (DESNZ) Assessment and Rating of Wind Turbine Noise (DESNZ, 2026)
- Institute of Acoustics (IOA) A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA, 2013)
- Transport Infrastructure Ireland (formerly NRA) (TII) Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (TII, 2014)
- British Standard Institute (BSI) BS 5228-1:2009 +A1:2014 Code of Practice for noise and vibration control of construction and open sites - Part 1: Noise (BSI, 2014)
- British Standard Institute (BSI) BS 5228-2:2009+A:2014 Code of Practice for noise and vibration control of construction and open sites - Part 2: Vibration (BSI, 2014)

- British Standard Institute (BSI) BS 7385: 1993 Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration (BSI, 1993)
- United Kingdom Highways England (now National Highways) (UKHE) Design Manual for Roads and Bridges (DMRB) Sustainability & Environment Appraisal LA 111 Noise and Vibration Revision 2 (UKHE, 2020)
- International Organization for Standardization (ISO) ISO 1996: 2017: Acoustics – Description, measurement, and assessment of environmental noise (ISO, 2017)
- Environmental Protection Agency Office of Environmental Enforcement (OEE) Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) (OEE, 2011)
- Environmental Protection Agency Office of Environmental Enforcement (OEE) Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (OEE, 2016)
- British Standard Institute (BSI) BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound (BSI, 2019)
- IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group (IOA) A Method for Rating Amplitude Modulation in Wind Turbine Noise (IOA, 2016)
- International Organization for Standardization (ISO) ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General Method of Calculation (ISO, 1996)
- WHO Regional Office for Europe (WHO) Environmental Noise Guidelines for the European Region (WHO, 2018)
- Department of Housing, Planning and Local Government (DoHPLG) Draft Wind Energy Development Guidelines (DoHPLG, 2019)
- Department for Business, Energy & Industrial Strategy Wind Turbine AM Review: Phase 2 Report Project Number: 3514482A Issue: 3 Issued August 2016
- International Electrotechnical Commission (IEC) Technical Specification 61400-11-2 (Edition 1.0, 2024) Wind Energy Generation Systems – Part 11-2: Acoustic noise measurement techniques – Measurement of wind turbine sound characteristics in receptor position (IEC, 2024)