



Chapter 13 Noise and Vibration

Ballinlee Wind Farm

Ballinlee Green Energy Ltd.

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13. Noise and Vibration

13.1 Introduction

Enfonic Ltd. have been commissioned by Malachy Walsh and Partners (MWP) to conduct a noise and vibration impact assessment in relation to the proposed Ballinlee Wind Farm (the Proposed Development). This chapter considers any likely significant direct and indirect effects of the potential noise and vibration impacts of the Proposed Development. The full development description is set out in **Volume II Chapter 02** of this Environmental Impact Assessment Report (EIAR).

Noise and vibration impact assessments have been prepared for the construction, operational and decommissioning phases of the Proposed Development. To inform these assessments, baseline noise levels have been measured at several representative Noise Sensitive Locations (NSLs) and noise predictions to the NSLs within the study area have been prepared.

Other wind farm developments (operational, permitted or proposed) with the potential for cumulative impacts were identified and included as part of this assessment. The list of other wind farms considered are provided in **Volume II Chapter 01** of this EIAR. Other non-wind turbine developments (operational, permitted or proposed) are not considered as relevant by the *Wind Energy Development Guidelines for Planning Authorities* published by the Department of the Environment, Heritage and Local Government in 2006 (WEDG-06).

13.1.1 Competency of Assessor

This assessment was prepared in accordance with the EIA Directive 2014/52/EC and the applicable guidance, policies and best practice as described in **Section 13.2** by the following staff of Enfonic Ltd.

Drafted by: Aishaani Sharma, (Junior Consultant) graduated with an MSc in Environmental Science from Trinity College in 2024 and holds a BSc (Hons.) in Biotechnology and qualified with IOA Certificate in Environmental Noise Measurements (2024). Since starting with Enfonic in May 2024 she has undertaken many noise surveys including baseline surveys in relation to wind farms. She provides expertise in relation to impacts on biodiversity and has drafted several noise and vibration chapters for Environmental Impact Assessment Reports (EIARs) for proposed wind farm developments.

Reviewed by: David Courtney, BEng, MIOA (Acoustic Consultant) graduated with a BEng. in Mechatronic Engineering from DCU in 2017 and qualified with IOA Diploma in Acoustics and Noise Control (2019) & Certificate in Environmental Noise Measurements (2017). He undertakes all types of noise and vibration surveys in relation to wind turbines planning and compliance, IPPC & IE compliance, BS4142, BS5228 and BS8233 assessments, traffic noise, construction, building acoustics and occupational assessments. He also manages the team of survey engineers and provides technical support to consultants. He has considerable expertise in the assessment of wind turbine noise and conducted many similar impact assessments for EIARs.

Reviewed and Approved by: Gary Duffy, BEng, MIOA (Principal Consultant) is the managing director of Enfonic with over 25 years' experience as an acoustic engineer and consultant. He has extensive knowledge in the field of noise measurement, prediction, and impact assessment. He co-wrote the EPA's original guidance note on noise and represented the Institute of Acoustics (IOA) on the technical advisory committee of the Department of the Environment's revision of Part E (Sound Insulation) of the Building Regulations. He is a founder member of the Irish branch of the Institute of Acoustics and a sitting member of the current committee. He has considerable expertise in the assessment of wind turbine noise and conducted many similar impact assessments for EIARs.

13.1.2 Fundamentals of Noise

The audible range of sounds can be expressed in terms of Sound Pressure Levels (SPL) and ranges from 0dB (for the threshold of hearing) to 140dB (for the threshold of pain). It should be noted that a doubling in sound energy (such as may be caused by a doubling of traffic flows) increases the SPL by 3dB.

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 is most sensitive to the frequency range of language (300Hz-3,000Hz) and decreases substantially as frequency falls.

It is necessary to adjust the measured noise level by an instrument to reflect the sensitivity response of human hearing and the 'A-weighting' system has been defined in the international standard, BS ISO 226:2003 Acoustics (BS ISO 226:2003 Acoustics, 2003) to do this. A SPL measured using 'A-weighting' is expressed in terms of dBA.

An indication of the level of some common sounds on the dBA scale is as follows:

Table 13.1: Common sounds of the dBA scale

Source	Decibel Level (dBA)
Threshold of Hearing	0
Rustling Leaves	10
Whisper	20
Quiet Rural Setting	30
Quiet Living Room	40
Suburban Neighbourhood	50
Normal Conversation	60
Busy Street Traffic	70
Vacuum Cleaner	80
Heavy Truck	90
Jackhammer	100
Front Row of Rock Concert	110
Threshold of Pain	130
Military Jet Take-off	140

A glossary of acoustic terminology used in this report is provided in **Appendix 13A**.

13.2 Applicable Guidance and Policy

The following guidance in this section is applicable to the assessment of the noise impact of the Proposed Development.

13.2.1 Construction Phase

13.2.1.1 Noise

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

BS 5228-1:2009+A1:2014

In the absence of specific noise limits which may be set by the Local Authority, appropriate construction limits given in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* have been adopted in this assessment. This standard provides information on the prediction and measurements of noise from construction sites and operations such as mines and quarries. It also includes a large database of source noise levels for commonly used equipment and activities on construction sites.

The standard provides guidance on the 'threshold of significant effect' in respect to noise impacts at dwellings. The proposed 'ABC method' derives appropriate construction noise limits from existing ambient noise levels and the relevant categories are provided in **Table 13.2**.

Table 13.2: BS 5228 – BS5228 Categorisation Table.

Assessment Category and Threshold Value Period.	Threshold values in Decibel Level (dB $L_{Aeq,1hr}$)		
	Category A ^{A)}	Category B ^{B)}	Category C ^{C)}
Night-time (23.00–07.00)	45	50	55
Evenings and weekends ^{D)}	55	60	65
Daytime (07.00–19.00) and Saturdays (07.00–13.00)	65	70	75
NOTE 1 A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.			
NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e., the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.			
NOTE 3 Applied to residential receptors only.			
^{A)} Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values.			
^{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.			

Assessment Category and Threshold Value Period.	Threshold values in Decibel Level (dB L _{Aeq,1hr})
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.	
D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.	
Periods may be amended to suit local conditions	

In general, the noise impact due to the construction phase will be from the specific items of plant used, the duration and phasing of the construction methods, the time of day that each plant will be used and their location. For the appropriate period (e.g., daytime) the ambient noise level is determined and rounded to the nearest 5dB.

13.2.1.2 NRA/ TII Guidelines

The Transport Infrastructure Ireland's (TII's) (formally National Roads Authority (NRA)) *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014)* publication provides suitable vibration criteria below which building damage is unlikely to occur from vibration, in their Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (NRA, 2014) as given in **Table 13.3**.

Table 13.3: Summary of Applicable TII Vibration Criteria.

Allowable vibration at the closest part of sensitive property to the source of vibration			
Frequency (Hz)	<10	10-50	>50-100
Vibration PPV* (mm/s)	8	12.5	20

*Peak Particle Velocity

13.2.2 Operational Phase

Once operational, the wind turbines will emit an increasing level of noise between the 'cut-in' wind speed threshold when the blades commence rotation, and the 'rated power' wind speed threshold, when the blades reach their maximum rotational velocity. Thereafter the turbine rotation speed and the noise emission levels will not increase further. The assessment of wind turbine noise emissions summarised in this chapter is in compliance with current guidance and best practice in relation to acceptable levels of noise from wind farms as contained in the document *Wind Energy Development Guidelines for Planning Authorities* published by the Department of the Environment, Heritage and Local Government in 2006 (WEDG-06).

These guidelines are in turn based on detailed recommendations set out in the UK's Department of Trade and Industry – Energy Technology Support Unit (ETSU) publication *The Assessment and Rating of Noise from Wind Farms (1996)*. The ETSU document has been used to supplement the guidance contained within the WEDG-06 publication where necessary.

Vibration emission levels from operational wind turbines are negligible and imperceptible except at the turbine foundation.

13.2.2.1 Wind Energy Development Guidelines (WEDG-06)

The WEDG-06 guidelines serve several key purposes, especially in the context of noise impact assessments:

- **Establishing Standards:** They provide clear standards for assessing and managing noise impacts from wind energy projects. This includes guidelines on acceptable noise levels and methodologies for measuring and predicting noise.
- **Consistency in Planning:** By offering a standardized approach, the guidelines ensure consistency in how noise impacts are evaluated across different projects and regions. This helps planning authorities make informed decisions based on uniform criteria.
- **Protecting Communities:** The guidelines aim to protect the health and well-being of communities living near wind energy developments. They include measures to minimize noise pollution and its potential effects on residents.
- **Facilitating Development:** By providing a clear framework, the guidelines help streamline the planning process for wind energy projects. This can reduce delays and uncertainties for developers, promoting the growth of renewable energy in Ireland.
- **Compliance and Monitoring:** The guidelines outline requirements for ongoing noise monitoring and compliance checks. This ensures that wind energy projects continue to meet noise standards throughout their operational life.

Section 5.6 of WEDG-06 outlines the appropriate noise criteria in relation with wind farm developments. The following extract from it set outs the general aim of an impact assessment:

“An appropriate balance must be achieved between power generation and noise impact.”

It should be noted that there is no specific advice given by WEDG-06 in relation to what constitutes an ‘appropriate balance’.

Furthermore, a **Noise Sensitive Location (NSL)** is defined as follows:

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

As can be seen from the calculations presented later in this chapter, the various topics identified in this extract have been incorporated into this assessment. It should be noted that the noise limits are defined in terms of the $L_{A90,10min}$ parameter.

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

This represents the commonly adopted **daytime** noise criterion in relation to wind farm developments. However, an important caveat should be noted as detailed in the following extract.

*“However, in very **quiet areas**, the use of a margin of 5 dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that*

the daytime level of the LA90,10min of the wind energy development be limited to an absolute level within the range of 35-40 dB(A)."

In relation to **night-time** periods the following guidance is given:

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

Note again this limit is defined in terms of the LA90,10min parameter. This represents the commonly adopted night-time noise criterion in relation to wind farm developments.

It is proposed to adopt a lower daytime threshold of 40 dB LA90,10min for low noise environments where the background noise is less than 30dB LA90,10min at a given wind speed range. It should be noted that the EPA document 'Guidance Note for Noise: License Applications, Surveys and assessments in Relation to Scheduled Activities' proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. The proposed lower threshold here is 5dB more stringent than this level.

A summary of the operational noise limits set out in WEDG-06 is as follows:

- 35 to 40 dB for quiet daytime environments of less than 30dB at a given wind speed range;
- 45dB for daytime environments greater than 30dB or a maximum increase of 5dB above background noise (whichever is the higher); and
- 43dB for night-time periods or a maximum increase of 5dB above background noise (whichever is the higher).

It should be noted that while the caveat of an increase of 5dB above background for the night-time period is not explicit within the current guidance it is commonly applied in noise assessments prepared and is detailed in numerous examples of planning conditions issued by local authorities and An Coimisiún Pleanála.

13.2.2.2 ETSU-R-97 – The Assessment and Rating of Wind Farm Noise (1997)

The core of the noise guidance contained within the WEDG-06 is based on the Energy Technology Support Unit publication *The Assessment and Rating of Noise from Wind Farms (ETSU-R-97)*.

ETSU-R-97 calls for the control of wind turbine noise by the application of noise limits at the nearest noise sensitive properties. It is considered that absolute noise levels applied at all wind speeds are not suited to wind turbine developments and therefore best practice is to adopt noise limits relative to background noise levels in the vicinity of the noise sensitive locations. A critical aspect of the noise assessment of wind energy proposals relates to the identification of baseline noise levels through on-site noise surveys.

13.2.2.3 Institute of Acoustics Good Practice Guide

The original ETSU-R-97 concepts underwent a thorough review in 2013 with the Institute of Acoustics (IOA) publication of *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (GPG)* and six accompanying *Supplementary Guidance Notes (SGNs)* as follows:

1. Data Collection
2. Data Processing & Derivation of ETUS-R-97 Background Curves
3. Sound Power Level Data
4. Wind Shear
5. Post Completion Measurements
6. Noise Propagation Over Water for On-Shore Wind Turbines

This publication was endorsed by the UK, Department of Energy and Climate Change (DECC), the Northern Ireland Executive, the Scottish Executive and the Welsh Assembly and provides guidance on all aspects of the use of ETSU-R-97.

The GPG and SGNs are considered to represent best practice and have been adopted for this assessment.

13.2.2.4 Period Definitions

Period definitions adopted from the GPG are as follows:

Amenity (Daytime) hours are:

- All evening from 18:00 to 23:00hrs;
- Saturday Afternoons from 13:00 to 18:00hrs, and;
- All day Sunday from 07:00 to 18:00hrs.

Night-time hours are 23:00 to 07:00hrs.

13.2.2.5 Financially Involved

ETSU-R-97 considers it appropriate to allow a higher level of incident noise associated with turbine operation for properties with occupants that have an interest in the development, both as a higher fixed level (45 dB) and/or a higher level above the prevailing background noise level. It is considered that the occupants of a financially involved property should be direct beneficiaries to allow an increase to the fixed limit noise levels.

13.2.2.6 Draft Wind Energy Guidelines 2019

A Draft Revised Wind Energy Development Guidelines was published in December 2019 for consultation. During the public consultation process considerable concerns in relation to the proposals were expressed by various parties including members of the Institute of Acoustics and various experts in the field of wind turbines noise assessments.

It is acknowledged that this document remains the subject of detailed consultation with interested parties and stakeholders. At the time of writing this chapter, the document is still in draft format. Therefore, for the avoidance of doubt and has been mentioned previously, the assessment presented in this report is based on the guidance currently outlined in Section 5.6 of WEDG-06 as supplemented by ETSU-R-97 and IOA Good Practice Guides in accordance with best practice.

13.2.2.7 Local Planning Policy

Limerick Development Plan 2022-2028 (section 11.7.2.1 Wind Energy) states the following in relation to planning applications for renewable energy schemes:

“They will be considered in the context of current Government policy on the subject but will take into account other, often competing, Council policies and any relevant guidelines issued from time-to-time by the Department of Housing, Local Government and Heritage.”

It goes on to state the following relevant sections in relation to wind turbine noise:

“When assessing planning applications for wind energy developments the Planning Authority will have regard to the Wind Energy Development Guidelines for Planning Authorities (2006).”

Background noise surveys shall be carried out in accordance with A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013), unless current guidelines require otherwise.

Noise levels, including the addition of any penalties for special audible characteristics, shall comply with current guidelines.

Any proposed lower fixed noise limit for night-time at noise sensitive properties shall not exceed 38 dB(A) L₉₀ or 5dB(A) above background noise levels, whichever is the greater.

Cumulative low frequency noise levels for one-third octave bands between 10 Hz and 160 Hz (L_{pA,LF}) from wind turbines shall not exceed 20 dB(A) at evening and night (19:00 to 07:00 hours) and 25 dB(A) during the day (07:00 to 19:00 hours), at any wind speed inside habitable rooms of noise sensitive properties when measured at locations meeting the requirements of the Environmental Noise Regulation of Denmark (Orientering nr. 45);

Where noise levels interfere with the amenities of the area, the operator shall comply with any requirements of the Planning Authority to undertake an investigation (including shutting down wind turbines for background noise monitoring if required) and implement mitigation measures, up to and including taking turbine(s) out of operation."

This criteria suggests that where special characteristics or rated levels are to be considered, the rated noise levels should comply with the existing WEDG06 criteria identified above, but where it is a fixed LA₉₀ limit the 38dB or 5dB above the background should be applied. This is consistent with the conservative consideration of the maximum 5dB penalty difference between the rated level and measured LA₉₀, but it does provide a different night-time limit level when comparing the Development Plan to WEDG06.

13.2.2.8 World Health Organization (WHO) Noise Guidelines for the European Union

The WHO Environmental Noise Guidelines for the European Region (2018) provides health-based recommendations based on average environmental noise exposure of several sources of environmental noise, including wind turbine noise.

However, the quality of evidence used for the WHO research is identified as being 'Low' in relation to wind turbine noise and the document states the following:

"..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."

13.2.2.9 Noise Limits

The recommendations for wind turbine noise are therefore conditional and based on the professional competence and expertise of the authors, the combination of guidance provided in WEDG 2006, ETSU, IOA GPG and SGNs is considered best practice and have been adopted for this assessment.

The noise limits for the proposed development are set out in **Section 13.5.3.3** below.

13.2.2.10 Special Audible Characteristics

Wind turbine noise emissions may exhibit some 'Special Characteristics' which would render the noise more annoying than the equivalent noise emission level without such characteristics. It may therefore be appropriate to apply a rating penalty to a noise level to account for this factor.

A guarantee will be required in the procurements of the turbine to be used onsite, stating that there should be no clearly tonal or impulsive components audible at any noise sensitive receptor location. Others may be controlled by curtailment e.g. Amplitude Modulation. In all cases, it is not possible to predict the occurrence of any special characteristic at the planning stage. Post-construction monitoring programmes and campaigns following prescribed guidelines can objectively investigate these characteristics and appropriate mitigation measures can be identified and implemented at that time.

It should also be noted that these are rare events associated with a limited number of wind farms. Nevertheless, the details and assessment of each is set out below.

13.2.2.10.1 Tonal Noise

Tonality is a characteristic that is applicable to a wide range of sound descriptions, such as 'humming', 'droning', 'whining', 'whistling', 'buzzing' etc., depending on the frequencies in the sound and its harmonic structure. These sounds are associated with concentrations of energy into very narrow parts of the frequency spectrum, which may include a single tone or multiple tones.

Tonal noise from wind turbines, characterized by a distinct "hum" or "whine" at a steady pitch, is relatively rare in modern turbines. This type of noise is typically caused by mechanical components or unusual wind currents interacting with turbine parts. Advances in turbine design have significantly reduced the occurrence of tonal noise, making it much less common in newer models.

It should be noted that tonal noise is associated with wind turbine operation, and it is not possible to predict an occurrence of tonality at the planning stage. In the event of a complaint regarding tonality, a detailed assessment following the guidance outlined in the *IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014)* will be followed.

Furthermore, a guarantee will be sought in the procurements of the turbine to be used onsite, stating that there should be no clearly tonal or impulsive components audible at any noise sensitive receptor location.

13.2.2.10.2 Amplitude Modulation

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

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

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

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

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

'Normal' AM

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

This effect is reduced for an observer on or close to the turbine axis, and therefore would not generally be expected to be significant at the separation distances of the Proposed Development.

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

'Other' AM

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

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

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

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

Prediction of AM

It should be noted that AM is associated with wind turbine operation under site specific conditions, and there is currently no mechanism to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is unlikely and is the exception rather than the rule.

Renewable UK Research Document states the following in relation to the matter:

"Even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent."

"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."

"There is nothing at the planning stage that can presently be used to indicate a positive likelihood of AM 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."

Assessment of AM

Research and Guidance in the area is ongoing with publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016)*. The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response.

The AMWG does not propose any limits for AM but does provide information on noise penalty schemes in the event that AM is confirmed at an operational wind farm. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of amplitude modulation. The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work and is currently the subject of a separate UK Government funded study. For the above reasons AM is not considered in this noise impact assessment.

13.2.2.10.3 *Infrasound and Low Frequency Noise*

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

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

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

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

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

"Infrasound is widespread in modern society, being generated by cars, trains and aircraft, and by industrial machinery, pumps, compressors and low speed fans. Under these circumstances, infrasound is usually accompanied by the generation of audible, low frequency noise. Natural sources of infrasound include thunderstorms and fluctuations in atmospheric pressure, wind and waves, and volcanoes; running and swimming also generate changes in air pressure at infrasonic frequencies."

"For infrasound, aural pain and damage can occur at exposures above about 140dB, the threshold depending on the frequency. The best-established responses occur following acute exposures at intensities great enough to be heard and may possibly lead to a decrease in wakefulness. The available evidence is inadequate to draw firm conclusions about potential health effects associated with exposure at the levels normally experienced in the environment, especially the effects of long-term exposures. The available data do not suggest that exposure to infrasound below the hearing threshold levels is capable of causing adverse effects."

The Institute of Acoustics Bulletin in March 2009 included a statement of agreement between acoustic consultants regularly employed on behalf of wind farm developers, and conversely acoustic consultants regularly employed on behalf of community groups campaigning against wind farm developments. The intent of the article

was to promote consistent assessment practices, and to assist in restricting wind farm noise disputes to legitimate matters of concern. On the subject of infrasound, the article notes:

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

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

The article concludes that:

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

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

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

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

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

“The contribution of wind turbines to the measured infrasound levels is insignificant in comparison with the background level of infrasound in the environment.”

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

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

“For the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013 Draft).”

“The results of this measurement project comply with the results of similar investigations on a national and international level.”

13.2.2.10.4 Assessment of Operational Special Characteristics

A summary of applicable guidance for the assessment of special acoustic characteristics is as follows:

Infrasound and Low Frequency:

University of Salford Proposed Criteria for the Assessment of Low Frequency Noise Disturbance, Revision 1

Amplitude Modulation:

IOA Noise Working Group (Wind Turbine Noise) Amplitude Modulation Working Group Final Report, A Method for Rating Amplitude Modulation in Wind Turbine Noise

Tonality:

ISO/PAS 20065:2016 Acoustics — Objective method for assessing the audibility of tones in noise — Engineering method.

A suitable Noise Complaint Monitoring Programme (NCMP) will be implemented for the proposed development. Should a noise complaint or evidence of an exceedance of the noise limits occur, the operator shall comply with any requirements of the Planning Authority to undertake an investigation (including shutting down wind turbines for background noise monitoring if required) and the implementation of appropriate mitigation measures, such as a curtailment programme, on the wind turbine operations will be undertaken. The NCMP will follow the guidance outlined above and in the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014).

13.2.2.11 ISO 9613-2:2024

Sound power emission level of wind turbines are provided by manufacturers at source. Noise levels must then be predicted to distant locations such as NSLs and *ISO 9613: Acoustics – Attenuation of sound outdoors, Part 2: General method of calculation (2024)* provides guidance on the necessary calculations. This standard considers noise attenuation provided by distance, ground absorption, directivity, atmospheric absorption and other relevant factors.

Noise predictions to specific locations are prepared for various wind speeds and the predicted levels compared against the relevant noise criteria to demonstrate compliance.

Typically, proprietary software is used to perform calculations to *ISO 9613-2:2024*, provide result data and graphical images.

13.2.2.12 ISO 1996-1:2016

Measurements of environmental noise for the purposes of impact assessment should follow the guidance set out in *ISO 1996-1:2016 Acoustics — Description, measurement and assessment of environmental noise Part 1: Basic quantities and assessment procedures*. The standard defines the basic quantities to be used for the description of noise in community environments and describes basic assessment procedures.

13.2.2.13 BS 4142: 2014

BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound described a method for assessing the impact of a proposed or existing industrial or commercial sound source. This guidance is appropriate for the assessment of non-turbine related noise sources including the on-site Substation.

The procedure rates the 'Specific' noise (from the Substation compound in this case) at Noise Sensitive Locations (NSLs) and compares it with the 'Background' noise levels. The level difference is an indication of the impact that the operation under investigation may have.

In addition, Rating penalties applied to the Specific noise level may be appropriate to provide for the increased significance that additional characteristics such as Tonality or Impulsivity have on noise in the community.

The 'context' of the development and its environs e.g. time of day, nature of the neighbourhood, local attitudes to the development, etc. ought also to be considered. There is also a degree of uncertainty applicable to the results e.g. for weather, instrumentation, measurement duration, calculation errors etc. which ought to be considered.

13.2.2.14 Vibration

Ground borne vibration waves are attenuated rapidly as they propagate from a source through the substrate. During operation, modern wind turbines do not generate sufficiently high levels of vibration to be perceptible at any distance much beyond the turbine foundations. Typically, at a distance of 100 m from a 1 MW turbine unit the level of operational vibration is the order of 5-10 mms^{-1} which would be imperceptible.

As a result, little research had been conducted on the subject however a report published by the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg, Germany in 2016, *Low frequency noise incl. infrasound from wind turbines and other sources* conducted a vibration study for an operational Nordex N117 – 2.4 MW wind turbine. The report confirmed 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 closest NSLs are more than 500 m from the nearest proposed wind turbine and operational vibration impacts are anticipated to be imperceptible and are therefore not considered.

13.2.2.15 Vehicular Activities

Some additional traffic is associated with the operational phase of the Proposed Development and it is appropriate to assess the effect by calculating the increase in traffic noise levels that will arise because of vehicular movements on the public road network (See **Volume II, Chapter 16 Traffic and Transport** of the EIAR).

The IEMA Guidelines set out in **Section 13.1.1** consider a change in traffic noise levels of 3 to 4.9 dBA would be noticeable, in excess of 5dBA would be clearly noticeable, and depending on the final noise level, the impact may be moderate or significant. A change in noise level of less than 3dB would be imperceptible.

Furthermore, the *UK Design Manual for Roads and Bridges* (DMRB, Volume 11, Section 3, Part 7) states that a change in noise level of 1dB $L_{A10,18h}$ is equivalent to a 25% increase or a 20% decrease in traffic flow, assuming other factors remain unchanged and a change in noise level of 3dB $L_{A10,18h}$ is equivalent to a 100% increase or a 50% decrease in traffic flow.

The operation of the Proposed Development is largely automated with occasional maintenance and other visits by a small number of vehicles. Any increase in associated noise level will be negligible and imperceptible.

13.3 Health Effects of Wind Farms

This section of this noise assessment reviews the literature and findings on the potential health effects of noise from wind farms.

13.3.1 Health Service Executive (HSE) Public Health Medicine Environment and Health Group

In Ireland the HSE Public Health Medicine Environment and Health Group drafted a position paper in 2017 titled Position Paper on Wind Turbines and Public Health. The group identified that there is no published scientific evidence to support adverse effects of wind turbines on health and concluded that:

“Published scientific evidence is inconsistent and does not support adverse effects of wind turbines on health. However, adequate setback distances and meaningful engagement with local communities are recommended in order to address public concern.”

13.3.2 Dáil Éireann Discussion – Wind Turbine Noise and Health Considerations

On Wednesday, 26 February 2025, a Dáil Éireann debate addressed concerns regarding wind turbine noise and the potential health effects of wind turbine noise and shadow flicker.

In response to a parliamentary question on this matter, the Minister for Health, Deputy Jennifer Carroll MacNeill, stated:

“The position of the Department of Health on wind turbine noise and shadow flicker from a health perspective is informed by advice from the HSE. The most recent advice from colleagues in the HSE found that there is currently no robust evidence in the international scientific literature to show that wind turbines negatively affect people’s physical health once they are appropriately installed, in accordance with guidelines.

The Deputy may wish to note that the Department of Housing, Local Government and Heritage in conjunction with the Department of Environment Climate and Communications and their expert noise consultants are currently updating the wind energy guidelines having appropriate regard to the impact of noise and shadow flicker.”

13.3.3 The National Health and Medical Research Council

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

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

13.3.4 Health Canada

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

No evidence was found to support a link between exposure to wind turbine noise and any of the self-reported illnesses. Additionally, the study’s results did not support a link between wind turbine noise and stress, or sleep

quality (self-reported or measured). However, an association was found between increased levels of wind turbine noise and individuals reporting of being annoyed.

13.3.5 New South Wales Health Department

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

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

13.3.6 The Australian Medical Association

The Australian Medical Association put out a position statement, *Wind Farms and Health 2014 (Australian Medical Association, 2014, Wind farms and health)*. The statement said:

“The available Australian and international evidence does not support the view that the infrasound or low frequency sound generated by wind farms, as they are currently regulated in Australia, causes adverse health effects on populations residing in their vicinity. The infrasound and low frequency sound generated by modern wind farms in Australia is well below the level where known health effects occur, and there is no accepted physiological mechanism where sub-audible infrasound could cause health effects.”

13.3.7 Journal of Occupational and Environmental Medicine

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

The study found that:

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

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

13.3.8 Summary

The peer reviewed research outlined in the preceding sections supports that there are no negative health effects on people with long term exposure to wind turbine noise. Refer to **Volume II Chapter 05 Population and Human Health** of this **EIAR** for further details of potential health effects associated with the Proposed Development.

13.4 Assessment Methodology and Significance Criteria

The assessment of impact effects has been undertaken in compliance with the applicable guidance as set out in **Section 13.2** relating to noise and vibration for the construction, operational and decommissioning phases of the Proposed Development, which are set out within the relevant sections of this chapter.

As set out in **Volume II Chapter 02, Section 2.4.1**, 1 no. candidate wind turbine model is to be considered for the Proposed Development.

13.4.1 Approach to the Assessment

The methodology adopted for this noise impact assessment represents best practice in the expert opinion of the author and can be summarised as follows:

- Review of applicable guidance to identify appropriate noise and vibration criteria for the construction, operational and decommissioning phases;
- Define the study area;
- Quantify the receiving environment through baseline noise surveys at representative Noise Sensitive Locations (NSLs) within the study area;
- Undertake predictive calculations to assess the potential effects associated with the construction and decommissioning phases of the Proposed Development;
- Undertake predictive calculations to assess the potential effects associated with the operational phase of the Proposed Development;
- Evaluate the potential noise and vibration effects;
- Specify mitigation measures to reduce, where necessary, the identified potential outward effects relating to noise and vibration from the Proposed Development; and
- Describe the significance of the residual noise and vibration effects associated with the Proposed Development.

13.4.2 Description of Effects

In addition to the appropriate impact assessment criteria that will be set out in this chapter, the significance of effects of the Proposed Development shall be described in accordance with the Environmental Protection Agency (EPA) document *Guidelines on the information to be contained in Environmental Impact Assessment Reports (EIAR)*, 2022 (EPA Guidelines).

The EPA Guidelines describe various factors involved in the determination of an impact's significance including Quality, Description and Duration. The central factor in describing a noise impact is the associated change in noise level.

The EPA Guidelines do not however quantify the impacts in decibel terms. In the absence of such information, reference is made to *Guidelines for Environmental Noise Impact Assessment (2014)* from the Institute of Environmental Management and Assessment (IEMA Guidelines). The IEMA Guidelines state similar terminology to the EPA Guidelines and quantifies the effect categories in decibel terms for various receptor categories, with residential receptors having the greatest sensitivity to noise.

Table 13.4 presents the effect descriptions and their respective noise level change for residential receptors.

Table 13.4: Effects Description (EPA Guidelines and IEMA Guidelines) and noise level change criteria.

EPA Significance of Effect	IEMA Guidelines	Noise Level Change (dB LAeq)
Imperceptible	None / Not significant	Less than 2.9
Not Significant		
Slight	Slight	3.0- 4.9
Moderate	Moderate	
Significant	Substantial	5.0- 9.9
Very Significant	Very Substantial	Greater than 10.0
Profound		

The Noise Level Change is therefore the most appropriate measure to describe the Significance of Effects for the various elements of the Proposed Development. A summary based on the Noise Level Change is provided for each section in this assessment.

13.4.3 Baseline Noise Survey of Receiving Environment

A noise survey programme is used to quantify the existing baseline conditions. Analysis of the measured data is used for the following purposes:

1. Appropriate wind-speed dependant L_{A90} values are used to derive the operational cumulative noise limits for the wind turbines, and;
2. The average ambient Daytime $L_{Aeq,T}$ noise levels are used:
 - a) to derive the construction noise limits and;
 - b) for the purposes of describing the effects of the operational phase of the Proposed Development.

13.4.4 Study Area

The initial study area is defined in the IOA GPG as:

“The study area should cover at least the area predicted to exceed 35dB L_{A90} up to 10m/s wind speed from all existing and proposed turbines.”

An initial noise propagation model at the rated wind speed of the turbines was used to identify the NSLs within the study area. A map showing the 35dB contour and NSLs is provided in Figure 13-1.

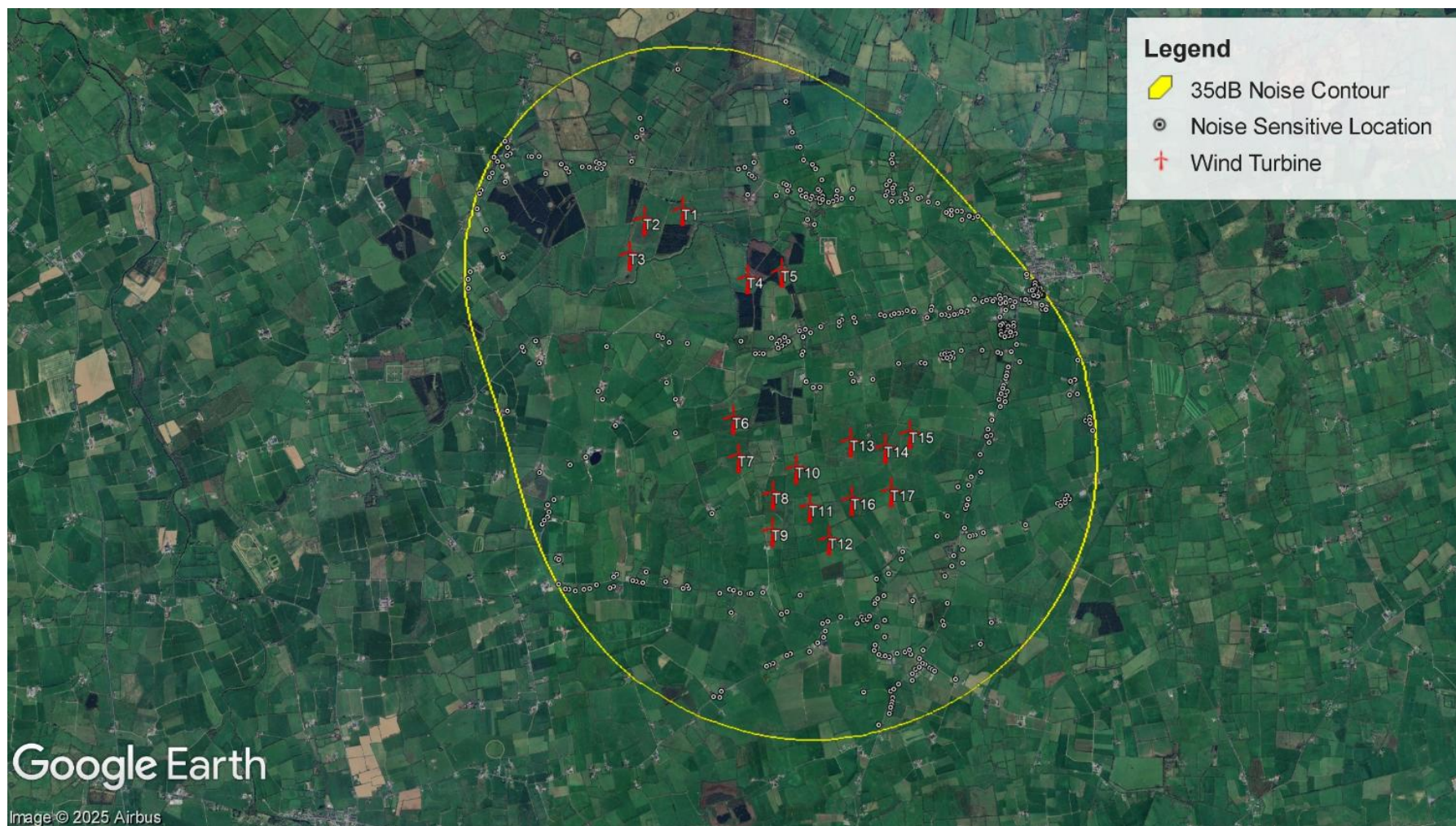


Figure 13-1: Map with initial 35dB Noise Contour and Noise Sensitive Locations

A total of 519 no. NSLs were identified and their coordinates are listed in **Appendix 13C – Schedule of Noise Sensitive Locations**.

13.4.5 Baseline Noise Survey

As required by *ETSU-R-97* a noise monitoring programme is required to establish the prevailing background noise levels across a range of wind speeds in the receiving environment.

A review of the NSLs provided an understanding of the range of ambient noise conditions within the study area. For example, some NSLs are located closer to agglomerations, roads or other noise sources than others. Using this information, a range of suitable Noise Monitoring Locations (NMLs) were selected to serve as proxy locations and therefore in the expert opinion of the author, are representative of the ambient noise conditions at all NSLs within the study area.

A noise monitoring programme was conducted at 6no. NMLs. In addition, wind speed data at various heights was provided by an on-site LiDAR which allowed for later analysis of wind speed dependant noise levels.

The NML and LiDAR locations are shown in **Figure 13-2** and detailed in **Table 13.5** and **Table 13-6**.

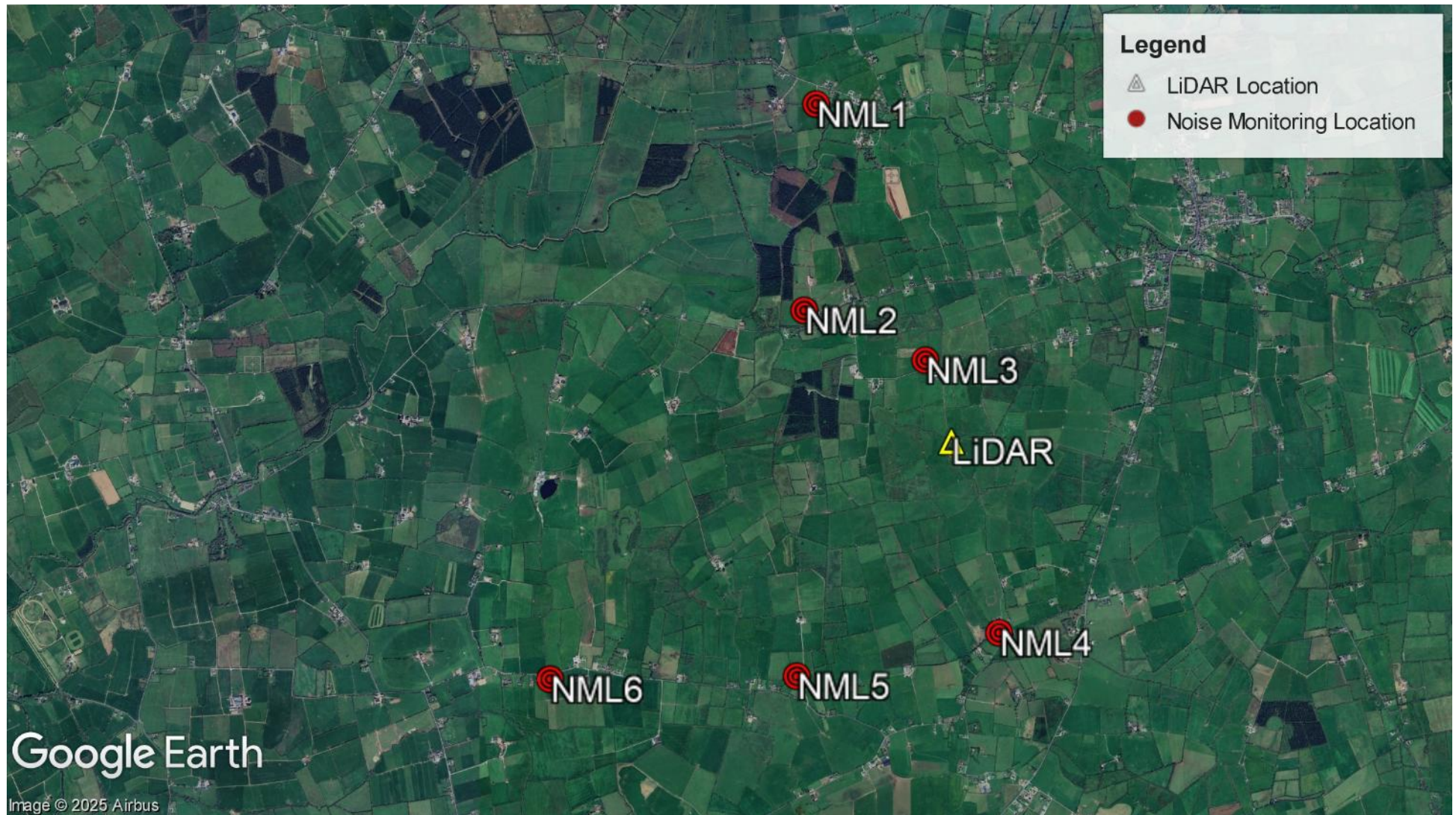


Figure 13-2: Noise Monitoring and LiDAR Locations.

Table 13.5: Noise Monitoring Locations (NMLs), coordinates and descriptions.

Location	ITM X	ITM Y	Description of Observed Noise Build-up during installation.
NML 1	560054	637066	Bird Song. Distant agricultural activity. Potential for rustling vegetation at higher winds.
NML 2	559956	635582	Bird Song, Distant agricultural activity, Occasional local road traffic noise (RTN).
NML 3	560828	635216	Bird Song. Distant agricultural noise. Robot lawn mower, Potential for agricultural noise. Potential for rustling vegetation at higher winds.
NML 4	561345	633250	Bird Song. Occasional local road traffic noise (RTN), Aircraft overhead. Potential for agricultural noise. Potential for rustling vegetation at higher winds.
NML 5	559880	632950	Bird Song. Occasional local RTN, potential for livestock noise nearby, potential for farm machinery nearby, potential for rustling vegetation in higher winds.
NML 6	558097	632943	Bird Song. Occasional local RTN. Potential for livestock nearby. Potential for agricultural noise. Potential for rustling vegetation at higher winds.

Table 13.6: LiDAR Co-ordinates

Device	ITM X	ITM Y
LiDAR	561017	634633

No significant sources of vibration were observed at any of the survey locations. Suitable noise monitoring instruments which satisfy the requirements of the *IOA Good Practice Guidance No.1* set out in **Section 13.2.2.3** were installed at each of the locations in **Table 13.5**.

The survey was conducted in general accordance with *ISO 1996: 2017: Acoustics - Description, Measurement and Assessment of Environmental Noise* and followed the methodology contained in EPA NG4.

Sections 2.9.1 of the IOA GPG states:

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

The survey period was between 31.07.2024 to 30.08.2024. It was confirmed that the survey period was of sufficient duration to measure adequate data to determine suitable representations of typical background noise levels across an appropriate range of wind speeds.

13.4.6 Instrumentation

The equipment installed at each Noise Monitoring Location (NML) consisted of a Class 1 Sound Level Meter (SLM), outdoor microphone, secondary (double) windscreen, batteries etc. which fully met the requirements set out in ETSU and IOA GPG.

Before and after the measurements, the SLMs were field calibrated using a Brüel & Kjær type 4231 Sound Level Calibrator.

Rainfall was monitored using a rain gauge installed at NML4 which allowed the removal of noise data during precipitation, in line with best practice outlined in IOA GPG Supplementary Guidance Note 2: Data Processing and Derivation of ETSU-R-97 Background Curves.

Microphones were fitted with double windscreens, mounted between 1.2m and 1.5m above ground level and, situated at least 3.5m from the nearest dwelling. The noise meters were located away from obvious sources of noise such as boiler flues, fans and ephemeral running water and at least 3.5m from hard reflective surfaces such as solid fences or walls.

Noise levels in terms of measurement parameters $L_{Aeq,10min}$ and $L_{A90,10min}$ were logged by each SLM. Instrumentation details, calibration certificates and photographs of the installations are given in **Volume III Appendix 13B** of this EIA.

13.4.7 Consideration of Wind Shear

Wind shear can be defined as the changes in the relationship between wind speed at different heights. As part of a robust wind farm noise assessment due consideration should be given to the issue of wind shear which has been considered in accordance with the IOA GPG. It is standard procedure to reference noise data to standardised 10 metre height wind speed. This guidance presents the following equations in relation to the derivation of a standardised wind speed at 10m above ground level:

Equation A

Shear Exponent Profile:

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

Where:

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

Equation B

Roughness Length Shear Profile:

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

Where:

- H_1 the height of the wind speed to be calculated (10m)
- H_2 the height of the measured wind speed.
- U_1 the wind speed to be calculated.
- U_2 the measured wind speed.
- z the roughness length.

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

Any reference to wind speed herein should be understood to be the 10m height standardised wind speed reference unless otherwise stated.

The background noise data has been analysed with respect to a 10m standardised height based on the turbine hub height in accordance with the guidance contained in the IOA GPG.

13.4.8 Meteorological Data

In accordance with the IOA GPG, background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.

A graphical distribution of the measured wind speeds and directions from the baseline monitoring programme is shown **Figure 13-3**.

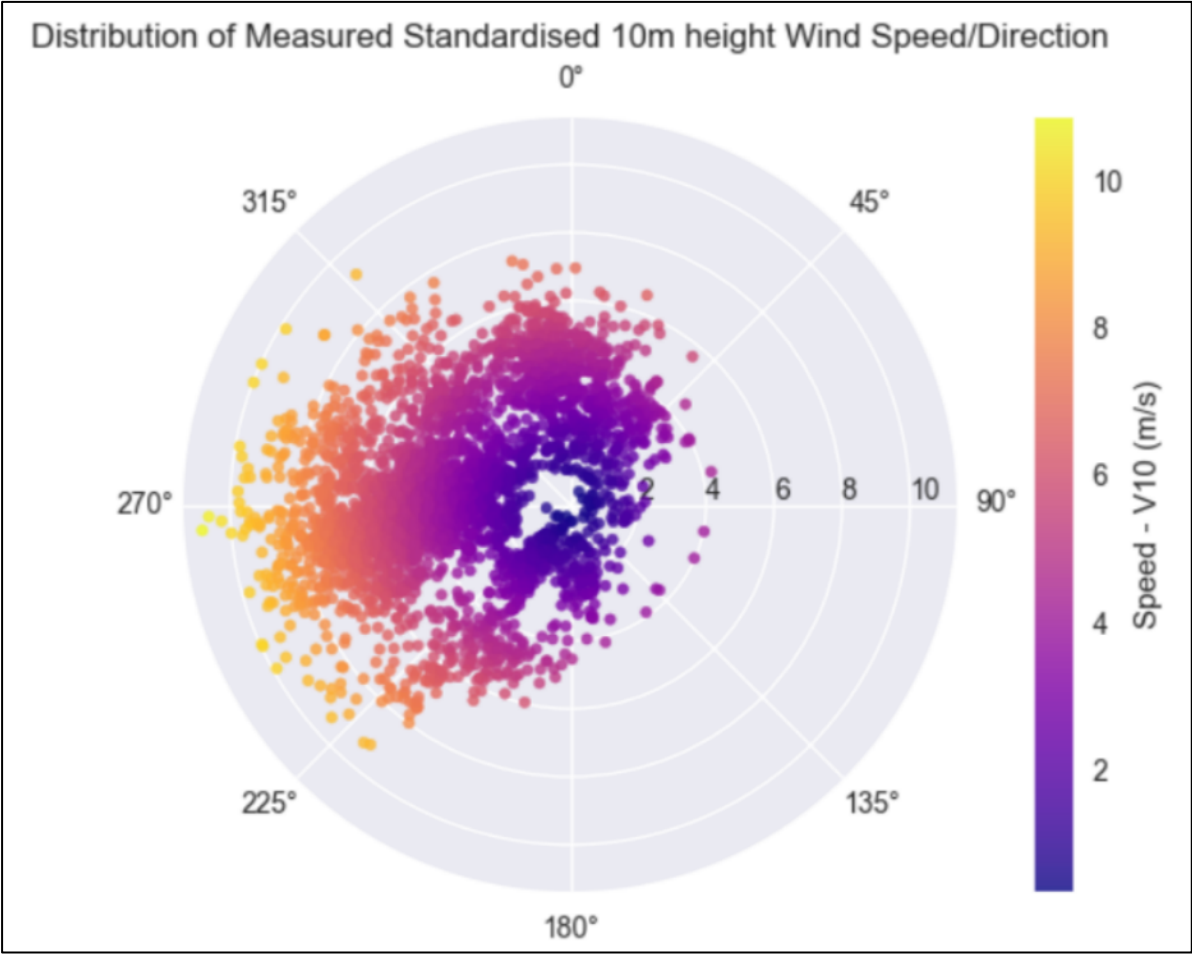


Figure 13-3: Distribution of Measured Standardised 10m height Wind Speed/Direction

13.4.9 Filtering and Analysis of Background Noise Data

Following assessment methods contained in the IOA GPG, the data sets have been filtered to remove issues such as the dawn chorus and the influence of other atypical noise sources. In addition, sample periods affected by rainfall or when rainfall resulted in prolonged periods of atypical noise levels have also been screened from the data sets.

The results presented in the following sections refer to the filtered noise data collated for daytime and night-time amenity periods.

13.4.10 Noise Survey Results

Following IOA GPG and SNG No. 2 Data Collection guidance, for the purposes of setting the noise criteria, the prevailing measured background noise levels are calculated using a best fit polynomial regression line through the measured $LA_{90,10min}$ noise data. These are presented for the Daytime amenity and Night-time periods with green and yellow lines respectively, as shown in **Figure 13-4** to **Figure 13-15**.

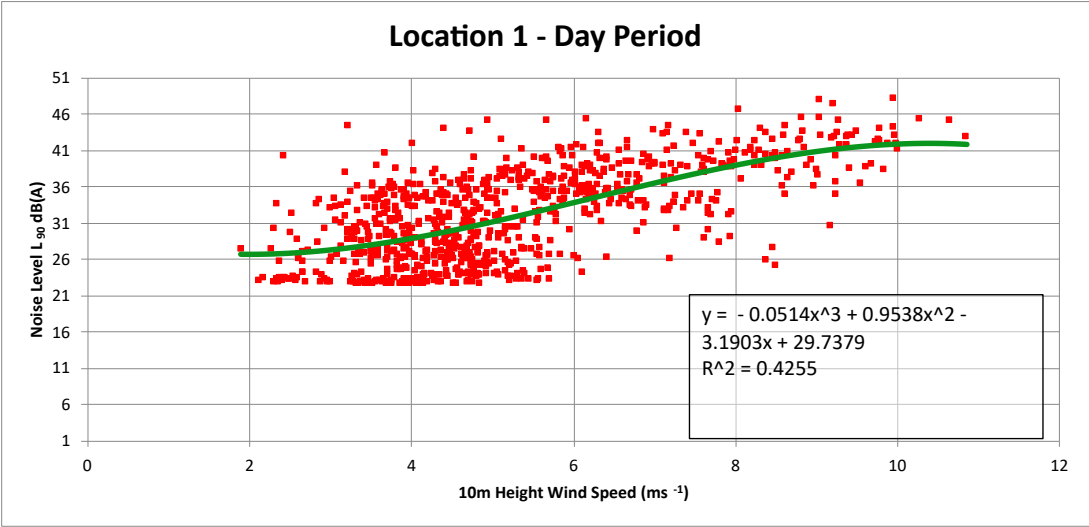


Figure 13-4: NML 1 – Background noise – Daytime Period

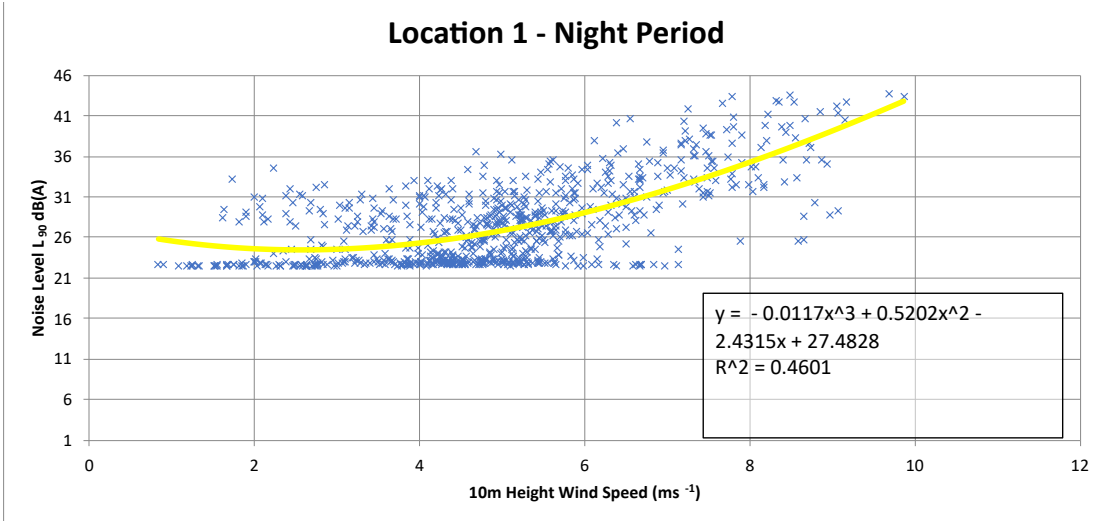


Figure 13-5: NML 1 – Background noise – Night-Time Period

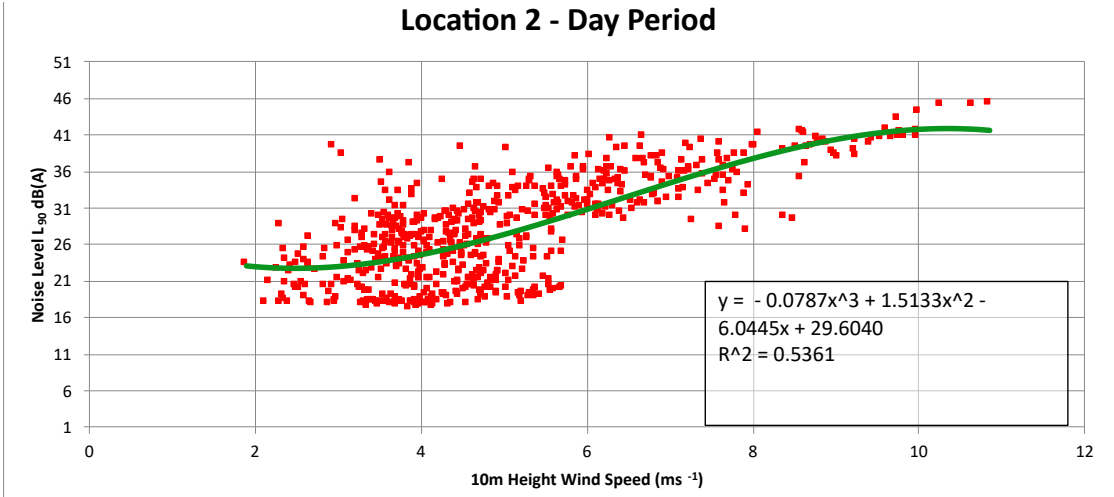


Figure 13-6: NML 2 – Background noise – Daytime Period

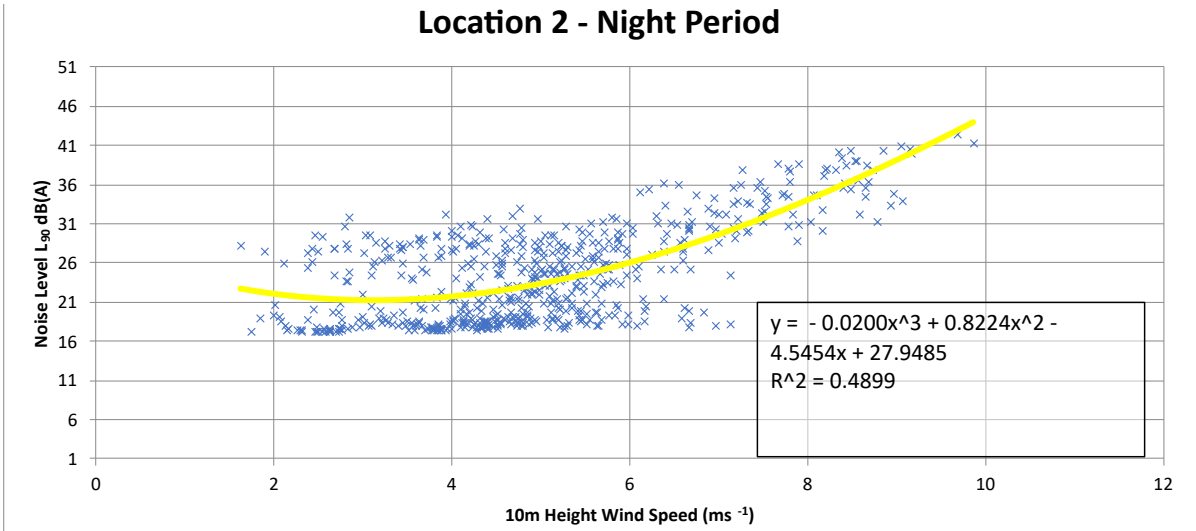


Figure 13-7: NML 2 – Background noise – Night-Time Period

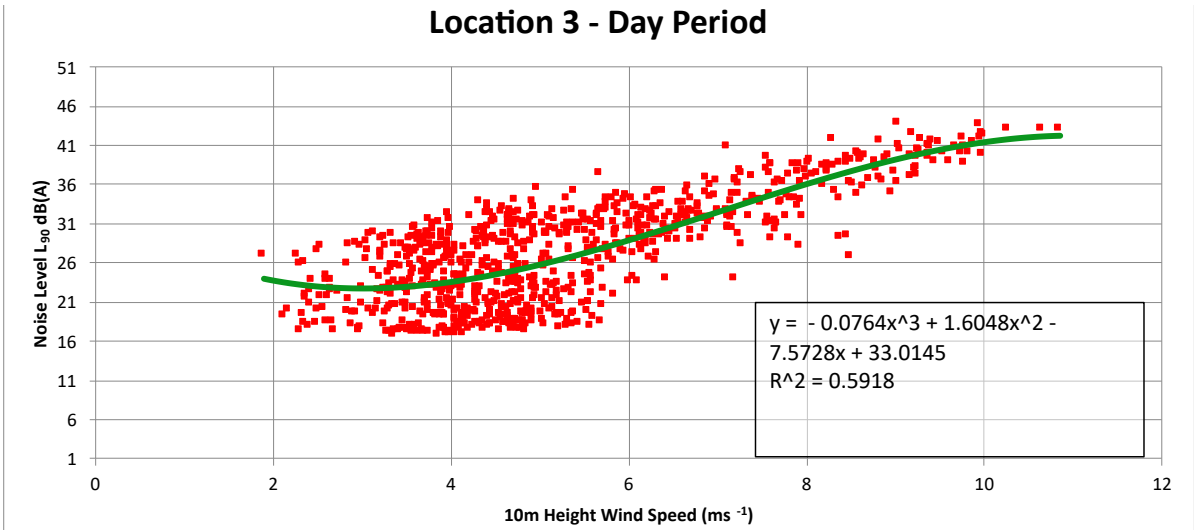


Figure 13-8: NML3 – Background noise – Daytime Period

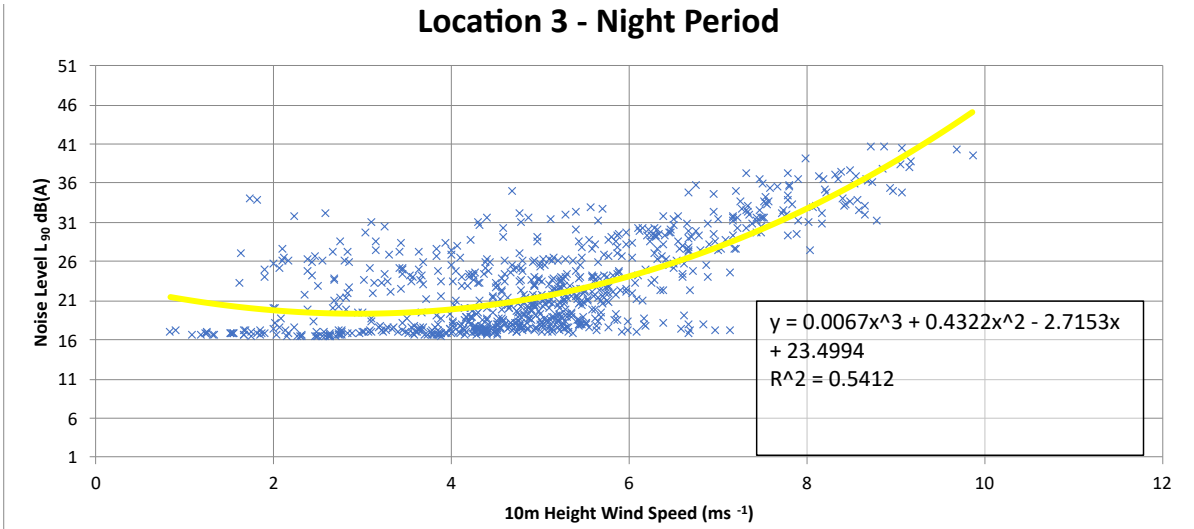


Figure 13-9: NML 3 – Background noise – Night-Time Period

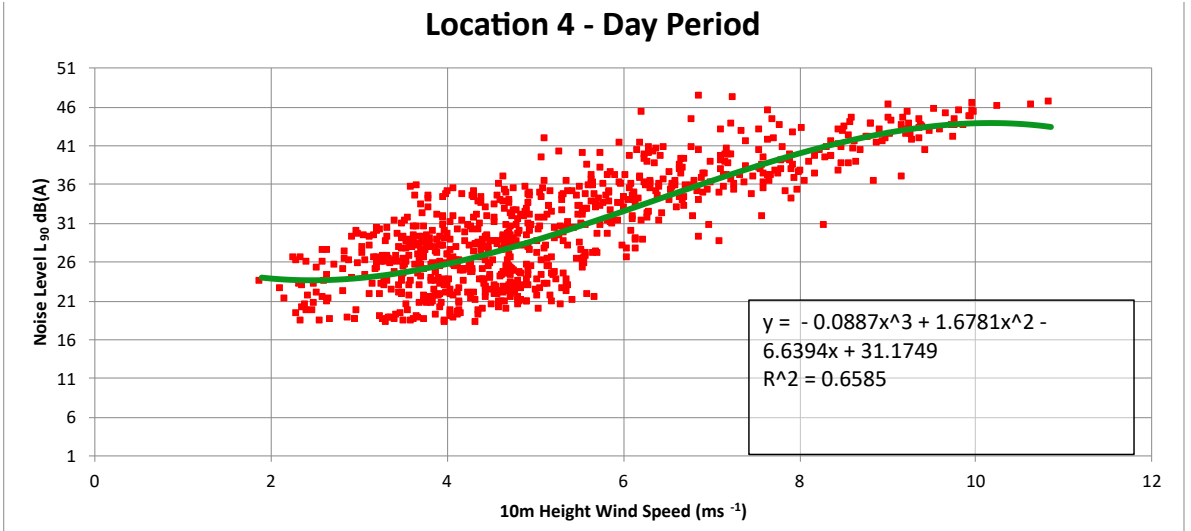


Figure 13-10: NML4 – Background noise – Daytime Period

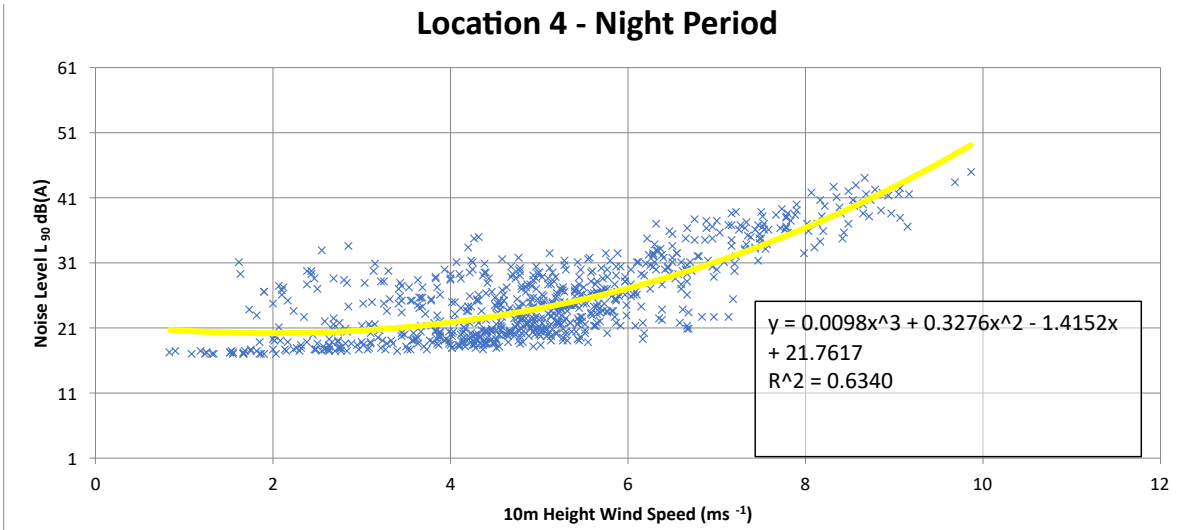


Figure 13-11: NML 4 – Background noise – Night-Time Period

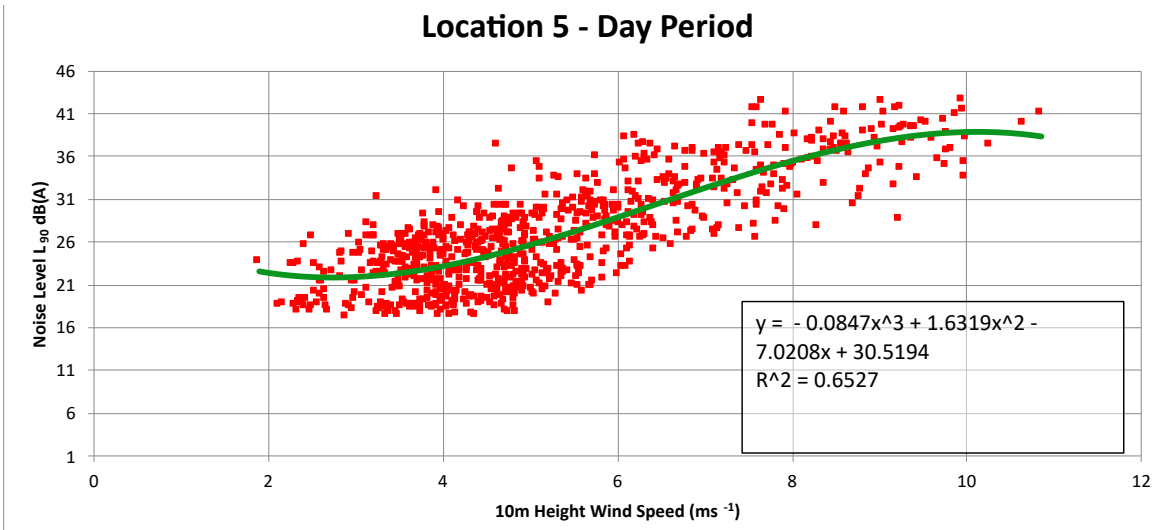


Figure 13-12: NML 5 – Background noise – Daytime Period

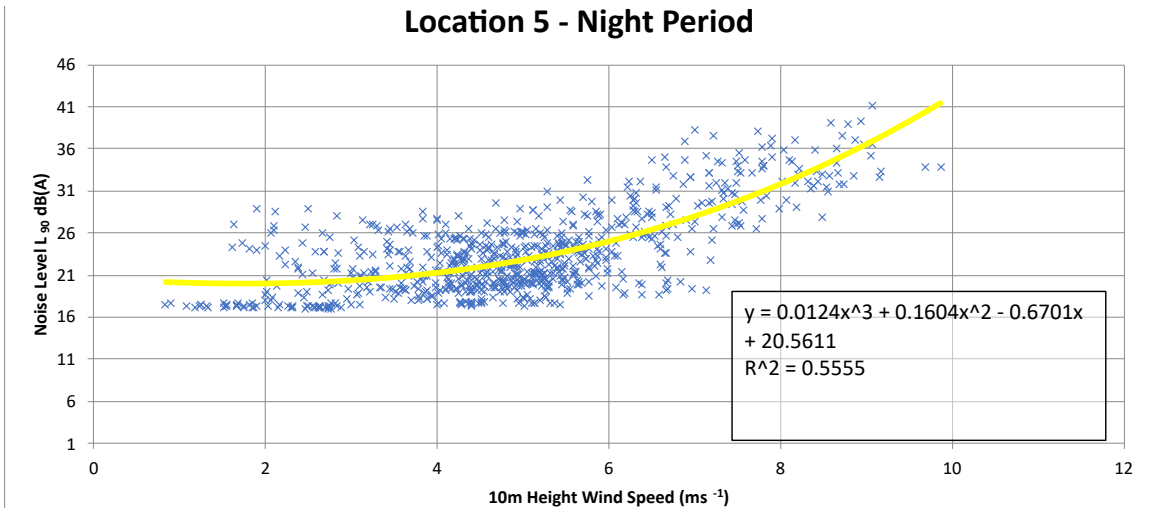


Figure 13-13: NML 5 – Background noise – Night-Time Period

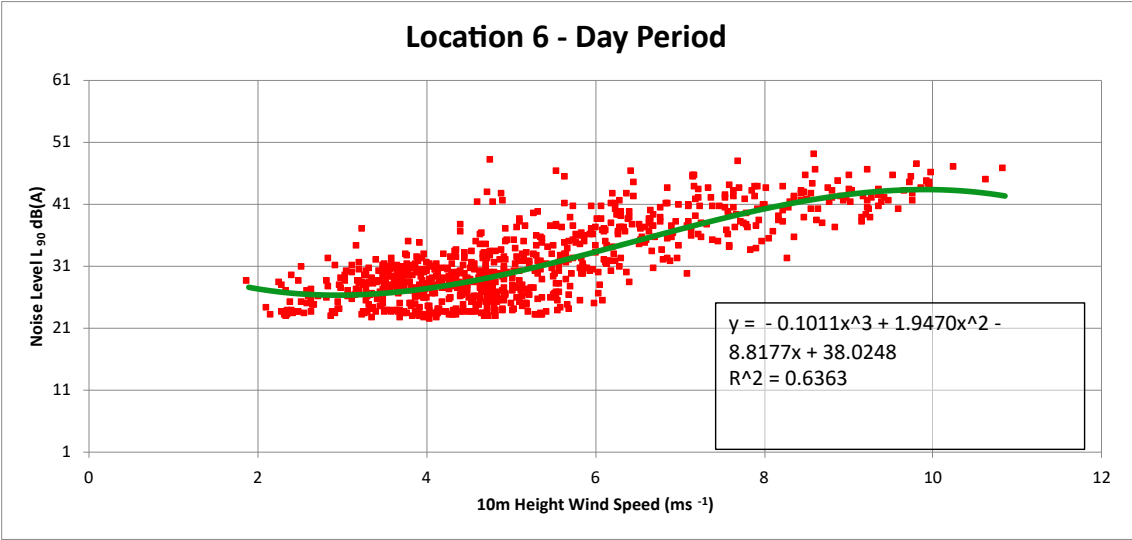


Figure 13-14: NML – Background noise – Daytime Period

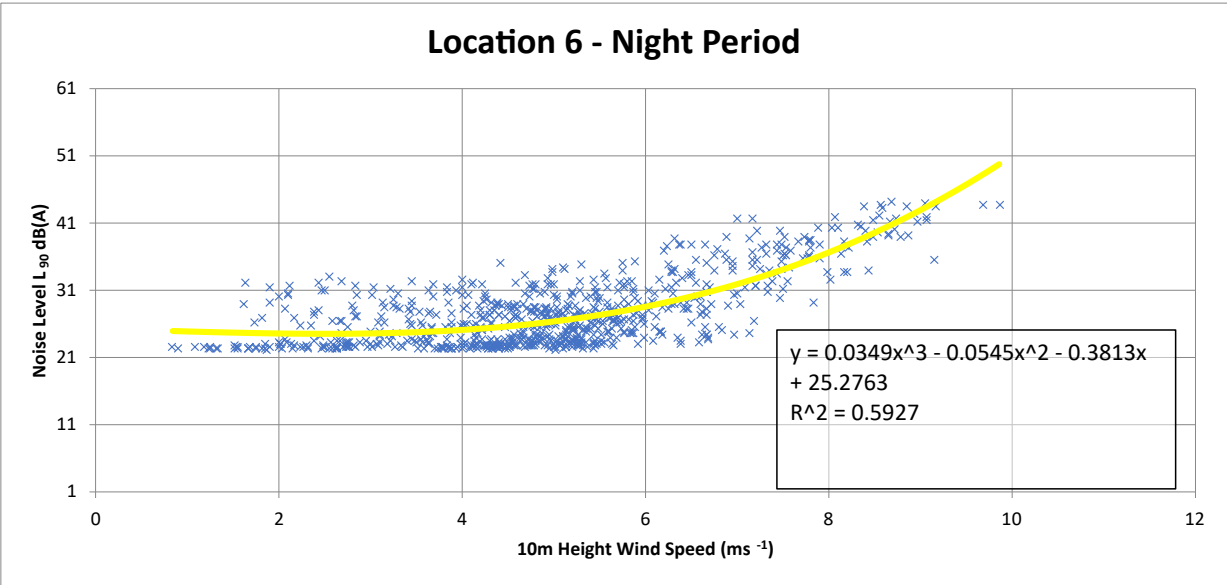


Figure 13-15: NML – Background noise – Night-Time Period

13.4.11Summary of Background Noise Levels

The derived $L_{A90,10\text{min}}$ noise levels for each of the monitoring locations for daytime and night-time amenity hours is presented in **Table 13.7**.

Table 13.7: Derived levels of $L_{A90,10min}$ for Various wind speeds

		Derived $L_{A90,10min}$ Levels (dB) at Standardised 10m Height Wind Speeds (m/s)								
Location	Period	2m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	>10 m/s
NML1	Day	27	27	29	31	34	37	39	41	42
	Night	25	25	25	27	29	32	35	39	43
NML2	Day	23	23	25	27	31	34	38	40	42
	Night	22	21	22	23	26	30	34	39	45
NML3	Day	24	23	24	26	29	32	36	39	41
	Night	20	19	20	22	24	28	33	39	46
NML4	Day	24	24	26	29	33	37	40	43	44
	Night	20	21	22	24	27	31	36	43	50
NML5	Day	22	22	23	26	29	32	35	38	39
	Night	20	20	21	23	25	28	32	37	42
NML6	Day	27	26	27	30	33	37	40	43	43
	Night	25	25	25	26	29	32	37	43	51
Nominal	Day	22	22	23	26	29	32	35	38	39
	Night	20	19	20	22	24	28	32	37	42

The Nominal criteria is the lowest background level from all NMLs per wind speed bin. The Nominal criteria are used to set the wind turbine operational noise limits for all Noise Sensitive Locations and a worst-case impact is therefore assessed.

The Nominal criteria at windspeeds up to 6ms^{-1} satisfies the low background noise criteria as defined in WEDG-06, which will be considered when deriving the noise limits.

13.4.12 Ambient Noise Levels

Noise levels in terms of L_{Aeq} and L_{A90} parameters are derived from the measured noise data following the guidance set out in *ISO 1996-1:2016*. The results are used to establish the following:

- The appropriate construction noise limit (L_{Aeq})
- The baseline level for the BS4142 impact assessment of the Substation (L_{A90}).

The Ambient (L_{Aeq}) and Background (L_{A90}) noise levels (rounded to the nearest integer) as measured at each NML and the averages are given in **Table 13.8**.

Table 13.8: Summary of Ambient and Background Noise Levels

Noise Monitoring Location	Daytime (07:00-19:00)		Night-time (23:00-07:00)	
	L_{Aeq} (dB)	L_{A90} (dB)	L_{Aeq} (dB)	L_{A90} (dB)
1	37	29	31	25
2	29	21	22	17
3	32	24	28	20
4	34	26	28	22
5	31	23	27	21
6	37	28	32	25
Average	33	25	28	22

13.5 Impact Assessment and Potential Effects

13.5.1 Evolution of the Baseline (Do Nothing Scenario)

If the Proposed Development is not progressed the existing noise environment will remain largely unchanged. Traffic noise is currently the most significant noise source in the area. In the absence of the Proposed Development, increases in traffic volumes on the local road network would be expected over time and would likely result in a slight but imperceptible increase in the overall baseline noise levels.

13.5.2 Construction Phase

The duration and phasing of the construction of the proposed development is provided in the Construction Environmental Management Plan (CEMP) in **Volume III Appendix 2A** of this EIAR and the noise impacts associated with activities are assessed in this section.

13.5.2.1 Construction Noise Limit

Using the Ambient noise levels from **Section 13.4.12** and following the methodology from *BS 5228-1:2009+A1:2014* set out in **Table 13.2**, the appropriate noise category has been established as Category A (the lowest limit) for all locations.

A summary of the construction noise criteria is therefore as follows:

- Monday to Friday 07:00 – 19:00 $L_{Aeq, 1hr}$ 65dB
- Saturdays 07:00 – 13:00 $L_{Aeq, 1hr}$ 65dB
- Saturdays 13:00-14:00 $L_{Aeq, 1hr}$ 55dB

13.5.2.2 Construction Working Hours

It is proposed that construction will occur within the hours 07.00am – 7.00pm, Monday to Saturday or as otherwise conditioned as part of the consent.

Due to the requirement for the concrete pours to be continuous, the working day may extend outside normal working hours in order to limit the traffic impact on other road users, particularly during peak school and work commuter traffic periods. Such activities are limited to the day of turbine foundation concrete pours, which are expected to be completed in a single day per turbine.

Turbine and crane erections may also occasionally occur outside of these times in order to take advantage of low wind periods. Working hours will be confirmed at the outset of the project and any changes in hours will be agreed with the Local Authority. The lower Category A limits for construction activities outside of the typical construction periods as set out in **Table 13.2** are applicable.

Subject to agreement with the Local Authority, works along public roads are expected to take place between 07.00 to 19:00, Monday to Friday and 09.00 to 14.00 on Saturdays.

No work will take place on Sundays or bank holidays unless agreed in advance with the Local Authority.

13.5.2.3 Construction Methodology

Notwithstanding that there are discrete construction activities set out in the CEMP, many of these share the same items of plant to perform the works. It is therefore appropriate, for the purposes of assessing the noise impacts, to group the activities as set out in **Table 13.9**.

Table 13.9: Summary of Proposed Construction Elements

Elements
Site Preparation – Tree Felling
Temporary Construction Compound
Permanent Meteorological Mast

Elements
Site Entrances, Internal Access Tracks, and Water Management
Traffic Management
Borrow Pits
Turbine Hardstands and Foundations
External Grid Connection and Jointing Bays
Substation Compound and Building
Horizontal Directional Drilling
Turbine Delivery
Turbine Erection
Vibration (General Works)
Vibration (Blasting Events)
Public Road Works for Turbine Delivery

The noise impact associated with each construction phase is estimated using expected typical construction methods and items of plants. These have been acquired from similar constructions and/or using guidance set out in *British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*.

Using this information the noise impacts can be predicted at the closest NSLs to the works and the results compared with the construction noise limit. Noise Sensitive Locations further away will have a reduced noise impact so worst case assessments are presented in the following sections.

No mitigation measures e.g. site hoarding, have been included in the predictions unless otherwise stated and, all noise sources are assumed to operate simultaneously and the results therefore represent a worst case assessment.

The appropriate effect categories based on the construction noise limit being satisfied for each stage are summarised at the end of this section in **Section 13.5.2.20**.

13.5.2.4 Site Preparation – Tree Felling

Felling of some hedgerows and portions of existing woodland will be required within and around wind farm infrastructure to accommodate the construction of the turbine foundations and associated hardstands, access tracks, turbine assembly, turbine delivery routes, and substation.

From the information provided in Section 4.1.3 of the **CEMP**, the closest NSL (NSL520) to this activity is c535m west of Turbine 9.

Indicative noise sources have been identified and predictions of the potential noise levels at the closest distance is given in **Table 13-10**.

Table 13.10: Indicative Tree Felling Noise Emission Levels

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dBA)	Predicted Noise level at nearest NSL (dBA)
	10m	535m
Forwarder	79	44
30-50T Excavator	79	44
Chainsaw	83	48
Total	86	51
¹ Typical/best practice 66% on-time applied.		

A total construction noise level of 51dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB $L_{Aeq,1hr}$. The effect is therefore expected to be **Not Significant**.

The duration of the likely effect is expected to be **Temporary**.

13.5.2.5 Temporary Construction Compound

Three (3no.) temporary construction compounds and welfare facilities will be constructed as set out in **Section 4** of the **CEMP Volume III 2A** of this **EIAR**. The distance to the nearest NSL (NSL359) from any of the construction compounds is 114m west as shown in **Figure 13-16**.



Figure 13-16: Location of Temporary Compound and the nearest NSLs

The associated items of construction plant, their noise emission levels, estimated operation on-times during a typical construction period and the predicted combined noise impact at the closest NSL are given in **Table 13-11**.

Table 13.11: Indicative Temporary Compound Construction Noise Emission Levels.

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
Telescopic Handler (C2.35)	71	80	49
Mobile Crane (C3.29)	70	80	48
Tracked Excavator (22 t) (C6.10)	79	80	57
Tracked Excavator (22 t) (C2.3)	78	80	56
Vibratory Roller (12t) (C5.21)	80	80	58
Articulated Dump truck (C4.2)	78	80	56
Tractor (towing trailer) (C4.75)	79	80	57
Wheeled Excavator (14 t) (C4.12)	77	80	55
Mini tracked excavator (5 t) (C4.68)	69	80	47
Diesel Generator (C4.76)	61	80	39
Total			65
¹ Typical/best practice assumption. No screening correction has been applied.			

A total construction noise level of 65dB L_{Aeq} at the nearest NSL has been predicted which is at the limit of 65dB L_{Aeq,1hr}.

The predicted noise level is at the limit and therefore the effect is expected to be **Slight**, and the duration **Temporary**.

13.5.2.6 Deposition Areas

Eleven (11) No. areas (9 permanent and 2 temporary) will be utilised as material storage areas during the construction phase. Excess material will be transported to and from the works areas and loaded/unloaded as required.

The distance to the nearest NSL from any of the deposition areas is c35m south of NSL061 as shown in **Figure 13-17**.



Figure 13-17: Location of closest NSLs to a Deposition area.

The identified items of construction plant, their noise emission levels and estimated operation on-times during a typical construction period are given in **Table 13-12**.

Table 13.12: Indicative Deposition Area Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dBA)	% on-time ¹
Tracked Hydraulic Excavator (37t) (C10.1)	Extracting/loading	80	80
Dozer (41t) (C2.10)	Earthworks	80	80
Rigid dump truck (40 tonne) (C9.24)	Distribution of material	85	80
Articulated Dump Truck (23t) (C2.33)	Distribution of material	81	80
¹ Typical/best practice assumption. No screening correction has been applied.			

Noise emissions are the result of a combination of slow-moving mobile plant transporting material to/from the Deposition area and fixed plant operating at the site. Suitable adjustment factors, as described in Methodology 2.7.1.3 of BS 5228-1:2009, have been applied in this assessment.

A construction noise level of 45 dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB $L_{Aeq,1hr}$.

The predicted noise level is below the limit and therefore effect is expected to be **Not Significant**, and the duration **Temporary**.

13.5.2.7 Permanent Meteorological Mast

The permanent meteorological mast will be installed c373m north of the closest NSL (NSL157).

The identified items of construction plant, their noise emission levels and estimated operation on-times during a typical construction period are given in **Table 13-13**.

Table 13.13: Indicative Permanent Meteorological Mast Construction Noise Emission Levels.

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
Telescopic Handler (C2.35)	71	80	39
Mobile Crane (C3.29)	70	80	38
Tracked Excavator (22 t) (C6.10)	79	80	47
Tracked Excavator (22 t) (C2.3)	78	80	46
Vibratory Roller (12t) (C5.21)	80	80	48
Articulated Dump truck (C4.2)	78	80	46
Tractor (towing trailer) (C4.75)	79	80	47
Wheeled Excavator (14 t) (C4.12)	77	80	45
Mini tracked excavator (5 t) (C4.68)	69	80	37
Diesel Generator (C4.76)	61	80	29
Total			54
¹ Typical/best practice assumption. No screening correction has been applied.			

A total construction noise level of 54dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB $L_{Aeq,1hr}$.

The predicted noise level is below the limit and therefore effect is expected to be **Not Significant**, and the duration **Temporary**.

13.5.2.8 Site Entrances, Internal Access Tracks and Water Management

The noise impact associated with the construction of site entrances, internal access tracks, and water management are considered here. New access tracks will be constructed to access each of the turbines, substation compound and meteorological mast.

A total of nine site entrances will be used during the construction phase, comprising eight new entrances and one existing entrance.

The distance to the nearest NSL from an access track or site entrance, or any works associated with the water management is c35m north of NSL501 as shown in **Figure 13-18**.



Figure 13-18: Location of Access tracks and closest NSLs.

The identified items of construction plant, their noise emission levels and estimated operation on-times during a typical construction period are given in **Table 13-14**.

Table 13.14: Indicative Site Access and Internal Access Track Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dBA)	% on-time ¹
Dozer (35 tonne) (C5.14)	Ground excavation/earthworks	86	40
Wheeled loader (C10.5)	Loading lorries	80	40
Rigid dump truck (40 tonne) (C9.24)	Distribution of material	85	40
Dozer (14 tonne) (C5.12)	Spreading chipping/ fill	77	40
Vibratory Roller (12t) (C5.21)	Compaction	80	20
Mobile Crane (C3.29)	Lifting	70	80
Diesel Pump (C4.88)	Pump Water	68	100
¹ Typical/best practice assumption. No screening correction has been applied.			

The resultant noise level from slow-moving mobile plant operating in close proximity to a NSL varies as the plant moves. Suitable adjustment factors, as described in Methodology 2.7.1.3 of BS 5228-1:2009, have been applied in this assessment.

A construction noise level of 64dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB $L_{Aeq,1hr}$.

The predicted noise level is below the limit and therefore the effect is therefore expected to be **Not Significant**. The works will progress at pace and are expected to last a number of days at any one location. The duration of the likely effect is therefore **Temporary**.

13.5.2.9 Traffic Management

The noise impact associated with the transportation of construction material and are considered here.

The peak period for material deliveries will be during internal Site Access Track construction. During this period there will be up to 5no. deliveries to site per hour for a period of approximately one week (peak period). Outside this period there will be up to 10no. deliveries of material to site per day (equates to <1.25 per hour).

Construction traffic will be carried on the existing public road network and the closest NSLs lie approximately 10m from the route. Using formula F.2.5 from BS 5228-1:2009+A1:2014, the associated noise level has been calculated as follows:

- Typical period (1 HGV per hour): 37dB
- Peak period (5 HGVs per hour): 43dB

To assess traffic noise impacts, it is appropriate and best practice to evaluate the change of noise level as a result of the increase in road traffic volumes associated with the delivery of material to the site rather than assess against the construction site's noise limit.

The IEMA Guidelines set out in **Section 13.4.2** consider a change in traffic noise levels of 3dB to 4.9dB would be noticeable, in excess of 5dBA would be clearly noticeable, and depending on the final noise level, the impact may be Slight/Moderate or Significant. A change in noise level of less than 3dB would be imperceptible.

The measured existing Ambient noise level was 33dB L_{Aeq} as set out in **Table 13-8**. Referencing the noise level change criteria provided in **Section 13.2.2.15**, the change in noise level ranges from 4dB for the Typical period to 10dB for the Peak period.

The change in noise level during the typical period therefore equates to a **Slight** impact and the increase during the peak period equates to a **Significant** impact. As has been outlined above, the effects associated with the Peak period will last for one week and the duration of the likely effect is therefore **Temporary**.

13.5.2.10 Borrow Pits

Two (2no.) proposed on-site borrow pits will provide the majority of the required fill material for internal tracks, passing bays, hardstands, foundations, and temporary compounds. The noise and vibration impacts associated with the works at the borrow pits are addressed here.

Borrow Pit 1 is located to the east of Turbine 1 (T1) closest to NSL359 and Borrow Pit 2 is situated to the south of Turbine 12 (T12) closest to NSL157. The closest NSL to either borrow pit is NSL157 located c50m south of Borrow Pit 2 as shown in **Figure 13-19**.



Figure 13-19: Borrow Pit 2 and nearest NSL.

The extraction of rock from the borrow pit is proposed to be undertaken by a combination of rock breaking and ripping.

The associated items of construction plant, their noise emission levels, expected operational on-times and the predicted combined noise impact at the closest NSL are given in **Table 13-15**.

Table 13.15: Indicative Rock-breaking Noise Emission Levels

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
Diesel Pump (C4.88)	Pump Water	68	100	54
Tracked Hydraulic Excavator (37t) (C10.1)	Face shovel extracting /loading dump trucks	80	75	65
Tracked crusher (90t) (C9.14)	Crushing/Screening	90	50	73
Crawler mounted dozer (48t) (C.6.28)	Ripping	85	50	68
Tracked Excavator (21t) (C4.65)	Trenching	71	50	54
Dozer (41t) (C2.10)	Ground excavation / earthworks	80	50	63
Articulated Dump Truck (23t) (C2.33)	Distribution of materials	81	50	64
Total				75
¹ Typical/best practice assumption. No screening correction has been applied.				

A construction noise level of 75 dB L_{Aeq} at the nearest NSL has been predicted which exceeds the limit of 65dB $L_{Aeq,1hr}$. The predicted noise level is >10dB above the limit and the effect is therefore expected to be **Very Significant**, and the duration of the likely effect is **Temporary**.

Ground-borne Vibration

It is not possible to accurately predict the expected vibration levels to the NSLs because of many variables that cannot be quantified including the nature of the works, the rock type and the intervening substrate between the works and the NSL. However, empirical data indicates that at distances of less than 200m there is potential for the vibration criteria set out in **Section 13.2.1.2** to be exceeded and the effect to be Significant.

The effect is expected to be **Significant** and the duration **Temporary**.

Noise – Air Overpressure (AOP)

Air overpressure is energy transmitted as pressure waves. This is a similar process to sound wave transmission but with fluctuations exceeding the ambient air pressure level. The maximum excess pressure in this wave is known as the peak air overpressure and is expressed in terms of dB (Lin).

The intensity of AOP from blasting relates to blast design and set up (e.g., detonating cord, stemming release and gas venting) and physical properties of the site (rock density, movement and reflection of stress waves). The transmission of the pressure wave through the atmosphere is highly dependent on meteorological conditions (temperature, cloud cover, humidity, wind speed and direction etc.). Due to the large variability in these conditions, it is not possible to reliably calculate AOP. The control of its intensity is therefore undertaken at source through careful blast design.

The majority of the energy is at frequencies of less than 20Hz and therefore inaudible but is sensed as pressure.

The effect is expected to be **Imperceptible** and the duration **Momentary**.

13.5.2.11 Turbine Hardstands and Foundations

The noise impact associated with the construction of Turbine Hardstands and Foundations is considered here.

The works may, subject to ground inspection, be undertaken by general construction techniques or supplemented with piling. Both activities have been assumed as a worst-case assessment.

The distance to the nearest NSL (NSL520) from a wind turbine is c 535m west of Turbine 9 as shown in **Figure 13-20**.

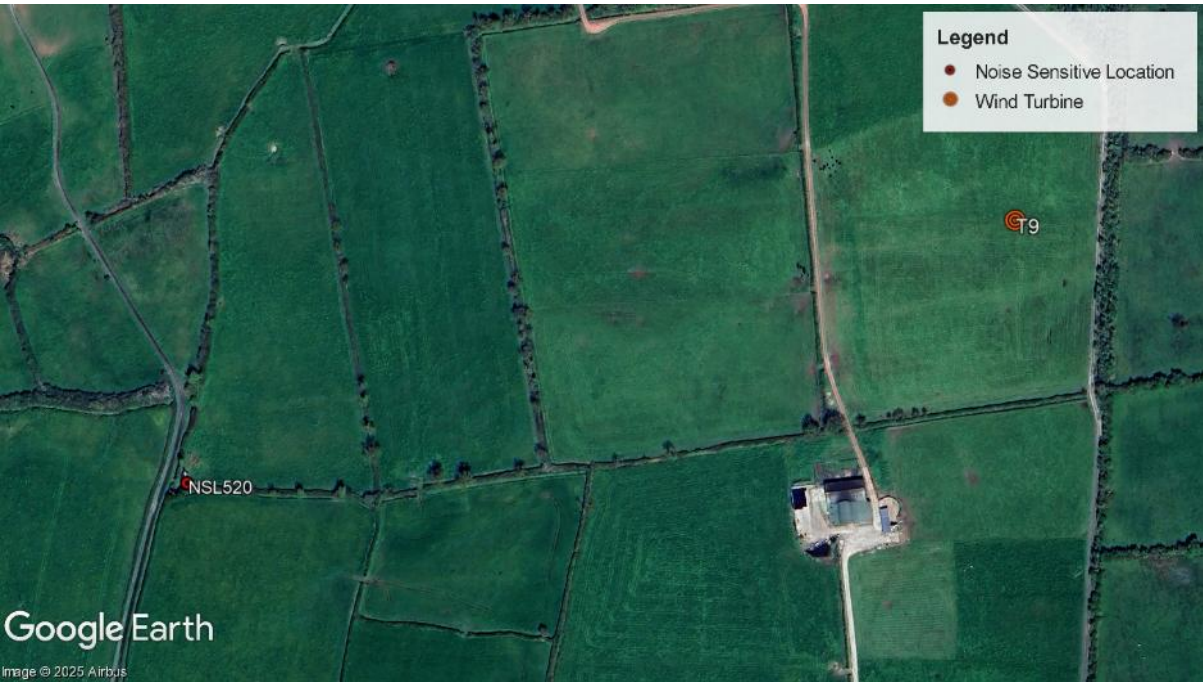


Figure 13-20: Location of the nearest NSL to a Turbine

The identified items of construction plant, their noise emission levels, estimated operation on-times during a typical construction period and the predicted combined noise impact at the closest NSL are given in **Table 13-16**.

Table 13.16: Indicative Wind Turbine Construction Noise Emission Levels.

Item (BS 5228 Ref.)	Activity/Notes	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
HGV Movement (C.2.30)	Removing soil and transporting fill and other materials.	79	100	44
Tracked (C.4.64)	Excavator Removing soil and rubble in preparation for foundation.	77	80	41
Excavator Mounted Rock Breaker (C9.12)	Excavation in rocky areas	85	80	49
Piling (C.12.14)	Operations Standard pile driving	88	50	50
General (Various)	Construction All general activities plus deliveries of materials and plant	84	80	48
Concrete Mixer Truck and Concrete Pump (C.4.27)	Turbine Foundations	75	80	39
Dumper Truck (C.4.4)	Backfilling Turbine Foundations	76	80	40
Mobile Telescopic Crane (C.4.39)	Turbine Erection	77	80	41
Dewatering (D.7.70)	Pumps If required	80	80	44
JCB (D.8.13)	For services, drainage and landscaping.	82	100	47
Vibrating Rollers (D.8.29)	Track surfacing	77	80	41
Total				56
¹ Typical/best practice assumption. No screening correction has been applied.				

A total construction noise level of 56dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB L_{Aeq,1hr}.

The predicted noise level is below the limit therefore the effect is expected to be **Not Significant** and the duration **Temporary**.

13.5.2.12 External Grid Connection and Jointing Bays

The grid connection including jointing bays will route to the Killonan 220/110kV substation as shown in **Figure 13-21**.



Figure 13-21: Grid Connection Route

The works can be separated into two phases:

- 1) trenching, duct works and filling and;
- 2) reinstatement.

Distances to the nearest NSLs along the route vary considerably and it is therefore appropriate to calculate the potential noise emissions at various distances.

Within each phase a sequence of activities will take place and the identified items of construction plant, their noise emission levels, percentage on-times (accounting for the construction sequence) and the predicted combined noise impact at the closest NSL for each phase are given in **Table 13-17** and **Table 13-18**.

Table 13.17: Indicative Grid Connection Noise Emission Levels – Phase 1

Item (BS 5228 Ref.)	Noise Emission Levels ¹ at Various Distances		
	20m	30m	40m
HGV Movement (C.2.30)	62	58	56
Tracked Excavator (C.4.64)	61	57	55
Excavator Mounted Rock Breaker (D8.12)	70	66	64
Total	70	67	64
¹ Typical/best practice assumption.			

Table 13-18 Indicative Grid Connection Noise Emission Levels – Phase 2

Item (BS 5228 Ref.)	Noise Emission Levels ¹ at Various Distances		
	20m	30m	40m
HGV Movement (C.2.30)	62	58	56
Tracked Excavator (C.4.64)	61	57	55
Vibrating Rollers (D.8.29)	69	65	63
Total	70	67	64
¹ Typical/best practice assumption.			

A maximum construction noise level of 70 dB L_{Aeq} at 20m has been predicted which exceeds the limit of 65dB L_{Aeq,1hr}. At distances greater than 40m the construction noise limit is not expected to be exceeded.

The significance of the effect will vary depending on the distance from the works, with effects being **Not Significant** at distances greater than 40m and **Slight** for receptors closer to the active construction area. Approximately 100m of Grid Connection works is expected to be constructed per day and the duration of the likely effect is therefore **Brief**.

13.5.2.13 Substation Compound and Building

The noise impact associated with the construction of Substation compound and Building is considered here.

The distance to the nearest NSL (NSL422) from the substation compound is c565m northeast as shown in **Figure 13-22**.



Figure 13-22: Location of substation compound

The identified items of construction plant, their noise emission levels, estimated operation on-times during a typical construction period and the predicted combined noise impact at the closest NSL are given in **Table 13-19**.

Table 13.19: Indicative Substation Construction Noise Emission Levels

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
Telescopic Handler (C2.35)	71	80	35
Mobile Crane (C3.29)	70	80	34
Tracked Excavator (22 t) (C6.10)	79	80	43
Tracked Excavator (22 t) (C2.3)	78	80	42
Vibratory Roller (12t) (C5.21)	80	80	44

Item (BS 5228 Ref.)	Plant Noise level at 10m Distance (dBA)	% on-time ¹	Predicted Noise level at nearest NSL (dBA)
Articulated Dump truck (C4.2)	78	80	42
Tractor (towing trailer) (C4.75)	79	80	43
Wheeled Excavator (14 t) (C4.12)	77	80	41
Mini tracked excavator (5 t) (C4.68)	69	80	33
Diesel Generator (C4.76)	61	80	25
Total			51
¹ Typical/best practice assumption. No screening correction has been applied.			

A total construction noise level of 51dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB L_{Aeq,1hr}.

The predicted noise level is below the limit and therefore the effect is expected to be **Not Significant**, and the duration **Temporary**.

13.5.2.14 Horizontal Directional Drilling

The proposed crossing methodology for the grid connection route is outlined in **Volume II, Chapter 2** Description of the Development, Section 2.4.13.1 of the **EIAR**. The noise impact associated with Horizontal Directional Drilling is considered here.

Indicative locations of the launch/receive pits are identified on the Planning Drawings accompanying this EIAR, however the locations may change at detailed design stage. Therefore, as a working assumption, the nearest identified Noise Sensitive Location (NSL) is estimated to be approximately 80m from the Launch/receive pit.

Indicative noise sources have been identified and calculated noise levels and estimated operation on-times during a typical construction period are given in **Table 13-20**.

Table 13.20: Indicative HDD Noise Emission Levels

Item (BS 5228 Ref.)	% on-time ¹	On-time Level (dB)	Predicted Noise level at 80m (dB)
Directional drill (C.2.44)	66	75	57
Mud Pump (D.7.70)	66	78	60
Diesel Pump (C4.88)	66	66	48

Tractor (D.10.220)	66	84	66
Dumper Truck (C.4.4)	66	74	56
Total			68
¹ Typical/best practice assumption. No screening correction has been applied.			

A total construction noise level of 68 dB L_{Aeq} has been predicted which exceeds the limit of 65dB $L_{Aeq,1hr}$.

The predicted noise level is above the limit and therefore the effect is expected to be **Slight**. The works will progress at pace and are expected to be completed within a week at any one location. Therefore, the duration of the likely effect is **Temporary**.

13.5.2.15 Turbine Delivery

Due to their abnormal size, blades and towers are proposed to be delivered at night to avoid disruption to daytime traffic using a convoy of slow moving vehicles. The exact specification of the transport convoy is not yet defined at this stage of the Proposed Development but based on the author's expertise and professional judgement, the noise impact of this the transporting operation can be suitably assessed using formula F.2.5 from BS 5228-1:2009+A1:2014.

The noise level associated with this operation has been calculated as 33dB L_{Aeq} at the closest NSLs (approximately 20m from the turbine delivery route). This noise level is marginally above the measured ambient night-time noise level of 28 dB L_{Aeq} as given in **Table 13-8**, however this 5dB increase would be subjectively imperceptible. The predicted level is also considerably below the 45dB maximum façade noise level recommended by the WHO to prevent sleep disturbance. As the increase in noise is minimal and well below the recommended thresholds, the significance of the effect is considered **Not Significant**. The convoy will quickly move along the route and therefore the duration of the effect is **Brief**.

13.5.2.16 Turbine Erection

The noise impact associated with the wind turbine erection, as highlighted in **Section 4** of the **CEMP**, are assessed here.

It is proposed that the erection of wind turbines will occur during the final months of the construction phase, with the process following a carefully coordinated schedule and using specialist lifting equipment with an average rate of one turbine being erected per week. The turbine erection process is a precision operation that relies on specialist plant and favourable weather conditions to ensure safe and accurate installation.

The distance to the nearest NSL (NSL 520) from a turbine erection is c. 535m. The identified items of construction plant, their noise emission levels, estimated operation on-times during a typical construction period and the predicted combined noise impact at the closest NSL are given in **Table 13-21**.

Table 13.21: Indicative Turbine Erection Construction Noise Emission Levels

Item (BS 5228 Ref.)	% on-time ¹	On-time Level (dB)	Predicted Noise level at 535m (dB)
2no. Mobile Telescopic Cranes (C.4.39)	80	79	44
Total			44
¹ Typical/best practice assumption. No screening correction has been applied.			

A total construction noise level of 44dB L_{Aeq} at the nearest NSL has been predicted which is below the limit of 65dB $L_{Aeq,1hr}$.

The predicted noise level is below the limit and therefore the effect is expected to be **Not Significant**, and the duration **Temporary**.

13.5.2.17 Vibration - General Construction Works

There are no substantial sources of vibration associated with the plant and activities of the general construction works and the distances to the nearest NSLs are such that vibration effects will be negligible. The effect is therefore expected to be **Not Significant** and the duration **Temporary**.

13.5.2.18 Vibration - Blasting Events

The level of vibration at a receiver location from a blast depends predominately on the distance from the blast, the maximum instantaneous charge (MIC), sequencing of charges and ground conditions between the blast area and the receiver location.

In the case of the proposed development, any blasting requirements will be designed and managed by a competent blasting supervisor. The blast charge will be designed to ensure the potential of ground-borne vibration is within the limits set out in **Section 13.2.1.2**. Therefore the effect associated with blasting events at turbine foundations is considered to be **Not Significant** and **Brief**.

13.5.2.19 Public Road Works for Turbine Delivery

The components for each turbine are expected to be delivered from Foynes Port along the route as described in **Section 4.2.16** of the **CEMP**. To facilitate abnormal load vehicle wheel over-run some localised temporary widening and stoning of public road verges and roundabouts will be required on the Turbine Delivery Route (TDR). In addition, edge cutting as well as temporary / permanent relocation of utility overhead lines, poles, lampposts, signage, and other street furniture will also be required. To facilitate the turbine delivery a new temporary access track is proposed on privately-owned predominantly agricultural lands within the townland of Tullovin approximately 3.3km southeast of Croom, Co. Limerick.

These works are considered minor from a noise impact perspective and will be conducted as required during the daytime periods. The impact is therefore considered **Slight**. Works are expected to be completed within a number of days, therefore the impact duration will be **Temporary**.

13.5.2.20 Decommissioning Phase

During the decommissioning phase of the proposed Project, there will be some effects on nearby noise sensitive properties due to noise emissions from site traffic and other on-site activities. Similar overall noise levels as those calculated for the construction phase would be expected, as similar tools and equipment are used.

However, certain infrastructure components will not be decommissioned, meaning there will not be an associated noise impact at certain locations. Specifically, the Onsite Substation and the GCR will remain part of the national infrastructure and will not be removed.

The effect is expected therefore to be **Not Significant** and the duration **Temporary**.

13.5.2.21 Summary of Construction Noise Effects

The potential worst-case effects associated with the above aspects of the construction phase are derived by comparing the predicted noise levels with the construction noise limit given in **Section 13.5.2** and the results presented in **Table 13-22**.

It should be noted that the significance levels provided are based on pre-mitigation conditions.

Vibration effects are assessed against background vibration levels which as set out in **Section 13.2.1.2** are typically imperceptible.

Table 13.22: Summary of Description of Pre-mitigation Construction Noise Effects

Aspect	Quality	Significance	Duration
Tree Felling	Negative	Not Significant	Temporary
Temporary Construction Compound	Negative	Slight	Temporary
Deposition Area	Negative	Not Significant	Temporary
Permanent Meteorological Mast	Negative	Not Significant	Temporary
Site Entrances, Internal Access Tracks, and Water Management	Negative	Not Significant	Temporary
Traffic Management	Negative	Slight (Normal Period) to Significant (Peak Period)	Temporary
Borrow Pits (General)	Negative	Very Significant	Temporary
Borrow Pits (Vibration)	Negative	Significant	Temporary

Aspect	Quality	Significance	Duration
Turbine Hardstands and Foundations	Negative	Not Significant	Temporary
External Grid Connection and Jointing Bays	Negative	Not Significant to Slight (Depending on the distance to the NSLs)	Brief
Substation Compound and Building	Negative	Not Significant	Temporary
Horizontal Directional Drilling	Neutral	Slight	Temporary
Turbine Delivery	Neutral	Not Significant	Brief
Turbine Erection	Negative	Not Significant	Temporary
Vibration (General Construction Works)	Negative	Not Significant	Temporary
Vibration (Blasting Events)	Negative	Not Significant	Brief
Public Road works for Turbine Delivery	Negative	Slight	Temporary
Decommissioning Phase	Negative	Slight	Temporary

13.5.3 Operational Phase

Once operational, the wind turbines and the substation facility will generate noise which will propagate into the receiving environment. No rating penalties for special audible characteristics have been applied as these cannot be assessed at this stage as discussed. **Section 13.10** provides details of the assessment of operational noise in the event of such occurrence.

The potential effects are described in the following sections.

13.5.3.1 Wind Turbines – Proposed Development

There is 1 no. candidate wind turbine type to be considered for the Proposed Development as set out in **Table 13-23**.

Table 13.23: Candidate Turbine Type

Turbine Type Identifier	Candidate Model	Turbine Tip Heights	Hub Heights
A	Vestas V-136	160m/150m	92m/82m

The candidate turbine model is considered to be representative of the type of turbine that will be installed at the site and will include serrated trailing edge to the blades.

A total of 17 no. turbines at the locations in **Table 13-24** are provided.

Table 13.24: Turbine Co-ordinates

Turbine Ref.	Tip Height/Hub Height	Co-ordinates	
		ITM X	ITM Y
T1	160m/92m	559035	636918
T2	160m/92m	558629	636821
T3	160m/92m	558471	636454
T4	160m/92m	559699	636226
T5	160m/92m	560048	636262
T6	150m/82m	559575	634719
T7	160m/92m	559635	634317
T8	160m/92m	559967	633921
T9	160m/92m	559988	633538
T10	160m/92m	560213	634189
T11	160m/92m	560355	633784
T12	160m/92m	560540	633452
T13	160m/92m	560792	634470
T14	160m/92m	561156	634401

Turbine Ref.	Tip Height/Hub Height	Co-ordinates	
		ITM X	ITM Y
T15	160m/92m	561442	634564
T16	160m/92m	560787	633896
T17	160m/92m	561214	633948

13.5.3.2 Cumulative Assessment

This assessment has considered the potential cumulative effects of the Proposed Development in combination with other wind energy developments in the area as required by best practice guidance discussed in **Section 13.2.2**.

The IOA GPG states that cumulative noise exceedances should be avoided and where existing or permitted development is at the noise limit any new turbine noise sources should be designed to be 10 B below the limit value.

Section 5.1 of the relevant IOA GPG states the following:

“...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...

If an existing wind farm has permission to generate noise levels up to ETSU-R-97 limits, planning permission noise limits set at any future neighbouring wind farm would have to be at least 10 dB lower than the limits set for the existing wind farm to ensure there is no potential for cumulative noise impacts to breach ETSU-R-97 limits (except in such cases where a higher fixed limit could be justified). Such an approach could prevent any further wind farm development in the locality, and a more detailed analysis can be undertaken on a case-by-case basis.

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.

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

An appraisal of the wider study area around the Proposed Development identified the nearest proposed, permitted and operational wind farms developments listed in **Volume II, Chapter 01 Introduction Section 1.4.4** of this **EIAR**.

Noise from wind energy sites greater than c.10km distance are unlikely to effect the cumulative assessment nevertheless, as an abundance of caution, the proposed, permitted and operational wind farms located within a 20 km radius were considered and are detailed in the **Table 13-24**.

Table 13.25: Nearest proposed, permitted and operational wind farms for cumulative assessment

Wind Farm	Location to the nearest turbine in the Proposed Development	No. of Turbines	Turbine Type
Garrane Wind Farm	c.8km	9	Vestas V150 6MW
Boolard Wind Farm	c.18km	2	Nordex N100
Rathnacally Wind Farm	c.15km	2	Senvion M114
Kilmeedy Wind Farm	c.19km	2	Enercon E-82 E2
Ballyhoura Wind farm	c.16km	6	Vestas V90
Castlepook Wind Farm	c.16km	14	Vestas V90
Slieveragh Wind Farm	c.19km	2	Enercon E70 (Assumed)

- **Garrane Wind Farm (planning stage):**
Location: Approximately 8km southwest of the nearest turbine in the Proposed Development
Consisting of: 9no. Vestas V150 6MW.
- **Boolard Wind Farm (existing):**
Approximately 18km southwest of the nearest turbine (T12) in the Proposed Development
Consisting of: 2no. Nordex N100.
- **Rathnacally Wind Farm (existing):**
Location: Approximately 15km southwest of the nearest turbine (T12) in the Proposed Development
Consisting of: 2no. Senvion M114.
- **Kilmeedy Wind Farm (existing):**
Location: Approximately 19km west of the nearest turbine (T3) in the Proposed Development
Consisting of: 2no. Enercon E-82 E2.
- **Ballyhoura Wind Farm (existing):**
Location: Approximately 16km south of the nearest turbine (T12) in the Proposed Development
Consisting of: 6no. Vestas V90.
- **Castlepook Wind Farm (existing):**
Location: Approximately 16km south of the nearest turbine (T12) in the Proposed Development
Consisting of: 14no. Vestas V90.
- **Slieveragh Wind Farm (existing):**
Location: Approximately 19km south of the nearest (T12) in the Proposed Development.
Consisting of: 2no. Turbine (Enercon E70 assumed).

These wind farms were considered for the cumulative assessment and following the same methodology set out in **Section 13.5.3.2**, the predicted noise levels from these turbines has confirmed that there is no potential for cumulative impacts i.e. that they are at least 10dB below the predicted noise levels from the Proposed Development at the NSLs.

13.5.3.3 Wind Turbine Noise Criteria

As outlined in **Section 13.2.2**, the recommended best practice noise limits for the proposed development, shall be a combination of guidance provided in WEDG 2006, ETSU, IOA GPG and SGNs. This is considered best practice based on the professional competence and expertise of the authors and has been adopted for this assessment.

Following a detailed review of the background noise data set out in **Section 13.4.11**, appropriate noise criteria between cut-in and the rated power wind speeds for the candidate turbine type have been calculated and are given in **Table 13-25**.

Table 13-25: Summary of Noise Criteria

Location	Period	Noise Limit Criteria (dB) at Standardised 10m Wind Speeds							
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	>10 m/s
NSL1	Day	40	40	45	45	45	45	46	46
	Night	43	43	43	43	43	43	45	45
NSL2	Day	40	40	40	45	45	46	50	50
	Night	43	43	43	43	43	43	46	46
NSL3	Day	40	40	40	40	45	45	45	46
	Night	43	43	43	43	43	43	43	43
NSL4	Day	40	40	40	45	45	45	48	48
	Night	43	43	43	43	43	43	48	48
NSL5	Day	40	40	40	40	45	45	45	45
	Night	43	43	43	43	43	43	43	43
NSL6	Day	40	40	45	45	45	45	48	48
	Night	43	43	43	43	43	43	47	47
Nominal	Day	40	40	40	40	45	45	45	45
	Night	43	43	43	43	43	43	43	43

The Nominal criteria are the minimum values derived from the data. This criteria is applicable to all NSLs considered within the study area and therefore represents a worst case assessment.

The assessment has been undertaken in accordance with best practice guidance outlined in the *IOA GPGs* and calculated to the *ISO 9613-2* standard. It should be noted that the predicted noise levels assume that all receptors (Noise Sensitive Locations) are downwind of all turbines simultaneously. In reality this can never occur so this approach therefore represents a worst case assessment.

13.5.3.4 Noise Prediction

A computer-based noise propagation model has been prepared to predict the noise levels from the proposed turbines. This section discusses the methodology behind the noise modelling process and presents the results.

13.5.3.5 Noise Prediction Software

The proprietary software used (DGMR’s iNoise Pro) calculates noise levels in accordance with *ISO 9613:2024 Acoustics – Attenuation of sound during propagation outdoors* and has been used for noise modelling of many other wind farms in Ireland.

The resultant noise levels are calculated considering a range of factors affecting the propagation of the sound, including:

- The magnitude of the noise source in terms of A-weighted sound power levels (L_{WA});
- The distance between the source and the receiver;
- Topography;
- The presence of obstacles such as screens or barriers in the propagation path;
- The presence of reflecting surfaces;
- The acoustic property of the ground between the source and receiver;
- Attenuation due to atmospheric absorption

13.5.3.6 Input Data Assumption

Sound power levels (L_{WA}) are provided by the manufacturer for Sound Optimised Modes (blades with serrated trailing edge) at hub height wind speeds (V_{hh}) as presented in **Table 13-26**.

Table 13.26: Sound Power (L_{WA}) levels at Hub Height wind speeds

Turbine Type Identifier	Sound Power levels (L_W dB) at Hub Height wind speeds							
	3m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	>10 m/s
A	96.9	100.5	102.9	103.6	104.3	104.9	105.4	106.0

Appendix 13D – Noise Modelling Calculation Parameters provides information on the noise model calculation parameters and settings.

13.5.3.7 Predicted Noise Levels

Predicted noise levels are given in terms of the L_{Aeq} parameter and best practice guidance in the IOA GPG states that:

“ L_{A90} levels should be determined from calculated L_{Aeq} levels by subtraction of 2dB.”

Therefore, a 2dB conversion has been applied to the predicted noise levels and all levels in this report are therefore presented in terms of $L_{A90,10min}$.

13.5.3.8 Uncertainty

Uncertainty in the noise assessment ought to be considered and following the GPG in the absence of specific information, the data used in this report has an uncertainty of +2dB applied.

13.5.3.9 Tonality

A warranty will be sought from the supplier of the turbine for the Proposed Development that the turbine will emit no tonal component.

13.5.3.10 Directionality

Noise emissions from wind turbines are not omni-directional with downwind being most significant. The noise impact assessment adopts a worst-case by assuming that all NSLs are simultaneously downwind of all turbines (an impossible scenario).

Where noise predictions indicate that adopted criteria may be exceeded, consideration can be given to detailed downwind analysis to refine the assessment.

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

- Downwind (i.e. $0^\circ \pm 80^\circ$);
- Crosswind (i.e. $90^\circ \pm 10^\circ$ and $270^\circ \pm 10^\circ$);
- Upwind (i.e. $180^\circ \pm 70^\circ$).

Figure 13-23 illustrates the directivity attenuation factor that can be applied to turbines when considering noise propagation in downwind conditions.

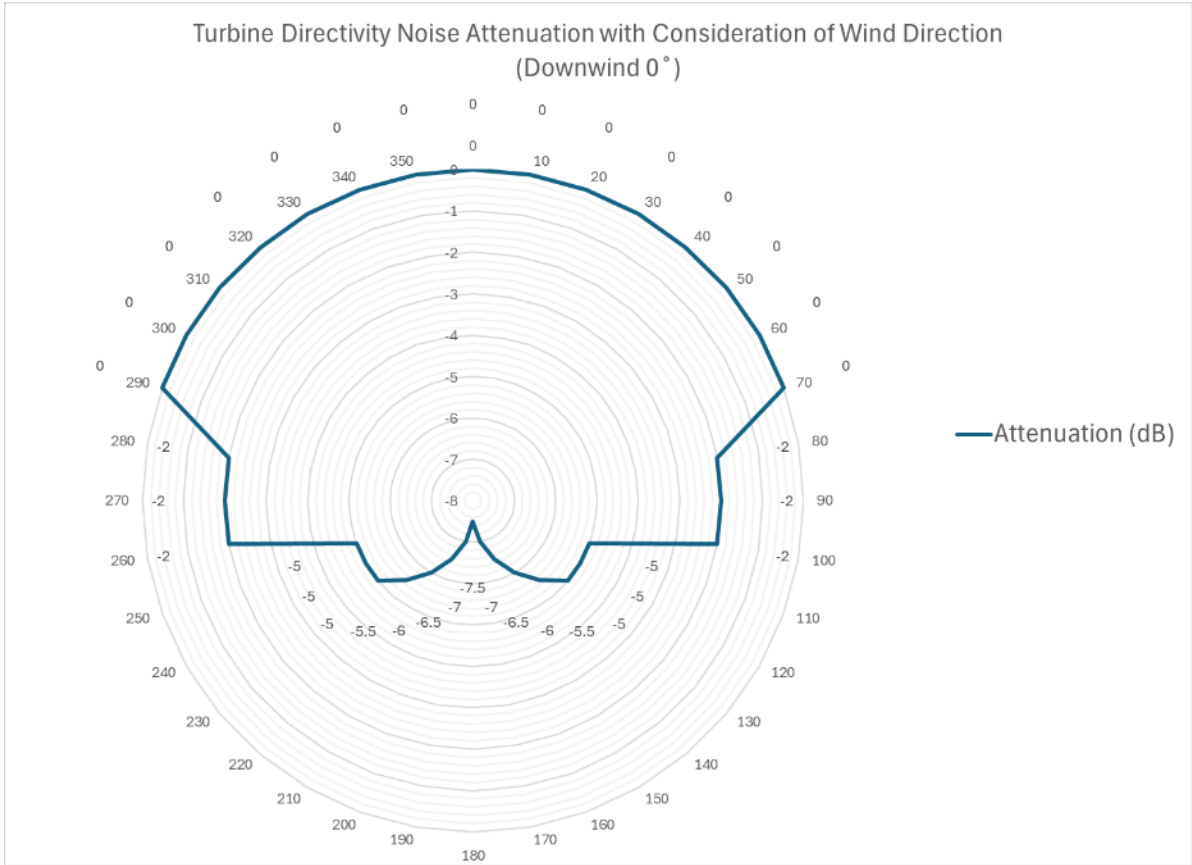


Figure 13-23: Turbine Directivity Attenuation with Consideration of Wind Direction

13.5.3.11 Predicted Noise Levels

A summary of the predicted noise levels at the schedule of Noise Sensitive Locations is provided in **Appendix 13G, EIAR Volume III**.

It was found that the predicted cumulative noise levels from the Proposed Development, when combined with the noise emissions from the schedule of other wind farms provided in **Table 13-24**, were below the noise limit criteria at all NSLs with the exception of 6no. of the closest NSLs where the criteria was exceeded by up to 0.8dB. Of these, 3 no. are financially involved in the Proposed Development. It is therefore appropriate to add 5dB to the applicable noise limits at these NSLs as discussed in **Section 13.2.2.5**, and there is no exceedance for these NSLs when applied.

A summary of the exceedances is provided in **Table 13-27**.

Table 13.27: Turbine Identifier A – Summary of Noise Exceedances

Criteria	Criteria and Predicted Noise Levels (dB) at Standardised 10m Wind Speeds								Financially Involved?
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	>10 m/s	
Daytime Limits	40	40	40	40	45	45	45	45	
Night-time Limits	43	43	43	43	43	43	43	43	
Location									
NSL057	28.5	30.2	36.9	40.2	41.3	41.3	41.3	41.3	Yes
NSL065	28.4	30.1	36.8	40.1	41.2	41.2	41.2	41.2	No
NSL370	28.7	30.4	37.1	40.4	41.5	41.5	41.5	41.5	No
NSL422	28.7	30.4	37.1	40.4	41.5	41.5	41.5	41.5	No
NSL503	29.1	30.8	37.5	40.8	41.9	41.9	41.9	41.9	Yes
NSL520	28.9	30.6	37.3	40.6	41.7	41.7	41.7	41.7	Yes

Of the 3no. NSLs that are not financially involved, the Daytime Amenity limit is exceeded at the 6m/s wind speed bin by 0.1dB at NSL065 and by 0.4dB at NSL370 and NSL422. This is a marginal exceedance based on a worst-case with the NSLs simultaneously downwind of all wind turbines (an impossible scenario). Noise levels are below the limit at wind speeds less than 5m/s and greater than 7m/s.

Noise levels do not exceed the night-time criteria at any wind speed.

13.5.3.11.1 Directional Analysis

By applying the methodology set out in **Section 13.5.3.10** a directional analysis was undertaken and it demonstrated that the cumulative noise levels from the wind turbines will be below the noise criteria limits at all wind speeds and in all wind directions.

A colour noise contour plot for the turbine type is provided in **Appendix 13E**.

The directional calculations are provided in **Appendix 13F**.

13.5.4 Description of Effects – Noise

As demonstrated above, the Proposed Development is expected to operate within the established noise criteria. Therefore, the effects are considered to be **Long Term** and **Not Significant**.

13.5.5 Description of Effects – Vibration

Wind turbines generate only minimal vibration when operational, which is too weak to be felt by people or affect buildings and structures. Research indicates that any vibration diminishes rapidly with distance from the turbine.

As a result, no noticeable impact on nearby receptors or structures are anticipated, therefore, in EIA terms, there is **Imperceptible** effect.

13.5.6 On-site Electrical Substation (110kV)

Following BS 4142:2014 guidance set out in **Section 13.2.2.13**, the Specific (L_{Aeq}) noise level at the nearest NSLs as a result of the emissions from the Substation is compared with the measured Background (L_{A90}) noise levels.

The derivation of Background (L_{A90}) noise level is described in Section 8.1 of BS414:2014 as:

“the objective is not simply to ascertain a lowest measured background sound level, but rather to quantify what is typical during particular time periods”.

The nearest NSL (NSL422) is located c565m northeast of the substation. The closest Noise Monitoring Location (NML) to NSL422 was NML3 and Background (L_{A90}) noise levels from this monitor are therefore the most appropriate to use. As the substation is expected to operate during the daytime and night-periods, it is appropriate to assess the night-time period as a worst case.

A summary of the *BS4142:2014* impact assessment is given in **Table 13-28**.

Table 13.28: BS4142 Impact Assessment Summary

Parameter	Results	Commentary
Measured background sound level, (L_{AF90})	20dB	Typical night-time level
Calculated specific sound level, L_s (L_{Aeq})	7dB	At closest NSL
Acoustic feature correction	0 dB	Tone Standard: ISO 1996-2:2007 (simplified)
Manual correction	0 dB	N/A
Rating level, L_{Ar}	7dB	
Excess of rating over background sound level	-13dB	
Assessment indicates a likely adverse impact?		No, not likely
Context of the assessment		Impact is imperceptible/ Not Significant

The results demonstrate that the predicted (L_{Aeq}) noise level is 13dB below the existing Background (L_{A90}) noise level for the Night-time period at the nearest NSL.

The impact from the substation is therefore considered **Long Term** and **Imperceptible/Not Significant**.

13.6 Operation Phase – Description of Effect Summary

The **Table 13-29** below summarises the description of effects during the operational phases.

Table 13.29: Summary of the Description of Noise Effects During the Operational Phase.

Aspect	Quality	Significance	Duration
Noise	Negative	Not Significant	Long Term
Vibration	Negative	Imperceptible	Long Term
On-Site Substation	Negative	Imperceptible	Long Term

13.7 Mitigation and Monitoring Measures

The assessment of potential effects has demonstrated that the Proposed Development is expected to operate within the noise criteria set out and in accordance with the Wind Energy Development Guidelines 2006 without mitigation. Some construction activities require mitigation measures to minimise noise and vibration effects and the decommissioning phase is expected not to have any associated significant effects.

To ameliorate any noise and vibration effects, a schedule of noise and vibration control measures for the construction, operational and decommissioning phases include the following.

13.7.1 Construction Phase

Regarding construction activities, reference shall be made to *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise*, which offers guidance on the control of noise and vibration from construction activities. It is proposed that best practices be adopted during construction as required, including the following:

- Prior to the commencement of construction an active community engagement exercise shall be undertaken by the community liaison officer. Letter drops shall take place in advance of the works. The nature of the information letters provided details of the Project, specifically:
 - Contractor name and contact details.
 - Project description.
 - Expected duration of works.
 - A commitment to implement procedures and measures to minimise noise and vibration.

This community notification exercise will be repeated in the event of an expected intensification of works in any area and/or in advance of works that occur outside of the permitted construction operating hours (any such works will be subject to prior agreement with the Local Authority).

- A site representative responsible for matters relating to noise and vibration will be appointed;

- The construction programme will be managed to ensure that plant with the highest levels of noise and vibration emissions are not operated simultaneously and for the minimum amount of time as practicable;
- Keeping the surface of the site access tracks even to mitigate the potential for vibration from lorries.
- The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall be restricted to between 07:00hrs and 19:00hrs Monday to Saturday or as otherwise conditioned on the part of the consent. However, to ensure that optimal use is made of good weather period or at critical periods within the programme (i.e., concrete pours) or to accommodate delivery of large turbine component along public routes it could be necessary on occasion to work outside of these hours. Any such out of hours working will be agreed in advance with the Local Authority.
- Selection of plant with low inherent potential for generation of noise and/or vibration;
- Placing of noisy/vibratory plant as far away from sensitive properties as permitted by site constraints.

13.7.1.1 Noise

The contract documents shall specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures when deemed necessary to comply with the recommendations of *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction on open sites – Noise*. The following list of measures will be implemented to ensure compliance with the relevant construction noise criteria:

- The best means practicable, including proper maintenance of plant, will be employed to minimise the noise produced by on site operations.
- All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the contract.
- Compressors will be attenuated models, fitted with properly lined and sealed acoustic covers which will be kept closed whenever the machines are in use and all ancillary pneumatic tools shall be fitted with suitable silencers.
- Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.
- A site hoarding will be erected at the boundary of the Borrow Pits and can be applied at any construction site/activity where necessary. A suitably constructed site hoarding can achieve a noise reduction of 3 dB to 10dB depending on the circumstances.
- Any plant, such as generators or pumps, which is required to operate before 07:00hrs or after 19:00hrs will be surrounded by an acoustic enclosure or portable screen.
- During the construction programme, supervision of the works will include ensuring compliance with the limits detailed in **Section 13.5.2** using methods outlined in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* by limiting the noise emission levels, reducing the operational time or a combination of both.
- Erect site hoarding and temporary screens around noisy equipment.

- Acoustic enclosures or portable screens will be utilised for plant and equipment operating in close proximity to residential dwellings.

13.7.1.2 Vibration – General Construction Works

No significant effects due to vibration are expected during the general construction works and no mitigation measures are therefore applicable.

13.7.1.3 Vibration – Borrow Pits

During the works, suitable vibration monitoring will be conducted at the closest NSLs to Borrow Pit 1 and Borrow Pit 2 (NSL359 and NSL157 respectively) to ensure that the vibration criteria set out in **Section 13.2.1.2** is satisfied.

The following mitigation measures will be employed to control the impact during the works at the 2no. Borrow Pits:

- The site representative will liaise with the likely affected homeowners.
- Suitable vibration monitoring will be conducted at the closest NSLs to ensure that the vibration criteria set out in **Section 13.2.1.2** are satisfied.
- The condition of the properties will also be regularly inspected to ensure no cosmetic or structural damage occurs.

13.7.1.4 Blasting Events

The following mitigation measures will be employed to control the impact during blasts associated with the turbine foundation works:

- The site representative will liaise with the likely affected NSL(s).
- Trial blasts will be undertaken to obtain scaled distance analysis.
- Ensuring appropriate burden to avoid over or under confinement of the charge.
- Accurate setting out and drilling.
- Appropriate charging.
- Appropriate stemming with appropriate material such as sized gravel or stone chipping.
- Delay detonation to ensure small maximum instantaneous charges.
- Decked charges and in-hole delays.
- Suitable vibration monitoring will be conducted to enable adjustment of subsequent charges and that the vibration criteria set out in **Section 13.2.1.2** are satisfied.
- Good blast design to maximise efficiency and reduce vibration.
- Avoid using exposed detonating cord on the surface.

13.7.2 Operational Phase

The noise levels associated with the Proposed Development have been assessed using best practice contained in the 'Wind Energy Development Guidelines for Planning Authorities, 2006' and have been assessed following guidance from ETSU-R-97 and the IOA GPG and its supplementary guidance notes, and no likely significant effects are predicted to arise during the operational phase. No specific mitigation measures are therefore required. If the Proposed Development is permitted and constructed, post-commissioning noise surveys will be carried out in accordance with best practice.

In the unlikely event that an issue with low frequency noise is associated with the proposed development, an appropriate detailed investigation will be undertaken. Due consideration would be given to guidance on conducting such an investigation which is outlined in *Appendix VI* of the EPA document entitled *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities* (2016). This guidance is based on the threshold values outlined in the Salford University document *Procedure for the assessment of low frequency noise complaints*, Revision 1, December 2011.

In the unlikely event that an issue of AM is associated with the proposed development, an appropriate investigation shall be undertaken in accordance with the guidance outlined in the Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) namely, *A Method for Rating Amplitude Modulation in Wind Turbine Noise* (August 2016) or subsequent revisions.

As discussed in **Section 13.2.2.9.4**, a suitable NCMP will be implemented for the proposed development. Should a noise complaint or evidence of an exceedance of the noise limits occur, the operator shall comply with any requirements of the Planning Authority to undertake an investigation (including shutting down wind turbines for background noise monitoring if required) and the implementation of appropriate mitigation measures such as a curtailment programme on the wind turbine operations will be undertaken. The NCMP will follow the guidance outlined in the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014). For more information on Post-Construction Monitoring please refer to **Section 13.10**.

On-site electrical Substation

The impact assessment has demonstrated that there is no likely significant effect with respect to Noise and Vibration at the NSLs, therefore no mitigation measures are required.

13.7.3 Decommissioning Phase

Activities and noise levels associated with the decommissioning phase are expected to be similar to the construction phase. The mitigation measures that will be considered in relation to any decommissioning of the site are the same as those proposed for the construction phase of the Proposed Development.

13.8 Residual Effects

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

13.8.1 Construction Phase

During the construction phase of the Proposed Development, the significance of noise effect ranges from Not Significant to Very Significant depending on the activity and distance to the NSL.

The proposed mitigation measures, will ensure that noise and vibration effects are minimised. For certain construction phases however, the residual impact may not be reduced entirely due to the nature of works and proximity to the NSLs.

A summary of the likely residual noise and vibration impacts associated with the construction phases is presented in **Table 13-30**.

Table 13.30: Summary of Description of Post-mitigation Construction Noise Effects

Aspect	Quality	Significance	Duration
Borrow Pits (General)	Negative	Slight	Temporary
Borrow Pits (Vibration)	Negative	Slight	Brief
Vibration (Blasting Events)	Negative	Slight	Brief

The duration of the works is temporary or brief and the assessment has considered the worst-case scenario in which all the equipment is operating simultaneously, which is not expected to occur in reality.

13.8.2 Operational Phase

Wind Turbines - Noise

No mitigation measures are required in relation to the operation of the wind turbines and the residual noise effects is expected to be remain Not Significant.

Wind Turbines - Vibration

No mitigation measures are set out in relation to vibration emissions from the wind turbines and the residual vibration effects will remain as Imperceptible/Not Significant.

Substation

No mitigation measures are required in relation to the operation of the substation and the residual noise effects will remain as imperceptible.

Summary

A summary of the likely residual noise and vibration impacts associated with the operational phase, following the implementation of the mitigation measures, is presented in **Table 13-31**.

Table 13.31: Summary of Description of Post-mitigation Operational Noise Effects

Aspect	Quality	Significance	Duration
Wind Turbines – Noise	Negative	Not Significant	Long-term
Wind Turbines – Vibration	Negative	Imperceptible	Long-term
Substation	Negative	Not Significant	Long-term

13.8.3 Decommissioning Phase

With the implementation of the proposed mitigation measures in relation to the decommissioning phase, the residual effects are expected to be minimal, ensuring that any noise and vibration impact will remain as Not Significant.

13.9 Cumulative Effects

This assessment has considered the potential cumulative impacts of the Proposed Development in combination with other wind energy developments in the area as required by best practice guidance discussed in **Section 13.5.3.2**.

Predicted noise levels from these turbines confirm that there is no potential for cumulative impacts, as they are at least 10 dB below the predicted noise levels from the Proposed Development at the nearest noise-sensitive locations (NSLs).

It was concluded that effects between the Proposed Development in combination with other wind farm developments is therefore, considered **Not Significant**.

13.10 Operational Phase Monitoring

Compliance with the prescribed limits as set out in **Section 13.5.3.3**, **Table 13.7** may be demonstrated by a suitable post-construction Noise Complaint Monitoring Programme (NCMP). The NCMP will adopt the guidance in IOA SGN No.5 Post Completion Measurements.

A detailed methodology shall be agreed in writing with the planning authority prior to the commissioning of the wind farm but the following are appropriate:

- Monitoring to be conducted under downwind conditions (45 degree sector);
- Wind turbines to operate in normal mode i.e. without any additional restrictions;
- Monitoring to be conducted at one or more Noise Monitoring Location(s) as set out in **Section 13.4.5** (where pre-commissioning background noise levels are available) or at representative/nearest Noise Sensitive Location(s); and
- Synchronised 10-minute wind speeds at standardised 10 m height to be derived from upwind anemometer or from turbine power output curves.

It will usually be necessary to carry out noise monitoring for around 1 month to obtain the necessary range of wind speeds and wind directions to enable a conclusive evaluation of whether noise limits are being met for worst case downwind propagation conditions. However, extended periods of noise monitoring may be necessary to capture sufficient conditions and will be carried out as necessary.

Some periods of wind turbine shut-down may be required to facilitate the NCMP and will be carried out as necessary.

The instrumentation used will comply with IOA SGN No. 1 Data Collection and conducted by a professionally competent organisation.

Where the results of the measurements demonstrate an exceedance of the permitted noise levels, it will be necessary to formulate a mitigation strategy to reduce turbine noise levels to within the prescribed noise criteria limits. The noise monitoring will then be repeated with such mitigation measures in place to demonstrate compliance with the conditions and for the operator to continue to run the site in this way unless circumstances change.

As outlined in **Section 13.2.2.10** special audible characteristics (such as AM), is not a factor that can be foreseen at planning stage, but its presence can be measured and rated, typically in the event of a complaint, post construction. The NCMP will include standard practice methodology for AM to be investigated, only in the event of complaint, and, where the investigation verifies its presence, mitigation measures will be put in place to address the identified turbine AM noise characteristics. The most recent information in relation to assessing AM comes in the IEC TS 61400-11. The scope of this document includes an assessment of the sound characteristics of the noise and relies on an evolution of the Institute of Acoustics Reference Method (IoA RM) to quantify the AM level along with a penalty scheme. The methodology contained within the IoA RM, IEC 61400 and Draft Assessment and Rating of Wind Turbine Noise documents the quantification of all aspects of AM and the penalty scheme allows quantification of the mitigation required, if any. An appropriate penalty can be added onto the measured LA90 noise level, to allow direct comparison to an overall applicable noise limit. It can also allow a quantification of the mitigation required to reduce the rated noise levels from turbines, if exceedances are identified post the wind farm becoming operational.

13.11 Conclusion / Summary

When considering a project of this nature, the potential noise and vibration effects on the surrounding area must be considered for two scenarios: the short-term construction/decommissioning and the long-term operational phase.

The assessment of construction noise and vibration and has been conducted in accordance best practice guidance contained in *BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise* and *BS 5228-2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Vibration*. Following mitigation, the likely effect is expected to range between Slight and Not Significant for the majority of construction phases, to Significant for the grid connection route. However, as the construction works will progress at around 100 m to 200 m per day, the impact at any NSL for this activity will be Brief.

Based on detailed information on the site layout, turbine noise emission levels and turbine height, worst-case cumulative turbine noise levels have been predicted at NSLs for a range of operational wind speeds. Noise criteria have been derived following the Irish *Wind Energy Development Guidelines (2006)* and assessed following guidance in *ETSU-R-97* and *Institute of Acoustic Good Practice Guidelines* published in 2014. The predicted operational noise levels are not expected to exceed the noise criteria, and the likely effect is therefore considered to be Not Significant.

No vibration effects are associated with the operation of the site, and the effect is therefore considered Not Significant.