FEHILY TIMONEY

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED BARNADIVANE WIND FARM & SUBSTATION, CO. CORK

VOLUME 2 – MAIN EIAR
CHAPTER 9 – NOISE AND VIBRATION

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9 NOISE AND VIBRATION

9.1 Introduction

This chapter contains an assessment of the potential noise and vibration impacts associated with the Proposed Development. The assessment including undertaking of the background noise surveys has been carried out by Fehily Timoney and Company, based on information provided by the developer and in accordance with current guidance and best practice. A description of the Proposed Development is provided in Chapter 2 of the EIAR.

Potential construction noise and vibration impacts have been determined with reference to British Standard 5228:2009+A1:2014 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise*.

Operational noise associated with the Proposed Development includes noise from the proposed wind turbines and on-site substation. The operational noise is compared with noise limits derived in accordance with the Wind Energy Development Guidelines 2006 currently in force and in accordance with current industry best practice.

Decommissioning noise and vibration impacts have been assessed in accordance with the same standards used to determine the construction noise and vibration impacts.

9.2 Description of Noise and Vibration Impacts

9.2.1 Construction Noise and Vibration

Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks, and construction of the substations.

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

Vibration is generated by construction activities such as rock breaking and passing heavy goods vehicles.

Typical vibration generated from construction activities for the Proposed Development are:

- Tracked excavators and disc cutters from cable trenching (0.8mm/s at 4m)
- Pneumatic breakers for cable trenching (0.7 mm/s at 10 m)
- Rock breaking at borrow pits (0.03 mm/s at 100 m)
- Excavation of turbine foundations (0.6 mm/s at 100 m)
- HGV traffic on normal road surfaces (0.01 to 0.5 mm/s) at footings of buildings located 20m from roadway.
- Potential vibration sources from construction activities at the substation hardstanding area are scoped out as the closest vibration sensitive locations are over 250m from the Proposed Substation.

The threshold of human perception of vibration is in the range of 0.14mm/s to 0.3mm/s[1], described as "*might just be perceptible*". The guideline values for damage to buildings from vibration are 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. The nearest noise sensitive locations are sufficiently distant that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration. As such, construction vibration will not be considered further in this chapter.

9.2.2 Operational Noise and Vibration

Noise is generated by wind turbines as they rotate to generate power. This only occurs above the 'cut-in' wind speed and below the 'cut-out' wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring. The cut-in speed at the turbine hub-height is approximately 3 m/s and the cut-out wind speed is approximately 25 m/s.

The principal sources of noise are from the blades rotating in the air (aerodynamic noise) and from internal machinery, normally the gearbox and, to a lesser extent, the generator (mechanical noise).

The blades are carefully designed to minimize noise whilst optimising power transfer from the wind. See Oerlemans et al. (2008) 'Location and quantification of noise sources on a wind turbine' for further details on the principal sources of noise from a wind turbine.

Noise may also be generated from ancillary equipment such as transformers at on-site substations. However, these generally have low source noise levels compared to wind turbines themselves and, provided they are not located within the immediate vicinity of a residential dwelling, are unlikely to cause disturbance in the context of the other noise sources. Noise from the substation has been considered as part of this assessment and is discussed further in Section 9.5.3.

9.2.2.1 Blade Swish (Amplitude Modulation of Aerodynamic Noise)

This is the periodic variation in noise level associated with turbine operation, at the rate of the blade passing frequency (rotational speed multiplied by number of blades). It is often referred to as blade swish or amplitude / aerodynamic modulation (AM). This effect is discussed in ETSU-R-97, 'The Assessment and Rating of Noise from Wind Farms' (1996), which states that *'… modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine... '* and that at distances further from the turbine where there are *'… more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)'*. It concludes that *'the noise levels (i.e. limits) recommended in this report take into account the character of noise described ... as blade swish'.*

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

In some cases amplitude modulation 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. This is known as *'Other AM or OAM'.*

[1] British Standard 5228 Part 2:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites- Part 2: Vibration

It was proposed in the RenewableUK 2013 study that the fundamental cause of OAM 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[2] of the rotor blade.

The University of Salford carried out a study on behalf the Department for Business, Enterprise and Regulatory Reform (BERR) to investigate the prevalence of amplitude modulation of aerodynamic noise on UK wind farm sites. The study concluded that AM has occurred at 4 out of 133 wind farms in the UK. A further investigation of the four sites by the Local Authority showed that the conditions associated with AM might occur between 7% and 15% of the time.

The most recent research into AM was conducted by RenewableUK, 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' (December 2013).

This research focused on the less understood *'Other AM or OAM'* where reported incidents are relatively limited and infrequent but is a recognised phenomenon. However, the occurrence and intensity of Other AM is specific to a location and its likelihood of occurrence cannot be reliably predicted.

Section 6 of the 'Summary of Research into Amplitude Modulation of Aerodynamic Noise from Wind Turbines - Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effect' states that *'At present there is no way of predicting OAM at any particular location before turbines begin operation due to the general features of a site or the known attributes of a particular turbine.'*

However, the Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3) states…

'features which are thought to enhance this effect are:

- *close spacing of turbines in linear rows;*
- *tower height to rotor diameter ratio less than approximately 0.75;*
- *stable atmospheric conditions;*
- *topography leading to different wind directions being seen by the blades at different points in their rotation'.*

The RenewableUK study *'has found that by minimising the onset of blade stall, the occurrence of OAM is also likely to be minimised.'* It goes on to discuss *'the future involvement of turbine manufacturers in developing methods of avoiding or minimising the partial stall mechanism identified as a primary cause of OAM; and suggests that in future changes to blade design and the way in which the blade pitch (the angle of attack of the blade to the incoming air flow) is controlled are likely to have a role to play in achieving better management of the phenomenon.'* Ultimately, further work is required to identify the exact on-blade conditions required for OAM to occur. The further work will aid in the development of a measure to fully mitigate the OAM. If OAM occurs from the Proposed Development, the wind turbine(s) will be operated in a manner to address this by way of implementation of blade pitch regulation, vortex generators or shut downs.

In 2016, the IOA published 'A Method for Rating Amplitude Modulation in Wind Turbine Noise'. It sets out a procedure for obtaining input noise data.

[2] The stall source mechanism radiates equally upwind and downwind, but propagation effects reduce noise levels upwind.

The procedure proposed in the IoA guidance document is recommended by the Department of Business, Energy & Industrial Strategy (BEIS) who have published a study on amplitude modulation.

At present there is no method for predicting OAM at any particular location before turbines begin operation based on the general features of a site or the known attributes of a particular turbine. Therefore, it is not possible 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 the exception rather than the rule. The RenewableUK study states that "even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent.", and "There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."

Assessment of AM Research and Guidance is ongoing, with recent publications being issued by the Institute of Acoustics (IOA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) :"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 or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of AM. 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. There has been no adoption of endorsement of an AM 'penalty' scheme by any government. The IOA GPG states in "The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM."

Where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements. The 'Reference Method' for measuring AM outlined in the IOA AMWG document will provide a robust and reliable indicator of AM and yield important information on the frequency and duration of occurrence, which can be used to evaluate different operational conditions which will be implemented to avoid the occurrence.

9.2.2.2 Infrasound and Low Frequency Noise

The definition of low frequency noise can vary, but it is generally accepted that low frequency noise is noise that occurs within the frequency range of 10 Hz to 160 Hz.

Infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it must be at very high amplitude, and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance. However, wind turbines do not produce infrasound at amplitudes capable of causing annoyance as outlined in the following paragraphs.

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms', concluded that:

"infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Even assuming that the most sensitive members of the population have a hearing threshold which is 12 dB lower than the median hearing threshold, measured infrasound levels are well below this criterion. "

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

The study reports that low frequency noise is measurable but below the DEFRA low frequency noise criterion. The study also assessed low frequency measurements against the Danish criterion of LpA,LF = 20 dB. It was found that internal levels do not exceed 20dB when measurements are undertaken within rooms with the windows closed. However, the study acknowledges that wind turbine noise (low frequency) may result in an internal noise level that is just above the threshold of audibility as defined in ISO 226. The study goes on to say… *'However, at all the measurement sites, low frequency noise associated with traffic movement along local roads has been found to be greater than that from the neighbouring wind farm.'*

Bowdler et al. (2009) concludes 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'.*

In January 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms. Measurements were undertaken at seven locations in urban areas and four locations in rural areas including two residences approximately 1.5 km from the wind turbines. The study concluded *'that the level of infrasound at houses near the wind turbines … is no greater than that experienced in other urban and rural environments and is also significantly below the human perception threshold.'*

In 2016, the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany published a report entitled *'Low-frequency noise incl. infrasound from wind turbines and other sources.'* It assessed infrasound and low frequency sound from wind turbines and other sources. It found that 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).'*

We conclude that infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Infrasound is not a source which may be injurious to the health of a wind farm neighbour.

Wind turbines may produce low frequency noise at levels above the threshold of audibility. However, there is no evidence of health effects arising from low frequency noise generated by wind turbines. Given the evidence described above, an assessment of infrasound and low frequency noise from the Proposed Wind Farm has been scoped out.

9.2.2.3 Tonal Noise

ETSU-R-97 describes tonal noise as *'noise containing a discrete frequency component most often of mechanical origin'.* Wind turbine sound can be tonal in some cases, for example if there is a defect in a turbine blade or a fault in the mechanical equipment such as the gearbox. Tonality from wind turbines is generally caused by structural resonances in the mechanical parts of the turbine and thus is highly specific not only to the turbine model but the specific components used, including tower height. However, a correctly operating wind turbine is not considered to have tonal sound emission. In the event of tonal noise being present and following establishment of the likely cause, this can be addressed by turbine manufacturers and/or operator as and when it occurs. A warranty will be provided by the manufacturers of the turbine to ensure that the noise output will not require a tonal noise correction under ETSU R-97 best practice guidance.

9.2.2.4 Vibration

Vibration from operational wind turbines is low and will not result in perceptible levels at nearby sensitive receptors nor will the levels of vibration result in any structural damage. Research undertaken by Snow3 found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) and were lower than limits specified for residential premises by an even greater margin. Hence, the level of vibration produced by wind turbines at this distance is low and does not pose a risk to human health.

More recently, the Low Frequency Noise Report[4] published by the Federal State of Baden-Württemberg simultaneously measured vibration at several locations, ranging from directly at the wind turbine tower to up to 285m distance from an operational Nordex N117 – 2.4 MW wind turbine with a hub height of 140.6m. The report concluded that at less than 300m from the turbine, the vibration levels had reduced such that they could no longer be differentiated from the background vibration levels.

Considering that the nearest sensitive receptor is over 330m from the nearest turbine, the level of vibration is significantly below any thresholds of perceptibility. Vibration from the turbines is too low to be perceived at neighbouring residential dwellings.

Vibration levels will also be significantly below levels that would result in damage to the nearest buildings (including farm buildings). Therefore, operational vibration has been scoped out.

9.2.3 Decommissioning Noise and Vibration

The impacts associated with decommissioning of the Proposed Wind Farm are comparable to those described for the construction phase.

9.3 Methodology

The methodology adopted for this noise and vibration assessment is as follows:

- Review of appropriate guidance and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise environment;
- Prediction of the noise impact associated with the Proposed Development, and;
- Evaluation of noise impacts;
- Propose mitigation, and;
- Assess residual impacts.

[3] ETSU (1997), Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm, prepared by D J Snow.

[4] Low-frequency noise incl. infrasound from wind turbines and other sources', State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany, 2016.

9.3.1 Relevant Guidance

EIA Guidance:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022
- Advice Notes on Current Practice, Environmental Protection Agency, Draft 2015
- Environmental Impact Assessment of Projects – Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU).

Noise Modelling Standards and Technical Advice:

- International Standard *ISO 9613-2: 1996 Attenuation of sound during propagation outdoors, Part 2: General method of calculation;*
- UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) and supplementary notes;
- British Standard *BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise;*
- Irish Wind Energy Association, *Best Practice Guidelines for the Irish Wind Energy Industry* (2012);
- UK Department of Trade and Industry (DTI), ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (1996);
- British Standard 4142:2014+A1:2019, *Methods for rating and assessing industrial and commercial sound.*

Guideline Noise Levels:

- Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government (2006);
- Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government, 2019;
- Cork County Development Plan 2022 – 2028;
- Cork County Development Plan Review: Energy, Background Document No. 9, Planning Policy Unit, Cork County Council, March 2020.

9.3.2 Study Area

Construction and decommissioning noise have been assessed by comparing predicted construction activities against best practice construction noise criteria at the nearest residential dwellings to the construction activities. As such, if the construction noise meets the relevant noise limits at the nearest locations, it will also be below the relevant noise limits at more distant residential locations.

The operational noise study area includes all residential dwellings with a predicted noise level greater than 35 dB L_{A90} (which is the lowest limit prescribed in the 2006 Department of the Environment, Heritage, and Local Government, *Wind Energy Development Guidelines*).

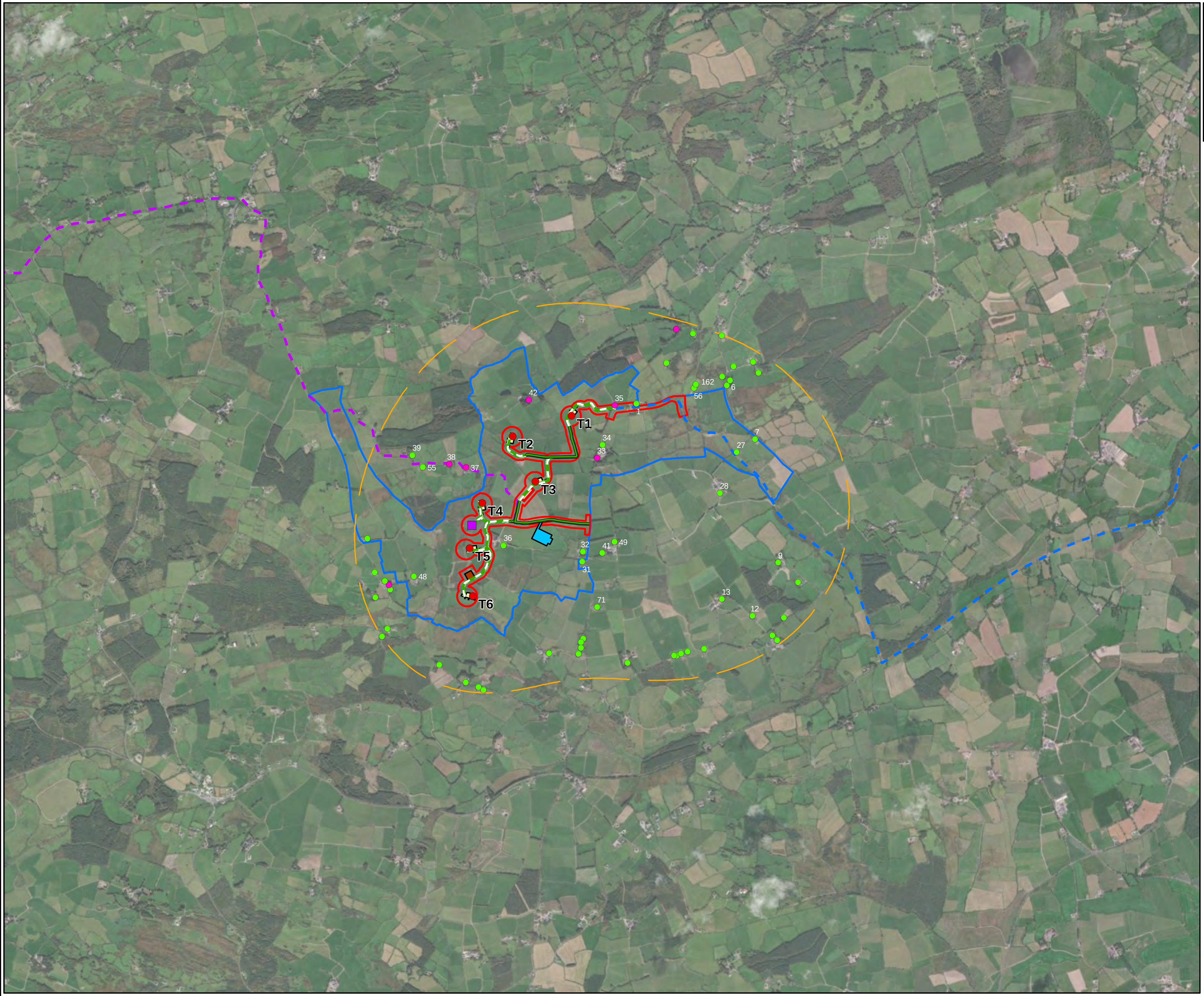
The study area is also in accordance with the UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) whereby the guidance document defines the study area as "*the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35dB L_{A90} at up to 10 m/s wind speed*."

This chapter is based on assessment from a proposed turbine, the Nordex N117, with a hub height of 72.5m.

The IOA guidance documents also states… "*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*." The Proposed Windfarm is next to the existing windfarm at Garranereagh. The operational study area is presented in Figure 9-1. The study area includes 61 no. Noise Sensitive Locations (NSLs). However, excluding derelict properties, there are 54 no. noise sensitive locations.

As construction and operational vibration, Infrasound and Low Frequency Noise have been scoped out (see Section 9.2.2.1 and 9.2.2.2) there is no requirement to set study areas for each.

Path: R:\Map Production\2021\P21-143\Workspaces\EIAR\P21-143_GIS_Fig9-1_Noise_Sensitive_Locations_within_Study_Area_A3.mxd



Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route
- 35db Noise Contour

Receptors

- Derelict
- Occupied

TITLE: Noise Sensitive Locations within Study Area

PROJECT: Barnadivane Wind Farm and Substation, Co. Cork

FIGURE NO:	9-1		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:30000	**REVISION:**	0
DATE:	3/6/2023	**PAGE SIZE:**	A3

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0 0.25 0.5 1 Kilometers

9.3.3 Evaluation Criteria

9.3.3.1 Construction Noise criteria

There is no statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. In the absence of specific noise limits, appropriate emission criteria relating to permissible construction noise levels for a project of this scale may be found in the British Standard *BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Noise.*

BS 5228-1:2009+A1:2014 contains several methods for the assessment of the potential significance of noise effects. The ABC Method was used to derive appropriate noise limits for the proposed project. The threshold limit to be applied (as defined in Table 9-1) is dependent on the existing ambient noise levels (rounded to the nearest 5dB).

Table 9-1: Threshold of Potential Significant Effect during Construction and Decommissioning

Threshold value period (L_{Aeq})	Threshold Value, in decibels (dB)		
	Category A	Category B	Category C
Night-time (23:00 – 07:00hrs)	45	50	55
Evenings (19:00 – 23:00 hrs) and weekends (13:00 – 22:00 Saturdays) and (07:00 – 19:00 hrs Sundays)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (08:00 – 16:30)	65	70	75

Note

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

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

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

The approach adopted here calls for the designation of a Noise Sensitive Location into a specific category (A, B or C) based on existing ambient noise levels in the absence of construction noise. For the appropriate period (e.g. daytime), the ambient noise level is determined and rounded to the nearest 5dB.

The baseline noise survey results ambient (free-field) noise levels were analysed. A correction of +3dB was added to the noise levels to convert free-field noise levels to façade noise levels. The ambient façade noise level when rounded to the nearest 5dB varies, but for the most part it is less than 60 dB L_{Aeq}. The nearest residential dwellings to the Proposed Development are afforded Category A designation (65 dB $L_{Aeq,1hr}$ during daytime periods).

Section 9.5.2 provides the detailed assessment of construction activity in relation to this site.

If the modelled construction noise level exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,1hr}$ during daytime periods) then a potential significant effect is predicted and mitigation measures may be required to reduce the noise levels below the $L_{Aeq,1hr}$ daytime noise limit.

9.3.3.2 Wind Farm Operational Noise Criteria

The operational noise assessment summarised in the following sections has been based on guidance in relation to acceptable levels of noise from wind farms as contained in the document Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006).

ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996) published by the Department of Trade and Industry (UK) Energy Technology Support Unit (ETSU) and Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013) has been used to supplement the guidance contained within the 'Wind Energy Development Guidelines' publication where necessary.

The Cork County Development Plan 2022-2028 identifies the area where the Proposed Development is situated as a location where wind energy is 'Acceptable in Principle', subject to consideration of the following objectives, relating to noise:

Objective 13.6 Acceptable in Principle
"Commercial wind energy development is normally encouraged in these areas subject to protection of residential amenity particularly in respect of noise, shadow flicker, visual impact and the requirements of the Habitats, Birds, Water Framework, Floods and EIA Directives and taking account of protected species of conservation concern."

The "Good Practice for Wind Energy Development Guidelines 2016" does not provide guidance on appropriate noise limits but provides guidelines for community engagement.

The noise criteria used to assess operational noise from the Proposed Development is based on a Best Practice Approach, currently used by the acoustics industry This best practice approach is based on:

- Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006);
- ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996);
- Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013).

The DoEHLG guidelines (2006) contain recommended noise limits to control operational noise from wind farms and state…

> *In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits.*

Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the $L_{A90,10min}$ of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).

Separate noise limits should apply for day-time and for night-time. During the night, the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night.

In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, best practice has typically been to consider the guidance contained in ETSU-R-97 and more recently the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes.

Where background noise is less than 30 dB(A), an absolute level within the range of 35-40 dB(A) is applicable. However, there is no appropriate approach in relation to the identification of low noise environments *"where background noise is less than 30dB(A)"* nor is there details on the application of *"an absolute level within the range of 35-40 dB(A)."* In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, on what range of *35-40 dB* to use, we have referred to guidance from ETSU-R-97[5] which states…

"*The actual value chosen for the day-time lower limit, within the range of 35-40dB(A), should depend upon a number of factors:*

- *Number of dwellings in the neighbourhood of the wind farm.*
- *The effect of noise limits on the number of kWh generated.*
- *Duration and level of exposure."*

The 2006 DoEHLG Wind Energy Development Guidelines do not provide the specific periods which are represented by daytime and night-time hours, therefore the definitions from ETSU-R-97 are taken as 07:00 to 23:00 hrs for daytime and 23:00 to 07:00 hrs for night-time.

The operational noise criteria include noise from wind turbines and any other ancillary noise sources such as the on-site substation transformer.

The Supreme Court decision in *Balz and Heubach v An Bord Pleanála and others [2018] IEHC 309* does not change the legal position of the Wind Energy Development Guidelines, 2006 (WEDGs). It has however clarified the extent of the duty on planning authorities to consider submissions in relation to the continued relevance of the WEDGs. The EIAR considered the application of other noise guidelines. However, the Draft Revised Wind Energy Development Guidelines, published in December 2019 (dWEGs) which is the most recent publication from the Department of Housing, Planning and Local Government have a number of technical errors, ambiguities and inconsistencies and requires further detailed review and amendment. This is a fact supported by several acoustic consultants from Ireland and the UK. In assessing the dWEGs, the WHO 45 dB L_{den} noise criterion was considered. The WHO document is based on a very limited data set, which only estimated the L_{den} for the sites studied, rather than assessing it directly from wind statistics. Furthermore, the WHO recommendation is "conditional". The guidelines also state… *"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."*

[5] See Page 65 of *The Assessment and rating of noise from wind farms (ETSU-R-97)*: ETSU (Energy Technology Support Unit) for more details.

Therefore, it would be premature to adopt the WHO recommendations without further careful and detailed consideration and therefore this has not been adopted. The best practice guidance contained in ETSU-R-97 together with the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes have been considered and applied to ensure a robust and best practice approach to the assessment.

9.3.4 Significance of Impact

The criteria for determining the significance of impacts and the effects are set out in the EPAs 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports, August 2022'. The EPA guidelines do not quantify the impacts in decibel terms. In absence of such information, reference is made to relevant standards and guidance documents noise limits. If the predicted impact from the construction or operational phase are below the respective noise limits, it is considered that no significant effect occurs.

For this assessment, it has been assumed that dwellings have a medium to high sensitivity. Table 9-2 presents the impact significance criteria from the EPA guidelines:

Table 9-2: Impact Significance Criteria

Impact Significance	Criteria
Imperceptible	An impact capable of measurement but without noticeable consequences
Not significant	An impact which causes noticeable changes in the character of environment but without significant consequences
Slight impacts	An impact which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate impacts	An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends
Significant impacts	An impact which, by its character, magnitude, duration or intensity significantly alters a sensitive aspect of the environment
Very Significant	An impact which, by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
Profound impacts	An impact which obliterates sensitive characteristics

9.3.5 Consultation Requirements

Details of the consultation are given in Chapter 4 of this EIAR. This includes the public consultation process at the time of the original EIAR in 2014, in addition to the subsequent Judicial Review Proceedings.

A summary is presented below:

- Consultation with the Department of Agriculture, Food and the Marine (DAFM) in 2014 recommended any potential impacts on agricultural activities including noise should be considered.
- During public consultation in 2014 concerns regarding potential noise impacts from the Proposed Wind Farm were raised, particularly in combination with Garraneragh windfarm.
- Following the initial 2014 EIAR submission an RFI was requested on issues relating to noise and vibration.
- Noise issues related to the Balz v. An Bord Pleanála (2019) judgement were raised. These are addressed in section 9.3.3.2.
- NPWS was consulted as part of a data request, which was returned on [1]5th November 2022. No specific receptors were flagged in the area.
- A further public consultation event was held in the Castle Hotel in Macroom, County Cork on the 5^{th} December 2022, with engagement on a host of issues, including the potential noise impacts and proximity to dwellings.
- An additional EIA Scoping Consultation was carried out between the 15^{th} December 2022 and 6^{th} February 2023.

9.4 Existing Environment

Baseline noise monitoring was undertaken at four NSLs surrounding the Proposed Development to establish the existing background noise levels in the vicinity of the Proposed Development. These locations comprise the original locations monitored before submission of the original 2014 EIS. These represent the closest locations to the Proposed Development as well as representing different noise environments in the vicinity of the Proposed Development.

The 35 dB L_{A90} study area as described in Section 9.3.2 and Figure 9-1 was reviewed to determine NSLs to be considered for noise monitoring. Permission to access the noise measurement locations was arranged by the applicant, with Fehily Timoney & Company setting up the noise monitoring equipment. Baseline noise data was collected at the four locations, shown in Figure 9-2 and details of the noise monitoring locations are presented in Table 9-3. The rationale for the selection of these monitoring locations is described in Appendix 9.1 which presents details on the baseline measurements and data analysis.

Table 9-3: Noise monitoring location details

Location ID	Easting	Northing	Description	Photograph* (see Appendix 9.1)
H1	534934	563889	This location is northeast of the Proposed Development. The noise monitor was in a field approximately 80m from the representative property, with direct line of sight to the Proposed Development.	Plate A9.1-1*
H40	532783	563850	This location is north west of the Proposed Development. This location was in a field next to a property, approximately 8m from the property façade, in the direction of the Proposed Development.	Plate A9.1-2*
H48	533193	562565	This location is south west of the Proposed Development. The noise monitoring location was in a field to the rear of the property approximately 10m from the rear façade of the property. The noise monitoring location was chosen to have a line of sight to the Proposed Development. The amenity area at the property is south of the house.	Plate A9.1-3*
H71	534631	562467	This location is south east of the Proposed Development. Noise was monitored in a field opposite the property, in the direction of the Proposed Development, approximately 140m north west of the property.	Plate A9.1-4*

*Photographs provided in Appendix 9.1

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community
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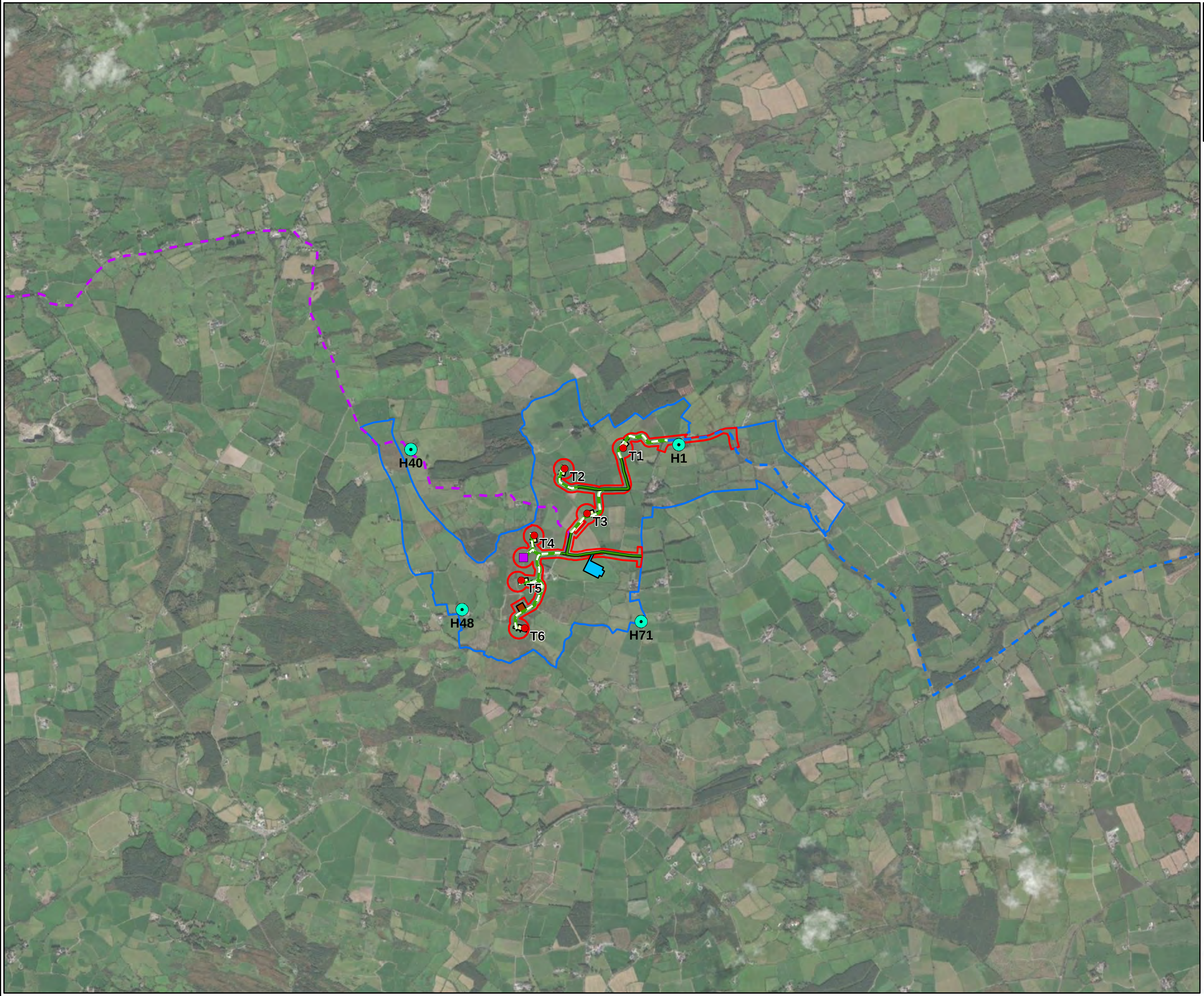
Path: R:\Map Production\2021\P21-143\Workspaces\EIAR\P21-143_GIS_Fig9-2_Noise_Monitoring_Locations_A3.mxd



Legend

- Development Planning Boundary
- Study Area Boundary
- Proposed Substation
- Turbine Hardstandings
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Met Mast
- Proposed Turbine Layout
- Noise Monitoring Locations
- Tracks-Existing
- Tracks-Proposed
- Alternative Grid Connection Route
- Turbine Delivery Route

TITLE:
Noise Monitoring Locations

PROJECT:
Barnadivane Wind Farm and Substation, Co. Cork

FIGURE NO:	9-2		
CLIENT:	Barna Wind Energy Ltd. & Arran Windfarm Ltd.		
SCALE:	1:30000	**REVISION:**	0
DATE:	23/02/2023	**PAGE SIZE:**	A3

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Cork | Dublin | Carlow
www.fehilytimoney.ie

0 0.25 0.5 1 Kilometers

9.4.1 Analysis of Baseline Data

The raw baseline L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level due to equipment malfunction. Any inconsistent data points were removed from the raw noise level data. The raw noise level data was then correlated with the time synchronised 10 m standardised wind speed and rainfall data. Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. Noise was measured in two Lots. Lot 1 data has been used to represent the baseline noise at location H1. As described in the Appendix, there was no rain gauge data for this noise monitoring location. Therefore data was removed for the days where rain occurred based on nearby weather station data. Lot 2 data did have rain gauge information and this was used to represent the remaining locations. Note that only H1 data was obtained during lot 1. H1 was not used to derive noise limits as these were derived from quieter noise monitoring locations. Once the remaining data sets were found to be representative of the noise environment, they were analysed to ensure that sufficient data sets remained to provide sufficient data coverage over the necessary wind speeds. A 'best fit' trend (not higher than a fourth order polynomial) was then derived to present the prevailing background noise level at each monitoring location. Appendix 9.1 presents the results of the data analysis.

The prevailing daytime amenity noise levels at the four noise monitoring locations are presented in Table 9-4. The derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point.

Table 9-4: Prevailing Background Noise during Daytime Periods (72.5m hub height)

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
H1	27.3	29.8	32.8	36.1	39.9	44.1§	44.1§	44.1§	44.1§	44.1§
H40	21.6	26.9	31.9	36.5	40.7	44.5	48.0	51.1	53.8	56.1
H48	26.0	29.3	32.6	35.7	38.9	41.9	44.9	47.8	50.7	53.5
H71	25.7	29.0	32.1	35.2	38.1	40.9	43.6	46.2	48.7§	48.7§
§ - noise level restricted to the highest derived point										

Table 9-5: Prevailing Background Noise during Night-time Periods (72.5m hub height)

Location	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
H1	24.3	27.6	30.8	33.8	36.8	39.6§	39.6§	39.6§	39.6§	39.6§
H40	21.5	25.9	30.2	34.5	38.6	42.7	46.6	50.4	54.2	57.9
H48	24.8	27.4	30.2	33.2	36.4	39.8	43.5	47.4	51.5	55.9
H71	25.0	26.8	29.0	31.6	34.5	37.9	41.6	45.6	50.1	54.9
§ - noise level restricted to the highest derived point										

9.4.2 Derived Windfarm Noise Limits

The standard approach outlined in the Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) to derivation of noise limits is to carry out background measurements at several locations representative of different noise environments around the Proposed Development site. As it is not usually possible to carry out measurements at every NSL, NSLs near to the measurement location are then assigned the same limits as the measurement location. The operational impact at each of the measurement locations was assessed in accordance with the IOA GPG.

As detailed in previous sections the noise criteria used to assess operational noise from the Proposed Development is based on a Best Practice Approach, currently used by the acoustics fraternity. This best practice approach is based on:

- Wind Energy Development Guidelines published by the Department of the Environment, Heritage and Local Government (2006);
- ETSU-R-97, The Assessment and Rating of Noise from Wind Farms (1996);
- Institute of Acoustics' A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, (May 2013).

The 2006 guidelines state that a fixed limit of 43 dB L_{A90} applies during night-time periods. However, the derivation of the daytime noise limit uses the prevailing daytime amenity background noise data. Where low background noise levels are found, the 2006 guidelines recommend a limit of 35 to 40 dB L_{A90}. There is no further detail provided on which to determine how the appropriate noise limit be derived as stated previously above. However, the guidelines state… *"An appropriate balance must be achieved between power generation and noise impact."* Reference has also been made to planning permissions for adjacent wind farms. Finally, reference is also made to ETSU-R-97 which recommends that the following three factors be considered when determining the fixed limit:

1) *Number of dwellings in neighbourhood of the wind farm.*
2) *The effect of noise limits on the kWh.*
3) *Duration and level of exposure.*

The IOA GPG states the following with respect to the ETSU-R-97 criteria… *"It can be argued that assessing these factors do not represent an acoustic consideration but ultimately a planning consideration."*

The first factor to be considered is the "*Number of dwellings in neighbourhood of the wind farm*". ETSU-R-97 describes this factor as balancing the benefits from a wind energy project with the local environment impact, "*The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate.*" The number of NSLs (including properties that have been granted planning permission but not yet built) within the 35dB L_{A90} study area is 61. Of these properties 7 properties are derelict. As for the previous EIS a limit of 40 dB L_{A90} has been selected for low background noise areas.

The second factor is the effect of noise limits on the power output of the wind farm. Similarly, to the first factor, this balances the planning merit of the project against the local impact. The Proposed Project has 6 turbines. If the limit is lowered, then, based on the noise modelling results, curtailment would be required.

Since this project is considered to have merit in assisting Ireland in meeting its renewable energy targets, the upper end of the limit range is appropriate.

The final ETSU factor relates to the duration and level of exposure. The prevailing background noise levels are described in detail in Section 9.4.1 and Appendix 9.1. Figure 9-1 presents the nearby Noise Sensitive Locations. In terms of the location of the properties within the Study Area boundary, these are mainly located north east, south and southwest of the Proposed Development site. The majority of properties outside the Study Area boundary are located to the south and west and north of the Proposed Development.

The Wind Energy Development Guidelines (2006) states that *"An appropriate balance must be achieved between power generation and noise impact."* As most properties are located upwind of the prevailing wind the development the limit of 40 dB L_{A90} is appropriate.

Given the information above, it is recommended that a fixed limit of 40 dB L_{A90} for low background noise conditions should apply for the Proposed Project. It represents an appropriate balance between power generation and noise.

The noise limits have been based on the lowest measured background noise across the site. From Table 9-4 above the quietest measured daytime noise levels were at location H40 (west of the proposed site) and H71 (south east of the proposed site). The background at H40 has been used at up to and including 5m/s and the background at H71 has been used for higher windspeeds as the represents the lowest background noise. A night time limit of 43 dB has been applied, as summarised in Table 9-6.

Table 9-6: Derived Noise Limits

Location	Period	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)									
		3	4	5	6	7	8	9	10	11	12
(H40/H71)	Daytime	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Night-time	43	43	43	43	43	43	43	43	43	43

9.5 Potential Impacts

9.5.1 Potential Impacts during Construction

The construction of the Proposed Development in its entirety is expected to take between 12 – 18 months. The proposed construction programme is outlined in Chapter 2 Description of the Proposed Development. Noise predictions were undertaken to determine the likely impact during the construction works. BS 5228-1:2009+A1:2014 sets out sound power levels and L_{Aeq} noise levels of plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations.

Construction noise modelling is based on the details presented in Chapter 2 of this EIAR as well as a review of other chapters of the EIAR. Noise modelling was carried out using guidance and plant noise data from BS 5228:2009+A1:2014. The ground cover is predominately acoustically soft (G=1)[6]. The noise model assumes that the ground cover is a mix between acoustically hard and soft ground with a ground cover of G=0.75 to allow for pockets of acoustically hard ground. Percentage on time[7] for plant is outlined for each of the plant items used during construction.

The construction noise model assessed several tasks with the potential to generate noise. These tasks include deliveries and/or removal of material to and from site, preparation of access roads, excavation of material from borrow pits, preparation of hardstands and drainage, pouring of foundations, installation of wind turbines and works associated with grid connection. Also considered, were the proposed on-site borrow pit and noise from removal of forestry.

Site Traffic

Detailed information on construction traffic is presented in Chapter 11. To summarise, additional light goods vehicles travelling to and from the site during the construction phase would be expected to peak during the morning (arrival of contractors at the site) and evening (departure of contractors from the site) and are envisaged not to be a continuous source of noise emissions from the site during a typical working day. The noise impact from construction personnel movements to and from the site is expected to be low.

Site traffic has been summarised in Chapter 11. For the purpose of this assessment, the traffic assumptions during construction works is based on the following summary, based on information in Chapter 11:

- Concrete pouring during site preparation 120 two way HGV’s per day
- Site preparation and ground works 39 HGV’s per day
- Turbine construction 8 HGV’s per day

For the purpose of this assessment, a worst-case upper value of 120 two way HGV movements have been assumed per day for Preparation of Access roads, Hardstands and Drainage and Wind Turbine Foundations. For the remaining activities a worst-case upper value of 20 two way HGV movements has been assumed per day.

All deliveries of turbine components to the site will only be by way of the proposed turbine delivery route (TDR). The point of arrival for the wind farm plant is likely to be Cork Harbour. The TDR includes the following routes:

- Turn off the N22 national secondary road at Inchirahilly;
- R585 through Crookstown and Béal na Bláth;
- R585 / L6008 junction at Bengour West;
- Local road network through Lackereagh;
- Access junction and route through the Site.

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[6] G denotes the ground cover from an acoustic perspective. G=0 refers to acoustically hard or reflective surface and G=1 refers to acoustic soft or absorptive surface.

[7] Percentage on-time refers to the percentage of the assessment period for which the activity takes place.

A grant of permission by Cork County Council was received for road improvement works at the junction of the R585 and L6088 (CCC PL Ref. 14/6803) (enabling TDR works) to facilitate the delivery of turbine components to the site.

The noise impact for construction works traffic will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection and foundation pours, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions. Turbine deliveries required at night will be subject to agreement with the relevant planning authority and it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Borrow Pits

There is 1 no. borrow pit on site proposed between Turbines 5 and Turbine 6. The location of the proposed borrow pit is shown in Figure 2-2. The proposed borrow pit shall provide site-won stone that will significantly reduce the amount of construction aggregates that would need to be delivered to site. A Construction Programme has been provided in Chapter 2. It has been assumed that the borrow pit will be required for the duration of the construction phase.

There will be no blasting required in the borrow pit. It is expected that a crusher/ripper will be required at the borrow pit. Table 9-7 presents the most affected NSLs where the highest noise levels from this activity are predicted. The nearest NSL is located approximately 500m (H48) from the borrow pit. Although 1900m from the borrow pit, the NSL most affected during borrow pit works is H1. the predicted noise at this location is dominated by traffic on the adjacent access track. There are closer NSLs, however the noise predicted at these locations are lower. Assuming all plant is operating at the borrow pit, the predicted cumulative noise at H1 is 56.8 dB and at H48 is 53.7 dB $L_{Aeq,1hr}$. The predicted noise is below the daytime noise limit of 65 dB $L_{Aeq,1hr}$ at all locations.

At all properties the borrow pit activity is expected to have a slight impact which is temporary in duration.

Table 9-7: Borrow Pit – Likely Plant

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) at H1	Predicted Noise Level (dB L_{Aeq}) at H48
Diesel Pump	C4.88	Pump water	100	0	0
Tracked Hydraulic Excavator (37t)	C10.1	Face shovel extracting/ loading dump trucks	80	11.5	45.7
Rock Breaker	C9.12	Rock breaking	50	12.2	48.9
Crusher	C1.14	Crushing material	100	14.3	48.6
Tracked Excavator (21t)	C4.65	Trenching	80	0	0
Dozer (41t)	C2.10	Ground Excavation/Earthworks	80	12.5	46.1
Articulated Dump Truck (23t) *	C2.33	Distribution of Material	Maximum 20 two-way trips per day	56.8	36.3
Cumulative				56.8	53.7
* - Drive-by maximum sound level					

Preparation of Access roads, Hardstands and Drainage

Table 9-8 presents the likely plant required for the preparation of access roads, hardstanding and drainage. It is estimated that this phase of the construction works will last for approximately 6 months. Also presented is the NSL where the highest noise levels for this activity are predicted.

The nearest NSL where the highest predicted noise level is predicted (H1) is located next to (within 10m) the adjacent access road. . L .

The predicted noise at this location is dominated by traffic on the adjacent access track. There are closer properties. However, the noise predicted at these locations are lower.

Table 9-8 presents the likely plant required for the preparation of access roads, hardstanding and drainage. Also presented are the predicted noise levels at the most affected locations, H1 and H48. Assuming all construction activities required for the preparation of the access road occur simultaneously, the predicted noise level from the construction activities is 67.5 dB $L_{Aeq,1hr}$, which is above the 65dB $L_{Aeq,1hr}$ noise limit.
The noise level predicted at (H1) is 67.5 dB $L_{Aeq,1hr}$ which is above the 65dB $L_{Aeq,1hr}$ noise limit. The predicted noise level at H48 is 55.8 dB $L_{Aeq,1hr}$.

In summary, there is one property that is expected to be above the 65dB $L_{Aeq,1hr}$ noise limit, as a result of the Access Tracks and Hardstandings works. At this property, the preparation of access roads, hardstands and drainage are expected to have an adverse impact and temporary in duration.

For all other properties, the preparation of access roads, hardstands and drainage are expected to have a slight impact and temporary in duration.

Table 9-8: Preparation of Access roads, Hardstands and Drainage - Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) at H1	Predicted Noise Level (dB L_{Aeq}) at H48
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	57.8	50.7
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	49.2	41.5
Dozer (14t)	C5.12	Spreading chipping/fill	80	57.8	50.3
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	48.3	40.3
Excavator (21t)	C4.65	Trench for drainage	80	54.2	46.2
Lorry*	C11.9	Delivery of Material	Maximum 120 two-way trips per day	66	49.3
Cumulative				67.5	55.8
* - Drive-by maximum sound level					

Preparation of Wind Turbine Foundations

Table 9-9 presents the likely plant required for the wind turbine foundations. As outlined in the Construction Programme provided in Chapter 2, it is estimated that this phase of the construction works will take approximately 6 months to complete.

The most affected NSL (H1), where the highest predicted noise level is predicted is located next to (within 10m) the adjacent access road near the site entrance. .

The predicted noise at this location is dominated by traffic on the access track. There are properties that are closer to the wind turbines. However, the noise levels predicted at these locations are lower. Predicted noise levels at the most affected locations, H1 and H36 are presented below. Assuming all construction activities required for the preparation of the turbine foundations occur simultaneously, the predicted noise level at H1from the construction activities is 65.4 dB $L_{Aeq,1hr}$, marginally above the 65dB $L_{Aeq,1hr}$ noise limit. The predicted levels are worst-case assumptions, with all construction activities assumed to occur simultaneously. The construction works associated with the preparation of the turbine foundations are expected to have a slight impact and temporary in duration.

At all other locations construction works associated with the installation of the proposed wind turbines are expected to have a slight impact and temporary in duration.

Table 9-9: Preparation of Wind Turbine Foundations – Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) H1	Predicted Noise Level (dB L_{Aeq}) H1
Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	33.4	41.9
Excavator (23t)	C10.8	Loading sand / soil	80	31.7	43.2
Diesel Pump	C4.88	Pump water	100	20.6	32.3
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	23	34.4
Concrete mixer truck & concrete pump	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	100	29.6	41.9
Lorry*	C11.9	Delivery and removal of material	Maximum 120 two-way trips per day	65.4	54.5
Cumulative				65.4	55.3
* - Drive-by maximum sound level					

Installation of Wind Turbines

Turbine components will be delivered to site and a mobile telescopic crane will lift the turbine components into place. It is estimated that this phase of the construction works will take approximately 3 months to complete. The highest predicted noise levels activities associated with the wind turbine installation activities at the most affected NSLs (H1 and H36) are presented in Table 9-10. Noise at these locations is dominated by noise from the access road to the northeast of the site. The predicted noise level at H1 is 57.6 dB and 4606 dB at H36, which is below the 65 dB $L_{Aeq,1hr}$ noise limit.

At all locations, construction works associated with the installation of the proposed wind turbines are expected to have a slight impact and temporary in duration.

Table 9-10: Installation of Wind Turbines – Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) at H1	Predicted Noise Level (dB L_{Aeq}) at H36
Mobile telescopic crane (x2)	C4.41	Lifting turbine components	100	0	34.9
Lorry *	C11.9	Delivery of Turbine Components	Maximum 20 two-way trips per day	57.6	46.6
Cumulative				57.6	46.6
* - Drive-by maximum sound level					

Construction of Proposed Substation

The construction of the Proposed Substation building will occur during the construction phase of the Proposed Development and will take approximately 12 months to complete. The construction works will be progressed in a number of phases:

- Site clearance and Preparation
- Preparation and pouring of foundations and floor areas
- Preparation of hardstanding areas
- Erection of blockwork/ installation concrete slabs
- General Construction including installation of electrical and mechanical plant

Table 9-11 presents the assumed plant required for the different construction phases of the proposed buildings to be constructed on site. The most affected NSL during Substation works is H1. Noise levels at H1 during this phase of the works is dominated by traffic movements on the access track. The cumulative predicted noise levels for the worst combination of plant (Preparation of Hardstanding Areas) is 57.9 dB $L_{Aeq,1hr}$ which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$.

The nearest occupied dwelling to the Proposed Substation (H36) will be approximately 200 m away from the Substation. The cumulative predicted noise levels for the worst combination of plant (Site Clearance and Preparation) is predicted to be 53.9 dB $L_{Aeq,1hr}$ at H36, which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$.

At the most affected properties to the substation works, the construction noise meets the noise limit and the works are expected to have a slight and temporary in duration.

Table 9-11: Construction of Substation – Likely Plant and Predicted Levels

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) at H1	Predicted Noise Level (dB L_{Aeq}) at H36
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Clearing Site	80	25.3	47.3
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	26.3	50
	Loading Lorry	C10.8	Loading Sand to Lorry	80	27.2	49.5
Cumulative					31.1	53.9
Preparation pouring of Foundations	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	25.3	47.2
	Concrete mixer truck + truck mounted concrete pump + boom arm	C4.32	Concrete pumping	80	22.6	47.6
	Lorry*	C11.9	Delivery of material	Maximum of 20 two-way trips per day	57.7	38.4
Cumulative					57.7	50.7
Preparation of hardstanding areas	Articulated Dump Truck (23t)	C2.33	Delivery/Removal of Material	Maximum of 20 two-way trips per day	57.8	35.4
	Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	26.6	46.9
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	14.1	37.5
	Dozer (14t)	C5.12	Spreading chipping/fill	80	22	46.3
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	14	36.2
	Lorry*	C11.9	Delivery of material	Maximum of 20 two-way trips per day	41.4	38.4

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level (dB L_{Aeq}) at H1	Predicted Noise Level (dB L_{Aeq}) at H36
Cumulative					57.9	50.5
Erection of blockwork/ installation concrete slabs	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	23	46.6
	Lorry* (32t)	C11.9	Delivery of material	Maximum of 20 two-way trips per day	57.7	37.5
Cumulative					57.7	47.1
General Construction including installation of electrical and mechanical plant	Generator	C4.84	Power for site cabins	100	20.5	44.4
	Telescopic handler	C4.54	Lifting Plant	80	22.4	48.4
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	20.5	50.4
Cumulative					26.0	53.1
* Drive-by maximum sound level						

Grid Connection Works including Link between Onsite Substations

A full description of the Proposed Substation and AGCR option is presented in Chapter 2, Section 2.3.10.

There are two possible scenarios, in terms of noise, for the AGCR works. The first is that the substation is built and connected to the existing overhead lines, in which case noise from the AGCR works does not need to be considered. Noise from the AGCR is addressed within the cumulative noise section.

9.5.2 Potential Impacts during Operation

Predicted Noise Levels

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term down wind conditions or long-term overall averages.

Only the short-term downwind condition has been considered in this assessment, which is – for wind blowing from the proposed turbines towards the nearby NSLs regardless of wind direction. When the wind is blowing in the opposite direction (away from the house) noise levels will be significantly lower. The impact will be reduced further where there is any shielding between the turbines and the NSLs.

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

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

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

L_W – Source Sound Power Level

The sound power level of a noise source is normally expressed in dB re:1pW. Noise predictions are based on sound power levels provided for the Nordex N117 3.6 MW with 72.5 m hub height. The standardised sound power data, based on the equipment supplier data for the 76m high turbine is summarised in Table 9-12.

The declared apparent sound power level values for the turbine, given in Table 9-12, are based on measured noise levels by the manufacturer with values added to account for uncertainty.

The UK Institute of Acoustics', Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG) states that it should be ensured that a margin of uncertainty is included within source wind turbine noise data used in noise predictions, and that if declared sound power levels are used, as is the case here, the levels can be used directly, as the calculated levels include an appropriate uncertainty. For the purpose of this assessment a +2dB has been applied to the data in Table 9-1, as per the IOA Good Practice Guide.

Table 9-12: Nordex N117/3600 Sound Power Levels (dB LWA) at standardised wind speed, with trailing edge serration (76m data)

Turbine	Standardised 10 m height Wind Speed (m/s)							
	3	4	5	6	7	8	9	10
31.5	62.0	61.9	69.6	73.8	74.8	74.8	74.8	74.8
63	72.8	73.5	79.2	83.2	84.2	84.2	84.2	84.2
125	80.1	80.2	86.2	89.5	90.4	90.4	90.4	90.4
250	86.5	86.2	89.5	93.1	93.3	93.3	93.3	93.3
500	86.6	86.4	89.7	93.7	93.8	93.8	93.8	93.8
1k	85.1	87.6	92.1	95.8	96.6	96.6	96.6	96.6
2k	84.4	89.0	93.8	96.9	98.0	98.0	98.0	98.0
4k	81.0	85.8	92.9	96.4	97.0	97.0	97.0	97.0
8k	75.9	74.1	83.0	86.9	87.7	87.7	87.7	87.7
Overall	92.5	94.4	99.3	102.8	103.5	103.5	103.5	103.5

D – Directivity Factor

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

A_{geo} – Geometrical Divergence

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

$A_{geo} = 20 \times \log(d) + 11$
where, d = distance from the turbine

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

A_{atm} – Atmospheric Absorption

The atmospheric absorption accounts for the frequency dependent linear attenuation with distance of sound power over the frequency spectrum according to:

$A_{atm} = d \times \alpha$
where, α = the atmospheric absorption coefficient of the relevant frequency band

Published values of 'α' from ISO 9613 Part 1[8] have been used, corresponding to a temperature of 10^{o}C and a relative humidity of 70%, the values specified in the IOA GPG, which give relatively low levels of atmospheric attenuation, and subsequently worst-case noise predictions as given in Table 9-13:

Table 9-13: Atmospheric Octave Band Attenuation coefficients (dB/m)

63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
0.00012	0.00041	0.00104	0.00193	0.00366	0.00966	0.03280	0.11700

A_{gr} – Ground Effect

Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation).

[8] ISO 9613-1, Acoustics - Attenuation of sound during propagation outdoors, Part 1: Method of calculation of the attenuation of sound by atmospheric absorption, International Organization for Standardization, 1992

The GPG states that use of G = 0.5 and a receptor height of 4 m should be used to predict the resultant turbine noise level at dwellings neighbouring a Proposed Development provided that an appropriate allowance for measurement uncertainty is accounted for within the stated source noise levels.

Therefore, predictions in this report are based on G = 0.5 with a receptor height of 4 m and, due to the confidence associated with the use of the declared apparent sound power levels (calculated using three independent measurement reports), these predictions are considered to be conservative.

Abar – Barrier Attenuation

The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise. The barrier attenuations predicted by the ISO 9613 model have, however, been shown to be significantly greater than that measured in practice under downwind conditions. The results of a study of propagation of noise from wind farm sites carried out for ETSU concludes that an attenuation of just 2 dB(A) should be allowed where the direct line of sight between the source and receiver is just interrupted and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of sight.

The GPG states that *'Topographic screening effects of the terrain (ISO 9631-2, Equation 2) should be limited to a reduction of no more than 2 dB, and then only if there is no direct line of sight between the highest point on the turbine rotor and the receiver location*'. There are no significant topographical barriers surrounding the Proposed Development. As a result, this has not been accounted for within the predictions.

Amisc – Miscellaneous Other Effects

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

The predicted turbine noise L_{Aeq} has been adjusted by subtracting 2 dB to give the equivalent L_{A90} as suggested in the IOA GPG. It should be noted that noise levels will be lower at lower wind speeds.

Potential Cumulative Impacts

The neighbouring Garranereagh Wind Farm is situated approximately 1 km east of the Proposed Development. It consists of four Enercon E-82 2.3 MW turbines with 78 m hub height. Predictions of the noise associated with Garranereagh Wind Farm operating in combination with the Proposed Development have been carried out according to the same method set out above, with the exception of the turbine source sound power level data which is as follows:

Table 9-14: E-82 Declared Apparent Sound Power Levels (dB L_{WA})

Turbine	Standardised 10 m height Wind Speed (m/s)				
	6	7	8	9	10
E-82 Measured Noise Level	101.1	102.9	103.5	103.9	103.1
K (95%) Confidence Interval*	2.4	2.2	1.9	2.0	2.6
Declared Apparent Sound Power Level	103.5	105.1	105.4	105.9	105.7

* measurement uncertainty from manufacturer test data

The octave band spectrum used for the noise predictions is shown below in Table 9-15, taken from results of measurements provided by the manufacturer, and normalised to an overall declared apparent sound power level of 105.7 dB, corresponding to a standardised wind speed of 10 m/s.

Table 9-15: Wind Turbine Octave Band Noise Levels (dB)

Turbine	Octave Band Centre Frequency (Hz)								
	Overall	63	125	250	500	1k	2k	4k	8k
E-82 2.3 MS	105.7	86.2	93.5	99.7	101.1	98.2	95.9	91.6	84.8

Predictions have been carried out of the Proposed Substation, based on an example transformer; the Siemens TLPN7747 40000 / 50000 kVA. The sound power level for the transformer is 93 dB(A). The octave band profile for the transformer has been sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' published by CED Engineering. The A-weighted octave band data is presented in Table 9-16. If an alternative transformer is selected this will not exceed a sound power level of 93 dB(A):

Table 9-16: Transformer Octave Band Sound Power Data

Equipment	A-weighted Octave Band Centre Frequency (Hz)									Overall
	31.5	63	125	250	500	1k	2k	4k	8k	L_{WA}
Transformer Ω	81.0	87.0	89.0	84.0	84.0	78.0	73.0	68.0	61.0	93.0

Ω - Manufacturer's datasheet provided information on overall sound power levels. Octave band data was sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' CED Engineering

9.5.3 Summary of Potential Impacts

Noise predictions were performed for the proposed 6-wind turbine layout using the highest noise levels at each wind speed, for the proposed turbine for a range of standardised 10m height wind speeds from 2 m/s up to 12 m/s . Noise from the transformer for the Proposed Substation was also predicted. NSLs within the 35 dB L_{A90} noise contour of the turbines were modelled. A number of the receptors were identified as farm buildings. These are not considered noise sensitive and have not been considered as part of the impact assessment, and were not assessed against the derived daytime and night-time noise levels.

Table 9-17 presents predicted noise levels adjacent to NSLs closest to the Proposed Development. The predicted noise levels at all NSLs are presented in Appendix 9. Note: the predicted noise levels are for a worst-case scenario with NSL downwind of the Proposed Development.

In practice, NSLs will not be downwind of all noise sources and the actual noise levels will be lower than those presented in Table 9-17 and Appendix 9.6.

Table 9-17 also presents derived daytime and night-time noise limits at each of these locations. The predicted noise levels from the Proposed Project are below the daytime and night-time noise levels at all locations, except at NSL H36, which is a stakeholder property. At H36 the daytime limit is exceeded by 0.5 dB at 7 and 8m/s. The night time limit is exceeded by between 1.8 to 2.5 dB. At some NSL locations, particularly those west of the site, away from the existing Garranereagh windfarm, with the introduction of a new source of noise into the soundscape, it is expected that there will be a long-term moderate significance of impact on the closest dwellings to the Proposed Wind Farm.

In order to protect residents, the cumulative impact from the other nearby wind farm development, Garranereagh must also be considered and this is assessed in Section 9.5.7.

Table 9-17: Predicted Noise Levels vs Standardised 10 m Height Wind Speed Barnadivane WF

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB									
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H1	Predicted Level	28.2	29.1	33.2	36.8	37.5	37.5	37.5	37.5	37.5	37.5
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H28	Predicted Level	21.6	22.0	26.1	29.8	30.3	30.3	30.3	30.3	30.3	30.3
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H32	Predicted Level	28.6	29.4	33.5	37.1	37.7	37.7	37.7	37.7	37.7	37.7
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H34	Predicted Level	32.4	33.6	37.8	41.4	42.0	42.0	42.0	42.0	42.0	42.0
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB									
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H36	Predicted Level	35.7	37.0	41.2	44.8	45.5	45.5	45.5	45.5	45.5	45.5
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	**0.5**	**0.5**	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	**1.8**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**	**2.5**
H48	Predicted Level	30.9	31.9	36.1	39.7	40.3	40.3	40.3	40.3	40.3	40.3
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H55	Predicted Level	29.9	30.8	34.9	38.5	39.1	39.1	39.1	39.1	39.1	39.1
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-

9.5.4 Potential Noise during Decommissioning

On decommissioning, cranes will disassemble the above ground turbine components which would be removed off site for recycling. All the major component parts are bolted together, so this is a relatively straightforward process. The foundations will be covered over and allowed to re-vegetate naturally. It is proposed that the internal site access tracks will be left in place. It is proposed that the substation will remain in place.

These activities will be undertaken during daytime hours, and noise, which will be of a lesser impact than for construction, will be controlled through the relevant guidance and standards in place at the time of decommissioning.

A detailed decommissioning plan will be agreed in advance of construction with Cork County Council. A decommissioning plan is contained in the CEMP.

9.5.5 Potential Cumulative Impacts

9.5.5.1 Construction Phase

It is not expected that there will be cumulative impacts with other large or small scale developments in the vicinity of the Proposed Development, given the distance between the developments and nature of the works proposed as part of these developments. There is potential for cumulative impacts with other construction activities, which will be short-term and temporary.

As detailed within the EIAR for the AGCR, there is a potential for the construction noise limits to be exceeded at distances where a NSL is within 20m of the works. In this case detailed consideration would be required and appropriate mitigation measures implemented to manage the impacts. As stated in the EIAR for the AGCR,

"the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of British Standard BS 5228-1:2009+A1:2014 Code of Practice for noise and vibration control on construction and open sites-Noise.

These measures will ensure that:

- *No plant used on site will be permitted to cause an on-going public nuisance due to noise.*
- *The best means practicable, including proper maintenance of plant will be employed to minimise the noise produced by on site operations."*

Also, the EIAR for the ACGR states that during the course of the programme, supervision of the works will include ensuring compliance with the construction noise limits using methods outlined in British Standard BS5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites -Noise. In order to mitigate against potential cumulative noise impacts, further mitigation measures are specified in 9.5.8 of this EIAR.

Construction noise from the proposed enabling TDR Works will need to be assessed as there are properties opposite the proposed site for the TDR works. The original grant of planning permission (Ref. 14/6803) was subject to 10 planning conditions, none of which refer to noise.

Given the distance between the proposed construction works and enabling TDR works, cumulative impacts are not considered likely. However, in addition to the Construction Noise Mitigation measures Section 9.5.8 of this report it is recommended that the contractor adopt good practice noise control measures as outlined in *British Standard BS5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites -Noise* .

9.5.5.2 Operational Phase

Noise has been predicted from the adjacent wind farm 1km from the site at Garranereagh consisting of 4 no. turbines. The IOA GPG criteria, states that cumulative noise from nearby windfarms (i.e. Garranereagh) needs to be considered if the Proposed Wind Farm (i.e. Barnadivane Windfarm) produces noise within 10 dB of the existing Garranereagh windfarm.

Table 9-18 presents predicted noise levels from the adjacent Garranereagh windfarm only, with the predicted cumulative noise levels from both windfarms set out in Table 9-19. The predicted noise from Garranereagh Windfarm at all NSLs are presented in Appendix 9.6, with cumulative predicted noise presented in Appendix 9.7. Note: the predicted noise levels are for a worst-case scenario with NSLs downwind of the Proposed Wind Farm. In practice, NSLs will not be downwind of all noise sources and the actual noise levels will be lower.

When noise from only Garreneragh Windfarm is considered, the noise limits are exceeded at one Garreneragh stakeholder property, H28. This exceeds the noise limit by between 2.2 and 4.1dB during the daytime and up to 6.6 dB during the night time.

When cumulative noise from both windfarms are considered, the noise limits are exceeded at the following locations:

- At H28 the night time limit is exceeded by between 4.2 to 6.6 dB and the daytime limit by between 2.2 and 7.2 dB. H28 is a Garreneragh stakeholder property.
- At H34, the night time limit is exceeded by 1.5 dB above 10 m/s. The daytime limit is met at this location. H34 is a stakeholder property.
- At H36, the night time limit is exceeded by 2.8 dB above 10 m/s. The daytime limit is met at this location. H36 is a stakeholder property.

At some NSLs, a new source of noise will be introduced into the soundscape and it is expected that there will be a long-term moderate significance of impact on the closest dwellings to the Proposed Development. This is for properties west of the Proposed Development.

The predicted cumulative noise levels comply with the daytime and night-time limits at the majority of NSLs. The exceedances are at stakeholder properties (H34 and H36). There is an exceedance at Garranereagh stakeholder property H28, close to the existing Garranereagh windfarm, but this is due to noise from Garranereagh windfarm. The noise modelling assumed that this NSL is downwind of all wind turbines. In practice, this will not occur all the time and the actual noise levels at the NSL will be lower when the NSL is upwind or cross wind of the wind farm.

Table 9-18: Predicted Noise Levels vs Standardised 10 m Height Wind Speed Garreneragh WF (only above 5m/s)

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB						
		6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H1	Predicted Level	36.8	38.4	38.7	39.2	41.5	41.5	41.5
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-
H28	Predicted Level	47.2	48.8	49.1	49.6	49.6	49.6	49.6
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	**2.2**	**3.8**	**4.1**	**3.0**	**2.5**	**2.5**	**2.5**
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	**4.3**	**5.8**	**6.1**	**6.6**	**6.6**	**6.6**	**6.6**
H32	Predicted Level	36.6	38.2	38.5	39.0	41.4	41.4	41.4
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-
H34	Predicted Level	38.4	40.0	40.3	40.8	40.6	40.6	40.6
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB						
		6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H36	Predicted Level	31.0	32.6	32.9	33.4	45.8	45.8	45.8
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	2.8	2.8	2.8
H48	Predicted Level	26.1	27.7	28.0	28.5	40.6	40.6	40.6
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-
H55	Predicted Level	26.8	28.4	28.7	29.2	39.5	39.5	39.5
	Daytime limit	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-

Table 9-19: Predicted Noise Levels vs Standardised 10 m Height Wind Speed Cumulative

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB									
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H1	Predicted Level	37.4	37.5	38.4	39.8	41.0	41.2	41.5	41.3	41.3	41.3
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H28	Predicted Level	47.2	47.2	47.2	47.3	48.8	49.1	49.6	49.4	49.4	49.4
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	**7.2**	**7.2**	**2.2**	**2.3**	**3.8**	**4.1**	**3.0**	**2.3**	**2.3**	**2.3**
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	**4.2**	**4.2**	**4.2**	**4.3**	**5.8**	**6.1**	**6.6**	**6.4**	**6.4**	**6.4**
H32	Predicted Level	37.2	37.3	38.3	39.9	41.0	41.1	41.4	41.3	41.3	41.3
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H34	Predicted Level	39.4	39.6	41.1	43.2	44.1	44.2	44.5	44.4	44.4	44.4
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	**-**	**-**	**-**	**0.2**	**1.1**	**1.2**	**1.5**	**1.4**	**1.4**	**1.4**

NSL ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB									
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s
H36	Predicted Level	37.0	38.0	41.6	45.0	45.7	45.7	45.8	45.7	45.7	45.7
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	**-**	**0.7**	**0.7**	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	**-**	**-**	**-**	**2.0**	**2.7**	**2.7**	**2.8**	**2.7**	**2.8**	**2.8**
H48	Predicted Level	32.2	32.9	36.5	39.9	40.5	40.5	40.6	40.6	40.6	40.6
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-
H55	Predicted Level	31.6	32.2	35.5	38.8	39.5	39.5	39.5	39.5	39.5	39.5
	Daytime limit	40	40	45	45	45	45	46.6	47.1	47.1	47.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-

9.5.6 Mitigation Measures

Construction Noise

The predicted noise from vehicle movements on the access track to the north of the site has the potential to exceed the noise limits in BS 5228-1:2009+A1:2014. This exceedance affects one property located immediately north of the access track (H1). It is therefore recommended that construction hoarding is located between this property and the adjacent access road for the duration of the construction works.

At other locations, the predicted noise levels from on-site activity from the Proposed Project is below the noise limits in BS 5228-1:2009+A1:2014. Nonetheless, several mitigation measures will be employed to minimise any potential impacts from the proposed project.

The noise impact for construction works traffic will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions. If turbine deliveries are required at night it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Consultation with the local community is important in minimising the impacts and therefore construction will be undertaken in consultation with the local authority as well as the residents being informed of construction activities through the Community Liaison Officer.

The construction works on site will be carried out in accordance with the guidance set out in BS 5228:2009+A1:2014, and the noise control measures set out in the Construction Environmental Management Plan (CEMP) within this EIAR. Proper maintenance of plant will be employed to minimise the noise produced by any 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 project. Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 07:00 - 19:00 hours Monday to Saturday However, to ensure that optimal use is made of fair-weather windows, or at critical periods within the programme, it could occasionally be necessary to work outside these hours. Any such out of hours working would be agreed in advance with the local planning authority.

The on-site construction and decommissioning noise levels will be below the relevant noise limit of 65 dB $L_{Aeq,1hr}$ for operations exceeding one month, and therefore construction noise impacts are not considered to be significant. However, there is potential for temporary elevated noise levels due to the grid connection works. However, the impact of these works at any particular NSL will be for a short duration (i.e. less than 3 days). Where the works at elevated noise levels are required over an extended period at a given location, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required. The noise impact will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable.

Operational Noise

There are nineteen properties close to the Proposed Development which are either derelict, owned by stakeholders or both. Full details are provided in Appendix 9.3.

The predicted noise from the Proposed Development is within the daytime and night-time noise limits at all but one non-stakeholder NSL (H28). This location is a Garreneragh stakeholder property and exceeds the limits as a result of the adjacent Garreneragh windfarm. Noise from the Proposed Wind Farm only is within the criteria at this property. No noise mitigation is proposed at this location as the noise levels are determined by Garreneragh Windfarm.

There are two stakeholder properties (H34 and H36) that exceed daytime and night-time limits, as discussed in previous sections. Again, no noise mitigation is proposed for these properties. The stakeholder properties have been made aware of the exceedances and are happy to proceed on this basis.

This assessment is based on noise modelling which assumes that NSLs are downwind of all wind turbines. In practice, this will not occur all the time and when the NSL is upwind or cross-wind the actual noise levels will be lower.

Mitigation during Decommissioning

Similar mitigation measures should be employed as for during construction works, although construction noise levels are anticipated to be below the construction noise limits. The main noise mitigation measures include construction works traffic will be mitigated by restricting movements along access routes to the standard working hours and exclude working on Sundays, unless specifically agreed otherwise with the local authority. Decommissioning works, which will be of a lower impact than construction works, will be carried out in accordance with the policies and guidance required at the time of the works, and restricted to normal working hours, 07:00 - 19:00 hours Monday to Saturday in accordance with best practice.

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