FEHILY TIMONEY

DESIGNING AND DELIVERING
A SUSTAINABLE FUTURE

ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR THE PROPOSED CLOONKETT WIND FARM, CO. CLARE

Volume 2 - Main EIAR

Chapter 8 –Noise & Vibration

Prepared for:
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8. NOISE AND VIBRATION

8.1 Introduction

This chapter contains an assessment of the likely significant direct effects with respect to noise and vibration from the Proposed Development. The assessment, including undertaking of background noise surveys, has been carried out by Fehily Timoney and Company, in accordance with current guidance and best practice. Descriptions of the Proposed Development are provided in Chapter 2 – Development Description, Volume 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 and Part 2: Vibration. This is considered the best practice standard in the assessment of construction noise and vibration, based on my professional expertise and opinion.

Potential operational noise impacts associated with the Proposed Development have been determined with reference to the UK Institute of Acoustics', A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (2013). Note that a draft replacement document to ETSU-R-97 was published for consultation in July 2025, but is unlikely to be formally issued before the submission date of this EIAR. Until this is formally adopted, it is not considered best practice. Operational noise associated with the Proposed Development includes noise from the proposed wind turbines and on-site substation. The Wind Turbine operational noise is compared with noise limits derived in accordance with the Wind Energy Development Guidelines 2006 (DEHLG 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.

As discussed in Chapter 2, the proposed turbine model for this development will be a Vestas 136, which has been used as the basis for the operational noise assessment.

8.1.1 Statement of Authority

Maureen Marsden, Fehily Timoney and Company (FTC) is an Acoustic Engineer with a Master of Engineering degree in Acoustics and Vibration and over 20 years' experience, in noise and vibration, in particular in industrial noise, including wind farm and solar farm projects. Maureen is a member of the Institute of Acoustics and the Institute of Engineers Ireland. Maureen has worked with wind farm and renewable energy projects for over five years. She has undertaken baseline noise surveys for wind farms, assessed construction and operational noise for wind farm projects and developed noise curtailment strategies where required. In addition to writing Environmental Impact Assessment Chapters, she has responded to Requests for Information (RFI's) post EIAR submission and provided input to the legal response for Judicial Reviews. Maureen Marsden undertook the baseline noise surveys for Cloonkett windfarm. She has assessed both operational and construction noise for the Proposed Development. The noise data for this development has been compared with best practice criteria, and mitigation has been provided as required.

John Cullen, Fehily Timoney and Company (FT) is an Environmental and Acoustic Engineer with a degree in Agri-Environmental Science, a post Graduate Diploma in Environmental Engineering and a Diploma in Acoustics and Noise Control. John is a member of the Institute of Engineers Ireland, the Institute of Environmental Sciences and the Institute of Acoustics. John has over eight years' experience in the assessment of environmental noise and vibration, and he has worked within renewable energy and wind farm projects for three years. He has undertaken baseline noise surveys for wind farms, developed computational noise models, assessed construction and operational noise impacts for wind farm projects and provided input to the legal response for Judicial Reviews. John undertook the baseline noise survey and reviewed the noise and vibration chapter in accordance with best practice guidance and criteria.

8.2 Description of Noise and Vibration Impacts

The following sections describe the potential noise and vibration impacts associated with the proposed temporary construction and permanent works. For the windfarm operational noise a summary of the current research on windfarm noise is outlined. For both temporary and permanent works, the noise and vibration criteria are set out, where relevant.

8.2.1 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. The threshold of human perception of vibration is in the range of 0.14mm/s to 0.3mm/s, described as “might just be perceptible” in BS 5228 Control of Noise and Vibration on Open and Construction Sites- Part 2: Vibration.

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 , as summarised in BS 5228.

Vibration levels generated from the construction activities proposed at Cloonkett Wind Farm are calculated as:

- Tracked excavators and disc cutters from cable trenching (0.8 mm/s at 4m)
- Pneumatic breakers for cable trenching (0.7 mm/s at 10 m)
- Excavation of turbine foundations (0.06 mm/s at 100 m)
- HGV traffic on normal road surfaces (0.01 to 0.5 mm/s) at footings of buildings located 20 m from roadway.

The nearest noise sensitive locations are sufficiently distant, over 140m, and less than the values above such that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration. In addition, as piling is proposed at a distance of approximately 600m to the nearest sensitive location, vibration from piling is scoped out of this assessment. As such, construction vibration will not be considered further in this chapter.

8.2.2 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 power 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. (2007) '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 8.5.3.

8.2.3 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*'.

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 of the rotor blade.

In the UK, the University of Salford carried out a study on behalf the Department for Business, Enterprise and Regulatory Reform (BERR, 2007) to investigate the prevalence of amplitude modulation of aerodynamic noise on UK wind farm sites. The study concluded that AM 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.

RenewableUK conducted research into AM and this was summarised in:, '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) (EPA 2011) 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 (BERR 2013) '*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 and thus aid in the development of mitigation measures for OAM. If OAM occurs from the Proposed Wind Farm, the wind turbine software controls will be used to reduce it by implementing blade pitch regulation, vortex generators, or temporary turbine shut down.

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

At present there is no method for predicting AM 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 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 to use existing research to develop a Reference Methodology for the measurement and rating of AM.

The current best practice relating to AM is outlined in a more recent document: A review of noise guidance for onshore wind turbines (ref 70081416-001-03-05), September 2023, UK Department for Business, Energy & Industrial Strategy, WSP.

With respect to the current guidance relating to AM, the WSP report (2016) identifies controls for AM in wind turbine sound as a priority area. This report notes that the IOA Reference Method (referred to above) for AM measurement has been shown to be a robust and practical approach to quantifying or measuring AM. Of the measurement methods available, the IOA methodology offers the best balance between reliability and practicality.

The WSP report states that there is limited scientific evidence available concerning the impact of AM as experienced by wind farm neighbours in their homes. It is not currently possible to reliably predict AM at the planning stage that may be used to include an appropriate OAM threshold as a planning condition. The approach for assessing AM or OAM, should this occur, is addressed in the mitigation section.

The WSP report recommends a study to determine most effective way of controlling the impact of AM.

In summary, where it occurs, AM is typically an intermittent occurrence, therefore assessment may involve long-term measurements. As described in the WSP report, 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.

8.2.4 Infrasound & 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 as defined in NANR45: Procedure for assessment of low frequency noise, Salford University Report.

Infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, owning 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 UK 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 20 dB 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).*' They concluded that infrasound noise emissions from wind turbines are significantly below the recognised threshold of perception for acoustic energy within this frequency range. Therefore, 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 wind farm has been scoped out.

A draft version of the Assessment and Rating of Wind Turbine Noise was published by the UK Department of Energy Security and Next Zero, in July 2025. This is undergoing a consultation process and does not represent a final position for the UK government. However, this document states that certain potential effects do not require assessment, namely infrasound, ground borne vibration and low frequency sound. The document quotes a scoping report (WSP for the Department for Business, Energy & Industrial Strategy (2022), A review of noise guidance for onshore wind turbines, report reference 70081416 001 03 03] which concludes that "the findings from the existing evidence base indicate that infrasound from wind turbines at typical exposure levels has no direct adverse effects on physical or mental health".

8.2.5 Tonal Noise

Relevant industry Guidance, "The Assessment and Rating of Noise from Wind Farms 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.

The WSP Consultants report "A review of noise guidance for onshore wind turbines" (WSP, 2023) notes there are several methods for evaluating tonal characteristics. Also, tonality characteristics in sound emissions from turbines have been effectively addressed with improved technology from turbine manufacturers. However, it also suggests that future issues with tonal noise could potentially occur if there are design changes to reduce overall broadband noise which could cause tones to reemerge. Therefore selection of wind turbines without tonal components is an important part of the final Turbine selection process.

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. It is recommended that tonality of wind turbines is considered during the procurement stage The assessment of the wind turbine noise in this EIAR chapter assumed that a tonal penalty is 0 dB. This assumption is considered best practice, provided manufactures data is confirmed at the procurement stage that the turbines are not tonal in nature. If the turbines are deemed to be tonal in nature a tonal correction will need to be applied.

8.2.6 Substation Noise

8.2.6.1 BS4142 Assessment Methodology

The proposed substation has been assessed using the methodology described in the British Standard, BS4142:2014+A1:2019 Methods for rating industrial and commercial sound.

BS4142 describes a method for rating and assessing sound of an industrial and/or commercial nature and is considered best practice guidance for the assessment of substation noise emissions. The method described in BS 4142 uses outdoor sound levels to assess the likely effects of sound on people inside or outside a dwelling or premises used for residential purposes upon which sound is incident. This standard has a number of descriptors of the sound summarised below:

Background sound level, $L_{A90,\,T}$ This is the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured with a Fast time weighting.

Residual sound This is the ambient sound remaining at the assessment location when the specific sound (i.e the source being assessed), is suppressed to such a degree that it does not contribute to the ambient sound.

Specific sound level, (L_S=$L_{Aeq,Tr}$) This is the equivalent continuous A-weighted sound pressure level of the specific sound source (i.e. the source being assessed) at the assessment location over a given reference time interval T_r. The reference time interval is 1 hour during the day (07:00 to 23:00) or 15minutes at night (23:00 to 07:00).

Rating level ($L_{ar,Tr}$) This is the specific sound plus any adjustment for the characteristic features of the sound.

The significance of a sound of an industrial or commercial source depends on the difference between the rating level of the specific source and the background noise level and the context under which the sound occurs. Generally, the greater the difference the greater the magnitude of the impact.

- A difference of +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of +5dB is likely to be an indication of an adverse impact, depending on the context.

Also, BS4142 notes that where the initial estimate of the impact needs to be modified due to the context, the following needs to be considered:

1. The absolute level of the sound. Where the background noise levels are low, absolute noise levels may be more relevant, particularly at night.
2. Character and level of residual sound compared to character and level of specific sound.
3. Sensitivity of receptor to sound and whether design measures that improve the acoustic environment can be considered (e.g. façade insulation, ventilation or acoustic screening).

8.2.6.2 World Health Organisation Criteria

World Health Organisation Night Noise Guidelines for Europe 2009 define noise criteria for L_{night}, which is the equivalent outdoor sound pressure associated with a particular type of noise during the night (at least 8 hours) over a period of a year, outside. A limit of L_{night}, outside of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise. As stated within these guidelines, "these guidelines are applicable to the Member States of the European Region, and may be considered as an extension to, as well as an update of, the previous WHO Guidelines for community noise (1999)"

8.2.7 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 Snow (ETSU (1997), *Low Frequency Noise and Vibrations Measurement at a Modern Wind Farm*) 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 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 518 m 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 deemed out of the scope for this assessment as no potential impacts arise.

8.2.8 Decommissioning Noise and Vibration

The impacts associated with decommissioning of the Proposed Development are comparable to those described for the construction phase. The current best practice guidance for construction noise and vibration assessment described above also applies to the decommissioning phase of the project at the end of the service life of the proposed project.

8.3 Methodology

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

- Review of appropriate best-practice guidance and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise environment/baseline;
- Prediction of the noise impact associated with the Proposed Development, and;
- Evaluation of noise impacts and assessment of resulting likely direct significant effects;
- Propose mitigation, and;
- Assess residual impacts.

8.3.1 Relevant Guidance

A list of relevant guidance documents is provided below. These have been referred to where referenced or applied in the relevant sections hereafter.

EIA Guidance:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022
- Environmental Impact Assessment of Projects - Guidance on the preparation of the Environmental Impact Assessment Report, 2017 (Directive 2011/92/EU as amended by 2014/52/EU).

Noise Modelling Standards and Technical Advice:

- International Standard *ISO 9613-2: 2024 Attenuation of sound during propagation outdoors, Part 2:* Engineering method for the prediction of sound pressure levels outdoors*;*
- 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);
- UK Department of Trade and Industry (DTI), ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (1996);
- EPA Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3)
- 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 (DEHLG, 2006);
- World Health Organisation Night Noise Guidelines for Europe, 2009Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government, (DHPLG, 2019);
- Clare County Development Plan 2023 – 2029;
- Clare Renewable Energy Strategy, Volume 5, County Development Plan 2023-2029.
- Clare Wind Energy Strategy, Volume 6, County Development Plan 2023-2029.

8.3.2 Study Area

Construction and decommissioning noise have been assessed by comparing predicted construction activities against best practice construction noise criteria, namely BS5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise; 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. There is no definition of a study area within the construction guidance and the study area for construction is based on the closest noise sensitive locations to proposed construction works.

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 compliant 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."

As discussed earlier in this Chapter, the turbine selected and assessed is Vestas V136 4.5MW, with a hub height of 82m.

The IOA guidance (IOA, 2013) 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 recently constructed Crossmore 7-turbine windfarm is located approximately 4.6 km west of Cloonkett Windfarm. However, the IOA GPG states that if a location is upwind of a noise source a reduction of 10 dB can be applied. As noise sensitive locations between Cloonkett and Crossmore Windfarm cannot be downwind of both simultaneously noise from Crossmore is at least 10 dB below that from Cloonkett Windfarm. Therefore, no cumulative noise from adjacent windfarms has been considered as part of this assessment. The operational study area is presented in Figure 8.1 in Volume IV of the EIAR; it includes 67 no. noise sensitive locations. These are either properties classified as residential, or residential and commercial.

As construction and operational vibration have been scoped out (see Section 8.2.1 and 8.2.2) there is no requirement to set study areas for each.

8.3.3 Evaluation Criteria

8.3.3.1 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 Development. The threshold limit to be applied (as defined in Table 8-1) is dependent on the existing ambient noise levels (rounded to the nearest 5dB).

Table 8-1: Threshold of Potential Significant Noise 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.			

Using the BS 5228-1:2009+A1:2014 methodology, noise sensitive locations were assigned to specific categories (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 5 dB.

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 5 dB varies, but for the most part it is less than 50 dB L_{Aeq}. The nearest residential dwellings to the Proposed Development are therefore afforded Category A designation (65 dB $L_{Aeq,1hr}$ during daytime periods).

Section 8.5.2 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.

8.3.3.2 Wind Farm Operational Noise Criteria

The EIAR considered the application the Draft Revised Wind Energy Development Guidelines, published in December 2019 which is the most recent publication from the Department of Housing, Planning and Local Government. However these guidelines 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 draft Guidelines, the WHO 45 dB Lden noise criterion was considered. The WHO document is based on a very limited data set, which only estimated the Lden 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 Lden or Lnight may be a poor characterization of wind turbine noise and may limit the ability to observe associations between wind turbine noise and health outcomes.”

A conditional recommendation, before it becomes folded into any legislative context, would require substantial debate of stakeholders (such as, but not limited to the Public, government bodies, wind farm developers and operators as well as turbine manufacturers). A conditional recommendation is based on low quality evidence that this chosen noise level is effective. 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 haves been considered and applied to ensure a robust and best practice approach to the assessment.

Therefore, 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 current 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 UK Department of Trade & 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, (IOA, 2013) was used to supplement the guidance contained within the 'Wind Energy Development Guidelines' where necessary. These are considered best practice by the industry for the assessment of wind farm noise.

The Clare Renewable Energy Strategy (within the current Clare County Development Plan 2023-2029) states:

"A coherent Wind Energy Strategy (WES) has been useful. A review of the WES will enable future growth to be managed (to be undertaken when new wind energy guidance is issued)."

The current Clare Wind Energy Strategy, within the Clare County Development Plan 2023-2029 defines the site as Acceptable in Principle for Wind Energy Developments. Projects within these areas must be "*Designed and developed in line with the Planning Guidelines in terms of siting, layout and environmental studies.."*

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, Final Report, Sept 1996 (DTI, 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 LA90,10min 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 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 standard approach for the identification of low noise environments *"where background noise is less than 30dB(A)"* nor are 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* this impact assessment referred to the industry best practice guidance from ETSU-R-97[1] 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-97for amenity hours are defined as:

Amenity/Quiet Daytime hours:	18:00 – 23:00 Monday to Friday
	13:00 – 18:00 Saturday
	07:00 – 18:00 Sunday
Night-time hours:	23:00 – 07:00

Amenity hours were used to assess the background noise levels in this assessment for the daytime period, and night time hours have been used to set the night time limits.

Windfarm turbine operational noise was assessed relative to the WEDG 2006 criteria; substation transformer noise has been assessed according to British Standard BS 4142 as detailed in Section 8.3.5.

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

8.3.4 Significance of Effect

The criteria for determining the significance of impacts and effects are set out in the EPA's 'Guidelines on the information to be contained in Environmental Impact Assessment Reports', Environmental Protection Agency, May 2022. The EPA 2022 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 8-2 presents the impact significance criteria from the EPA Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022.

Table 8-2: Significance of Effects Criteria

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

8.3.5 Consultation

Details of the consultation process are described in Chapter 5 EIA Scoping and Consultation of this EIAR. A summary of the issues raised during the consultation process relating to noise and vibration are listed below.

During consultation with Clare County Council Planning Department the following points were raised regarding noise:

- Acoustics and vibration should be considered in relation to the noise and vibration arising from the proposed development.
- Baseline readings at all noise-sensitive locations should be obtained – with the noise reports also providing assessment of the potential impacts on sensitive receptors arising from the activities associated with the proposed borrow pit(s).
- Account for any permitted dwellings and other sensitive development which may not as yet be constructed in the assessment of noise sensitive receptors.

In response to Clare County Council Planning Department, acoustics and vibration have been considered from both construction and optional noise from the development.

It is not normal practice to measure baseline noise at every single noise sensitive location and therefore a representative sample, at the closest locations to the proposed development is normally measured, as discussed in Appendix 8.1. Noise from construction activities from the proposed borrow pit are discussed in Section 8.5.2.

The assessment has considered noise sensitive locations based on Eircode information and house survey data. In addition permitted developments detailed Appendix 1.2 Volume III of this EIAR have been reviewed and there are no additional noise sensitive developments close to the Proposed Development.

Consultation with Transport Infrastructure Ireland included the following guidance for consideration with respect to noise:

- Consideration of the Environmental Noise Regulations 2006 and how the development will impact any future plans by the relevant competent authority.
- Consideration of the need for the implementation of noise barriers (in line with the Guidelines for the Treatment of Noise and Vibration in National Road Schemes' (1st Rev., NRA, 2004).

The methodology used to assess potential noise from the development is outlined in Section 8.3. Noise barriers are normally more appropriate for control of road traffic noise. Mitigation relating to construction noise is detailed in Section 8.6.1.

During Public Consultation the following issues were raised regarding noise:

- Potential daytime and nighttime noise impact
- Mitigation of potential noise impacts

The potential daytime and night time noise impact from operation of the site is addressed in Section 8.5.3, with mitigation summarised in Section 8.6.3. Construction noise is assessed in Section 8.5.2 with mitigation summarised in Section 8.6.1.Existing Environment

Baseline noise monitoring was undertaken at ten receptor locations surrounding the Proposed Wind Farm to establish the existing background noise levels in the vicinity of the Proposed Development. These are some of the closest locations to the Proposed Development as well as representing different noise environments in the vicinity of the Proposed Development.

Clare County Council Planning Department required that noise monitoring takes place at every noise sensitive location. This is not practical and as is normal practice, noise monitoring was conducted at a representative number of properties, closet to the windfarm.

The 35 dB L_{A90} study area as described in Section 8.3.2 and Figure 8.1 in Volume IV was reviewed to determine receivers to be considered for noise monitoring. The noise sensitive locations within the study area are presented in Figure 8.1 and the Noise Monitoring Locations are presented in Figure 8.2, Volume IV. Noise Sensitive Location details are provided in Appendix 8.3, Table 8.3.1. 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 ten locations, shown in Figure 8.2 in Volume IV and Appendix 8.1, with details of the noise monitoring locations are presented in Appendix 8.1, Table 8-3. The rationale for the selection of these monitoring locations is described in Appendix 8.1 which presents details on the baseline measurements and data analysis. Photographs of each location are also displayed in Appendix 8.1.

Table 8-3: Details of Location of Noise Monitoring Equipment in the Study Area

Location ID	ITM Easting	ITM Northing	Description	Photograph* (see Appendix 8.1)	Distance from measurement location to closest turbine
NL1	520070	660794	Located in a field adjacent to the dwelling and approximately 40m from the dwelling façade. The location was chosen so it was away from tree along the boundary of the property.	Plate 8.1-1*	499m to T4
NL2	521834	661609	Located on public land approximately 20m south of the L2070. Proxy location for properties along this road.	Plate 8.1-2*	446m to T12
NL3	522814	661229	Located east of proposed windfarm, on agricultural land. Nearest noise sensitive location beyond forested area.	Plate 8.1-3*	193m to T14
NL4	522758	660642	Located in field adjacent to residential dwelling, immediately at the boundary of the curtilage.	Plate 8.1-4*	548m to T14
NL5	522389	660181	Located south east of proposed windfarm approximately 27m from property. Forestry plantation to the north.	Plate 8.1-5*	777m to T13
NL6	521327	659864	Located in the rear garden of the dwelling in the direction of the wind farm.	Plate 8.1-6*	698m to T6
NL7	519977	659929	Located east of windfarm within a bog area	Plate 8.1-7*	375m to T4

Location ID	ITM Easting	ITM Northing	Description	Photograph* (see Appendix 8.1)	Distance from measurement location to closest turbine
NL8	519395	659876	Located approximately 18m from property, west of Proposed Wind Farm.	Plate 8.1-8*	502m to T1
NL9	518622	660600	Holiday home	Plate 8.1-9*	583m to T1
NL10	519159	660898	North west of site, at farm beside Morgan O Connel Shed	Plate 8.1-10*	400mm to T3

8.3.6 Analysis of the Baseline Data

The raw background L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level owing to equipment malfunction. The raw noise level data was then correlated with the time synchronised 10 m standardised wind speed, based on a hub height of 82m, and rainfall data. Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. 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 required wind speeds. A "best-fitting polynomial" (not higher than a fourth order) was determined to present the prevailing background noise level at each monitoring location. Appendix 8.1 presents the results of the data analysis.

The prevailing daytime amenity noise levels at each of the (ten) noise monitoring locations are presented in Table 8-4. 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, as described in IOA GPG Supplemental Guidance Note 2: Section 2.9.1. This states "where background noise data has not been collected for higher windspeeds, it may be appropriate to cap the background noise curve".

Table 8-4: Summary of Prevailing Background Noise during Daytime Periods

Location	Prevailing Background Noise LA90,10min (dB) at Standardised 10 m Height Wind Speed (m/s)									
	1	2	3	4	5	6	7	8	9	10
NL1	16.3	17.3	18.4	19.4	20.4	21.5	22.5	22.5§	22.5§	22.5§
NL2	17.6	17.7	19.8	23.3	27.7	32.4	37.0	40.8	40.8§	40.8§
NL3	19.4*	19.4	20.0	21.3	23.1	25.2	27.4	29.5	29.5§	29.5§
NL4	17.0	19.5	22.1	24.8	27.5	30.3	33.1	36.1	36.1§	36.1§
NL5	21.4	23.1	24.8	26.5	28.3	30.0	31.7	33.4	33.4§	33.4§
NL6	29.0*	29.0	29.1	29.5	30.3	31.3	32.6	34.2	34.2§	34.2§
NL7	25.0	25.6	26.3	27.3	28.6	30.2	32.3	35.0	38.2	42.0
NL8	21.1*	21.1	21.3	22.0	23.0	24.5	26.2	28.3	28.3§	28.3§
NL9	25.3	25.5	26.1	27.2	28.7	30.8	33.4	36.4	40.0	40.0§
NL10	34.2*	34.2	34.0	34.1	34.7	35.8	37.5	39.8	39.8§	39.8§

§ - noise level restricted to the highest derived point

* - noise level restricted to lowest derived point

Table 8-5: Prevailing Background Noise during Nighttime Periods

Location	Prevailing Background Noise LA90,10min (dB) at Standardised 10 m Height Wind Speed (m/s)									
	1	2	3	4	5	6	7	8	9	10
NL1	16.3	17.3	18.4	19.4	20.4	21.5	22.5	22.5§	22.5§	22.5§
NL2	17.6	17.7	19.8	23.3	27.7	32.4	37.0	40.8	40.8§	40.8§
NL3	19.4*	19.4	20.0	21.3	23.1	25.2	27.4	29.5	29.5§	29.5§
NL4	17.0	19.5	22.1	24.8	27.5	30.3	33.1	36.1	36.1§	36.1§
NL5	21.4	23.1	24.8	26.5	28.3	30.0	31.7	33.4	33.4§	33.4§
NL6	29.0*	29.0	29.1	29.5	30.3	31.3	32.6	34.2	34.2§	34.2§
NL7	25.0	25.6	26.3	27.3	28.6	30.2	32.3	35.0	38.2	42.0
NL8	21.1*	21.1	21.3	22.0	23.0	24.5	26.2	28.3	28.3§	28.3§
NL9	25.3	25.5	26.1	27.2	28.7	30.8	33.4	36.4	40.0	40.0§
NL10	34.2*	34.2	34.0	34.1	34.7	35.8	37.5	39.8	39.8§	39.8§
§ - noise level restricted to the highest derived point * - noise level restricted to lowest derived point										

8.3.7 Derived Wind Farm Noise Limits

The standard approach outlined in the good practice guidance (IOA GPG,2013) regards the derivation of noise limits is to carry out background measurements at several locations representative of different noise environments around the proposed site. As it is not usually possible to carry out measurements at every noise sensitive location (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 Guidance.

As outlined earlier, the noise criteria used to assess operational noise from the Proposed Development is based on a Best Practice Approach and currently used by the acoustics industry (see Section 8.3.1).

The 2006 WEDG guidelines state that a fixed limit of 43 dB L_{A90} applies during night-time periods. In this case a limit of 43 dB L_{A90} has been assumed or +5dB above background, whichever is the greater. 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 guidance regards how to choose the noise limit from within this range. For the Proposed Development, for low noise areas (<30 dB L_{A90}) a limit of 40 dB L_{A90} has been adopted.

Also, there is no guidance available on how to determine the appropriate noise limit of between 35-40 dB. However, the ETSU 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.

1. However, The IOA GPG (IOA, 2013) 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."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 noise sensitive locations (includes planning permissions) within the 35dB L_{A90} study area is 67. A noise limit of 40 dB L_{A90} is appropriate.

2. The effect of noise limits on the power output of the wind farm: Similar to the first factor, this balances the planning merit of the project against the local impact. The Proposed Wind Farm has 14 turbines. If the limit is lowered, then, based on the noise modelling results, curtailment would be required. Since this Proposed Development is considered to have merit in assisting Ireland in meeting its renewable energy targets, the upper end of the limit range is appropriate.

3. Duration and level of exposure: The prevailing background noise levels are described in detail in Section 8.4.1 and Appendix 8.1. In terms of the location of the properties within the study area, these are located north, south-east and west of the proposed site. The areas are not densely populated and properties are evenly distributed in all directions. The derived noise limits are summarised in Table 8-6, based on the prevailing noise levels detailed in Section 8.4.1. The limits are based on the quietest background noise measured across the site and therefore are considered conservative. Note also that the nearby Crossmore windfarm (Planning Reference: P09123) , was granted planning with Condition 10 relating to operational noise: "Noise levels from the proposed development (operational phase) when measured at the nearest noise sensitive location shall not exceed 43 dB $L_{Aeq\ 15mins}$, The IOA GPG adjusts wind turbine noise in L_{Aeq} by subtracting 2 dB to give the equivalent L_{A90}. Therefore Condition 10 applies a limit of 41 dB $L_{A90,\ 15mins}$. This is comparable with the 40 dB $L_{A90,\ 10mins}$ applied to this project for daytime for low noise areas.

Table 8-6: Derived Noise limits at each Monitoring Location within the Study Area

Location	Period	Prevailing Background Noise $L_{A90,10min}$ (dB) at Standardised 10 m Height Wind Speed (m/s)								
		2	3	4	5	6	7	8	9	10
N1	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N2	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N3	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N4	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N5	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N6	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N7	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N8	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N9	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
N10	Daytime	40	40	40	40	40	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43

8.4 Potential Effects

8.4.1 Do Nothing Scenario

Under the Do-Nothing scenario, the Proposed Development is not constructed or operated. The noise environment remains largely unchanged.

8.4.2 Potential Effects during Construction

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 Section 2.5 of this 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) . Acoustically soft ground is normally assumed for agricultural land (G=1), and hard surfaces such as roads or concrete would be acoustically hard (G=0).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 for plant is outlined for each of the plant items used during construction.

The construction noise model assessed all tasks with the potential to generate noise. These tasks included: deliveries and/or removal of material to and from site, tree felling, borrow pit activity, preparation of access roads, preparation of hardstands and drainage, pouring of foundations, installation of wind turbines and works associated with construction of the on-site substation, grid connection route and TDR accommodation works.

Site Traffic

Detailed information on construction traffic is presented in Chapter 13. 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). They are not expected to be a continuous source of noise emissions from the site during a typical working day. Therefore, noise generated from construction personnel movements to and from the site is expected to be low.

Deliveries of turbine and substation components to the site will be limited to the turbine delivery route (TDR) outlined in Chapter 13. The construction period is expected to take 24 months. The most intensive period of the works for HGVS will be months 5-7. The busiest construction period will include when the Internal access tracks, preparation of turbine foundations, turbine installation and substation works will be ongoing in parallel. The noise impact for construction works and related traffic will be mitigated by restricting movements along access routes to the standard working hours and excluding 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. If turbine deliveries are required at night, it will be subject to agreement with the relevant planning authority and it would 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. Site traffic is addressed as part of specific construction activities in subsequent sections.

Tree Felling

Tree felling will be required where proposed access tracks intersect existing forested areas, for example to the north central part of the site. Table 8-7 presents the predicted noise from tree felling at the nearest dwellings. Location R231 is close to the access road entrance to the east of the site, and is approximately 140m east of the site entrance. Assuming all plant associated with tree felling is operating, the predicted cumulative noise at noise sensitive location R231 is 49.9 dB. Therefore, the predicted noise at the nearest noise sensitive location is below the daytime noise limit of 65 dB $L_{Aeq,1hr}$. The noise levels predicted at other locations in the vicinity of tree felling are lower. The noise associated with the felling activity is expected to have a **slight effect that is temporary in duration**.

In terms of the noise generated from tree felling construction activities, this not predicted to generate a significant effect.

Table 8-7: Predicted Noise from Tree Felling Activities

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R231 $L_{Aeq,1hr}$ dB(A)
Harvester §	C2.5	Harvesting trees	80	27.2
Forwarder µ	C4.53	Moving felled trees	80	27.8
Lorry *	C11.9	Transporting timber and brash off site	71 trips per day.	49.9
Cumulative:				49.9

* Drive-by maximum sound pressure level
§ - Excavator BS 5228 Ref C2.5
µ - Lorry with lifting boom – C4.53

Borrow Pits

There are 5 no. on-site borrow pits proposed during construction. Details of the methodology for the borrow pit construction is provided in the CEMP in EIAR Volume III, Appendix 2.1. Table 8-8 presents the expected plant/ equipment required for the borrow pit construction activities. Four of these borrow pits are located south of the proposed Turbines 1 and 2. The final borrow pit is located north of the site, close to the site entrance. Three representative properties have been assessed in terms of potential construction noise from borrow pit activities. R216 is the closest noise sensitive location to the northern borrow pit at a distance of approximately 270m from the edge of the northern borrow pit. Location R115 is approximately 370m south west of the southern group of borrow pits, with R114, being located approximately 375m south east of the closest borrow pit. There is a property located within the site boundary and is located at the centre of the four borrow pits (R133). However, this location is an involved landowner and therefore this property has not been assessed for construction noise. Table 8-8 sets out the predicted noise level at the three locations closest to the borrow pits. Assuming all construction activities required for the borrow pit occurs simultaneously, the highest predicted noise level from the construction activities is 54.2 dB $L_{Aeq,\ 1hr}$ which is below the 65dB $L_{Aeq,\ 1hr}$ noise limit. The predicted construction noise from borrow pit activities at other locations is lower. The borrow pit construction activities are expected to have a **slight effect that is temporary in duration.**

In terms of the noise generated from borrow pit construction activities, this not predicted to generate a significant effect.

Table 8-8: Predicted noise levels at Borrow Pits

Plant	BS 5288 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R216 (N) $L_{Aeq,1hr}$ dB(A)	Predicted Noise Level at R216 (SW) $L_{Aeq,1hr}$ dB(A)	Predicted Noise Level at R216 (SE) $L_{Aeq,1hr}$ dB(A)
Diesel Pump	C4.88	Pump water	100	37	34.4	35.3
Tracked Hydraulic Excavator (37 t)	C10.1	Face shovel extracting/loading dump trucks	Maximum 20 two-way trips per day	47.6	45.1	46.3
Rock Breaker	C9.12	Rock breaking	50	49.4	47.1	48.8
Crusher	C1.14	Crushing material	100	46.3	43.9	45
Tracked Excavator (21t)	C4.65	Trenching	80	38.7	36.1	36.6
Dozer (41t)	C2.10	Ground excavation/earthworks	80	46.8	44.4	45.9
Articulated Dump truck (23t)*	C2.33	Distribution of Material	71 movements per day	42	43.5	41.8
Cumulative				54.2	52.2	53.3
*Drive by maximum sound level						

Preparation of Access roads, Hardstands and Drainage

Table 8-9 presents a summary of the typical plant/ equipment used for the preparation of access tracks, hardstanding and drainage. Three locations have been considered, R231 which is approximately 140m from the north eastern site entrance, R216 approximately 230m from the northwestern site entrance and R115 which is approximately 350m west of the southern on site access track. Assuming all construction activities required for the preparation of the access tracks occur simultaneously, the predicted noise level at the closest location to these construction activities is 56.7 dB $L_{Aeq,1hr}$ which is below the 65 dB $L_{Aeq,1hr}$ noise limit. The predicted level at locations farther from the works is lower. Noise from construction activities from construction of access tracks, hardstands and drainage are expected to have a **slight effect that is temporary in duration**.

Table 8-9: Predicted noise levels from the Construction of Access Tracks, Hardstands and Drainage

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R231 (NE)	Predicted Noise Level at R216 (NW) $L_{Aeq,1hr}$ dB(A)	Predicted Noise Level at R115 (SW) $L_{Aeq,1hr}$ dB(A)
Tracked excavator 25t	C2.19	Ground excavations/earthworks	80	52.8	42.9	38.5
Articulated dump truck 23t	C2.33	Moving Fill	Maximum 71return trips/ day	43.3	33.4	29
Articulated dump truck (tipping) 23t	C2.32	Tipping Fill	20	52	42.1	37.7
Dozer (14t)	C5.12	Spread Chipping/Fill	80	41.9	32	27.6
Vibratory roller (3t)	C5.27	Rolling & Compaction	80	46.6	36.7	32.3
Tracked excavator 21t	C4.65	Trench for drainage	80	45.2	39.7	45
Cumulative:				56.7	47.3	45

Preparation of Wind Turbine Foundations

Table 8-10 presents the expected plant required for the preparation of wind turbine foundations. Predicted noise levels at the two locations where the highest noise levels are predicted from Wind Turbine construction activities are presented. R193 is located approximately 675m from Turbine 1 and R168 is located approximately 615m from Turbine 14. Assuming all construction activities required for the preparation of the turbine foundations occur simultaneously, the predicted noise level from the construction activities is 50.9 dB $L_{Aeq,1hr}$. The predicted noise levels are below the 65dB $L_{Aeq,1hr}$ noise limit. The construction works associated with the preparation of the turbine foundations are expected to have **a slight effect that is temporary in duration.**

In terms of the noise generated from construction of wind turbine foundations, this not predicted to generate a significant adverse effect.

Table 8-10: Predicted Noise from the Construction of Wind Turbine Foundations

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193 $L_{Aeq,1hr}$ dB(A)	Predicted Noise Level at R168 $L_{Aeq,1hr}$ dB(A)
Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	37.2	38.5
Excavator (23t)	C10.8	Loading sand / soil	20	40	41.2
Diesel Pump	C4.88	Pump water	100	29.6	30.8
Tubular Steel Piling – Hydraulic Hammer (4t hammer)	C3.2	Piling	80	47.1	29.5
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	47.1	48.3
Concrete mixer truck & concrete pump	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	100	30.9	33.1
Lorry*	C11.9	Delivery and removal of material	Maximum 71 return trips / day	35.6	36.8
Cumulative:				50.9	49.9
* Drive-by maximum sound level					

Installation of Wind Turbines

Turbine components will be delivered to the site and a mobile telescopic crane will lift the turbine components into place. A worst-case scenario would be the two cranes lifting turbine components 80% of the time was assumed, in addition to noise related to the delivery of turbine components. R193 is located approximately 675m from Turbine 1 and R167 is located approximately 625m from Turbine 14. The predicted noise levels are presented in Table 8-11. The predicted cumulative noise level at R193 is 45.5 dB $L_{Aeq,1hr.}$ The predicted noise levels are below the 65 dB $L_{Aeq,1hr}$ noise limit. The predicted noise from this activity at other locations are lower. The construction works associated with the installation of the wind turbines are expected to have a **slight effect that is temporary in duration**.

In terms of the noise generated from installation of the wind turbines, this not predicted to generate a significant adverse effect.

Table 8-11: Predicted Noise Levels from the Delivery and Installation of Wind Turbines

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193 $L_{Aeq,1hr}$ dB(A)	Predicted Noise Level at R167 $L_{Aeq,1hr}$ dB(A)
Mobile telescopic crane (x2)	C4.41	Lifting turbine components	80	34	35
Lorry *	C11.9	Delivery of Turbine Components	Maximum 71 return trips / day	45.2	44.6
Cumulative :				45.5	45.1
* Drive-by maximum sound level					

On-site Clear Span Bridge Construction

One water crossing is planned within the site and will require the installation of a clear span bridge as described in Chapter 2 of this EIAR. The noise impact associated with the delivery and construction of bridge components was assessed. Table 8-12 presents the expected plant required for such construction. Also presented are predicted noise levels at the nearest dwelling, R193, approximately 650 m from the works. The cumulative predicted noise levels assuming all activity occurs simultaneously is predicted to be 44.3 dB $L_{Aeq,1hr}$ at the nearest occupied dwelling which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$. The works associated with the construction of the bridge is expected to have a **slight effect which is temporary** in duration.

In terms of the noise generated from the clear span bridge construction, this not predicted to generate a significant adverse effect.

Table 8-12: Predicted noise levels from the Construction of the Clear Span Bridge Watercourse Crossing

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193, at 650m from works $L_{Aeq,1hr}$ dB(A)
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	37.6
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	28.1
Excavator (23t)	C10.8	Loading sand / soil	80	40.2
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	26.7
Mobile telescopic crane	C4.41	Lifting turbine components	100	32
Concrete plant	C4.32	Concrete truck discharging concrete	80	37.9

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193, at 650m from works $L_{Aeq,1hr}$ dB(A)
Poker Vibrator	C4.33	Concrete activities	20%	32.4
Cumulative:				44.3

Substation Construction

As outlined in Chapter 2 of this EIAR, it is proposed to construct an onsite electricity substation (220kV loop in/out). The related construction will include the substation buildings, associated infrastructure and access tracks. The 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 8-13 presents the expected plant required for the different construction phases of the proposed substation and related buildings. The nearest occupied dwelling R193 is approximately 150m from the edge of the substation area. The highest cumulative predicted noise levels for both the Site Clearance and Preparation works and the preparation of hardstanding areas is predicted to be 57.0 dB $L_{Aeq,1hr}$ at the nearest occupied dwelling which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$. The works associated with the construction of the substation are expected to have **a slight effect and temporary in duration**.

In terms of the noise generated from construction works associated with the substation, this not predicted to generate a significant adverse effect.

Table 8-13: Predicted noise levels from the Construction of Substation

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193 LAeq,1hr dB(A)
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Earthworks/site clearance	80	52
	Tracked excavator 25t	C2.19	Earthworks/site clearance	80	48.5
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	51.7
	Loading Lorry	C10.8	Loading Sand to Lorry	80	51.1
	Cumulative				57.0
Preparation and pouring of Foundations	Concrete mixer truck + truck mounted concrete pump + boom arm	C4.32	Concrete pumping	80	48.9
	Lorry*	C11.9	Delivery of material	Maximum of 71 two-way trips/day	46
	Cumulative				50.7
Preparation of hardstanding areas	Articulated Dump Truck (23t)	C2.33	Delivery/Removal of Material	Maximum of 71 two-way trips/day	44.1
	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	48.4
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	38.9
	Dozer (14t)	C5.12	Spreading chipping/fill	80	47.6
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	37.5

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R193 LAeq,1hr dB(A)
	Lorry*	C11.9	Delivery of material	Maximum of 71 two-way trips/day	46
	Cumulative				53.1
Erection of blockwork/ installation concrete slabs	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	47.6
	Lorry* (32t)	C11.9	Delivery of material	Maximum of 71 two-way trips/day	46
	Cumulative				49.9
General Construction including installation of electrical and mechanical plant	Generator	C4.84	Power for site cabins	100	45.4
	Telescopic handler	C4.54	Lifting Plant	80	49.4
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	51.4
	Cumulative				54.1
*Drive by maximum sound level					

Grid Connection Route (GCR) and Overhead Line (OHL) Connection Works

As described in Chapter 2 of this EIAR, with further construction methodology in Appendix 1.1, Volume III, each turbine will be connected to the on-site electricity substation via underground cables (UGC) which will follow the internal access tracks between the turbines. Also, the on-site substation will connect by an overhead line to the existing overhead line (OHL). The loop connection infrastructure includes construction of 6 No. steel pylons and approximately 800m of new overhead line.

The grid connection works will be carried out over a 4-month period; Table 8-14 presents the expected plant required for the underground connection works between the turbines and substation that are located on access tracks. Table 8-15 presents the expected plant for overhead line and mast installation. The closest location to the grid connection works is R193, north west of the substation, approximately 240m to underground grid connection works by the substation access track and 125m to the closest OHL pylon. The cumulative predicted noise levels from underground grid connection works at R193, assuming all activity occurs simultaneously is predicted to be 52.3 dB $L_{Aeq,1hr}$ which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$. The cumulative predicted noise levels from OHL connection works at R193, assuming all activity occurs simultaneously is 62.5 dB $L_{Aeq,1hr}$, which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$.The works associated with the grid connection works is therefore expected to have a **slight effect and that is temporary** in duration.

In terms of the construction noise generated from the grid connection route and overhead line connection works, this not predicted to generate a significant adverse effect.

Table 8-14: Predicted noise from Underground Grid Connection Works

Plant	BS5228 Ref	Percentage on-time (%)	Activity	R193 240m From underground grid works $L_{Aeq,1hr}$ dB(A)
Road sweeper	C4.90	10	Sweeping and dust suppression	37.5
Mini excavator with hydraulic breaker	C5.2	25	Breaking Road Surface	48.1
Vibratory roller	C5.27	50	Rolling and Compaction	35.2
Wheeled excavator	C5.34	50	Trenching	38.6
Hand-held circular saw (petrol)	C5.36	10	Cutting Concrete Slabs	48.2
Dump truck (tipping fill)	C2.30	10	Tipping Fill	40.7
Vibratory plate (petrol)	C2.41	10	Compaction	41.7
Cumulative:				52.3

Table 8-15: Predicted noise for Mast Foundation and OHL Installation

Plant	BS5228 Ref	Percentage on-time (%)	Activity	R193 125m from OHL works $L_{Aeq,1hr}$ dB(A)
Tractor and Trailer	C3.75	80	Moving materials	56.6
Crane	C4.41	80	Lifting	26.8
Teleporter	C2.35	80	Lifting	47.9
Chains/small tools	C3.35	10	Cutting metal	33.2
Tracked excavator	C2.3	80	Ground works	55.3
Tracked dumper	C2.19	80	Removing fill	54.8
Sheet piling	C3.8	10	Shutter piles	56.2
Concrete truck discharging	C4.32	50	Mast foundation	53.1
Cumulative:				62.5

Turbine Delivery Route (TDR) Construction Activities

This section assesses noise from temporary accommodation works along the turbine delivery route which have the potential to generate noise.

The details of the proposed temporary accommodation works associated with the TDR route are summarised in Chapter 2 Description of the Development, Section 2.4.3. Table 2.3 of Chapter 2 identifies the TDR Node Number and the construction activities proposed along the route. TDR Nodes 1 to 5 involve small scale activities, such as street furniture and road sign change, with no potential for likely significant effects. Therefore potential noise from these activities have not been assessed.

TDR Nodes 6 to 8 involve laying of a load bearing surface and potential noise from these activities have been assessed. TDR Node 6 accommodation works are at the N68/L6180 interface. The nearest noise sensitive location is approximately 40m from the edge of the works. There are four noise sensitive locations within approximately 70m of the works. The closest noise sensitive location to TDR Node 7 accommodation works is at approximately 225m north east of the works. The closest noise sensitive location to the Node 8 accommodation works is approximately 290m east of the works.

Note that, as described in Chapter 13 Traffic and Transportation, in addition to the TDR Node accommodation works, temporary road widening works will be carried out as required for targeted sections along the L-2072 between TDR Node 8 and the Western site entrance. These works will involve temporary verge widening of the local road and will involve verge striping and stoning. These works will take place over a two month period.

Table 8-16 presents predicted noise levels for the TDR road surface works at the closest noise sensitive to the proposed TDR accommodation works at Nodes 6-8. From Table 8-16, At TDR 6, if all plant operate simultaneously, the cumulative noise has the potential to exceed the daytime limit by just over 3 dB. The works associated with the TDR accommodation works at Node 6, if all plant operates simultaneously, is therefore expected to have a **significant effect and that is temporary** in duration. Mitigation measures are discussed in Section 8.6.1. However if the work is phased, so no two items of plant operate at once the daytime construction noise limit is met.

At TDR Nodes the predicted construction noise at the closest noise sensitive location to TDR 7 and 8 are below the daytime noise limit. Therefore at these locations, the works are predicted to have a **slight effect that is temporary** in duration.

For the temporary road widening works between Node 8 and the site western entrance, the daytime limit may be exceeded when works are passing close to properties on the road. However, these works will be for a short duration at a particular property (i.e. typically less than 3 days) and where the works are to occur over an extended period, a temporary barrier or screen will be used to reduce noise level below the noise limit. There is a potential of a **significant temporary effect** from road widening works. General mitigation measures are discussed in Section 8.6.1.

In terms of the noise generated from construction works at TDR Nodes , without mitigation, a significant adverse effect is predicted at Node 6. For temporary road widening works, a significant adverse effect is predicted from road widening works between Node 8 and the site entrance, without mitigation.

Table 8-16: Predicted noise for TDR Accommodation Works, Nodes 6 to 8

Plant	BS5228 Ref	Percentage on-time (%)	Activity	Predicted Noise Level $L_{Aeq,1hr}$ dB(A)		
				TDR 6 At 40m	TDR 7 At 225m	TDR 8 At 290m
Tracked excavator 25t	C2.19	Ground excavations/ earthworks	80	64.2	48.4	45.5
Articulated dump truck 23t	C2.33	Moving Fill	Maximum 71 return trips/ day	59.9	55.1	47.3
Articulated dump truck (tipping) 23t	C2.32	Tipping Fill	20	54.7	38.9	36
Dozer (14t)	C5.12	Spread Chipping/Fill	80	63.4	47.6	44.7
Vibratory roller (3t)	C5.27	Rolling & Compaction	80	53.3	37.5	34.6

Plant	BS5228 Ref	Percentage on-time (%)	Activity	Predicted Noise Level $L_{Aeq,1hr}$ dB(A)		
				TDR 6 At 40m	TDR 7 At 225m	TDR 8 At 290m
Tracked excavator 21t	C4.65	Trench for drainage	80	58	42.2	39.3
Cumulative:				**68.4**	56.8	51.3

Potential Effects during Operation

Noise predictions have been carried out using International Standard ISO 9613:1996, *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 downwind (i.e. worst case) conditions or long-term overall averages.

The noise predictions in this assessment also considered the ISO9613: 1996 regulatory requirements. However, during the course of the design and assessment process this standard was updated 2024; the relevant software was updated at the start of 2025, but it has not been validated yet. Hence, the noise predictions herein are based on the 1996 version of the software. Also, the updated methodology slightly decreases the predicted levels closer to the wind turbines. Therefore, the noise levels presented in this Chapter represent a worst-case scenario for the assessment of operational noise from the site.

Only the worst-case downwind condition has been considered in this assessment, i.e., for wind blowing from the proposed turbines towards the nearby houses. When the wind is blowing in the opposite direction noise levels may be significantly lower, especially where there is any shielding between the turbines and the houses.

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:

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

These factors are discussed further 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. Sound power level data for Vestas V136 4.5MW turbine to be installed as part of the Proposed Development was modelled. Further details on the wind turbines are provided later in this section. Sound Power Level data is presented in Appendix 8.4.

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, and therefore a directivity factor of 0 has been assumed.

Ageo – Geometrical Divergence

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

A_{geo} = 20 x log(d) + 11

where, d = distance from the turbine

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

Aatm - Atmospheric Absorption

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

A_{atm}= d x α

where, α = the atmospheric absorption coefficient of the relevant frequency band

Published values of 'α' from ISO9613 Part 1 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 conservative noise predictions as given in Table 8-16:

Table 8-17: Atmospheric Octave Band Attenuation coefficients, dB/m

Octave Band Centre Frequency (Hz)							
63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
0.00012	0.00041	0.00104	0.00193	0.00366	0.00966	0.03280	0.11700

Agr - 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 is inherently complex and depends 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 ranges 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). The Good Practice Guidance (IoA, 2013) 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 inclusion of the assumed uncertainty (see next section 'Overview of Input Datasets' for more details) within the source noise levels, these predictions are considered to be worst case.

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 site between the source and receiver is just interrupted by a landform, such as a hill and that 10 dB(A) should be allowed where a barrier lies within five metres (5 m) of a receiver and provides a significant interruption to the line of site.

The IoA GPG states that 'Topographic screening effects of the terrain (ISO 9613-2, 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'. As a conservative approach, this has not been included in the noise model predictions.

Amisc – Miscellaneous Other Effects

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

The site topography was also analysed to determine if there is a valley correction (+3 dB) for concave ground profile, or where the ground falls away significantly, between the turbine and the receiver location. The IoA guidelines provide a criterion of application and it was determined that no valley correction is applicable.

Predicted Noise Levels

The predicted turbine noise LAeq has been adjusted by subtracting 2 dB to give the equivalent LA90 as suggested in the IoA GPG.

Overview of Input Datasets

In order to calculate the noise levels at noise sensitive locations, an accurate representation of the source and receiver positions (See Appendix 8.3 for details) was necessary for the prediction modelling. The turbine locations are presented in Chapter 2 of this EIAR Development Description, Table 2-1.. The closest dwelling is 518 m from the nearest turbine.

The assessment has considered the range of turbine design elements. From a noise perspective when following the guidance contained within the Institute of Acoustics (IoA) document, A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (IOA GPG, 2013), and Supplementary Guidance Notes the hub height range is the only element of the turbine dimensions that influence the operational noise impact assessment. Any influence from the variation of blade length is accounted for by the turbine manufacturer in their sound power data, which was provided and used for the purpose of modelling the proposed turbine layout using the candidate turbine.

Manufacturers data for the proposed turbine was used to calculate the sound power level standardised to a height of 10m, as required by the IOA GPG, based on V136 manufacturers data provided at hub height. The sound power level and octave band values for the turbine are based on the noise levels provided by the manufacturers. The sound power levels at standardised 10 m height wind speeds are presented in Table 8-16, with octave band data in dB(A) presented in Table 8-17. The wind turbine data used as part of the assessment is presented in Appendix 8.4.

Table 8-18: Wind Turbine (Vestas V136 4.5MW) Sound Power Levels, dB L_{WA} at hub height 82m (with trailing edge serrations), from manufacturer's data

Turbine	Standardised 10 m Height Wind Speed (m/s)					
	2	3	4	5	6	7m/s and above
Vestas V136	90.9	91.4	94.7	99.6	103.3	103.9
*The sound power was calculated as per the guidance in IOA supplementary guidance note 3: Sound Power Level Data, Section 5.						

Table 8-19: Wind Turbine (Vestas V136 4.5MW) Octave Band Noise Levels, dB(A) for a range of Standardised 10m Height Wind Speeds (with trailing edge serrations) 82m hub height, from manufacturer's data

Standardised 10 m Height Wind Speed (m/s)	Octave Band Level Centre Frequency in Hz							
	63	125	250	500	1000	2000	4000	8000
2	71.1	78.0	82.6	85.1	85.3	83.3	79.1	72.7
3	71.6	79.1	84.0	86.2	85.8	82.7	77.1	68.6
4	75.1	82.5	87.2	89.5	89.1	86.1	80.5	72.2
5	80.1	87.2	91.8	94.1	94.0	91.3	86.4	78.9
6	83.9	90.9	95.4	97.7	97.6	95.2	90.4	83.3
7	84.5	91.4	96.0	98.3	98.2	95.9	91.2	84.2
8	84.5	91.1	95.6	98.0	98.2	96.3	92.2	86.0
9	84.5	90.7	95.1	97.5	98.1	96.7	93.5	88.4
10	84.6	90.5	94.7	97.2	97.9	96.9	94.3	89.8
11	84.7	90.5	94.6	97.0	97.9	97.0	94.5	90.4
12	85.0	90.6	94.5	97.0	97.8	97.0	94.6	90.6
13	85.3	90.7	94.6	96.9	97.7	97.0	94.6	90.8
14	85.5	90.9	94.7	97.0	97.7	96.9	94.6	90.7
14.3 and above	85.6	91.0	94.7	97.0	97.7	96.9	94.5	90.7

The industry accepted Good Practice Guidance (IoA, 2013) states that a margin of uncertainty must be included within source wind turbine noise data used in noise predictions. Therefore, a two decibel (2 dB) correction was added to the sound power level presented in Table 8-17 to account for a margin of uncertainty.

It is possible to run the proposed turbine model in a sound optimised mode of operation whereby the noise level is lessened by reducing the rotational speed of the turbines, with a resultant loss of electrical energy production. The Vestas/ turbine manufacturer specification for sound power data and sound optimised modes are detailed in Section 8.6.2.

Substation Noise Assessment

Noise from the proposed substation has been assessed in line with BS4142. This standard compares the background noise with the specific noise from the source to be introduced to assess the potential for adverse impacts, as detailed in Section 8.2.6.

Background noise measured at location NL9 has been used to determine the background noise at the closest location to the proposed substation location. NL10 is also close to the substation, but this was affected by noise from the working farm and therefore location NL9 is more representative.

The daytime and night time background noise measurements ($L_{A90,\ 10min}$) have been filtered to exclude data for windspeeds above 5m/s and any data during which rainfall occurred. BS4142 categorises daytime as 0700-2300, with night time between 2300-0700. Note that measurements presented are for 10 minute intervals whereas normally BS4142 requires the background period is 1 hour during the day or 15 minutes at night.

Predictions have been carried out 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 8-19; if an alternative transformer is selected this will not exceed a sound power level of 93 dB(A):

Table 8-20: Substation Transformer Octave Band Sound Power Level Data

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

$^{\Omega}$ - 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

Noise predictions were carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. A worst case scenario with plant/equipment producing their highest noise emissions has been assumed. The on-site substation transformer noise has been predicted in terms of the L_{Aeq}.

Table 8-21 summarises the basis of the BS4142 assessment for the transformer noise.

Table 8-21: BS4142 Assessment of Transformer Noise

Results	Daytime	Night time
Measured ambient plus predicted noise from transformer	(Residual 46 dB + specific 37 dB=) 47 $L_{Aeq, 60mins}$	(Residual 26 dB + specific 37 dB=) 37 dB $L_{Aeq, 15mins}$
Residual sound level	46 dB $L_{Aeq, 60min}$	37 dB $L_{Aeq, 15min}$
Background sound level (when source not in operation)	34 dB $L_{A90\ (60mins)}$	23 dB $L_{A90\ (15\ mins)}$
Reference period	1 hour	15 minutes
Specific sound level	37 dB $L_{Aeq, 60mins}$	37 dB $L_{Aeq, 15mins}$
Acoustic character correction (none applied)	-	-
Rating level (no correction applied)	37 dB $L_{A90, 60mins}$	37 dB $L_{A90, 15mins}$
Background sound level	34 dB $L_{A90, 10mins}$	23 dB $L_{A90, 10mins}$
Excess of rating over background	+ 3 dB	+ 14 dB
Results	The difference of +3dB is below the level where there is an indication of an adverse impact (normally +5dB). The predicted noise level is low and steady in character and only marginally above the existing background noise.	The difference of +14 dB is above the difference (+10dB), which indicates a significant adverse impact, depending on the context. The context is important here as the noise levels are very low at night and therefore an absolute level is more appropriate.
Uncertainty of assessment	The uncertainty of assessment is unlikely to change the result	The uncertainty of assessment is unlikely to change the result

Daytime Assessment

From the Table 8-21, during the daytime the difference in the specific level and background is below the level where there is an indication of an adverse effect. The uncertainty is unlikely to affect the outcome of this assessment. There is some uncertainty or variability in the noise level assumed for the transformer compared with that which will ultimately be installed. As measurements were conducted over 10-minute intervals, as opposed to the reference interval of 1 hour the background may also change slightly. The measurement period was for a long time and measurements which could be influenced by wind or rain have been removed which would minimise the uncertainty.

Nightime Assessment

During the nighttime the difference in noise level indicates a potentially significant adverse impact, depending on the context. The industry standard, BS4142 states the initial estimate of the impact needs to be modified due to the context in the case the absolute noise levels are low, particularly at night. It also states that where noise levels are low, an absolute noise criteria is more appropriate.

World Health Organisation Night Noise Guidelines for Europe (WHO, 2009) define a noise limit for L_{night} , which is the equivalent outdoor sound pressure associated with a particular type of noise during the night (at least 8 hours) a period of a year, outside. A limit of L_{night}, outside of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise. As the noise predicted from the transformer is 5dB below this then there is no anticipated adverse health effect from night time operation of the proposed substation.

The noise level (ambient plus transformer noise) is predicted to be 37 $L_{Aeq,\ 15mins}$ at the nearest noise sensitive location. Therefore, the predicted night time noise levels are at a level that do not lead to an adverse effect at night time.

In summary, the substation **predicted daytime noise levels are below the level that would lead to an adverse effect**. At night time, absolute noise levels are considered more appropriate and the **predicted noise levels are at a level that will not lead to any adverse effects**.

8.4.2.1 Potential Operational Effects – Predicted Noise Levels

Noise predictions were performed for the wind turbine layout using the highest noise levels at each wind speed, for the proposed turbine model have been selected for a range of standardised 10m height wind speeds from 2 m/s up to 14 m/s (cut-out occurs at 7m/s[2]). Receptors including those within the 35 dB L_{A90} noise contour of the turbines were modelled. Predicted noise levels from other on-site noise sources, that is the substation have been assessed in the previous section. Noise from the proposed windfarm were assessed against the derived noise limits.

Table 8-22 presents predicted noise levels for the 82m hub height turbine at 10 receptor locations that include the highest predicted noise levels, in addition to controlling locations close to the proposed windfarm. Table 8-22 also presents the derived noise limits for each location. The predicted noise levels at all receptor locations are presented in Appendix 8.5. Note that the predicted noise levels assumes that noise sensitive receptors are downwind of the Proposed Wind Farm. In practice, receptor locations will not be downwind of all noise sources and the actual noise levels will be lower than those presented in Table 8-20 and Appendix 8.5.

[2] Noise emissions from the wind turbines plateau at wind speeds above 7 m/s

At 16 locations the noise limits are exceeded at the 6m/s windspeed by between 0.1 and 2.8 dB. The location where the largest exceedance occurs is north west and central to the Proposed Wind Farm. This location also exceeds the night time criteria very marginally (by 0.2 to 0.4 dB) at 7m/s and 8m/s. The noise criteria are met at all other locations for the night time and also the daytime. Section 8.7.2 sets out mitigation measures to reduce the noise level to within the noise limits. At the 16 locations where the noise limit is exceeded, as described in Section 8.3.4, there will be a **long term moderate effect.** For the remaining locations, at some receptor locations, a new source of noise will be introduced into the soundscape and it is expected that there **will be long-term slight to moderate effect.** The **moderate significance of effect** is at the closest dwellings to the Proposed Wind Farm.

In terms of the noise generated from operational noise from the proposed development, without mitigation, this not predicted to generate a significant effect.

Table 8-22: Assessment of Predicted LA90 Noise Levels for the Proposed Wind Farm against Noise Limits

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
NL1/R189	Predicted Level	30.2	31.1	34.4	39.1	42.8	43.4	43.2	42.9	42.6	42.6	42.6	42.5	42.6	42.6
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	2.8	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	0.4	0.2	-	-	-	-	-	-	-
NL2/R231	Predicted Level	29.1	30.0	33.3	38.0	41.6	42.2	42.1	41.8	41.5	41.5	41.4	41.4	41.5	41.5
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	1.6	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL4/R167	Predicted Level	28	28.9	32.2	36.9	40.5	41.1	40.9	40.6	40.4	40.3	40.3	40.3	40.4	40.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL5/R148	Predicted Level	27	27.9	31.2	35.9	39.5	40.1	39.9	39.6	39.4	39.3	39.3	39.3	39.3	39.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL5/R139	Predicted Level	28.1	29.0	32.3	37.1	40.7	41.3	41.1	40.8	40.6	40.5	40.5	40.4	40.5	40.5
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL6/R134	Predicted Level	28.4	29.3	32.6	37.3	40.9	41.5	41.3	41.0	40.8	40.7	40.7	40.7	40.7	40.7
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	0.9	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL7/R114	Predicted Level	27.7	28.6	31.9	36.6	40.2	40.8	40.6	40.3	40.1	40.0	40.0	40.0	40.0	40.0
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL8/R133	Predicted Level	29.4	30.3	33.6	38.3	42.0	42.6	42.4	42.1	41.9	41.8	41.8	41.8	41.8	41.8
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL9/R166	Predicted Level	26	26.9	30.2	34.9	38.5	39.1	39.0	38.6	38.4	38.3	38.3	38.3	38.4	38.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N10/R193	Predicted Level	27.5	28.4	31.7	36.4	40.0	40.6	40.4	40.1	39.9	39.8	39.8	39.8	39.9	39.9
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-

8.4.3 Potential Effects 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.

Grid connection infrastructure including substations and ancillary electrical equipment shall form part of the national grid and will be left in situ.

These activities will be undertaken during daytime hours, and noise will be of a lesser impact than for construction. Noise from decommissioning activities 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 Clare County Council. A decommissioning plan is contained in the CEMP in Appendix 2-1.

8.4.4 Potential Cumulative Effects

Details of projects considered in the cumulative assessment are detailed in Chapter 1.

There are a number of renewable energy projects in the area including:

- A 7 turbine windfarm at Crossmore, approximately 4.6km west of the site, which is due to commence operation in 2025
- Two solar farms at Manusmore and Clarecastle located over 17km from the development,
- Stonehall Solar Farm at Newmarket on Fergus (15.3km),
- A BESS storage facility at 17km from the development ,
- A proposed biomass processing and storage facility, and
- A plant for production of biofuels (at 15km from the development)

Of the above developments, only the Crossmore windfarm is close enough that it has potential to contribute to noise from Cloonkett Windfarm.

Condition 10 of the planning approval for the development Ref:09/123 states:

"*(i) Noise levels from the proposed development (operational phase) when measured at the nearest noise sensitive location shall not exceed 43 dB(A)* $L_{Aeq\ (15mins)}$*....*"

And

"*(ii) The developer shall arrange for the monitoring of noise levels within six months of the commissioning of the development. Details on the nature and extent of the monitoring programme, including any mitigation measures, shall be submitted to and agreed in writing with the planning authority prior to commencement of development*"

The EIAR as part of the original 09/123 submission stated that the resulting sound level at a distance of 500m was calculated to be under 43 dB(A). The report does not specify if this is L_{Aeq} or L_{A90}. However the predicted noise is compared to the 2006 guidance levels, which are defined in terms of L_{A90}.

The IOA GPG makes reference to directivity effects from wind turbines in Section 4.4 It states that if a noise source is upwind of a noise a reduction of 10 dB can be applied, and this must be clearly stated in any predictions, if applied. Given that noise sensitive locations are between Cloonkett and Crossmore windfarm, they cannot be downwind of both windfarms at any one time. Therefore, assuming a reduction of 10 dB from either Cloonkett or Crossmore windfarm, cumulative noise is not predicted to change the operational noise assessment from Cloonkett Windfarm.

In terms of the noise generated from operational noise from the proposed development, without mitigation, this not predicted to generate a significant effect.

8.4.4.1 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 wind farm given the distance between the developments and nature of the works proposed as part of these developments.

8.4.4.2 Operational Phase

The proposed seven (7 No.) turbine windfarm at Crossmore, approximately 4.6km west of the site has been assessed cumulatively with the Proposed Development.

Using the IOA GPG criteria, the cumulative noise from this wind farms has not been considered as the predicted noise from this wind farm more than 10 dB less than the predicted levels of the Proposed Development, and will therefore have a negligible cumulative impact.

8.5 Mitigation Measures

8.5.1 Mitigation Measures During Construction

The predicted noise levels from on-site activities from the proposed project is below the noise limits in BS 5228-1:2009+A1:2014.

Construction noise generated during from TDR Node 6 construction works has the potential to marginally exceed the construction daytime limit by 3 dB at the closest noise sensitive location (at 40m from the works), if all plant operates simultaneously, which is a worst case assumption. Noise mitigation measures that shall be implemented during TDR accommodation works at Node 6, including phasing works so not all plant is operated at once or use of a temporary barrier or screen.

Noise mitigation for TDR road widening works between TDR Node 8 and the western site entrance will be implemented if works take place for 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. Also the noise impact will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable.

In addition, 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 Cloonkett Green Energy 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) which is included in Appendix 2.1 of 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. As detailed in the CEMP, construction operations shall generally be restricted to between 08:00 - 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, for example during turbine base concrete pours, 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.

8.5.2 Mitigation Measures During Wind Farm Operation

The predicted operational noise levels are above the daytime noise limit of 40 dB at 6m/s at 16 locations.

The noise criteria are exceeded at 6m/s by between 0.2 and 2.8 dB. Of these, 10 properties are south of the Proposed Development and exceed the criteria by between 0.2 dB and 1.2 dB. Six properties to the north exceed the daytime noise criteria at 6m/s by between1.6 and 2.8 dB. Note that the noise predictions are for downwind conditions and it is unlikely that properties to the south of the development would be downwind for any period of time.

During the night time period, the noise criteria is exceeded at one location, R189 by 0.4 dB at 7m/s and 0.2 dB at 8m/s. This location is to the north of the proposed windfarm.

The proposed wind turbines have sound optimised (SO) modes of operation which generate reduced noise levels. These have been used to meet the noise criteria. Table 8-21 sets out the sound power data for these modes of operation.

A range of mitigation strategies can be developed to ensure compliance with the noise limits. Table 8-22 sets out the sound optimised modes which would allow the daytime and night time noise limits to be met at all noise sensitive locations at 6m/s, 7m/s and 8m/s where the operational noise is marginally exceeded.

With the proposed mitigation set out in Table 8-22, the predicted noise from the proposed wind farm meets the daytime and night-time noise limits at the closest locations to the proposed windfarm.

Based on the predicted noise levels, for some receptors, a new source of noise will be introduced into the soundscape and it is expected that there will be a long-term **slight to moderate significant effect** for dwellings within the 35 dB L_{A90} study area with a **moderate significance of effect on the closest dwellings to the proposed wind farm**.

In terms of the noise generated from operational noise from the proposed development, with mitigation, this not predicted to generate a significant effect.

In a small proportion of windfarm sites, there is a potential for the occurrence of Amplitude Modulation. Should complaints arise from the operational windfarm, developer is committed to commissioning a noise survey at noise sensitive locations. If complaints of AM occur, this survey shall establish the extent of the AM, and if a correction needs to be applied. It is intended that measurement methodology and corrections to be applied will be based on the updated ETSU guidance, currently draft form. This may require consideration of further mitigation in the form of operating at certain sound optimised modes. For AM this tends to occur for certain atmospheric conditions or wind directions, so the mitigation may be applied for certain conditions.

Table 8-23: Wind Turbine (Vestas V136 4.0MW) Octave Band Noise Levels, dB(A) for sound optimised mode at Standardised 10m Height Wind Speeds (with trailing edge serrations) 82m hub height

Standardised 10 m Height Wind Speed (m/s)	Octave Band Level Centre Frequency in Hz								Overall
	63	125	250	500	1000	2000	4000	8000	dBA
SO1 (6m/s)	82.5	90.8	95.8	97.1	95.0	90.7	83.5	73.2	101.7
SO1 (7m/s)	82.5	90.8	95.9	97.3	95.0	90.6	83.5	73.2	101.8
SO1 (8m/s)	83.5	91.4	96.1	97.5	95.0	90.7	83.6	73.6	102.0
SO2 (6m/s)	81.1	88.9	93.7	94.6	92.5	88.3	81.2	71.1	99.4
SO2 (7m/s)	81.7	89.2	93.8	94.5	92.5	88.4	81.5	71.8	99.5
SO2 (8m/s)	81.6	89.1	93.7	94.6	92.6	88.7	82.0	72.5	99.5

Table 8-24: Wind Turbine (Vestas V136 4.5MW) Sound Power Levels, dB L_{WA} at hub height 82m (with trailing edge serrations)

Turbine	Sound Optimised Modes to meet Daytime and Night time noise limits		
	Standardised 10 m Height Wind Speed (m/s)		
	6 (Daytime Limit)	7(Night time Limit)	8 (Night time Limit)
T1	SO2	Mode 0	Mode 0
T2	SO2	Mode 0	Mode 0
T3	SO2	Mode 0	Mode 0
T4	SO2	SO1	SO1
T5	SO2	SO1	Mode 0
T6	SO2	Mode 0	Mode 0
T7	SO2	Mode 0	Mode 0
T8	SO2	Mode 0	Mode 0
T9	Mode 0	Mode 0	Mode 0
T10	Mode 0	Mode 0	Mode 0
T11	Mode 0	Mode 0	Mode 0
T12	SO2	Mode 0	Mode 0
T13	SO1	Mode 0	Mode 0
T14	SO2	Mode 0	Mode 0
Mode 0 is Normal Operation			

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
NL1/R189	Predicted Level	30.2	31.1	34.4	39.1	39.9	42.9	43.0	42.9	42.6	42.6	42.6	42.5	42.6	42.6
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45 .0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL2/R231	Predicted Level	29.1	30.0	33.3	38.0	40.0	42.2	42.0	41.8	41.5	41.5	41.4	41.4	41.5	41.5
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL4/R167	Predicted Level	28	28.9	32.2	36.9	39.0	41.1	40.9	40.6	40.4	40.3	40.3	40.3	40.4	40.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL5/R148	Predicted Level	27	27.9	31.2	35.9	38.5	40.1	39.9	39.6	39.4	39.3	39.3	39.3	39.3	39.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL5/R139	Predicted Level	28.1	29.0	32.3	37.1	39.8	41.2	41.1	40.8	40.6	40.5	40.5	40.4	40.5	40.5
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL6/R134	Predicted Level	28.4	29.3	32.6	37.3	39.2	41.4	41.3	41.0	40.8	40.7	40.7	40.7	40.7	40.7

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL7/R114	Predicted Level	27.7	28.6	31.9	36.6	37.3	40.2	40.3	40.3	40.1	40.0	40.0	40.0	40.0	40.0
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL8/R133	Predicted Level	29.4	30.3	33.6	38.3	38.8	42.3	42.2	42.1	41.9	41.8	41.8	41.8	41.8	41.8
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level at 10m Standardised Wind Speed, dB													
		2 m/s	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s	11 m/s	12 m/s	13 m/s	14 m/s	14.3 m/s
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL9/R166	Predicted Level	26	26.9	30.2	34.9	35.5	39.1	38.9	38.6	38.4	38.3	38.3	38.3	38.4	38.4
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NL10/R193	Predicted Level	27.5	28.4	31.7	36.4	36.9	40.5	40.4	40.1	39.9	39.8	39.8	39.8	39.9	39.9
	Daytime limit	40.0	40.0	40.0	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	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	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-	-

8.5.3 Mitigation Measures during Decommissioning

As decommissioning works assume that there is no construction activities associated with the TDR route, the noise levels are predicted to be within the current daytime construction limits. The noise impact for 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.

The 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, 08:00 - 19:00 hours Monday to Saturdays, in accordance with best practice.

8.6 Residual Effects

Construction (excluding TDR accommodation works) and decommissioning on-site activities with a duration longer than one month will be below the construction noise limit of 65 dB $L_{Aeq,1hr}$ at residential dwellings. As a result, residual construction impacts range between **not significant to slight effect** with the duration of effect described as **temporary**. Therefore no likely significant effects arise.

There is potential for elevated noise levels due to the TDR accommodation works at Node 6, if all plant are operated simultaneously. With phasing of works or screening, this will result in a **slight effect** that is **temporary**. No significant likely effects arise.

TDR accommodation works between Node 8 and the Western site entrance may result in daytime noise limits being exceeded temporarily if works take place for an extended period close to properties. However, these works will be for a short duration for any individual property (i.e. typically less than 3 days at any particular receptor) and where the works are to occur over an extended period at a given location, a temporary barrier or screen will be used to reduce noise level below the noise limit and reduce any potential effect resulting in a **moderate short-term residual effect,**. that is **temporary.** No significant likely effects arise.

The operational wind farm noise levels meet the daytime and night-time noise limits derived using the Wind Energy Development Guidelines 2006. As detailed in the criteria section this is considered to be a current best practice approach. With the sound optimised modes as outlined in the Operational Mitigation, the predicted noise from the Proposed Wind Farm is below the noise limits at all noise sensitive locations. For some receptors closest to the Proposed Wind Farm, a new source of noise will be introduced into the soundscape and it is expected that there will be a slight to moderate significance of impact, with **dwellings closest to the Proposed Wind Farm with a long-term moderate significance of effect**. No significant likely effects arise.

8.7 Conclusions

This Chapter has assessed the likely direct significant effects from noise and vibration arising from the construction, operation and decommissioning phases of the Proposed Development.

For on-site construction noise, associated with on-site activities: access track construction, wind turbine foundation and turbine installation and substation and on-site grid connection works (both underground grid connections and loop in to the existing OHL), predicted noise is within recommended daytime limits. Therefore the construction noise impact from on-site activities is predicted to be **slight and temporary**. Construction works for TDR accommodation works may exceed the daytime limit marginally at Node 6. With recommended mitigation measures the noise effect at this location is **slight and temporary**. In addition, there may be **moderate short term effects** during TDR road widening works between Turbine Node 8 and the western site entrance. Therefore for construction works, with mitigation no significant likely effects arise.

Operational noise from the substation has been assessed. A baseline noise survey has been conducted to establish baseline noise levels and set the site operational noise limits based on the current 2006 WEDG guidelines. For the Proposed Substation, predicted daytime and nighttime noise are below the level that would lead to an **adverse effect**. Noise from the Proposed Wind Turbines has been assessed and are below the WEDG 2006 noise limits, with the recommended mitigation during the daytime at 6m/s and night time at 7 and 8m/s. With this mitigation, there will be a **slight to moderate effect** for dwellings within the 35 dB L_{A90} study area with a **moderate significance of effect on the closest dwellings to the proposed wind farm**. Therefore for operational noise, with mitigation no significant likely effects arise.

8.8 References

1. British Standards, BS 5228:2009+A1:2014: Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 1 -Noise and Part 2: Vibration.

2. UK Institute of Acoustics', Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise and supplementary notes, 2013

3. Oerlemans et al. (2007) 'Location and quantification of noise sources on a wind turbine', Journal of Sound and Vibration

4. UK Department of Trade and Industry (DTI), ETSU-R-97, the Assessment and Rating of Noise from Wind Farms, 1996

5. 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, Report for Renewable UK, December 2013

6. Guidance Note on Noise Assessment of Wind Turbine Operations at EPA Licensed Sites (NG3), 2011

7. Institute of Acoustics, (IoA) Noise Working Group (Wind Turbine Noise), Amplitude Modulation Working Group, A Method for Rating Amplitude Modulation in Wind Turbine Noise (Final Report), 9 August 2016 Version 1

8. BEIS, (2016), Review of the evidence on the response to amplitude modulation from wind turbines

9. A review of noise guidance for onshore wind turbines (ref 70081416-001-03-05), September 2023, Department for Business, Energy & Industrial Strategy, WSP.

10. Procedure for the assessment of low-frequency noise complaints, October 2009, The Journal of the Acoustical Society of America, University of Salford

11. The Measurement of Low Frequency Noise at Three UK Windfarms, Department of Trade and Industry, 2006

12. Bowdler et al. (2009). Prediction and Assessment of Wind Turbine Noise: Agreement about relevant factors for noise assessment from wind energy projects. Acoustic Bulletin, Vol 34 No2 March/April 2009, Institute of Acoustics

13. Environmental Protection Authority of South Australia, Infrasound levels near windfarms and in other environments, January 2013

14. 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.

15. British Standards, BS 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound.

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

17. Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency, May 2022

18. 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).

19. International Standard ISO 9613-2: 2024 Attenuation of sound during propagation outdoors, Part 2: Engineering method for the prediction of sound pressure levels outdoors;

20. Irish Wind Energy Association, Best Practice Guidelines for the Irish Wind Energy Industry (2012);

21. Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government (2006);

22. Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government, 2019;

23. World Health Organization. Night noise guidelines for Europe. (2009).

Information Note, Review of the Wind Energy Development Guidelines 2006, 'Preferred Draft Approach' published by the Department of Communications, Climate Action & Environment (2017)

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