ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR) FOR DERNACART WIND FARM

VOLUME 2 – MAIN EIAR

CHAPTER 8 - NOISE AND VIBRATION

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30 YEARS

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8 NOISE AND VIBRATION

8.1 Introduction

This chapter contains an assessment of the potential noise and vibration impacts associated with the proposed Dernacart Wind Farm Development. The assessment including undertaking of background noise surveys has been carried out by Fehily Timoney & Company, based on information provided by Statkraft Ltd and in accordance with current guidance and best practice. Descriptions of the proposed development are provided in Chapter 4 – Description of the Proposed Development, 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*.

Potential operational noise impacts associated with the proposed development have been assessed against the Department of the Environment, Heritage and Local Government's *Wind Energy Planning Guidelines* (2006) (WEDG2006).

The noise limits provided in WED2006 are being updated alongside shadow flicker and proximity considerations, but these revisions have not yet been adopted and released. As such, the current noise limits from the 2006 guidelines are used in this assessment, although it should be noted that it is possible to comply with revised noise limits through appropriate curtailment or shut down of particular turbines during daytime or night-time periods, as appropriate.

Operational noise associated with the introduction of the proposed substation has been assessed with reference to BS 4142:2014, *Methods for rating and assessing industrial and commercial sound*.

Decommissioning noise and vibration impacts have been discussed with similar references to the construction noise discussion.

8.2 Description of Noise and Vibration Impacts

8.2.1 Construction Noise & 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[1], described as "*might just be perceptible*". The guideline values for damage to buildings from vibration are 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above.

Typical vibration generated from construction activities for the proposed Dernacart Wind Farm are:

- Tracked excavators and disc cutters from cable trenching (0.8mm/s at 4m)
- Pneumatic breakers for cable trenching (1.8mm/s at 4m)
- HGV traffic on normal road surfaces (0.01 to 0.2 mm/s) at footings of buildings located a maximum of 20m from roadway

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

Short term vibration may be perceived by some residents within their dwellings close to proposed grid connection route. Vibration levels may be perceptible for short periods but are below the level that would lead to building damage. As such, construction vibration will not be considered further in this chapter.

8.2.2 Operational Noise & Vibration

Noise is generated by wind turbines as they rotate to generate power. This only occurs above the 'cut-in' wind speed and below the 'cut-out' wind speed. Below the cut-in wind speed there is insufficient strength in the wind to generate efficiently and above the cut-out wind speed the turbine is automatically shut down to prevent any malfunctions from occurring. The cut-in speed at the turbine hub-height is approximately 2-3 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.

Noise may also be generated from ancillary equipment such as a transformer at the onsite substation. However, it would 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.

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.

The University of Salford carried out a study[2] on behalf the Department for Business, Enterprise and Regulatory Reform (BERR) to investigate the prevalence of amplitude modulation of aerodynamic noise on UK wind farm sites. The study concluded that AM has occurred at 4 out of 133 wind farms in the UK. A further investigation of the four sites by the Local Authority showed that the conditions associated with AM might occur between 7% and 15% of the time.

The most recent research into AM was conducted by RenewableUK[3], '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.'

[2] Research into aerodynamic modulation of wind turbine noise: final report, Moorhouse, AT, Hayes, M, von Hünerbein, S, Piper BJ and Adams, MD, 2007

[3] 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

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

features which are thought to enhance this effect are:

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

The RenewableUK study 'has found that by minimising the onset of blade stall, the occurrence of OAM is also likely to be minimised.' It goes on to discuss 'the future involvement of turbine manufacturers in developing methods of avoiding or minimising the partial stall mechanism identified as a primary cause of OAM; and suggests that in future changes to blade design and the way in which the blade pitch (the angle of attack of the blade to the incoming air flow) is controlled are likely to have a role to play in achieving better management of the phenomenon.' Ultimately, further work is required to identify the exact on-blade conditions required for OAM to occur. The further work will aid in the development of a measure to fully mitigate the OAM. If OAM cannot be controlled by pitch regulation, shut down of wind turbines during conditions where OAM occurs will protect nearby noise sensitive locations. In the worst case, turbines would need to be stopped for 7 – 15% of the time to protect neighbouring amenity. It is therefore reasonable to conclude that even in the worst case, residential amenity can be appropriately protected.

Despite ongoing concern about amplitude modulation effects, the UK Government continues to support the limits in ETSU-R-97 for regulation of wind farm noise. However, the Wind Energy Development Guidelines (2006) in Ireland are under review and Draft Wind Energy Development Guidelines (2019) published for public consultation referred to a Relative Rated Noise Limit which includes provision for penalties for special audible characteristics including amplitude modulation.

In 2016, the IOA published 'A Method for Rating Amplitude Modulation in Wind Turbine Noise'[4]. It sets out a procedure for obtaining input noise data and analysing noise data to assess for AM. The procedure proposed in the IOA guidance document is recommended by the Department of Business, Energy & Industrial Strategy (BEIS) who have published a study on amplitude modulation[5]. The Draft Wind Energy Development Guidelines (2019) propose to use the methodology published by the IOA. A sliding penalty scheme of up to 5dB is proposed.

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. If it is determined that OAM is an issue on the site, following establishment of the likely cause, mitigation measures will be considered.

8.2.4 Infrasound & Low Frequency Noise

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

[4] 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

[5] BEIS, (2016), Review of the evidence on the response to amplitude modulation from wind turbines

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms'[6], 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'[7] and that 'it may therefore be concluded that infrasound associated with modern wind turbines is not a source which may be injurious to the health of a wind farm neighbour'.

The study reports that low frequency noise is measurable but below the DEFRA low frequency noise criterion[8]. The study also assessed low frequency measurements against the Danish criterion of LpA,LF = 20 dB. It was found that internal levels do not exceed 20dB when measurements are undertaken within rooms with the windows closed. However, the study acknowledges that wind turbine noise (low frequency) may result in an internal noise level that is just above the threshold of audibility as defined in ISO 226[9]. 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)[10] 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[11] into infrasound levels near wind farms. Measurements were undertaken at seven locations in urban areas and four locations in rural areas including two residences approximately 1.5 km from the wind turbines. The study concluded 'that the level of infrasound at houses near the wind turbines … is no greater than that experienced in other urban and rural environments and is also significantly below the human perception threshold.'

In 2016, the State Office for the Environment, Measurement and Nature Conservation of the Federal State of Baden-Württemberg in Germany published a report entitled 'Low-frequency noise incl. infrasound from wind turbines and other sources'. It assessed infrasound and low frequency sound from wind turbines and other sources. It found that for 'the measurements carried out even at close range, the infrasound levels in the vicinity of wind turbines – at distances between 150 and 300 m – were well below the threshold of what humans can perceive in accordance with DIN 45680 (2013).'

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

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[6] W/45/00656/00/00, The Measurement of Low Frequency Noise at Three UK Windfarms, Department of Trade and Industry, 2006

[7] Community Noise - Document Prepared for the World Health Organization, Eds. Bergland B. & Lindvall T., Archives of the Centre for Sensory Research Vol. 2(1) 1995: Section 7.1.4 : Page 41

[8] Proposed Criteria for the assessment of low frequency noise disturbance: Report for DEFRA by Dr Andy Moorhouse, Dr David Waddington, Dr Mags Adams, December 2011, Contract No. NANR45

[9] ISO 226:2003 Acoustics – Normal equal-loudness-level contours

[10] 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

[11] Environmental Protection Authority of South Australia, Infrasound levels near windfarms and in other environments, January 2013

8.2.5 Vibration

Research undertaken by Snow[12] 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.

Ground-borne vibration from wind turbines can be detected using sophisticated instruments several kilometres from the wind farm site as reported by Keele University[13]. This report clearly shows that, although vibration from wind turbines can be measured at considerable distances using highly sensitive instruments, the magnitude of the vibration is significantly below the human level of perception and does not pose any 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 (involved landowner) is 639 m away, the level of vibration is significantly below any thresholds of perceptibility. Vibration from the turbines is too low to be perceived at neighbouring residential properties. Therefore, operational vibration has been scoped out.

8.2.6 Decommissioning Noise & Vibration

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

8.3 Methodology

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

- Review of appropriate guidance and specification of suitable construction and operational noise / vibration criteria;
- Characterisation of the receiving noise environment;
- Prediction of the noise impact associated with the proposed development, and;
- Evaluation of noise impacts.

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 sections hereafter.

EIA Guidance:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports, Environmental Protection Agency (Draft), 2017
- Advice Notes on Current Practice, Environmental Protection Agency, Draft 2015
- Environmental Impact Assessment of Projects - Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU)

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

[13] Microseismic and infrasound monitoring of low frequency noise and vibrations from wind farms: recommendations on the siting of wind farms in the vicinity of Eskdalemuir, Scotland'. Keele University, 2005

Noise Modelling Standards and Technical Advice:

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

Guideline Noise Levels:

- Wind Energy Development Planning Guidelines, Department of the Environment, Heritage and Local Government (2006)
- BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1 Noise

8.3.2 Study Area

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

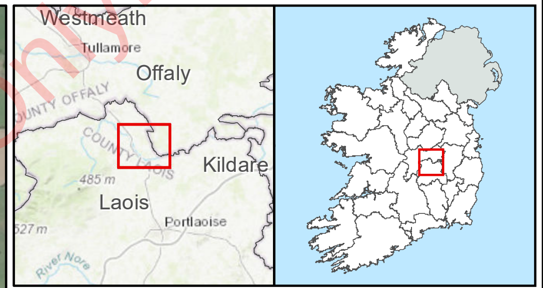
The operational noise study area has been defined as a minimum such that operational noise prediction results have been included for all noise sensitive locations with a predicted noise level greater than 35 dB L_{A90} (which is the lowest limit prescribed in the 2006 Department of the Environment, Heritage, and Local Government, *Wind Energy Planning Guidelines*). The study area is also in accordance with the UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) whereby the guidance document defines the study area as '*the area within which noise levels from the proposed, consented and existing wind turbine(s) may exceed 35dB L_{A90} at up to 10 m/s wind speed*.'

'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.' There are no nearby planned, consented or operational wind farm developments meeting the criteria above and the operational study area remains at the 35 dB L_{A90} boundary.

The operational study area in terms of a 35 dB L_{A90} boundary is presented in Figure 8.1. The noise prediction was carried out using the prediction model and applying the source data and parameters as described in Section 8.6.3.1 'Potential Impacts during operation'.

Since construction and operational vibration have been scoped out, there is no requirement to set study areas for each as they do not need to be assessed.

Path: R:\Map Production\2018\P1892\Workspace\EIAR\Chapter 8 - Noise and Vibration\P1892_Fig8-1_35dBLA90Contour_A3.mxd



35dB LA_{90} Contour
Proposed Turbines
Proposed Planning Boundary
Study Area Boundary
Proposed Cable Route
Proposed Turbine Hardstanding Areas
Proposed Substation
Proposed Temporary Compound

Proposed Access Tracks

Existing Track to be Upgraded
New Track

TITLE:	35dB LA_{90} Contour
PROJECT:	Dernacart Wind Farm
FIGURE NO:	8.1
CLIENT:	Statkraft
SCALE: 1:25000	**REVISION:** 0
DATE: 30/01/2020	**PAGE SIZE:** A3

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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 development of this scale may be found in the British Standard BS 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 Noise.

BS 5228-1:2009+A1:2014 contains several methods for the assessment of the 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). If this limit is exceeded during construction, it indicates a potential significant effect.

Table 8.1: Example Threshold of Potential Significant Effect at Dwellings

Assessment category and threshold value period (L_{Aeq})	Threshold Value, in decibels (dB)		
	Category A [A)]	Category B [B)]	Category C [C)]
Night-time (23:00 to 07:00hrs)	45	50	55
Evenings and weekends [D)]	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75

A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.
D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

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

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

Section 8.6.2 provides the detailed assessment of construction activity in relation to this site. If the modelled total noise level (including construction noise and ambient noise) exceeds the appropriate category value (e.g. 65 dB $L_{Aeq,1hr}$ during daytime periods) then a potential significant effect is predicted.

8.3.3.2 Wind Farm Operational Noise Criteria

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

The Assessment and Rating of Noise from Wind Farm' (1996) published by the 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, (May 2013) has been used to supplement the guidance contained within the '*Wind Energy Development Guidelines'* publication where necessary.

In preparing this assessment due consideration has also been given to the Laois County Development Plan 2017-2023. Appendix 5 summarises the Wind Energy Strategy for the County development plan. This states that 'Permitted maximum noise levels at noise sensitive residences shall be in compliance with noise specifications of the DoEHLG "Wind Energy Guidelines". Once commissioned the development will be monitored. In the event that the monitoring shows that any turbine is exceeding its projected noise levels and is having a detrimental noise impact, mitigating measures shall be agreed with the Local Authority.'

The DoEHLG guidelines 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.*

The limits are summarised below and are stated to be dB $L_{A90,10\ min}$ values:

- 35-40 dB(A) for quiet daytime environments of less than 30 dB(A)
- For daytime environments with background noise levels greater than 30 dB(A), 45 dB(A) or 5 dB(A) above background levels whichever is greater applies
- It is stated that '*A fixed limit of 43 dB(A) will protect sleep inside properties during the night'*

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

Where background noise is less than 30 dB(A), an absolute level within the range of 35-40 dB(A) is applicable. However, there is no appropriate approach in relation to the identification of low noise environments *'where background noise is less than 30dB(A)'* nor is there details on the application of *'an absolute level within the range of 35-40 dB(A).'* In the absence of detailed guidance from the Wind Energy Development Guidelines 2006, on what range of *35-40 dB* to use, we have referred to guidance from ETSU-R-97[14] 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 proposed operational limits in $L_{A90,\ 10\ min}$ for the Dernacart Wind Farm are therefore:

- The greater of 45dB or 5dB above background where background levels are greater than 30 dB for daytime periods and
- A fixed limit of 43 dB for night-time periods

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

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

It is also noted that on the 12th December 2019 the Draft Wind Energy Development Guidelines for public consultation were published by Eoghan Murphy T.D., Minister for Housing, Planning and Local Government (DHPCLG) and Richard Bruton T.D., Minister for Communications, Climate Action and the Environment (DCCAE). The consultation will run for ten weeks and it will have a deadline of the 19th of February.

The draft Wind Energy Development Guidelines (2019) do not have statutory effect and are therefore not considered in this assessment. Nonetheless, compliance with the guidelines in-force at the time of planning grant will be demonstrated through appropriate curtailment or shut down of particular turbines during daytime or night-time periods, as appropriate.

8.3.3.3 Substation Operational Noise Criteria

BS 4142:2014, *Methods for rating and assessing industrial and commercial sound*, provides an assessment methodology for determining the likely effects of external sound experienced at residential properties due to industrial and commercial sound sources. The standard describes a method for rating noise levels based on the difference between the level of existing background sound (in absence of the industrial or commercial source) and the sound emission level of the source at a particular receiver location (known as the specific sound level). In instances where the specific noise level exhibits an identifiable or perceived character (such as tonality, impulsiveness, intermittency or any other distinguishing characteristic) then a penalty, depending on the nature of the sound, should be added to give the rating level. The difference between the background level and the rating level (rating noise level minus the background sound level) is then used to determine the impact of the sound, as shown at Table 8.2.

Table 8.2: Extract from BS 4142

Difference	Assessment
Around 10 dB or more	'…likely to be an indication of a significant adverse impact.'
Around 5 dB	'…likely to be an indication of an adverse impact, depending on the context.'
0 dB	'… this is an indication of the specific sound source having a low impact, depending on the context.'

However, it is acknowledged and stressed within the standard that the source of noise should be described and assessed both in terms of the margin above background sound and in the context of the existing sound environment, especially in instances where the existing environment may already have ambient (or residual) sound levels that are high in relation to background sound level and when existing sound is similar in character to the assessed source.

Whilst BS 4142 provides a general approach to the assessment of sound impact on residential amenity, there are no guidelines for the specific approach to be taken in particular circumstances and for acceptable criteria in terms of defining potential noise limits. In these respects, the standard is left entirely open to interpretation. However, the standard states that *'Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night'*.

The previous version of BS 4142, issued in 1997 and in which a similar statement was given, contained a clarifying note stating that *'…for the purposes of this standard, background noise levels below 30 dB and rating levels below about 35 dB are considered to be very low'*.

It is therefore considered that, in general and for urban or industrialised sound environments in particular, if the rated noise level is below 35 dB L_{Aeq} then this would offer sufficient protection against noise for neighbouring residents.

The substation is to be located in a particularly rural area. The background noise levels will vary with wind speed. However, the rated noise level of the substation is below 35 dB L_{Aeq} and this is considered very low as per BS 4142 and therefore as the rated noise level is below 35 dB L_{Aeq} this would offer sufficient protection against noise for neighbouring residents.

8.3.4 Significance of Impact

The criteria for determining the significance of impacts and the effects are set out in the EPAs 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft), August 2017'. The EPA guidelines do not quantify the impacts in decibel terms. In absence of such information, reference is made to relevant standards and guidance documents noise limits. If the predicted impact is below the noise limits, it is considered that no significant effect is associated with the development or that aspect of the work.

For this assessment, it has been assumed that dwellings have a medium to high sensitivity. Table 8.3 presents the impact significance criteria from the EPA guidelines.

Table 8.3: Impact Significance Criteria

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

8.3.5 Consultation Requirements

There were no specific consultation requirements from a noise and vibration perspective related to the proposed wind farm development.

8.4 Existing Environment

Baseline noise monitoring was undertaken at 5 locations surrounding the proposed Dernacart Wind Farm development to establish the existing background noise levels in the vicinity of the proposed wind farm. 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.

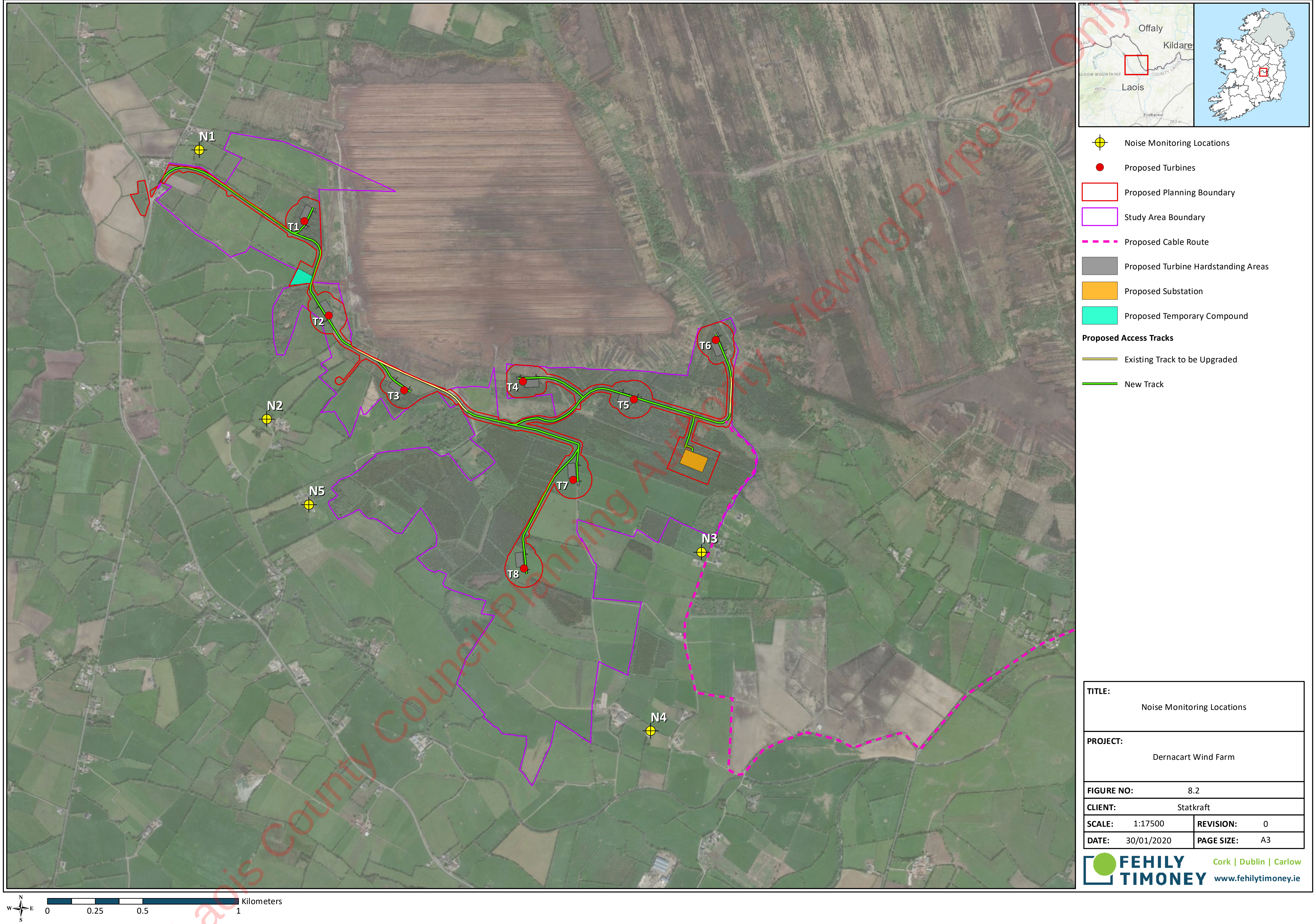
The 35dB L_{A90} study area as described in Section 8.3.2 and Figure 8.1 was reviewed to determine receivers to be considered for noise monitoring. The noise measurement locations were arranged by the developer, with Fehily Timoney & Company setting up the noise monitoring equipment.

Baseline noise data was collected at the five locations, shown in Figure 8.2 and details of the noise monitoring locations are presented in Table 8.4. 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.

Table 8.4: Details on the Noise Monitoring Locations

Location ID	Easting	Northing	Description	Photograph
N1	642551	712528	Located in a farmyard behind house H5 in direction of field and proposed wind farm.	Plate 8.1-1 (Appendix 8.1)
N2	642905	711118	Located in a field approximately 18m from dwelling H46.	Plate 8.1-2 (Appendix 8.1)
N3	645183	710422	Located in a field adjacent to noise sensitive locations H49 and H50.	Plate 8.1-3 (Appendix 8.1)
N4	644916	709486	Located at dwelling H93, in garden facing adjacent road and approximately 6m from façade.	Plate 8.1-4 (Appendix 8.1)
N5	643125	710671	Located at dwelling H39, in the front garden approximately 10m from the façade.	Plate 8.1-5 (Appendix 8.1)

Path: R:\Map Production\2018\P1892\Workspace\EIAR\Chapter 8 - Noise and Vibration\P1892_Fig8-2_NoiseMonitoringLocations_A3.mxd



- Noise Monitoring Locations
- Proposed Turbines
- Proposed Planning Boundary
- Study Area Boundary
- Proposed Cable Route
- Proposed Turbine Hardstanding Areas
- Proposed Substation
- Proposed Temporary Compound

Proposed Access Tracks

- Existing Track to be Upgraded
- New Track

TITLE: Noise Monitoring Locations			
PROJECT: Dernacart Wind Farm			
FIGURE NO:	8.2		
CLIENT:	Statkraft		
SCALE:	1:17500	**REVISION:**	0
DATE:	30/01/2020	**PAGE SIZE:**	A3

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8.5 Analysis of the Baseline Data

The raw baseline L_{A90} noise data was reviewed to determine whether there are any periods of non-consistent noise level due to equipment malfunction. If there was any data which was inconsistent, these noise level data points were removed from the raw data. The noise levels at monitoring location N5 were higher than expected for such a noise environment and the data at monitoring location N5 was removed from our analysis. The raw noise level data at monitoring location N1 to N4 were then correlated with the time synchronised 10 m standardised wind speed and rainfall data. Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. Once the remaining data sets were found to be representative of the noise environment, they were analysed to ensure that sufficient data sets remained to provide sufficient data coverage over the necessary wind speeds. A 'best fit' trend (not higher than a fourth order polynomial) was then derived to present the assumed prevailing background noise level at each monitoring location. Appendix 8.1 presents the results of the data analysis.

The assumed prevailing noise levels at the four noise monitoring locations are presented in Table 8.5. Also presented is a worst-case envelope based on the lowest average levels at the various wind speeds. In some instances, the prevailing background noise is higher at lower wind speeds, in keeping with the IOA guidelines, the lowest derived background noise level is adopted for all wind speeds below where this derived minimum occurs. Furthermore, the derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point.

Table 8.5: Prevailing Background Noise

Location	Period	Prevailing Background Noise LA90,10min (dB) at 10 m Standardised wind speed (m/s)									
		2	3	4	5	6	7	8	9	10	11
N1	Daytime	33.0	34.1	35.0	35.7	36.5	37.5	38.6	40.0	41.9	44.3
	Night-time	19.8*	19.8	20.4	21.7	23.9	26.9	30.7	35.3	35.3§	35.3§
N2	Daytime	36.0	36.8	37.6	38.4	39.3	40.2	41.2	42.2	43.3	43.3§
	Night-time	22.2*	22.2	23.4	26.1	29.6	33.1	35.8	35.8§	35.8§	35.8§
N3	Daytime	30.7	31.6	32.3	32.8	33.3	34.1	35.2	36.8	39.1	39.1§
	Night-time	22.6*	22.6	22.7	23.8	25.7	28.6	32.6	32.§	35.8§	35.8§
N4	Daytime	32.9	33.8	34.5	35.3	36.1	37.0	38.0	39.2	40.6	42.3
	Night-time	23.8*	23.8	24.5	26.2	28.2	29.8	30.4	30.4§	30.4§	30.4§
Envelope	Daytime	30.7	31.6	32.3	32.8	33.3	34.1	35.2	36.8	39.1	39.1§
	Night-time	19.8*	19.8	20.4	21.7	23.9	26.9	30.4	30.4§	30.4§	30.4§

* - lowest derived background noise level is adopted for all wind speeds below where this derived minimum occurs. For example, at monitoring location N1 the lowest derived background noise level occurs at a wind speed of 3 m/s. The trend line fitted to noise data showed a higher noise level at 2 m/s. Therefore, using this criterion, the noise level at 2 m/s has been assumed to be equal to that of the noise level at 3 m/s.

§ - noise level restricted to the highest derived point.

8.5.1 Wind Farm Noise Limits

8.5.1.1 Derived Wind Farm Noise Limits

The standard approach to derivation of noise limits is to carry out baseline measurements at several dwellings around the proposed site. Noise limits are then derived for the dwellings at which the measurements were carried out based on the results of these measurements. As it is not usually possible to carry out measurements at every dwelling, dwellings near to the measurement location are then assigned the same limits as the measurement location. The operational impact at each of the measurement properties was appraised in accordance with the IOA GPG.

As a conservative exercise, a worst-case envelope based on the lowest average noise levels at all measurement properties was used to derive a site wide noise limit and the operational impact from the wind farm was appraised.

Where low background noise levels are found, the DoEHLG guidelines recommend a limit of 35 to 40 dB $L_{A90.}$ There is no further detail provided on which to determine how the appropriate noise limit be derived. However, the background noise levels are above 30 dB L_{A90} at a wind speed of 2 m/s and above during daytime periods, and therefore there is no requirement to apply the low background noise criterion for this site.

The derived noise limits, according to the discussion within Section 8.3.3.2 Wind Farm Operational Noise Criteria with reference to the background noise environment found at dwellings surrounding the proposed development site and, where necessary, the meteorological conditions experienced during the survey are presented in Table 8.6. A worst-case envelope based on the lowest average noise levels at the various wind speeds are also presented in Table 8.6. The noise limits derived using the baseline noise envelope are considered a worst case and conservative approach to this aspect of the assessment. The measurement data indicates that the envelope prevailing background noise levels are above 30 dB L_{A90} for measured 10 m standardised wind speeds of 2 m/s and above. As a result, the low background noise limit criterion does not apply at this site. A 45 dB L_{A90} noise limit or 5 dB above background whichever is greater is proposed for night-time periods. A fixed 43 dB L_{A90} noise limit is proposed for night-time periods. The assessment uses more onerous limits than those in the wind energy development guidelines to demonstrate the site can meet these limits. However, the noise limits that will apply to the site are the wind energy development guidelines (2006) noise limits.

Table 8.6:   Derived Noise Limit

Location	Period	Derived $L_{A90,10min}$ (dB) Noise Limits at 10 m Standardised wind speed (m/s)									
		3	4	5	6	7	8	9	10	11	12
N1	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.9	49.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
N2	Day	45.0	45.0	45.0	45.0	45.0	45.2	46.2	47.2	48.3	48.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
N3	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
N4	Day	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.3
	Night	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Envelope	**Daytime**	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0

8.6 Potential Impacts

8.6.1 Do Nothing Scenario

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

8.6.2 Potential Impacts 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 outline construction programme implemented during the construction of the wind farm. Noise modelling was carried out using guidance and plant noise data from BS 5228:2009+A1:2014. The ground cover is predominantly acoustically soft (G=1)[15]. 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[16] for plant is outlined for each of the plant items used during construction.

The construction noise model assessed several tasks with the potential to generate noise. These tasks included: deliveries and/or removal of material to and from site, preparation of access roads, hardstands and drainage, pouring of foundations, installation of wind turbines and works associated with grid connection.

Site Traffic

Detailed information on construction traffic is presented in Chapter 10. To summarise, additional light goods vehicles travelling to and from the site during the construction phase would be expected to peak during the morning (arrival of contractors at the site) and evening (departure of contractors from the site) and are envisaged not to be a continuous source of noise emissions from the site during a typical working day. The impact from construction personnel movements to and from the site is expected to be low.

All deliveries of turbine components and other construction materials to the site will only be by way of the proposed transport route outlined in Chapter 10. The most traffic is generated during the main windfarm construction phase. The busiest period is during simultaneous road construction, turbine cranepad construction and preparation of turbine foundations.

The total number of HGV movements as detailed in traffic chapter is 14,516 two way trips for the total period. This corresponds with a daily HGV movement of 57 per day. For the purpose of this assessment a HGV movement of 58 has been assumed (so HGV's assumed to enter and leave on the same day). The construction traffic is expected to have a moderate short-term negative impact.

In addition, during construction, it is anticipated that there will be 40 light goods vehicles per day for workers on the site.

The noise impact for construction works traffic would 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 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.

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

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

Preparation of Access roads, Hardstands and Drainage

Table 8.7 presents the likely plant required for the preparation of access roads, hardstanding and drainage. Also presented are the predicted noise levels at the nearest dwelling (H4) approximately 40 m from the nearest access roads, near the site entrance. Assuming all construction activities required for the preparation of the access road occur simultaneously, the predicted noise level from the construction activities is predicted to be 69.4 dB $L_{Aeq,1hr}$ which is above the 65dB $L_{Aeq,1hr}$ noise limit. The dominant noise sources are the tracked excavator and the dozer. In practice, not all construction plant will be operating simultaneously at 40m away from dwelling H4. Nonetheless, where activity is to occur near dwelling H4, the simultaneous use of plant will be limited and the percentage on-time reduced to ensure compliance with the 65 dB $L_{Aeq,1hr}$ noise limit. The noise level at locations near to H4 are predicted to be below the 65dB $L_{Aeq,1hr}$ noise limit. With mitigation, the construction works associated with the preparation of the access roads, hardstands and drainage are expected to have a moderate impact and temporary in duration.

Table 8.7: Preparation of Access roads, Hardstands and Drainage Assumed Plant

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at H4 (site entrance)
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	65.4
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	55.9
Dozer (14t)	C5.12	Spreading chipping/fill	80	64.6
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	54.5
Excavator (21t)	C4.65	Trench for drainage	80	59.2
Lorry*	C11.9	Delivery of Material	Maximum 58 trips per day	59.3
Cumulative				69.4

Preparation of Wind Turbine Foundations Assumed Plant

Table 8.8 presents the likely plant required for the preparation of wind turbine foundations. Predicted noise levels at H47 and H5 are presented. These are two of the closest dwellings to wind turbines and receptor H47 is approximately 639 m from turbine T2 and receptor H5 is approximately 667 m from turbine T1. Assuming all construction activities required for the preparation of the turbine foundations occur simultaneously, the predicted noise level from the construction activities are 45.9 dB $L_{Aeq,1hr}$ and 54.0 dB $L_{Aeq,1hr}$ for receptors H47 and H5, respectively. The predicted noise levels are below the 65dB $L_{Aeq,1hr}$ noise limit. The construction works associated with the preparation of the wind turbine foundations are expected to have a slight impact and temporary in duration.

Table 8.8: Preparation of Wind Turbine Foundations Assumed Plant

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at	
				H47	H5
Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	37.5	37.6
Excavator (23t)	C10.8	Loading sand / soil	80	40.2	40.3
Diesel Pump	C4.88	Pump water	100	29.8	29.9
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	31.2	31.3
Concrete mixer truck & concrete pump	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	100	38.8	38.9
Lorry*	C11.9	Delivery and removal of material	Maximum 58 trips per day	41.2	53.5
Cumulative				45.9	54.0
* - Drive-by maximum sound level					

Installation of Wind Turbines

Turbine components will be delivered to site and a mobile telescopic crane will lift the turbine components into place. A worst case of the two cranes lifting turbine components 100% of the time is assumed along with delivery of turbine components. The predicted noise levels are presented in Table 8.11. The predicted cumulative noise level at receptors H47 and H5 are 41.6 and 53.5 dB $L_{Aeq,1hr}$, respectively. The predicted noise levels are below the 65 dB $L_{Aeq,1hr}$ noise limit. The construction works associated with the installation of the wind turbines are expected to have a slight impact and temporary in duration.

Table 8.9: Installation of Wind Turbine Assumed Plant

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at	
				H47	H5
Mobile telescopic crane (x2)	C4.41	Lifting turbine components	100	31.2	31.3
Lorry *	C11.9	Delivery of Turbine Components	Maximum 32 two-way trips per day	41.2	53.5
Cumulative				41.6	53.5
* - Drive-by maximum sound level					

Construction of Substation

The construction of the substation building will occur during the construction phase of the proposed development. This has the potential to impact residential properties east of the site. The construction works will be progressed in the following 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 8.10 presents the assumed plant required for the different construction phases of the proposed buildings to be constructed on site. The nearest occupied dwelling (H96) will be approximately 240 m from the proposed substation and the predicted noise levels are 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 impact and temporary in duration.

Table 8.10: Typical noise levels during construction works

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at H96
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Clearing Site	80	48.8
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	48.5
	Loading Lorry	C10.8	Loading Sand to Lorry	80	48
Preparation and pouring of Foundations	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	45.2
	Concrete mixer truck + truck mounted concrete pump + boom arm	C4.32	Concrete pumping	80	45.7
	Lorry*	C11.9	Delivery of material	Maximum of 58 trips per day	40.6
Preparation of hardstanding areas	Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	45.2
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	35.8
	Dozer (14t)	C5.12	Spreading chipping/fill	80	44.5
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	34.3
	Lorry*	C11.9	Delivery of material	Maximum of 58 trips per day	40.6
Erection of blockwork/	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	45.5

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at H96
installation concrete slabs	Lorry* (32t)	C11.9	Delivery of material	Maximum of 58 trips per day	40.6
General Construction including installation of electrical and mechanical plant	Generator	C4.84	Power for site cabins	100	35.5
	Telescopic handler	C4.54	Lifting Plant	80	47.2
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	49.3
* Drive-by maximum sound level					

Grid Connection Works

It is proposed to construct an on-site electricity substation within the proposed development site. This will provide a connection point between the wind farm and the proposed grid connection point at the proposed future Bracklone substation to be located in Portarlington. Each turbine will be connected to the on-site electricity substations via an underground medium voltage electricity cable. The cable route will follow the proposed access tracks between each turbine. The main on-site substation is at Forest Lower and a buried cable is proposed to connect to the proposed future Bracklone substation. The grid connection cable will travel along public roads. The grid connection works will be carried out over a 10-month period and 'rolling road closures' will be implemented, whereby the site will progress each day along a road, which will have the effect of reducing the impact for residents. The plant required during the construction works are presented in Table 8.11.

Table 8.11: Grid Connection Works – Assumed Plant and Predicted Noise Levels

Plant	Activity	Percentage on-time (%)	A-Weighted Sound Pressure Level, L_{Aeq}, dB			
			10m	25m	50m	100m
Road sweeper (C4.90)	Sweeping and dust suppression	10	46.5	38.6	31.5	24.3
Mini excavator with hydraulic breaker (C5.2)	Breaking Road Surface	25	75.9	68.4	61.3	54.1
Vibratory roller (C5.27)	Rolling and Compaction	50	63.3	55.6	48.4	41.2
Wheeled excavator (C5.34)	Trenching	50	66.9	59	51.9	44.7
Hand-held circular saw (petrol) (C5.36)	Cutting Concrete Slabs	10	76.0	68.5	61.4	54.2
Dump truck (tipping fill) (C2.30)	Tipping Fill	10	68.8	61.1	53.9	46.7
Vibratory plate (petrol) (C2.41)	Compaction	10	69.7	62.1	54.9	47.7

Table 8.11 also presents predicted noise level for a range of construction activities at distances of 10 m, 25 m, 50 m and 100 m from the works. The noise levels presented are predicted maximum expected levels and are expected to occur for only short periods of time at a very limited number of dwellings. There is one dwelling within 10m of the grid connection works, 53 dwellings between 10 – 25 m, 100 dwellings between 25 – 50 m and 94 dwellings between 50 – 100 m.

The dwelling within 10m of the grid connection works is predicted to be above the noise limit of 65 dB $L_{Aeq,1hr}$. This dwelling is located at Kilbride House, Kilbride (ITM 652818, 709322) on the outskirts of Portarlington.

For dwellings more than 25m from the works the noise limit of 65 dB $L_{Aeq,1hr}$ is predicted to be exceeded during operation of the hydraulic breaker and the hand held circular saw. However, these elevated noise levels will only occur for short durations. Given the nature of the works, construction activities will not occur over an extended period at any one location.

In general, there is potential for temporary elevated noise levels due to the grid connection works. However, these works will be for a temporary duration at a particular property (i.e. less than 3 days) and where the works are to occur over an extended period at a particular property, a temporary barrier or screen will be used to reduce noise level below the noise limit. The works are expected to have a significant temporary impact.

8.6.3 Potential Impacts during Operation

8.6.3.1 Operation of Wind Turbines

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. The propagation model described in Part 2 of this standard provides for the prediction of sound pressure levels based on either short-term downwind (i.e. worst case) conditions or long-term overall averages. Only the worst-case downwind condition has been considered in this assessment, that is – 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 in detail below. The predicted octave band levels from the turbine are summed together to give the overall 'A' weighted predicted sound level.

L_W - Source Sound Power Level

The sound power level of a noise source is normally expressed in dB re:1pW. Noise predictions are based on sound power levels provided for the GE 5.3 158 with a hub height of 106 m.

D – Directivity Factor

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

A_{geo} – Geometrical Divergence

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

$$A_{geo} = 20 \times \log(d) + 11$$

where, d = distance from the turbine

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

A_{atm} - Atmospheric Absorption

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

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

Published values of 'α' from ISO9613 Part 1[17] have been used, corresponding to a temperature of 10°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 8.12.

Table 8.12: 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

A_{gr} - Ground Effect

Ground effect is the interference of sound reflected by the ground with the sound propagating directly from source to receiver. The prediction of ground effects is inherently complex and depend on the source height, receiver height, propagation height between the source and receiver and the ground conditions.

The ground conditions are described according to a variable G which varies between 0 for 'hard' ground (includes paving, water, ice, concrete and any sites with low porosity) and 1 for 'soft' ground (includes ground covered by grass, trees or other vegetation). The IOA GPG states that use of G = 0.5 and a receptor height of 4 m should be used to predict the resultant turbine noise level at dwellings neighbouring a proposed development provided that an appropriate allowance for measurement uncertainty is accounted for within the stated source noise levels. Therefore, predictions in this report are based on G = 0.5 with a receptor height of 4 m and, due to the inclusion of the assumed uncertainty within the source noise levels, these predictions are considered to be conservative.

A_{bar} - 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 and that 10 dB(A) should be allowed where a barrier lies within 5 m of a receiver and provides a significant interruption to the line of 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*'. There are no significant topographical barriers surrounding the proposed site. As a result, this has not been accounted for within the predictions.

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

A_{misc} – Miscellaneous Other Effects

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

The 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 a valley correction is not required for the Dernacart Wind Farm.

Predicted Noise Levels

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

Overview of Input Datasets

In order to calculate the noise levels at noise sensitive locations, an accurate representation of the source and receiver positions was necessary for the prediction modelling. The turbine locations are presented Chapter 4 of this EIAR and noise sensitive locations are presented in Appendix 8.4. The closest dwelling (involved landowner) to the proposed Dernacart Wind Farm is approximately 639 m from the nearest turbine.

The actual turbines to be installed at the proposed wind farm will be the subject of a competitive tender process and may include turbines not amongst the turbine models currently available. Regardless of the make or model of the turbine eventually selected for installation on site, the noise it will give rise to will have to meet the stated noise limits.

For the purposes of this assessment, noise predictions are based on sound power levels provided for the General Electric Turbines GE 5.3 158. The turbine array has 8 No. turbines with a 106 m hub height (candidate turbine).

The sound power level values for the turbine are based on the noise levels provided by the manufacturer (Document ref: Noise_Emission-NO_5.3-158-50Hz_IEC_EN_r03.docx). The manufacturers datasheet presents sound power levels at integer hub height wind speeds. These have been interpolated to calculate the sound power levels at standardised 10 m height wind speeds and the overall sound power levels at integer wind speeds are presented in Table 8.13 and octave band data at integer wind speeds are presented in Table 8.14.

Table 8.13: GE 5.3-158 Wind Turbine Sound Power Levels, dB L_{WA}

Turbine	Standardised 10 m Height Wind Speed (m/s)				
	3	4	5	6	7 to cut-out
GE 5.3-158 (Normal Operation)	94.0	96.9	101.6	105.3	106

Table 8.14: Octave Band Sound Power Level Data for GE 5.3 158 Wind Turbine

Normal Operation A-weighted Octave Spectra [dB]						
Standardised 10m Height Wind Speed (m/s)		**3**	**4**	**5**	**6**	**7 to cut-out**
Frequency (Hz)	**16**	53.9	55.8	60.0	63.7	64.5
	32	67.4	69.1	73.4	77.2	78
	63	76.6	78.7	82.6	86.4	87.2
	125	83.7	86.6	89.5	92.1	92.6
	250	87.4	91.1	94.6	96.8	97.2
	500	87.4	90.8	96.1	99.2	99.7
	1000	87.4	89.8	95.9	100.5	101.3
	2000	86.4	88.2	93.2	98.1	99.1
	4000	81.3	83.6	87.2	90.9	91.7
	8000	65.8	69.1	72.9	75.5	76.0
Total Sound Power Level (dB)		**94.0**	**96.9**	**101.6**	**105.3**	**106.0**

The IOA GPG states that it should be ensured that a margin of uncertainty is included within source wind turbine noise data used in noise predictions. The manufacturers datasheet reports a standard deviation of production of 0.5 and a standard deviation of reproducibility of 0.8 dB. The expanded uncertainty was calculated as 2.2 dB. The 2.2 dB expanded uncertainty has been added to the sound power level data to obtain the input for the noise predictions.

Noise Predictions - Results

Noise predictions were performed for the 8-wind turbine layout modelling GE 5.3 158 wind turbines for a range of standardised 10m height wind speeds from 3 m/s up to 7 m/s (to cut-out[18]). Receptors within the 35 dB L_{A90} noise contour of the turbines were modelled. Several of the receptors were identified as commercial/farm buildings, unoccupied derelict buildings, or caravans or mobile homes and these have not been considered as part of the impact assessment and were not assessed against the derived daytime and night-time noise levels.

Table 8.15 presents predicted noise levels at the 9 nearest noise sensitive locations to the proposed development. The predicted noise levels at all receptor locations are presented in Appendix 8.2. Note: the predicted noise levels are for a worst-case scenario with noise sensitive receptors downwind of the proposed wind farm. In practice, receptor locations will not be downwind of all wind turbines and the actual noise levels will be lower than those presented in Table 8.15 and Appendix 8.2.

Table 8.15 also presents derived daytime and night-time noise limits at each of these locations. The predicted noise levels are below the daytime and night-time noise levels at all wind speeds. However, new sources of noise will be introduced into the soundscape and it is expected that there will be a long-term slight to moderate significance of impact for dwellings within the 35 dB L_{A90} study area with a moderate significance of impact on the closest dwellings to the proposed wind farm.

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

Table 8.15: Assessment of Predicted L_{A90} Noise Levels for Dernacart Wind Farm Operation against Daytime and Night-time Noise Limits

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level (dB) at a range of Standardised 10m Height Wind Speeds				
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s (to cut-out)
H46	Predicted Level	30.1	33.2	37.8	41.3	41.9
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H47	Predicted Level	30.1	33.2	37.9	41.3	41.9
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H45	Predicted Level	29.3	32.4	37.1	40.5	41.1
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H49	Predicted Level	29	32.2	36.8	40.2	40.8
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H96	Predicted Level	28.9	32	36.7	40	40.7
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H53	Predicted Level	28.9	32.0	36.6	40.0	40.6
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H52	Predicted Level	28.8	31.9	36.5	39.9	40.5
	Daytime limit	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
	Night-time Excess	-	-	-	-	-
H41	Predicted Level	28.7	31.8	36.4	39.8	40.4
	Daytime limit	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-

Receptor ID	Description	Predicted L_{A90} Sound Pressure Level (dB) at a range of Standardised 10m Height Wind Speeds				
		3 m/s	4 m/s	5 m/s	6 m/s	7 m/s (to cut-out)
	Night-time limit	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-
H51	Predicted Level	28.6	31.7	36.4	39.7	40.3
	Daytime limit	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
	Night-time Excess	-	-	-	-	-

8.6.3.2 Potential Operational Impact – Substations

Noise will be produced by the transformer located in the substation. The noise level is likely to depend on the load on the transformer which is dependent on the wind speed (as the wind turbines producing more energy in high wind speeds).

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 8.16.

Table 8.16: Octave Band Sound Power Level Data

Equipment	A-weighted Octave Band Centre Frequency (Hz)									Overall L_{WA}
	31.5	63	125	250	500	1k	2k	4k	8k	
Transformer Ω	81.0	87.0	89.0	84.0	84.0	78.0	73.0	68.0	61.0	93.0
Ω - Manufacturer's datasheet provided information on overall sound power levels. Octave band data was sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' CED Engineering										

Noise predictions have been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. The predicted noise levels at the nearest dwellings to the substation is 34.5 dB L_{Aeq} at receptors H96. It should be noted that rating levels below about 35 dB L_{Aeq} are very low (see Section 8.3.3.3), and therefore the noise emissions at the nearest noise sensitive locations are not considered to be significant. The significance of impact from the substation at the nearest noise sensitive location is expected to be not significant.

8.6.4 Potential Impacts during Decommissioning

Upon decommissioning of the proposed wind farm, the wind turbines would be disassembled in reverse order to how they were erected. All above ground turbine components would be separated and removed off-site for recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. These activities would be undertaken during daytime hours, and noise, which would be of a lesser impact than for construction, will be controlled through the relevant guidance and standards in place at the time of decommissioning.

Site access tracks could be in use for purposes other than the operation of the wind farm by the time the decommissioning of the project is to be considered, and therefore it may be more appropriate to leave the site access tracks in situ for future use.

If the roads were not required in the future for any other useful purpose, they could be removed where required. This would involve removing hard core material and placement of topsoil. The impact is expected to be less than that during the construction stage.

It is proposed that the underground cable will be cut back, and it will remain in-situ. The works associated with the cutting back of the underground cable will have a negligible impact.

8.6.4.1 Potential Cumulative Impacts

The proposed development has been considered in terms of cumulative impacts with other projects in the area.

8.6.4.2 Operational Phase

There are three wind farms in the surrounding area as detailed in Chapter 4. The wind farms within 20km of the site are Mount Lucas (existing), Cloncreen (permitted) and Moanvane (permitted). The nearest of these, the existing wind farm at Mount Lucas is approximately 12 km from the proposed development. The proposed wind farms of Cloncreen and Moanvane are approximately 20km and 17km, respectively, from the proposed Dernacart Wind Farm. Based on the IOA Good Practice Guide to the Application of ETSU-R-97, it is not necessary to consider cumulative noise from these windfarms, as these are considered sufficiently distant so that cumulative noise is 10 dB less than the predicted levels of the proposed Dernacart Windfarm.

8.7 Mitigation Measures

8.7.1 Mitigation Measures during Construction

The predicted noise levels from onsite activity from the proposed development are generally below the noise limits in BS 5228-1, except for a potential exceedance at H4 during the preparation of the access road and hardstanding construction works near the site entrance. The dominant noise sources are the tracked excavator and the dozer. Where activity is to occur near dwelling H4, the simultaneous use of plant will be limited and the percentage on-time reduced to ensure compliance with the 65 dB $L_{Aeq,1hr}$ noise limit.

No other exceedances are anticipated from onsite construction works. The construction works on site would 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). 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 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.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 07:00 hours and 19:00 hours Monday to Friday and 07:00 - 13:00 hours on Saturdays. However, to ensure that optimal use is made of fair-weather windows, or at critical periods within the programme, it could occasionally be necessary to work outside these hours. Any such out of hours working would be agreed in advance with the local planning authority.

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

With mitigation measures, the construction and decommissioning noise levels are likely to be below the relevant noise limit of 65 dB $L_{Aeq,1hr}$ for operations exceeding one month, and therefore construction noise impacts are not considered to be significant. However, there is potential for temporary elevated noise levels due to the instatement of sections of the internal access road and grid connection works. However, these works will be over an extended period but the potential impact at any particular receptor will be for a short duration (i.e. less than 3 days). Where the works at elevated noise levels are required over an extended period, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required.

The noise impact will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable.

8.7.2 Mitigation Measures during Wind Farm Operation

The predicted noise impact from the proposed development is below the daytime and night-time noise limits and no mitigation measures are required.

8.7.3 Mitigation Measures during Decommissioning

The noise impact for construction works traffic would be mitigated by generally 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 at 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, typically 07:00-19:00 hours Monday to Friday and 07:00 - 13:00 hours on Saturdays.

8.8 Residual Impacts

With mitigation measures, the predicted noise impact from onsite activity from the proposed development will be less than 65 dB $L_{Aeq,1hr}$ noise limit. As a result, residual construction impacts are not considered to be significant when assessed under these criteria. However, it is expected that there will be slight to moderate impact on nearby noise sensitive locations for the duration of the construction.

There is potential for temporary elevated noise levels due to the grid connection works. However, these works will be for a short duration at a particular property (i.e. 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. It is therefore considered that there will be a temporary significant residual impact at a limited number of residential dwellings for a short period of time.

Operational wind farm noise levels meet the derived night and daytime noise limits at all noise sensitive locations surrounding the wind farm which, under this criterion, is not considered to be of a significant impact. However, new sources 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 development with a long-term moderate significance of impact.

The substation transformers will be below a rating level of 35 dB $L_{Ar,Tr}$ which are considered to be very low and the impact is not significant.

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