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

VOLUME 2 – MAIN EIAR

CHAPTER 7 – NOISE AND VIBRATION

Prepared for: Ballinagree Wind Farm DAC

Ballinagree Wind farm

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7. NOISE AND VIBRATION

7.1 Introduction

This chapter contains an assessment of the potential noise and vibration impacts associated with the proposed Ballinagree Wind Farm project.. 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. This assessment has been undertaken by engineers with experience in assessment of windfarms in Ireland. The noise assessment and mitigation has been undertaken by John Mahon, who has a PhD in Acoustics and Vibration and has significant experience in noise impact assessments for wind farm projects. The main surveyor and co-author is Maureen Marsden, who has an Master in Engineering Acoustics and Vibration and is also a Member of the Institute of Acoustics. Please refer to Chapter 1 for curricula vitae for the competent experts.

A detailed description of the project assessed in this EIAR is provided in Chapter 3 and is comprised of the following key elements:

- The wind farm site **(referred to in this EIAR as** 'the Site');
- The grid connection route (**referred to in this EIAR** as the 'GCR');
- The turbine delivery route **(referred to in this EIAR as** the 'TDR');
- The Biodiversity Enhancement Management Lands (**referred to in this EIAR a**s the 'BEMP Lands')

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 project 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). Operational noise associated with the proposed project includes noise from the proposed wind turbines and on-site substation. The operational noise is compared with noise limits derived in accordance with the Wind Energy Development Guidelines 2006.

The noise limits provided in the Wind Energy Development Guidelines 2006 are being revised. The Draft Revised Wind Energy Development Guidelines were published on the 19th December 2019. The 2019 draft guidelines were out to public consultation until the 19th February 2020 and may be subject to further revision. The final version of 2019 draft guidelines has not yet been issued. As such, the noise limits from the 2006 guidelines are used in this assessment as they are the current ones the Board must have regard to pursuant to section 28 of the Planning and Development Act 2000, as amended. The 2006 Guidelines are still accepted as appropriate within the expert community. Furthermore, the 2019 draft guidelines have a number of technical errors, ambiguities and inconsistencies and require further detailed review and amendment. If new guidelines are adopted prior to a decision on this application, the Developer is happy to demonstrate compliance with same as appropriate.

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

As discussed in Chapter 3, the exact turbine make and model will be dictated by competitive process, but it will not exceed the range for which consent is sought for.

The hub height range is the only element of the turbine dimensions that influence the operational noise impact of the project. Any influence on the variation of blade length is accounted for by the turbine manufacturer in their sound power data which is used for the purpose of modelling the proposed turbine layout using the representative turbine. An analysis has been considered of this range and therefore a minimum hub height of 102.5 and maximum hub height of 110.5m have been assessed.

7.2 Description of Noise and Vibration Impacts

7.2.1 Construction Noise & Vibration

Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, extraction of material from borrow pits, horizontal directional drilling, felling, the construction of associated hardstandings 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”. 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.

Vibration levels generated from the construction activities proposed at the wind farm site are:

- 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)
- Rock breaking at borrow pits (0.03 mm/s at 100 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 from the on-site construction works as detailed in Section 7.5.2 are sufficiently distant that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration. As such, construction vibration will not be considered further in this chapter. The possible exception to this is the use of pneumatic breakers during grid connection works and this is discussed in the assessment of noise and vibration from the grid connection works.

7.2.2 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 3 m/s and the cut-out wind speed is approximately 25 m/s.

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

The blades are carefully designed to minimize noise whilst optimising power transfer from the wind. See Oerlemans et al. (2008) 'Location and quantification of noise sources on a wind turbine' for further details on the principal sources of noise from a wind turbine. Wind turbine vibration from turbines at operational stage is dealt with in Section 7.2.4 below.

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 7.5.3.

7.2.3 Wind Turbine Noise Characteristics

7.2.3.1 Blade Swish (Amplitude Modulation of Aerodynamic Noise)

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

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

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

In some cases amplitude modulation is observed at large distances from a wind turbine (or turbines). The sound is generally heard as a periodic 'thumping' or 'whoomphing' at relatively low frequencies. This is known as 'Other AM or OAM'. 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[1] of the rotor blade.

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.

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

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

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'[3], 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) [4] states….

'features which are thought to enhance this effect are:

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

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

In 2016, the IoA published 'A Method for Rating Amplitude Modulation in Wind Turbine Noise'[5]. It sets out a procedure for obtaining input noise data. 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[6].

At present there is no method for predicting OAM at any particular location before turbines begin operation based on the general features of a site or the known attributes of a particular turbine. Therefore, it is not possible to predict an occurrence of AM at the planning stage. It should also be noted that it is a rare event associated with a limited number of wind farms. While it can occur, it is the exception rather than the rule.

[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

[4] Guidance Note on Noise Assessment of Wind Turbine Operations at EPA licenced sites NG3, Environment Protection Agency, Office of Environmental Enforcement, June 2011

[5] 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

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

The RenewableUK study states that "even on those limited sites where it has been reported, its frequency of occurrence appears to be at best infrequent and intermittent." and "There is nothing at the planning stage that can presently be used to indicate a positive likelihood of OAM occurring at any given proposed wind farm site, based either on the site's general characteristics or on the known characteristics of the wind turbines to be installed."

Assessment of AM Research and Guidance is ongoing, with recent publications being issued by the Institute of Acoustics (IoA) Noise working Group (Wind Turbine Noise) Amplitude Modulation Working Group (AMWG) :"A Method for Rating Amplitude Modulation in Wind Turbine Noise (August 2016)". The document proposes an objective method for measuring and rating AM. The AMWG does not propose what level of AM is likely to result in adverse community response or propose any limits for AM. The purpose of the group is simply to use existing research to develop a Reference Methodology for the measurement and rating of AM. The definition of any limits of acceptability for AM, or consideration of how such limits might be incorporated into a wind farm planning condition, is outside the scope of the AMWG's work. There has been no adoption of endorsement of an AM 'penalty' scheme by any government. The IOA GPG states in "The evidence in relation to "Excess" or "Other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM."

While AM is the exception and not the rule. Should any concern regarding AM be raised during the future operation of the wind farm, the operator will employ an independent acoustic consultant to assess the level of AM in accordance with best practice guidance.

In the absence of published guidance to date, it is considered best practice to adopt the penalty rating and assessment scheme contained in an article published in the Institute of Acoustics publication Acoustics Bulletin (Vol. 42 No. 2 March/April 2017) titled, Perception and Control of Amplitude Modulation in Wind Turbines Noise.

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

7.2.3.2 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.

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

The UK Department of Trade and Industry study, 'The Measurement of Low Frequency Noise at Three UK Windfarms'[7], 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'[8] 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[9] low frequency noise criterion[10]. 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[11]. 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)[12] 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[13] 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.'

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

[8] 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

[9] Department of Environment, Food & Rural Affairs, UK

[10] 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

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

[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

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 from wind turbines is therefore 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.

7.2.3.3 Tonal Noise

ETSU-R-97 describes tonal noise as "noise containing a discrete frequency component most often of mechanical origin". Wind turbine sound can be tonal in some cases, for example if there is a defect in a turbine blade or a fault in the mechanical equipment such as the gearbox. Tonality from wind turbines is generally caused by structural resonances in the mechanical parts of the turbine and thus is highly specific not only to the turbine model but the specific components used, including tower height. However, a correctly operating wind turbine is not considered to have tonal sound emissions. 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 with maintenance or repairs if it occurs.

7.2.4 Vibration

Vibration from operational wind turbines is low and will not result in perceptible levels at nearby sensitive receptors nor will the levels of vibration result in any structural damage. Research undertaken by Snow[14] 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[15] 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 800m from the nearest turbine or borrow pit, 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.

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

[15] 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.

Vibration levels will also be significantly below levels that would result in damage to the nearest buildings (including farm buildings). Therefore, operational vibration has been scoped out. Potential vibration from the operation of the proposed substation has been scoped out on the basis that the nearest vibration sensitive location is over 1km from the proposed substation.

7.2.5 Decommissioning Noise & Vibration

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

7.3 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 project;
- Evaluation of noise impacts,
- Propose mitigation, and
- Assess residual impacts.

7.3.1 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, European Union, 2017, (Directive 2011/92/EU as amended by 2014/52/EU).

Noise Modelling Standards and Technical Advice:

- International Standard *ISO 9613-2: 1996 Attenuation of sound during propagation outdoors, Part 2: General method of calculation*
- UK Institute of Acoustics', *A Good Practice Guide to the Application of ETSU-R-97 for the Assessment at Rating of Wind Turbine Noise* (2013) and supplementary notes

- British Standard *BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Part 1: Noise*
- Irish Wind Energy Association, *Best Practice Guidelines for the Irish Wind Energy Industry* (2012)
- UK Department of Trade and Industry (DTI), ETSU-R-97, *The Assessment and Rating of Noise from Wind Farms* (1996)
- British Standard BS 4142:2014+A1:2019, *Methods for Rating and Assessing Industrial and Commercial Sound*

Guideline Noise Levels:

- Wind Energy Development Guidelines, Department of the Environment, Heritage and Local Government (2006)
- Draft Revised Wind Energy Development Guidelines (December 2019), Department of Housing, Planning and Local Government
- BS 5228 Part 1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 1: NoiseEPA's 'Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (Draft), August 2017'.

7.3.2 Study Area

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

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

As discussed in Chapter 3, the exact turbine make and model will be dictated by competitive process, but it will not exceed the range for which consent is sought. The hub height range is the only element of the turbine dimensions that influence the operational noise impact of the project. Any influence on the variation of blade length is accounted from by the turbine manufacturer in their sound power data which is used for the purpose of modelling the proposed turbine layout using the representative turbine. Therefore noise has been modelled at a minimum hub height of 102.5 (lower envelope) and maximum hub height of 110.5m (upper envelope).

The IOA guidance documents also states… *"During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary."* Adjacent wind farms have been considered in the cumulative assessment and the operational study area of 35 dB L_{A90} includes the noise emissions from adjacent wind farms (Carraigcannon, Bawnmore, Boggeragh 1 and 2, Esk). The operational study area is presented in Figure 7.1.

It includes 672 noise sensitive locations, 67 of which are directly related to the noise emissions from Ballinagree Wind Farm only.

Since construction and operational vibration have been scoped out (see Section 7.2.1), there is no requirement to set study areas for each.

Four private landowners, with a combined total of c. 304 ha of lands in the vicinity of the wind farm, but beyond 250m of any proposed turbine, have agreed to a long-term commitment to land management measures designed to maintain and enhance local biodiversity. In addition the Developer has undertaken to create wildlife corridors through strategic tree-felling between areas of open upland habitat in the vicinity of the proposed wind farm area.

The following actions will be undertaken as part of the Biodiversity Enhancement Management Plan (BEMP).

There shall be none of the following allowed on the lands included in the BEMP:

- Burning areas of vegetation.
- Removal of hedgerows.
- Planting of Conifers.
- New land drainage.
- Organising, allowing or engaging in recreational activities involving off-road or racing vehicles.
- Turf-cutting.
- Unapproved use of Herbicides.
- Unapproved of pesticides/rodenticides.

Common Management Measures:

For all of the BEMP areas, the following measures are to be applied:

- Removal of all self-sown conifer saplings,
- Removal of all invasive non-native species, notably *Rhododendron,*
- Control of Bracken (according to Sears/Natural Scotland (2008). Bracken Control: Guide to Best Practice).

In addition to the above it is proposed to fell 18ha of Coillte lands to provide enhanced ecological connectivity between large areas of open upland habitats.

The noise and vibration activities associated with the above will be no greater than common agricultural activities at a worst case.

Therefore, noise and vibration impacts from implementing the BEMP is scoped out with the exception of forestry felling which is dealt with in section 7.5.2.

Path: R:\Map Production\2019\P2114\Workspace\EIAR\P2114_GIS_Fig7-1_NoiseSensitiveLocationsWithinStudyArea_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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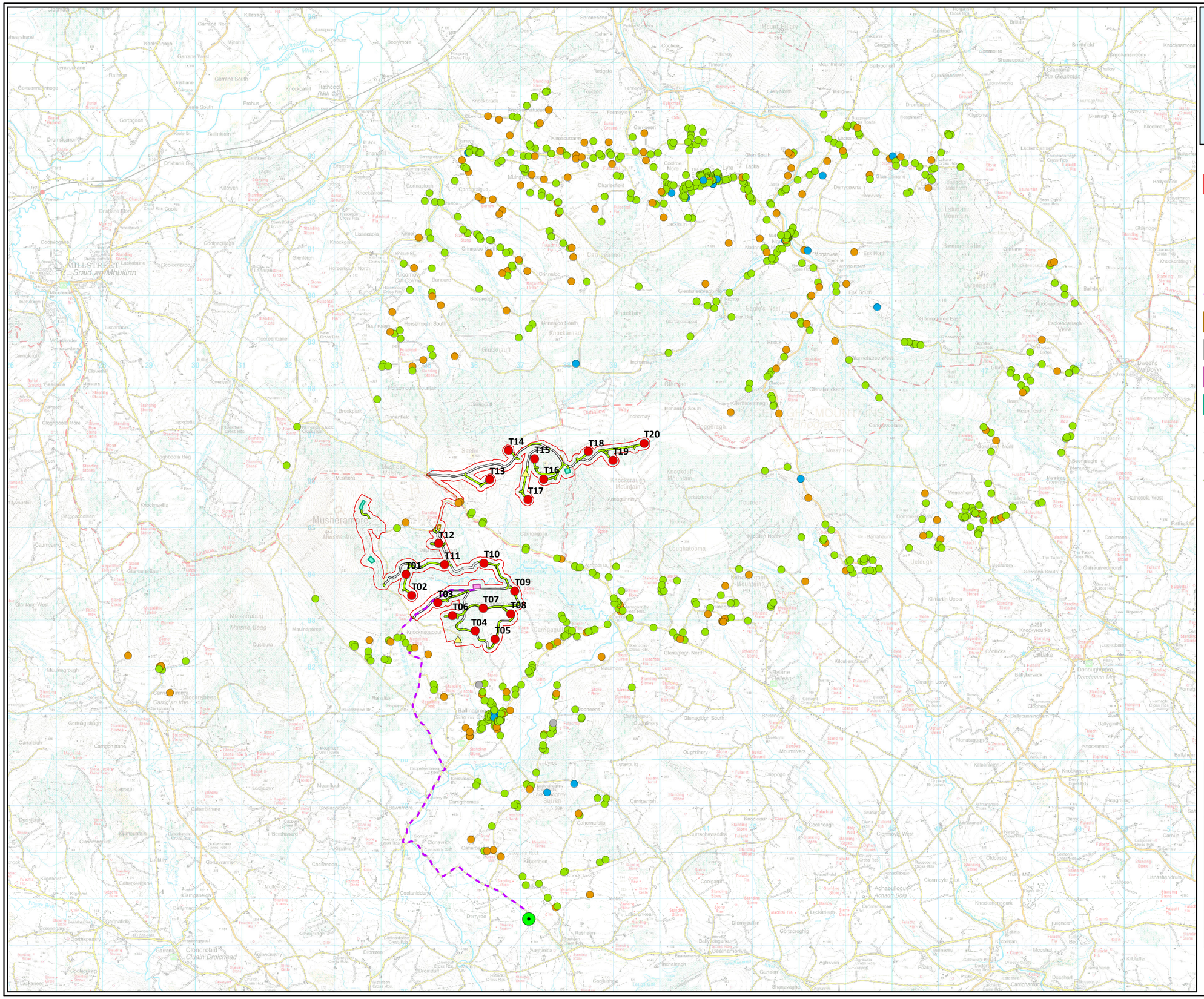

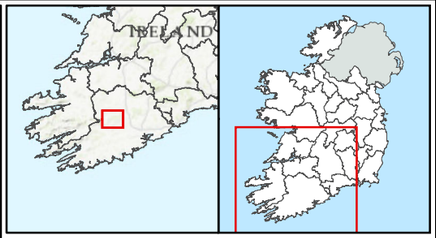

Legend

- Wind Farm Site Boundary
- Clashavoon Substation (110-220kV)
- Proposed Turbine Layout
- Met Mast
- Grid Connection
- Construction Compound
- Turbine Hardstanding Area
- Substation Compound
- Proposed Borrow Pits

Access Tracks

- Existing Track Upgrade
- New Access Track

Receptors

- Commercial
- Residential
- Residential and Commercial
- Unknown

TITLE: Noise Sensitive Locations within the Study Area			
PROJECT: Ballinagree Wind Farm			
FIGURE NO:	7.1		
CLIENT:	Coillte & Brookfield		
SCALE:	1:80000	**REVISION:**	0
DATE:	06/07/2021	**PAGE SIZE:**	A3

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7.3.3 Evaluation Criteria

7.3.3.1 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.* For information it is noted that the proposed approach is in keeping with the *Draft Revised Wind Energy Development Guidelines* (December 2019) published by the Department of Housing, Planning and Local Government which provide details on construction and decommissioning noise criteria. The guidelines state… '*Control of noise during the construction and decommissioning of wind energy developments will be carried out using the ABC method detailed in Annex E.3.2 of BS 5228 [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 potential significance of noise effects. The ABC Method was used to derive appropriate noise limits for the proposed project. The threshold limit to be applied (as defined in Table 7.1) is dependent on the existing ambient noise levels (rounded to the nearest 5dB).

Table 7.1: Threshold of Potential Significant Effect during Construction and Decommissioning

Threshold value period (L_{Aeq})	Threshold Value, in decibels (dB)		
	Category A	Category B	Category C
Night-time (23:00 - 07:00hrs)	45	50	55
Evenings (19:00 – 23:00 hrs) and weekends (13:00 – 22:00 Saturdays) and (07:00 – 19:00 hrs Sundays)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (08:00 – 16:30)	65	70	75
Note Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values. Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values. Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.			

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

The baseline noise survey 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}.

Therefore, the nearest residential dwellings to the proposed project are afforded Category A designation (65 dB $L_{Aeq,1hr}$ during daytime periods).

Section 7.5.2 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. In this case, the assessment needs to consider other project-specific factors, such as the number of receptors affected, and the duration and character of the impact, to determine if there is a significant effect. If a significant effect is determined, mitigation measures are required to reduce the noise levels below the noise limit for the period (65 dB $L_{Aeq,1hr}$ being the daytime noise limit).

It is proposed that there will be turbine deliveries at night time to facilitate project programme and to facilitate appropriate traffic and transportation management, as detailed in Chapter 13. At a worst case this will occur up to twice a month during months 9-15 of the proposed construction programme, and may extend over a 7 month period. It is anticipated that there will be up to 6 vehicles per convoy. The appropriate noise criteria for this is 45 dB $L_{Aeq, 1hr}$ if these occur between 23:00 and 07:00. It should be noted people are more sensitive when they are going to sleep and during the early morning period. Construction activities during these periods should be minimised.

7.3.3.2 Wind Farm Operational Noise Criteria

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

*ETSU-R-97, The Assessment and Rating of Noise from Wind Farm*s (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 (as described below).

In preparing this assessment the Cork County Development Plan 2014 has been reviewed. Section 9.3 'Renewable Energy' of the Cork County Development Plan 2014 states 'Development of on-shore wind shall be designed and developed in line with the "Planning Guidelines for Wind Farm Development 2006" issued by the [Department of the Environment, Heritage and Local Government] and any updates of these guidelines.'

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

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

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

> *In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the 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 is 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, and reference has also been made to the planning permissions for adjacent wind farm development. The assessment has fully considered the adjacent windfarm developments (Carraigcannon, Bawnmore, Boggeragh 1 and 2 and Esk Wind Farms).

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[16] which states...

> "*The actual value chosen for the day-time lower limit, within the range of 35-40dB(A), should depend upon a number of factors:*
>
> - *Number of dwellings in the neighbourhood of the wind farm.*
> - *The effect of noise limits on the number of kWh generated.*
> - *Duration and level of exposure."*

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

The Draft Revised Wind Energy Development Guidelines were published on the 19th December 2019. The 2019 draft guidelines were out to public consultation until the 19th February 2020 and may be subject to further revision. The final version of revised guidelines has not yet been adopted and issued. As such, the current noise limits from the 2006 guidelines are used in this assessment. If new guidelines are adopted prior to a decision on this application, the Developer happy to demonstrate compliance with same as appropriate.

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

The Draft Revised Wind Energy Development Guidelines, published in December 2019 (dWEGs) which is the most recent publication from the Department of Housing, Planning and Local Government have a number of technical errors, ambiguities and inconsistencies and require further detailed review and amendment. This is a fact supported by several acoustic consultants from Ireland and the UK. In assessing the dWEGs, the WHO 45 dB 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."* Therefore, it would be premature to adopt the WHO recommendations without further careful and detailed consideration and therefore this has not been adopted. The best practice guidance contained in ETSU-R-97 together with the detailed guidance contained in the Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (May 2013) and its six supplementary guidance notes have been considered and applied to ensure a robust and best practice approach to the assessment.

7.3.4 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 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 7.3 presents the impact significance criteria from the EPA guidelines.

Table 7.2: Impact Significance Criteria

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

7.3.5 Consultation Requirements

Chapter 5 of the EIAR refers to scoping consultation. Several submissions on noise were received as part of the consultation process. The submissions have informed the project design and this EIAR chapter. The main issues raised as part of this process are summarised below:

- Pre-application consultation with An Bord Pleanála included a recommendation to conder the potential cumulative impact from other windfarms in the area.
- Consultation with TII included a recommendation to consider noise barriers to reduce noise impacts (as detailed in Guidelines for the Treatment of Noise and Vibration in National Road Schemes)
- Concern was raised from residents regarding potential noise from the development.

7.4 Existing Environment

Baseline noise monitoring was undertaken at 17 receptor locations surrounding the proposed Ballinagree Wind Farm to establish the existing background noise levels in the vicinity of the proposed project. These are some of the closest locations to the proposed project as well as representing different noise environments in the vicinity of the proposed project. Noise monitoring locations were chosen to represent the closest properties to the proposed windfarms to represent groups of properties within the 35 dB L_{A90} study area. Consideration was given to local noise sources, in particular existing windfarms, roads and forested areas.

The 35 dB L_{A90} study area as described in Section 7.3.2 and Figure 7.1 was reviewed to determine receivers to be considered for noise monitoring. Permission to access the noise measurement locations was arranged by the Developer, with Fehily Timoney and Company setting up the noise monitoring equipment.

Background noise data was collected at the 17 locations, shown in Figure 7.2 and details of the noise monitoring locations are presented in Table 7.3. Further detail on the rationale for the selection of these monitoring locations is described in Appendix 7.1 which also presents details on the baseline measurements and data analysis.

Table 7.3: Details on Noise Monitoring Locations

Location ID	Easting	Northing	Description	Photograph (see Appendix 7.1)
N2	537874	583205	Located in a field adjacent to the dwelling and approximately 30 m from adjacent dwelling façade. The location was chosen so it was away from trees along the boundary of the property.	Plate 7.1-1*
N3	537963	582999	Located in front garden of dwelling in direction of proposed wind farm, approximately 5 m from dwelling façade.	Plate 7.1-2*
N4	537598	582500	Located in the rear garden of the dwelling facing the proposed wind farm.	Plate 7.1-3*

Location ID	Easting	Northing	Description	Photograph (see Appendix 7.1)
N5	537142	581929	Located in field adjacent to residential dwelling, immediately at the boundary of the curtilage.	Plate 7.1-4*
N6	536628	581611	Located in field approximately same distance from road and row of trees from adjacent dwelling (proxy location), next to a farm.	Plate 7.1-5*
N7	536248	581009	Located in the rear garden of the dwelling in the direction of the wind farm.	Plate 7.1-6*
N8	534953	582310	In rear garden of dwelling along rear fence, overlooking a field to rear of dwelling, approximately 9 m from rear façade.	Plate 7.1-7*
N10	532526	583491	In garden south of dwelling, away from road, approximately 5 m from the dwelling façade. Forested area across road.	Plate 7.1-8*
N11	531924	586386	Located in garden of dwelling on raised ground, east of the dwelling. Approximately 10 m from the dwelling façade.	Plate 7.1-9*
N12	532125	587243	Located next to drive overlooking rear garden of the dwelling.	Plate 7.1-10*
N13	532946	586946	In yard outside the dwelling, adjacent to a forested area (glamping site). Approximately 15 m from the dwelling.	Plate 7.1-11*
N14	533759	587844	Proxy location in field opposite dwelling approximately 100 m from the dwelling. The noise monitor is located equidistant from row of trees similar to the aspect for the dwelling.	Plate 7.1-12*
N15	535534	588742	Located in the yard of a farmhouse approximately 15 m from the dwelling.	Plate 7.1-13*
N16	541499	587708	Proxy location, in field next to dwelling. Approximately 160 m from dwelling.	Plate 7.1-14*
N17	535891	585368	Located next to drive opposite front façade of house overlooking adjacent road.	Plate 7.1-15*
N18	537054	584578	Located in a disused farmyard to the rear of the derelict dwelling.	Plate 7.1-16*
N19	537762	584406	Located in field adjacent to dwelling to the rear of building in the yard of a disused farm.	Plate 7.1-17*

*Photographs provided in Appendix 7.1

Path: R:\Map Production\2019\P2114\Workspace\EIAR\P2114_GIS_Fig7-2_ProposedNoiseMonitoringLocations_A3.mxd

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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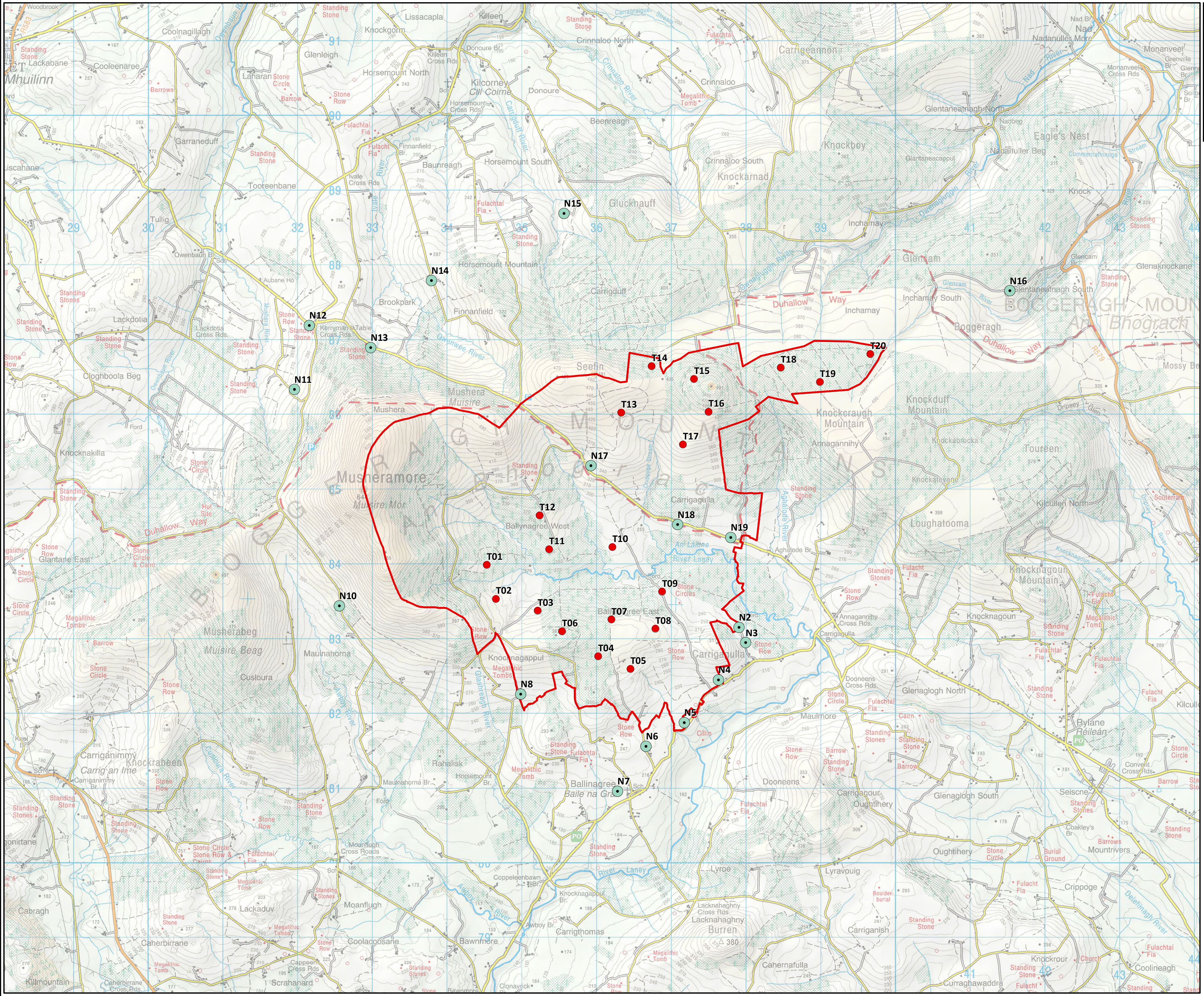

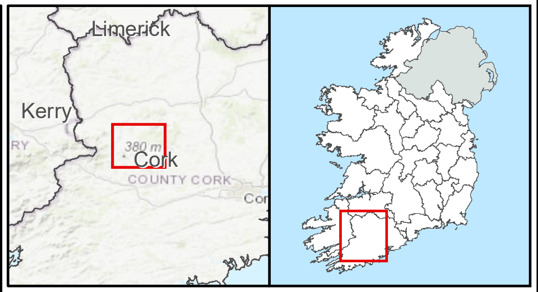

Legend

Proposed Site Boundary

Proposed Turbine Layout

Proposed Noise Monitoring Locations

Location	Easting	Northing
N2	537874	583205
N3	537963	582999
N4	537598	582500
N5	537142	581929
N6	536628	581611
N7	536248	581009
N8	534953	582310
N10	532526	583491
N11	531924	586386
N12	532125	587243
N13	532946	586946
N14	533759	587844
N15	535534	588742
N16	541499	587708
N17	535891	585368
N18	537054	584578
N19	537762	584406

TITLE:
Proposed Noise Monitoring Locations

PROJECT:
Ballinagree Wind Farm

FIGURE NO:	7.2		
CLIENT:	Coillte and Ørsted		
SCALE:	1:50000	REVISION:	0
DATE:	10/12/2021	PAGE SIZE:	A3

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7.4.1 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 raw noise level data was then correlated with the time synchronised 10 m standardised wind speed and rainfall data. Periods of rainfall, data affected by dawn chorus and atypical data was removed from the analysis. 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.

Equipment was installed at location N13, however, equipment was tampered with and a request to repeat the noise survey at this location was denied. It was not possible to get access to dwelling adjacent to location N16. A proxy location was used but following a review of the data the location was omitted from further analysis due to high levels on noise observed from a nearby water course. The removal of these locations does not affect the validity of baseline noise survey and derivation of noise limits.

The proposed wind farm is adjacent to several other wind farms. Analysis was undertaken to remove the contribution of adjacent wind farms where applicable. This involved undertaking directional noise predictions and correcting the background noise data. Where the difference between background noise levels and predicted noise levels was less than 3 dB, these data points were omitted from the analysis. The resulting corrected noise levels resulted in a higher prevailing background noise level due to the omission of these data points. Therefore, the uncorrected data set was used as it resulted in lower background noise levels which were used in the derivation of the noise limits. A ‘best fit’ trend (not higher than a fourth order polynomial) was then derived to present the prevailing background noise level at each monitoring location. When adjacent windfarm noise was removed, this resulted in a higher background. Therefore, all data that results in a lower background noise level has been used.. Appendix 7.1 presents the results of the data analysis. Appendix 7.2 presents equipment calibration certificates.

The prevailing daytime noise levels at the 15 noise monitoring locations (N13 and N16 removed) are presented in Table 7.4. The derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point.

Table 7.4: Prevailing Background Noise - Daytime Periods

Location	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	11	12	13	14
N2	25.4	27.2	28.9	30.7	32.4	34.1	35.7	37.4	39.0	40.6	42.2	43.7	45.3
N3	23.2	23.3	23.9	24.9	26.2	27.7	29.4	31.2	32.9	34.5	35.8	35.8§	35.8§
N4	32.8	34.9	36.6	38.0	39.1	40.0	40.8	41.5	42.3	43.2	44.3	45.7	47.5
N5	31.8	31.7	32.0	32.5	33.4	34.4	35.7	37.1	38.6	40.2	41.9	43.5	45.2
N6	29.1	28.7	29.2	30.3	32.0	34.1	36.5	39.1	41.8	44.4	46.9	49.0	50.7
N7	29.9	31.6	32.9	34.0	34.8	35.5	36.2	37.0	38.0	39.4	41.1	43.4	46.3
N8	24.8	25.7	27.0	28.6	30.5	32.5	34.7	37.0	39.3	41.7	44.1	46.4	48.6
N10	29.5*	29.5	29.7	30.5	31.8	33.6	35.7	38.0	40.5	43.0	45.3	47.5	49.4
N11	27.1	27.6	28.7	30.2	32.1	34.2	36.5	38.9	41.3	43.5	45.6	47.3	48.7
N12	36.3	36.9	37.4	38.0	38.5	39.0	39.6	40.1	40.7	41.2	41.7	42.3	42.8
N14	25.2	26.0	27.2	28.7	30.5	32.6	35.0	37.5	40.1	42.8	45.6	48.4	51.2
N15	34.5*	34.5	34.7	35.4	36.5	38.0	39.8	41.8	44.0	46.2	48.3	50.3	52.1
N17	27.6	30.8	33.7	36.4	38.9	41.1	43.2	44.9	46.5	47.8	48.9	49.8	50.4
N18	25.4	28.0	30.4	32.5	34.3	35.9	37.1	38.1	38.9	39.4	39.6	39.6§	39.6§
N19	26.9	29.4	31.8	34.1	36.3	38.3	40.3	42.2	44.0	45.7	47.3	48.8	50.2

§ - noise level restricted to the highest derived point
* - noise level restricted to lowest derived point
Cells greyed out represent background noise levels less than 30 dB $L_{A90, 10min}$

7.4.2 Derived Wind Farm Noise Limits

The standard approach (outlined in the IoA GPG) to 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 GPG.

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

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

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

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

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

The first factor to be considered is the "*Number of dwellings in neighbourhood of the wind farm*". ETSU-R-97 describes this factor as balancing the benefits from a wind energy project with the local environment impact, "*The more dwellings that are in the vicinity of a wind farm the tighter the limits should be as the total environmental impact will be greater. Conversely if only a few dwellings are affected, then the environmental impact is less and noise limits towards the upper end of the range may be appropriate.*" Whilst the study area as defined in Section 7.3.2 above is defined by the 35dB L_{A90} contour taking into consideration contributions from existing and planned wind farms, the deriver noise limits for Ballinagree Windfarm takes into consideration the number of noise sensitive locations (which includes planning permissions for habitable dwellings not yet constructed) that are predicted to be above 35 dB LA90 due to noise emission from Ballinagree Windfarm which has been calculated to be 67 properties which would indicated that the upper end of the limit range is appropriate limit given the relatively low number of properties.

The second factor is the effect of noise limits on the power output of the wind farm. Similar to the above referenced ETSU guidance, the Wind Energy Development Guidelines (2006) states that "An appropriate balance must be achieved between power generation and noise impact." Therefore a balance between the planning merit of the project against the local impact is a consideration. The proposed project has 20 turbines. If the limit is lowered, then, based on the noise modelling results, curtailment would be required. Since this project is considered to have merit in assisting Ireland in meeting its renewable energy targets, the upper end of the limit range is appropriate.

The final ETSU factor relates to the duration and level of exposure. The prevailing background noise levels are described in detail in Section 7.4.1 and Appendix 7.1. The wind rose for the proposed development shows that wind speeds of 3, 4, 5, 6, 7 and 8 m/s occur 7.7, 10.6, 11.7, 12.2, 12.5 and 11.0 % of the time and on that basis the lower end of the limit range is appropriate.

It should also be noted that the planning conditions for the adjacent wind farm developments (Carraigcannon, Bawnmore, and Boggeragh Wind Farms) have noise limits of 43 dB L_{A90} or 5 dB above background.

Given the information above and based on the statistical analysis of wind speed data and baseline noise level information, it is recommended that a fixed limit of 37.5 dB L_{A90} for low background noise conditions should apply for the proposed project which represents a conservative limit which will afford appropriate protection to dwellings. It is also 5.5 dB lower than the adjacent wind farm developments at these wind speeds.

Table 7.5: Derived Noise Limits

Location	Period	Derived Noise Limits $L_{A90,10min}$ (dB) at Standardised 10 m Height wind speed (m/s)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
N2	Daytime	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.2	48.7	50.3
	Night-time	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
N3	Daytime	37.5	37.5	37.5	37.5	37.5	37.5	37.5	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	43.0	43.0	43.0
N4	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	Night-time	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
N5	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.9	48.5	50.2
	Night-time	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
N6	Daytime	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.8	49.4	51.9	54.0	55.7
	Night-time	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
N7	Daytime	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.4	51.3
	Night-time	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
N8	Daytime	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	Night-time	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
N10	Daytime	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.5	48.0	50.3	52.5	54.4
	Night-time	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
N11	Daytime	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.3	48.5	50.6	52.3	53.7
	Night-time	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

Location	Period	Derived Noise Limits $L_{A90,10min}$ (dB) at Standardised 10 m Height wind speed (m/s)												
		2	3	4	5	6	7	8	9	10	11	12	13	14
N12	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	45.7	46.2	46.7	47.3	47.8
	Night-time	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
N14	Daytime	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.1	47.8	50.6	53.4	56.2
	Night-time	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
N15	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	49.0	51.2	53.3	55.3	57.1
	Night-time	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
N17	Daytime	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	Night-time	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
N18	Daytime	37.5	37.5	45.0	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	43.0	43.0	43.0
N19	Daytime	37.5	37.5	45.0	45.0	45.0	45.0	45.3	47.2	49.0	50.7	52.3	53.8	55.2
	Night-time	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

7.5 Potential Impacts

7.5.1 Do Nothing Scenario

Under the Do-Nothing scenario, the proposed project is not constructed or operated. The noise environment in the vicinity of the proposed wind farm site will remain largely unchanged.

7.5.2 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 details presented in Section 3.6 of this EIAR and the Construction and Environmental Management Plan as well as a review of other chapters in the EIAR. Noise modelling was carried out using guidance and plant noise data from BS 5228:2009+A1:2014. The ground cover is predominately acoustically soft (G=1)[17]. 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 of time[18] 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, felling, preparation of access roads, excavation of material from a borrow pit, preparation of hardstands and drainage, excavation of foundations, pouring of foundations and installation of wind turbines. The off-site works assessed included: works associated with grid connection, directional drilling at 4 no. locations along the proposed grid route and works at the TDR nodes.

Site Traffic

Detailed information on construction traffic is presented in Chapter 13. To summarise, additional light goods vehicles travelling to and from the site during the construction phase would be expected to peak during the morning (arrival of contractors at the site) and evening (departure of contractors from the site) and are envisaged not to be a continuous source of noise emissions from the site during a typical working day. The noise impact from construction personnel movements to and from the site is expected to be low.

All deliveries of turbine components to the site will only be by way of the proposed transport route outlined in Chapter 13. The most intensive period of the works programme will be Month 10 to 11 (see Figure 13.3 in Chapter 13 Traffic and Transportation) when multiple construction activities take place concurrently. The noise impact for construction works traffic (HGVs) will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine erection and foundation pours, an extension to the working day may be required, i.e. 05:00 to 21:00, but this would be necessary only on a relatively small number of occasions (maximum 20 days).

Based on this scenario there is a potential for the night criteria as set out in Section 7.3.3.1 to be exceeded at properties within 40m from the road edge.

[17] 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.

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

Therefore a significant impact would be expected for properties within 40m from the road. This will be a temporary significant effect while the vehicles are passing the properties. If construction activities are required at night it will be subject to agreement with the relevant planning authority and it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

Tree Felling

Much of the proposed site comprises commercial coniferous forestry. 10 of the 20 turbines are located within forestry and consequently tree felling will be required here to provide a clearing for turbine construction, hardstandings, crane pads. Tree felling is also required to accommodate temporary compounds, borrow pits, access tracks and the on-site substation. It is proposed that tree felling will occur over three months at the beginning of the project and is likely to occur before other works commence.

Table 7.7 presents the predicted noise levels from this activity at the nearest dwelling, R745, approximately 700 m from the construction compound just north of Turbine 12. Assuming all plant is operating, the predicted cumulative noise at noise sensitive location R745 is 45.4 dB $L_{Aeq,1hr}$. Therefore, the predicted noise at the nearest noise sensitive location is below the daytime noise limit of 65 dB $L_{Aeq,1hr}$. The noise associated with the felling activity is expected to have a slight impact and temporary in duration.

Table 7.6: Tree Felling – Likely Plant and Predicted Noise Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R745
Harvester §	C2.5	Harvesting trees	80	41.4
Forwarder µ	C4.53	Moving felled trees	80	42.8
Lorry *	C11.9	Transporting timber and brash off site	Two trips per hour.	29.3
Cumulative				45.4
* Drive-by maximum sound pressure level § - Excavator BS 5228 Ref C2.5 µ - Lorry with lifting boom – C4.53				

Borrow Pit

There are three proposed borrow pits, two of which are proposed to the west and one to the north. The borrow pit to the north will be used for the northern cluster of the wind farm construction. The location of the proposed borrow pits are shown in Figure 3-1. For the purpose of this assessment, it has been assumed that all borrow pits will be operational at the same time. As outlined in Section 9.3.6 of the EIAR intrusive site investigations undertaken at the proposed borrow pit locations identified overburden deposits comprising Gravels and Sands and Weathered Bedrock potentially suitable for use as General Till for the construction of the proposed development, which means rock blasting will not be required.

As no blasting is required in any of the borrow pits. It is expected that a rock breaker and crusher will be required at the borrow pits as a worst case scenario. Table 7.8 presents the likely plant at each of the borrow pits. The nearest dwelling R405 is approximately 825m from the closest Borrow pit. Assuming all plant is operating at the borrow pit, the predicted cumulative noise at R405 is 53.3 dB $L_{Aeq,1hr}$. The noise from all borrow pits operating at this location simultaneously does not exceed 54.5 dB $L_{Aeq,1hr}$. Therefore, the predicted noise at the nearest noise sensitive location is below the daytime noise limit of 65 dB $L_{Aeq,1hr}$. The noise associated with the borrow pit activity is expected to have a slight to moderate impact and temporary in duration.

Table 7.7: Borrow Pit – Likely Plant

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	R405 (nearest dwelling)
Diesel Pump	C4.88	Pump water	100	33.2
Tracked Hydraulic Excavator (37t)	C10.1	Face shovel extracting/ loading dump trucks	80	42.8
Rock Breaker	C9.12	Rock breaking	50	46
Crusher	C1.14	Crushing material	100	45.8
Tracked Excavator (21t)	C4.65	Trenching	80	34.6
Dozer (41t)	C2.10	Ground Excavation/Earthworks	80	43.3
Articulated Dump Truck (23t) *	C2.33	Distribution of Material	Maximum 14 trips per hour	49.7
Cumulative				53.3
* - Drive-by maximum sound level				

Preparation of Access roads, Hardstands and Drainage

Table 7.9 presents the predicted noise levels from this activity at dwelling R745 with the highest predicted noise impact from construction works associated with preparation of access roads, hardstandings and drainage. Assuming all construction activities required for the preparation of the hardstanding occur simultaneously, the predicted noise level from the construction activities is 41.2 dB $L_{Aeq,1hr}$ which is below the 65dB $L_{Aeq,1hr}$ noise limit. The preparation of access roads, hardstands and drainage are expected to have a slight impact and temporary in duration.

Table 7.8: Preparation of Access roads, Hardstands and Drainage - Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R745
Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	37.2
Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	27.7
Dozer (14t)	C5.12	Spreading chipping/fill	80	36.4
Vibratory roller (3t)	C5.27	Rolling and Compaction	80	26.3
Excavator (21t)	C4.65	Trench for drainage	80	31
Articulated Dump Truck *	C2.33	Delivery of Material	Eight trips per hour	30.9
Cumulative				41.2
* - Drive-by maximum sound level				

Preparation of Wind Turbine Foundations

Table 7.10 presents the likely plant required for the preparation of wind turbine foundations. Also presented are the predicted noise levels at the dwelling (R405) with the highest predicted impact. This property is approximately 900m from the nearest turbine. Assuming all construction activities required for the preparation of the turbine foundations occur simultaneously, the predicted noise level from the construction activities is 48.4 dB $L_{Aeq,1hr}$. The predicted noise level is 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 impact and temporary in duration.

Table 7.9: Preparation of Wind Turbine Foundations – Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R405
Tracked Excavator (25t)	C2.19	Ground excavation/earthworks	80	39.1
Excavator (23t)	C10.8	Loading sand / soil	80	41.8
Diesel Pump	C4.88	Pump water	100	31.4
Excavator mounted rock breaker (23t)	C9.12	Breaking Rock	50	32.6
Mobile telescopic crane	C4.41	Lifting reinforcing steel	80	40.4

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R405
Concrete mixer truck & concrete pump	C4.32	Concrete mixer truck + truck mounted concrete pump + boom arm	100	44.5
Lorry*	C11.9	Delivery and removal of material	Maximum 2 trips per hour	35.6
Cumulative				48.4
* - Drive-by maximum sound level				

Installation of Wind Turbines

Turbine components will be delivered to site and mobile telescopic cranes will lift the turbine components into place. Given the type of work and the requirements for specialist installers, only one turbine will be erected at a time. A worst case of the two cranes lifting turbine components 100% of the time at one location is assumed along with delivery of turbine components. The predicted cumulative noise level at receptor R405 is 38.6 dB $L_{Aeq,1hr.}$ The predicted noise levels are presented in Table 7.11. 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 be not significant and temporary in duration.

Table 7.10: Installation of Wind Turbines - Likely Plant and Predicted Levels

Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R405
Mobile telescopic crane (x2)	C4.41	Lifting turbine components	100	35.6
Lorry *	C11.9	Delivery of Turbine Components	Maximum 2 trips per hour	35.6
Cumulative				38.6
* - Drive-by maximum sound level				

Construction of Substation

The construction of the on-site substation building will occur during the construction phase of the proposed project. One substation compound is on site, at the centre of the site. The construction works will be progressed in several 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 7.12 presents the likely plant required for the different construction phases of the proposed buildings to be constructed on site. The dwelling (R1052) with the highest predicted noise from the on-site substation location will be approximately 1360 m away from the substation area. The cumulative predicted noise levels for the worst combination of plant (Preparation of hardstanding areas) are predicted to be 45.6 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 impact and temporary in duration.

Table 7.11: Construction of Substation - Likely Plant and Predicted Levels

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R1052
Site Clearance and Preparation	Tracked excavator (22t)	C2.3	Clearing Site	80	36.9
	Dozer (11t)	C2.12	Ground excavation/ earthworks	80	39.6
	Loading Lorry	C10.8	Loading Sand to Lorry	80	39.1
	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	36.4
	Cumulative				44.2
Preparation and pouring of Foundations	Concrete mixer truck + truck mounted concrete pump + boom arm	C4.32	Concrete pumping	100	37.7
	Lorry*	C11.9	Delivery of material	Two trips per hour	42.5
	Cumulative				43.7
Preparation of hardstanding areas	Articulated Dump Truck (23t)	C2.33	Delivery/Removal of Material	Two trips per hour	39.9
	Tracked Excavator (25t)	C2.19	Ground excavation/ earthworks	80	36.4
	Articulated Dump Truck (23t)	C2.32	Tipping Fill	20	26.9
	Dozer (14t)	C5.12	Spreading chipping/fill	80	35.6
	Vibratory roller (3t)	C5.27	Rolling and Compaction	80	25.5
	Lorry*	C11.9	Delivery of material	Two trips per hour	42.5
	Cumulative				45.6
Erection of blockwork/ installation concrete slabs	Mobile telescopic crane (80t)	C4.39	Lifting concrete slabs	80	35.6
	Lorry* (32t)	C11.9	Delivery of material	Two trips per hour	42.5

Phase	Plant	BS 5228 Ref.	Activity	Percentage on-time (%)	Predicted Noise Level at R1052
	Cumulative				43.3
General Construction including installation of electrical and mechanical plant	Generator	C4.84	Power for site cabins	100	33.6
	Lifting Platform (x2)	C.57	Lifting Personnel	80	29.1
	Telescopic handler	C4.54	Lifting Plant	80	37.5
	Angle grinder (grinding steel)	C4.93	Miscellaneous	80	39.6
	Cumulative				42.5
* Drive-by maximum sound level					

7.5.2.1 Cumulative Construction Impact

The most intensive period of the works programme will be Months 10 to 11 when multiple construction activities take place concurrently. These activities include access roads construction, turbine hard standing and foundation construction, turbine installation and substation construction.

The sum or cumulative noise from all of these activities has been assessed at the location where the highest noise level is predicted, R405. Based on the noisiest activity from substation hardstanding works above (Table 7.12), and adding this to the highest noise levels predicted at R405 from tables 7.8 to 7.11, the predicted cumulative noise at R405, will be less than 57 dB $L_{Aeq,1hr}$ at the nearest occupied dwelling which is below the construction noise limit of 65 dB $L_{Aeq,1hr}$. It should be noted that it is very unlikely that all of these activities will occur at the maximum intensity in each case at the same time.

Grid Connection Works

It is proposed to construct 1 no. on-site electricity substation within the proposed wind farm site. Each turbine will be connected to the on-site electricity substation via underground electricity cables. The internal cable routes will follow the proposed access tracks between each turbine. The on-site substation will be connected via a grid connection cable to an existing substation at Clashavoon. The cable will be installed predominantly along the public road and shall feature horizontal directional drilling at 4 no. locations to cross existing watercourses.

The grid connection works will be carried out over a 6-month period and 'rolling road closures' will be implemented, whereby the works will progress each day along a road, which will have the effect of reducing the impact for individual dwellings. The likely plant required during the construction works are presented in Table 7.14.

Table 7.12: Grid Connection Works – Likely 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	49.5	41.6	35.6	29.6
Mini excavator with hydraulic breaker (C5.2)	Breaking Road Surface	25	78.9	71.4	65.5	59.5
Vibratory roller (C5.27)	Rolling and Compaction	50	66.3	58.6	52.6	46.6
Wheeled excavator (C5.34)	Trenching	50	69.9	62	56	50
Hand-held circular saw (petrol) (C5.36)	Cutting Concrete Slabs	10	79	71.6	65.6	59.6
Dump truck (tipping fill) (C2.30)	Tipping Fill	10	71.8	64.1	58.1	52.1
Vibratory plate (petrol) (C2.41)	Compaction	10	72.7	65.1	59.1	53.1
Directional drilling (2.44)	Drilling	100	-	-	58.2*	49.3
* - Directional drilling distance 40 m						

Table 7.14 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 during the day. There are six dwellings within 10 m of the grid connection works, nine dwellings between 10 – 25m, eight dwellings between 25 – 50 m and five dwellings between 50 - 100 m.

Directional drilling is also required along the grid connection route at four locations. The nearest noise sensitive receptor from any of the proposed water crossing works associated with the grid connection route is at 40m. The next nearest dwellings are over 100m from the proposed directional drilling locations. The predicted noise from this activity is also presented in Table 7.14 The predicted noise levels are below the noise limits.

In some instances, the maximum predicted noise levels from grid connection works may be above the noise limit of 65 dB $L_{Aeq,1hr}$. However, these elevated noise levels will only occur for short durations at a limited number of dwellings. Given the nature of the grid connection works, construction activities will not occur over an extended period at any one location.

Mitigation measures will be employed to reduce any potential impacts. Mitigation measures are discussed in Section 7.6.1. With mitigation measures, 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. 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. The works are expected to have a significant temporary impact.

7.5.3 Potential Impacts during Operation

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. Sound power level data has been based on a worst case envelope from a range of wind turbines that meet the dimensional envelope of the proposed project. Further details on the modelled wind turbines are provided later in this section. Sound Power Level data is presented in Appendix 7.4.

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.

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[19] have been used, corresponding to a temperature of 10^0C 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 7.16.

Table 7.13: 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 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 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 (see 'Overview of Input Datasets' for more details) within the source noise levels, these predictions are considered to be worst case.

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.

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

The 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'*. As a conservative approach, this has not been accounted for in the noise model predictions.

A_{misc} – Miscellaneous Other Effects

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 a valley correction is applicable for some turbine – noise sensitive location combinations for this site and +3 dB correction has been added when the IoA criterion is met.

The valley correction for each wind turbine / noise sensitive location combination is presented in Appendix 7.5.

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.

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 7.3 for details) was necessary for the prediction modelling. The turbine locations are presented in Table 3.1 in Section 3.5.3 of Chapter 3 of this EIAR and noise sensitive locations are presented in Appendix 7.3. The closest dwellings are at least 800m from the nearest turbine. For the purpose of this assessment a 20 m offset from the building façade was used for the calculation of predicted operational noise impacts. The 20 m offset was to account for the curtilage of the dwelling. This is based upon the Good Practice Guide to the Application of ETSU-R-94 for Assessment and Rating of Wind Turbine Noise, which recommends monitoring between 3.5 and 20m from a property façade.

Several turbine models (Nordex N149, Siemens Gamesa SG 6.0 155 and Vestas V150) were assessed that meet the dimensional envelope of the proposed project. None of turbine models was determined to provide a worst case scenario across all wind speeds. Therefore, the worst case scenario was assessed by using the highest noise levels at each wind speed, for all the proposed turbine models that have been selected. Sound power levels are based on those for the hybrid model, referred to as the representative turbine, which has been modelled at a selection of hub heights to assess the full range of turbine dimensions proposed.

With the worst case scenario selected, the assessment considers the range of turbines for which consent is sought. The hub height range is the only element of the turbine dimensions that influence the operational noise impact of the project. Any influence on the variation of blade length is accounted for by the turbine manufacturer in their sound power data which is used for the purpose of modelling the proposed turbine layout using the representative turbine. An analysis has been considered of this range and therefore a minimum hub height of 102.5 and maximum hub height of 110.5m has been assessed.

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 be within the range assessed below.

The sound power level and octave band values for the turbine are based on the noise levels provided by the manufacturers of the turbines comprising the representative turbine. The sound power levels at standardised 10 m height wind speeds are presented in Table 7.17 and octave band data in dB(A) is presented in Table 7.18. The manufacturer's data is presented in Appendix 7.4.

Table 7.14: Wind Turbine Sound Power Levels, dB L_{WA}

Turbine	Standardised 10 m Height Wind Speed (m/s)						
	2	3	4	5	6	7	8 – Cut-out
Nordex N149	-	94	95.5	100.1	104.6	105.6	105.6
Vestas V150	91.3*	92.6	96.4	100.7	103.6	104.2	104.9
Siemens Gamesa SG 155	92.0	92.9	97.9	102.8	105.0	105.0	105.0
The greyed out cells identify turbine model used for each wind speed option. * - The source level is lower, however, the predicted noise level at the receptors is higher. This is due to the different frequency character for the wind turbines.							

Table 7.15: Wind Turbine Octave Band Noise Levels, dB(A) for a range of Standardised 10 m Height Wind Speeds

10 m Standardised wind speed (m/s)	Octave Band Level Centre Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
2	62.1	72.6	80.1	84.7	86.4	85.3	81.1	74.2	64.3
3	67.1	77.1	83.7	86.6	87.6	88.0	86.2	80.5	71.3
4	68.7	77.6	85.0	89.6	91.9	91.7	92.0	85.4	70.4
5	73.5	82.4	89.8	94.4	96.7	96.5	96.8	90.2	75.2
6	75.7	84.6	92.0	96.6	98.9	98.7	99.0	92.4	77.4

10 m Standardised wind speed (m/s)	Octave Band Level Centre Frequency in Hz								
	31.5	63	125	250	500	1000	2000	4000	8000
7	76.9	86.9	93.5	97.2	99.3	100.6	98.7	89.1	81.2
8	77.2	87.3	93.5	97.2	99.8	100.5	98.0	90.4	82.4

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. A 2 dB correction is added to the sound power level to account for a margin of uncertainty.

It is possible to run all turbine models in noise reduced modes of operation (NROs) whereby the noise level is lessened by reducing the rotational speed of the turbines, with a resultant loss of electrical energy production.

This assessment includes the cumulative noise from all on-site noise sources from the proposed project. In addition to the noise from wind turbines, 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).

Sound power data for a transformer has been provided for a HOKSV 31500/123 transformer which is representative of the class and size of transformer that will be installed in the onsite substation. This unit has a sound power level of 91 dBA. However, in order to assess worst case operational noise impact, predictions have been carried out based on an example transformer; a Siemens TLPN7747 40000 / 50000 kVA, which has a sound power level of 93 dB(A). While this particular transformer would not provide the adequate electrical power for the Ballinagree windfarm it has slightly higher noise characteristics and is therefore considered worst case. 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 7.19. Noise predictions have been based on data provided in Table 7.16.

Table 7.16: 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 also been carried out using International Standard ISO 9613, *Acoustics – Attenuation of Sound during Propagation Outdoors*. A worst case with plant producing their highest noise emissions has been assumed. Wind turbine noise predictions are presented in terms of the L_{A90} noise indicator. However, the on-site substation transformer is typically assessed in terms of the L_{Aeq} noise indicator. The noise limits for the proposed project are in terms of L_{A90}. For the purpose of assessing the cumulative impact from all noise sources on site, it has been assumed that noise from the on-site substation transformer and other windfarm noise sources is a constant level and the L_{Aeq} noise level is equal to the L_{A90} noise level. This is a conservative approach, but it facilitates the calculation of cumulative noise. Predicted results are presented in the next section.

7.5.3.1 Potential Operational Impact – Predicted Noise Levels

Noise predictions were performed for the 20-wind turbine layout using the highest noise levels at each wind speed, for the proposed turbine models that have been selected for a range of standardised 10m height wind speeds from 2 m/s up to 8 m/s (to cut-out[20]). Receptors within the 35 dB L_{A90} noise contour of the turbines were modelled. A number of the receptors were identified as farm buildings or commercial buildings 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. Predicted noise levels from other on-site noise sources were also modelled and cumulative noise from all on-site noise sources from the proposed project are assessed against the derived noise limits.

Noise was predicted for a range of turbine heights, with a lower range of 102.5m and an upper range of 110.5m. The predicted noise from the lower range hub height of 102.5m was the worst case, with noise levels at the closest receptors being up to 0.1dB higher than the noise level predicted at the upper range hub height.

Table 7.17 presents predicted noise levels adjacent to 28 receptor locations closest to the wind farm and at controlling properties adjacent to neighbouring wind farms. The controlling properties are locations that trigger the noise criteria, normally the closest properties, where maximum noise levels are predicted. The predicted noise levels at all receptor locations are presented in Appendix 7.5. Note: the predicted noise levels are for a worst-case scenario with all noise sensitive receptors being considered 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 7.17 and Appendix 7.5.

Table 7.17 also presents derived daytime and night-time noise limits at each of these locations. The predicted noise levels from the proposed project are all below the daytime and night-time noise limits for all hub heights within the range proposed. However, at some receptor locations, a new source of noise will be introduced into the soundscape and it is expected that there will be a long-term moderate significance of impact on the closest dwellings to the proposed wind farm.

In order to protect residents, the cumulative impact from other nearby operational and consented wind farm developments must also be considered and this is assessed in Section 7.5.5.

[20] Noise emissions from the wind turbines plateau at wind speeds above 8 m/s

Table 7.17: Assessment of Predicted L_{A90} Noise Levels for Ballinagree Wind Farm against Noise Limits for 102.5m height

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
R45	Predicted Level	25.7	27.9	31.3	36.1	38.3	39.2	39.4	39.4	39.4	39.4	39.4	39.4	39.4
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R49	Predicted Level	26.0	28.2	31.6	36.4	38.6	39.5	39.7	39.7	39.7	39.7	39.7	39.7	39.7
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R90	Predicted Level	12.7	15.4	17.9	22.7	24.9	26.0	26.2	26.2	26.2	26.2	26.2	26.2	26.2
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	45.7	46.2	46.7	47.3	47.8
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R180	Predicted Level	13.4	16.0	18.6	23.4	25.6	26.6	26.8	26.8	26.8	26.8	26.8	26.8	26.8
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.3	48.5	50.6	52.3	53.7
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R369	Predicted Level	25.8	28.0	31.4	36.2	38.4	39.3	39.5	39.5	39.5	39.5	39.5	39.5	39.5
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R386	Predicted Level	17.9	20.3	23.2	28.0	30.2	31.2	31.4	31.4	31.4	31.4	31.4	31.4	31.4
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.5	48.0	50.3	52.5	54.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R433	Predicted Level	15.2	17.8	20.5	25.3	27.5	28.5	28.7	28.7	28.7	28.7	28.7	28.7	28.7
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.1	47.8	50.6	53.4	56.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R513	Predicted Level	15.1	17.6	20.4	25.2	27.4	28.4	28.6	28.6	28.6	28.6	28.6	28.6	28.6
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R616	Predicted Level	16.2	18.7	21.5	26.3	28.5	29.5	29.7	29.7	29.7	29.7	29.7	29.7	29.7
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R721	Predicted Level	27.4	29.7	33.0	37.8	40.0	41.0	41.1	41.1	41.1	41.1	41.1	41.1	41.1
	Daytime limit	37.5	37.5	45.0	45.0	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

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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R735	Predicted Level	20.0	22.3	25.3	30.1	32.3	33.3	33.5	33.5	33.5	33.5	33.5	33.5	33.5
	Daytime limit	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.4	51.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R745	Predicted Level	27.6	29.8	33.2	38.0	40.2	41.2	41.3	41.3	41.3	41.3	41.3	41.3	41.3
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R777	Predicted Level	23.5	25.7	28.9	33.7	35.9	36.9	37.1	37.1	37.1	37.1	37.1	37.1	37.1
	Daytime limit	37.5	37.5	37.5	37.5	37.5	37.5	37.5	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R820	Predicted Level	24.3	26.5	29.8	34.6	36.8	37.8	37.9	37.9	37.9	37.9	37.9	37.9	37.9
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1042	Predicted Level	23.5	25.8	29.1	33.9	36.1	37.0	37.2	37.2	37.2	37.2	37.2	37.2	37.2
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.8	49.4	51.9	54.0	55.7
	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
	Night-time 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
R1048	Predicted Level	24.3	26.6	29.8	34.6	36.8	37.8	37.9	37.9	37.9	37.9	37.9	37.9	37.9
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.2	48.7	50.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1051	Predicted Level	25.1	27.3	30.5	35.3	37.5	38.5	38.7	38.7	38.7	38.7	38.7	38.7	38.7
	Daytime limit	37.5	37.5	45.0	45.0	45.0	45.0	45.3	47.2	49.0	50.7	52.3	53.8	55.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1052	Predicted Level	28.3	30.6	33.9	38.7	40.9	41.9	42.0	42.0	42.0	42.0	42.0	42.0	42.0
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1053	Predicted Level	27.0	29.3	32.6	37.4	39.6	40.6	40.7	40.7	40.7	40.7	40.7	40.7	40.7
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1087	Predicted Level	16.2	18.6	21.4	26.2	28.4	29.4	29.6	29.6	29.6	29.6	29.6	29.6	29.6
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	49.0	51.2	53.3	55.3	57.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1093	Predicted Level	24.0	26.3	29.6	34.4	36.6	37.5	37.6	37.6	37.6	37.6	37.6	37.6	37.6

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
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.9	48.5	50.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1670*	Predicted Level	6.0	9.2	11.1	15.9	18.1	19.4	19.6	19.6	19.6	19.6	19.6	19.6	19.6
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1944*	Predicted Level	8.7	11.7	13.8	18.6	20.8	22.0	22.2	22.2	22.2	22.2	22.2	22.2	22.2
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R2340*	Predicted Level	6.6	9.9	11.7	16.5	18.7	20.1	20.3	20.3	20.3	20.3	20.3	20.3	20.3
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
* - Controlling properties and noise limit used is the fixed part of the conditioned noise limit for the adjacent development.														

Table 7.18: Assessment of Predicted L_{A90} Noise Levels for Ballinagree Wind Farm against Noise Limits for 110.5m height

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
R45	Predicted Level	25.7	27.9	31.3	36.1	38.3	39.2	39.4	39.4	39.4	39.4	39.4	39.4	39.4
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R49	Predicted Level	26.0	28.2	31.6	36.4	38.6	39.5	39.7	39.7	39.7	39.7	39.7	39.7	39.7
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R90	Predicted Level	12.7	15.3	17.8	22.6	24.8	25.9	26.1	26.1	26.1	26.1	26.1	26.1	26.1
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	45.7	46.2	46.7	47.3	47.8
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R180	Predicted Level	13.4	15.9	18.5	23.3	25.5	26.5	26.7	26.7	26.7	26.7	26.7	26.7	26.7
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.3	48.5	50.6	52.3	53.7
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R369	Predicted Level	25.8	28.0	31.3	36.1	38.3	39.3	39.5	39.5	39.5	39.5	39.5	39.5	39.5
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R386	Predicted Level	17.9	20.3	23.2	28.0	30.2	31.2	31.4	31.4	31.4	31.4	31.4	31.4	31.4
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.5	48.0	50.3	52.5	54.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R433	Predicted Level	15.2	17.7	20.4	25.2	27.4	28.4	28.6	28.6	28.6	28.6	28.6	28.6	28.6
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.1	47.8	50.6	53.4	56.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R513	Predicted Level	15.1	17.5	20.4	25.2	27.4	28.4	28.6	28.6	28.6	28.6	28.6	28.6	28.6
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R616	Predicted Level	16.2	18.6	21.5	26.3	28.5	29.5	29.7	29.7	29.7	29.7	29.7	29.7	29.7
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R721	Predicted Level	27.4	29.7	33.0	37.8	40.0	41.0	41.1	41.1	41.1	41.1	41.1	41.1	41.1
	Daytime limit	37.5	37.5	45.0	45.0	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

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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R735	Predicted Level	20.0	22.2	25.3	30.1	32.3	33.3	33.5	33.5	33.5	33.5	33.5	33.5	33.5
	Daytime limit	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.4	51.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R745	Predicted Level	27.6	29.8	33.2	38.0	40.2	41.2	41.3	41.3	41.3	41.3	41.3	41.3	41.3
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R777	Predicted Level	23.5	25.7	28.9	33.7	35.9	36.9	37.1	37.1	37.1	37.1	37.1	37.1	37.1
	Daytime limit	37.5	37.5	37.5	37.5	37.5	37.5	37.5	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R820	Predicted Level	24.2	26.5	29.8	34.6	36.8	37.7	37.9	37.9	37.9	37.9	37.9	37.9	37.9
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1042	Predicted Level	23.5	25.8	29.1	33.9	36.1	37.0	37.2	37.2	37.2	37.2	37.2	37.2	37.2
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.8	49.4	51.9	54.0	55.7
	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
	Night-time 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
R1048	Predicted Level	24.3	26.5	29.8	34.6	36.8	37.8	37.9	37.9	37.9	37.9	37.9	37.9	37.9
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.2	48.7	50.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1051	Predicted Level	25.1	27.3	30.5	35.3	37.5	38.5	38.7	38.7	38.7	38.7	38.7	38.7	38.7
	Daytime limit	37.5	37.5	45.0	45.0	45.0	45.0	45.3	47.2	49.0	50.7	52.3	53.8	55.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1052	Predicted Level	28.2	30.4	33.8	38.6	40.8	41.7	41.9	41.9	41.9	41.9	41.9	41.9	41.9
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1053	Predicted Level	27.0	29.3	32.6	37.4	39.6	40.6	40.7	40.7	40.7	40.7	40.7	40.7	40.7
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1087	Predicted Level	16.1	18.6	21.4	26.2	28.4	29.4	29.6	29.6	29.6	29.6	29.6	29.6	29.6
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	49.0	51.2	53.3	55.3	57.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1093	Predicted Level	24.0	26.3	29.5	34.3	36.5	37.5	37.6	37.6	37.6	37.6	37.6	37.6	37.6

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
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.9	48.5	50.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1670*	Predicted Level	6.0	9.1	11.0	15.8	18.0	19.4	19.5	19.5	19.5	19.5	19.5	19.5	19.5
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1944*	Predicted Level	8.7	11.7	13.7	18.5	20.7	22.0	22.2	22.2	22.2	22.2	22.2	22.2	22.2
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R2340*	Predicted Level	6.6	9.8	11.7	16.5	18.7	20.0	20.2	20.2	20.2	20.2	20.2	20.2	20.2
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
* - Controlling properties and noise limit used is the fixed part of the conditioned noise limit for the adjacent development.														

7.5.4 Potential Impacts during Decommissioning

On decommissioning, cranes will disassemble the above ground turbine components which will 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.

The recreational trails and associated signage shall be left in situ.

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

A detailed decommissioning plan will be agreed in advance of construction with Cork County Council. A decommissioning plan is contained in the CEMP in Appendix 3-1 of Volume 3.

7.5.5 Potential Cumulative Impacts

7.5.5.1 Construction Phase

There are several solar farms, extensions to substation, battery storage and permitted wind farm within 20 km of Ballinagree Wind Farm listed in Appendix 1.2 of this EIAR. Each has been considered in terms of cumulative noise. There is a possibility that construction works could occur at the same time as Ballinagree. There are four solar farms proposed at a distances 5km, 11.5km, 13km and 14km from the site. Carragraigue windfarm is proposed 5km from the site, and Caherdowney is proposed 9km west of the site. Also there are works at Bawnmore windfarm substation comprising a substation extension and a solar panel array, at 1.7km and 1.9km. 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.

7.5.5.2 Operational Phase

The full list of existing and approved projects in Appendix 1.2 has been considered. There are several wind farms within 20 km of the site including Boggeragh 1, Boggeragh 2, Esk, Carrigcannon and Bawnmore which have been identified as having a potential for cumulative noise impact with the proposed development. Using the IOA GPG criteria, the cumulative noise from all these wind farms has been considered as the predicted noise from these wind farms is within 10 dB less of the predicted levels of the proposed Ballinagree Wind Farm.

Table 7.18 presents predicted cumulative noise levels adjacent to 28 receptor locations closest to the wind farm and at controlling properties adjacent to neighbouring wind farms. The predicted cumulative noise levels at all receptor locations are presented in Appendix 7.6. 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 noise sources and the actual noise levels will be lower than those presented in Table 7.18 and Appendix 7.6. Sound power data were sourced from manufacturers specifications.

The predicted cumulative noise levels comply with the daytime and night-time limits at the majority of noise sensitive locations. However, exceedances are observed at receptor R777 during daytime periods at standardised 10m height wind speeds 7 and 8 m/s. The noise modelling assumed that this receptor is downwind of all wind turbines. In practice, this will not be physically possible and the actual noise level at the receptor will be lower. Nonetheless, mitigation measures are outlined in Section 7.6.2. Exceedances are also observed at receptor R2340 during daytime and night-time periods at wind speeds of 8 m/s and above. The dominant noise at receptor R2340 is from Esk Wind Farm and Boggeragh 2 Wind Farm. Mitigation measures are outlined in Section 7.6.2.

Table 7.19: Assessment of Cumulative Predicted L_{A90} Noise Levels for Ballinagree Wind Farm and Adjacent Wind Farms against Noise Limits Lower Envelope 102.5m

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
R45	Predicted Level	27.8	29.3	32.0	36.4	38.6	39.6	39.8	39.8	39.8	39.8	39.8	39.8	39.7
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R49	Predicted Level	27.9	29.5	32.3	36.7	39.0	40.0	40.3	40.3	40.2	40.2	40.2	40.2	40.2
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R90	Predicted Level	21.8	22.2	23.0	25.8	28.0	29.6	30.3	30.4	30.1	30.0	30.0	30.0	29.9
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	45.7	46.2	46.7	47.3	47.8
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R180	Predicted Level	22.6	23.0	23.8	26.4	28.3	29.9	30.4	30.6	30.3	30.2	30.2	30.3	30.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.3	48.5	50.6	52.3	53.7
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R369	Predicted Level	28.0	29.5	32.2	36.5	38.7	39.7	39.9	39.9	39.9	39.9	39.9	39.9	39.8
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R386	Predicted Level	26.6	27.0	27.9	30.4	32.1	33.4	33.6	33.8	33.6	33.6	33.6	33.6	33.2
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.5	48.0	50.3	52.5	54.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R433	Predicted Level	24.0	24.5	25.3	28.5	30.9	32.6	33.4	33.5	32.9	32.8	32.8	32.9	32.8
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.1	47.8	50.6	53.4	56.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R513	Predicted Level	30.6	30.7	33.9	37.3	40.2	41.3	41.9	42.0	41.8	41.8	41.8	41.8	41.8
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R616	Predicted Level	34.3	34.3	36.1	39.2	42.2	43.6	44.4	44.4	43.9	43.8	43.8	43.8	43.8
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	0.6	1.4	1.4	0.9	0.8	0.8	0.8	0.8
R721	Predicted Level	29.3	30.9	33.8	38.3	40.6	41.6	41.9	41.9	41.8	41.8	41.8	41.8	41.8
	Daytime limit	37.5	37.5	45.0	45.0	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

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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R735	Predicted Level	28.2	28.6	29.7	32.3	34.1	35.3	35.4	35.6	35.5	35.5	35.5	35.5	35.2
	Daytime limit	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.4	51.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R745	Predicted Level	29.4	31.0	33.9	38.4	40.6	41.7	42.0	42.0	41.9	41.9	41.9	41.9	41.9
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R777	Predicted Level	26.7	28.0	30.6	34.7	37.0	38.1	38.4	38.4	38.3	38.3	38.3	38.3	38.3
	Daytime limit	37.5	37.5	37.5	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-	0.6	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R820	Predicted Level	27.4	28.7	31.2	35.4	37.6	38.6	38.9	38.9	38.9	38.9	38.9	38.9	38.8
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1042	Predicted Level	27.9	28.9	30.9	34.8	36.8	37.9	38.1	38.1	38.1	38.1	38.1	38.1	38.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.8	49.4	51.9	54.0	55.7
	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
	Night-time 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
R1048	Predicted Level	27.1	28.5	31.2	35.4	37.7	38.8	39.0	39.1	39.0	39.0	39.0	39.0	39.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.2	48.7	50.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1051	Predicted Level	27.9	29.2	31.9	36.3	38.6	39.6	40.0	40.0	39.9	39.9	39.9	39.9	39.9
	Daytime limit	37.5	37.5	45.0	45.0	45.0	45.0	45.3	47.2	49.0	50.7	52.3	53.8	55.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1052	Predicted Level	29.9	31.6	34.5	39.1	41.3	42.4	42.6	42.6	42.6	42.5	42.5	42.5	42.5
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1053	Predicted Level	29.1	30.6	33.4	37.9	40.1	41.2	41.5	41.5	41.4	41.4	41.4	41.4	41.4
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1087	Predicted Level	30.0	30.1	30.4	32.9	35.4	37.4	38.5	38.6	37.7	37.5	37.6	37.6	37.6
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	49.0	51.2	53.3	55.3	57.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1093	Predicted Level	27.7	28.8	31.1	35.1	37.3	38.3	38.5	38.5	38.5	38.5	38.5	38.5	38.4

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
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.9	48.5	50.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1670*	Predicted Level	29.7	29.7	30.3	31.9	34.0	35.9	37.1	37.2	36.8	36.7	36.7	36.8	36.8
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1944*	Predicted Level	33.0	33.0	33.1	33.7	34.7	37.2	38.7	39.1	38.7	38.7	38.7	38.7	38.7
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R2340*	Predicted Level	31.3	31.4	35.1	38.6	41.6	42.6	43.2	43.2	43.2	43.1	43.1	43.2	43.1
	Daytime 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
	Daytime Excess	-	-	-	-	-	-	0.2	0.2	0.2	0.1	0.1	0.2	0.1
	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
	Night-time Excess	-	-	-	-	-	-	0.2	0.2	0.2	0.1	0.1	0.2	0.1
* - Controlling properties and noise limit used is the fixed part of the conditioned noise limit for the adjacent development.														

Table 7.20: Assessment of Cumulative Predicted L_{A90} Noise Levels for Ballinagree Wind Farm and Adjacent Wind Farms against Noise Limits Upper Envelope 110.5m

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
R45	Predicted Level	27.8	29.3	32.0	36.4	38.6	39.6	39.8	39.8	39.8	39.8	39.8	39.8	39.7
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R49	Predicted Level	27.9	29.5	32.3	36.7	39.0	40.0	40.2	40.3	40.2	40.2	40.2	40.2	40.2
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R90	Predicted Level	21.8	22.2	23.0	25.8	27.9	29.6	30.3	30.4	30.0	29.9	30.0	30.0	29.8
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	45.7	46.2	46.7	47.3	47.8
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R180	Predicted Level	22.6	23.0	23.7	26.3	28.3	29.9	30.4	30.5	30.2	30.2	30.2	30.2	30.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.3	48.5	50.6	52.3	53.7
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R369	Predicted Level	28.0	29.5	32.2	36.5	38.7	39.7	39.9	39.9	39.9	39.9	39.9	39.9	39.8
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.7	49.1	51.4	53.6
	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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R386	Predicted Level	26.6	27.0	27.9	30.4	32.1	33.4	33.6	33.8	33.6	33.6	33.6	33.6	33.2
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.5	48.0	50.3	52.5	54.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R433	Predicted Level	24.0	24.4	25.3	28.4	30.8	32.5	33.4	33.4	32.9	32.8	32.8	32.9	32.8
	Daytime limit	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.1	47.8	50.6	53.4	56.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R513	Predicted Level	30.6	30.7	33.9	37.3	40.2	41.3	41.9	42.0	41.8	41.8	41.8	41.8	41.8
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R616	Predicted Level	34.3	34.3	36.1	39.2	42.2	43.6	44.4	44.4	43.9	43.8	43.8	43.8	43.8
	Daytime limit	37.5	37.5	45.0	45.0	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
	Night-time Excess	-	-	-	-	-	0.6	1.4	1.4	0.9	0.8	0.8	0.8	0.8
R721	Predicted Level	29.3	30.9	33.8	38.3	40.6	41.6	41.9	41.9	41.8	41.8	41.8	41.8	41.8
	Daytime limit	37.5	37.5	45.0	45.0	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

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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R735	Predicted Level	28.2	28.6	29.7	32.3	34.1	35.3	35.4	35.6	35.5	35.5	35.5	35.5	35.1
	Daytime limit	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.1	48.4	51.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R745	Predicted Level	29.4	31.0	33.9	38.4	40.6	41.7	42.0	42.0	41.9	41.9	41.9	41.9	41.9
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R777	Predicted Level	26.7	27.9	30.5	34.7	37.0	38.1	38.3	38.4	38.3	38.3	38.3	38.3	38.3
	Daytime limit	37.5	37.5	37.5	37.5	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0
	Daytime Excess	-	-	-	-	-	0.6	0.8	-	-	-	-	-	-
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R820	Predicted Level	27.4	28.7	31.2	35.4	37.6	38.6	38.9	38.9	38.8	38.8	38.8	38.8	38.8
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.8	46.5	47.3	48.2	49.3	50.7	52.5
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1042	Predicted Level	27.9	28.8	30.9	34.7	36.8	37.9	38.1	38.1	38.1	38.1	38.1	38.1	38.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	46.8	49.4	51.9	54.0	55.7
	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
	Night-time 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
R1048	Predicted Level	27.1	28.4	31.2	35.4	37.7	38.8	39.0	39.1	39.0	39.0	39.0	39.0	39.0
	Daytime limit	37.5	37.5	37.5	45.0	45.0	45.0	45.0	45.0	45.0	45.6	47.2	48.7	50.3
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1051	Predicted Level	27.9	29.2	31.9	36.3	38.6	39.6	40.0	40.0	39.9	39.9	39.9	39.9	39.9
	Daytime limit	37.5	37.5	45.0	45.0	45.0	45.0	45.3	47.2	49.0	50.7	52.3	53.8	55.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1052	Predicted Level	29.8	31.5	34.4	39.0	41.2	42.2	42.5	42.5	42.4	42.4	42.4	42.4	42.4
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1053	Predicted Level	29.1	30.6	33.4	37.9	40.1	41.2	41.5	41.5	41.4	41.4	41.4	41.4	41.4
	Daytime limit	37.5	45.0	45.0	45.0	45.0	46.1	48.2	49.9	51.5	52.8	53.9	54.8	55.4
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1087	Predicted Level	30.0	30.1	30.4	32.9	35.4	37.4	38.5	38.6	37.7	37.5	37.6	37.6	37.6
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.8	49.0	51.2	53.3	55.3	57.1
	Daytime Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
	Night-time limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1093	Predicted Level	27.7	28.8	31.1	35.1	37.2	38.3	38.5	38.5	38.5	38.5	38.5	38.5	38.4

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
	Daytime limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	46.9	48.5	50.2
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1670*	Predicted Level	29.7	29.7	30.3	31.9	34.0	35.9	37.1	37.2	36.8	36.7	36.7	36.8	36.8
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R1944*	Predicted Level	33.0	33.0	33.1	33.7	34.7	37.2	38.7	39.1	38.7	38.7	38.7	38.7	38.7
	Daytime 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
	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
	Night-time Excess	-	-	-	-	-	-	-	-	-	-	-	-	-
R2340*	Predicted Level	31.3	31.4	35.1	38.6	41.6	42.6	43.2	43.2	43.2	43.1	43.1	43.2	43.1
	Daytime 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
	Daytime Excess	-	-	-	-	-	-	0.2	0.2	0.2	0.1	0.1	0.2	0.1
	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
	Night-time Excess	-	-	-	-	-	-	0.2	0.2	0.2	0.1	0.1	0.2	0.1
* - Controlling properties and noise limit used is the fixed part of the conditioned noise limit for the adjacent development.														

7.6 Mitigation Measures

7.6.1 Mitigation Measures During Construction

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

The noise impact for construction works traffic will be mitigated by generally restricting movements along access routes to the standard working hours and exclude Sundays, unless specifically agreed otherwise. For example, during turbine foundation concrete pours and 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. For the proposed night time turbine deliveries, it will be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.

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

The construction works on site will be carried out in accordance with the guidance set out in BS 5228:2009+A1:2014, and the noise control measures set out Section 4.3.2 of the Construction Environmental Management Plan (CEMP) (Appendix 3.1). Proper maintenance of plant will be employed to minimise the noise produced by any site operations.

All vehicles and mechanical plant will be fitted with effective exhaust silencers and maintained in good working order for the duration of the project. Machinery that is used intermittently will be shut down or throttled back to a minimum during periods when not in use.

The hours of construction activity will be limited to avoid unsociable hours where possible. Construction operations shall generally be restricted to between 07:00 - 19:00 hours Monday to 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.

The on-site construction and decommissioning noise levels will be below the relevant noise limit of 65 dB $L_{Aeq,1hr}$ for operations exceeding one month, and therefore construction noise impacts are not considered to be significant. There is potential for temporary elevated noise levels due to the grid connection works. However, the impact of these works at any particular receptor will be for a short duration (i.e. less than 3 days at worst case). Works will be limited to daytime hours and there will be consultation with the relevant home owners well in advance of commencement of construction in the relevant area. Where the works at elevated noise levels are required for longer than 3 days at a given location, a temporary barrier or screen will be used to reduce noise levels below the noise limit where required. The noise impact will also be minimised by limiting the number of plant items operating simultaneously where reasonably practicable. During the proposed night time deliveries, there will be a brief significant effect while the convoy is passing the properties.

7.6.2 Mitigation Measures during Wind Farm Operation

The predicted noise from the proposed project range of turbines is below the daytime and night-time noise limits. However, there are some exceedances when the predicted cumulative noise from the proposed project and adjacent wind farms are assessed. Exceedances are observed at receptor R777 during daytime periods at standardised 10m height wind speeds of 7 and 8 m/s. The predicted noise exceeds the criteria marginally by 0.9dB which is considered slight and can be mitigated against through modes of turbine operation as described below. The noise modelling assumed that this receptor is downwind of all wind turbines. In practice, this will not be physically possible and the actual noise level at the receptor will be lower. Nonetheless, mitigation measures are outlined.

Exceedances are also observed at receptor R2340 during daytime and night-time periods at wind speeds of 8 m/s and above. The predicted noise at R2340 exceeds the criteria by up to 0.2 dB. The dominant noise at receptor R2340 is from Esk Wind Farm and Boggeragh 2 Wind Farm. The noise contribution from Ballinagree Wind Farm is negligible and it is not possible to demonstrate compliance at these wind speed as the noise from Esk Wind Farm and Boggeragh 2 Wind Farm are the cause of the exceedance. The noise emissions from Ballinagree Wind Farm are predicted to be at least 10 dB below the predicted operational noise from adjacent wind farms and on that basis, the contribution to the cumulative noise at this location will result in a negligible increase in cumulative noise. This follows guidance in the HMP Report and the IOA GPG[21].

In order to ensure the proposed wind farm is compliant with the daytime noise limit at receptor R777, some of the turbines will as a worst case scenario will need to be operated in noise reduced modes of operation[22]. Table 7.19 presents the sound power levels for the Nordex N149 for noise reduced modes of operation and a range of standardised 10m height wind speeds. This model is being used as this has the highest sound power levels at the windspeeds that are creating the impact.

Table 7.21: Nordex N149 –Sound Power Levels for a range of Noise Reduced Modes

Modes of Operation	Sound Power Levels for a range of Standardised 10m Height Wind Speeds					
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s – cut-out
Mode 0	94	95.2	99.8	104.2	105.6	105.6
Mode 1	94	95.5	100.1	104.6	105.2	105.2
Mode 2	94	95.5	100.1	104.4	104.8	104.8
Mode 3	94	95.5	100.1	104.2	104.4	104.4

[21] The HMP Report (See References) states that "*If an existing wind farm has permission to generate noise levels up to ETSU-R-97 limits, planning permission noise limits set at any future neighbouring wind farm would have to be at least 10 dB lower than the limits set for the existing wind farm to ensure there is no potential for cumulative noise impacts to breach ETSU-R-97 limits.*" The IOA GPG states…. in cases "*where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary*." The same principle applies for Ballinagree Wind Farm in that the noise emissions from Ballinagree Wind Farm will be 10 dB below those from Adjacent Wind Farms (Carraigcannon, Bawnmore, Boggeragh 1 and 2, Esk) and will have a negligible impact.

[22] It is possible to run the turbines in noise reduced modes of operation (NROs) whereby the noise level is lessened by reducing the rotational speed of the turbines, with a resultant loss of electrical energy production. Mode N1 refers to a noise reduced mode with a sound power of 105.2 dB rather than 105.6 dB when the turbine operates in normal mode of operation at a standardised 10m height wind speed of 8 m/s.

Modes of Operation	Sound Power Levels for a range of Standardised 10m Height Wind Speeds					
	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s – cut-out
Mode 4	94	95.5	100.1	103.9	104	104
Mode 5	94	95.5	100.1	103.5	103.5	103.5
Mode 6	94	95.5	100.1	103	103	103
Mode 7	94	95.5	100.1	102.5	102.5	102.5
Mode 8	94	95.5	100.1	102	102	102
Mode 9	94	95.5	100.1	101.5	101.5	101.5
Mode 10	94	95.5	99.1	99.5	99.5	99.5
Mode 11	94	95.5	98.6	99	99	99
Mode 12	94	95.5	98.1	98.5	98.5	98.5
Mode 13	94	95.5	97.7	98	98	98
Mode 14	94	95.5	97.2	97.5	97.5	97.5

A range of mitigation strategies can be developed to ensure compliance with the noise limits. Table 7.20 presents mitigation measures to ensure compliance with the daytime noise limit at receptor R777. It should be noted that the proposed curtailment strategies are not exhaustive; there may be several other configurations/alternatives that would allow noise limits to be met and that an appropriate mitigation strategy will be specified for the procured turbine model prior to construction of the wind farm. The operational noise resulting from the proposed project will meet the noise limits set out in Section 7.4.2 or be at least 10 dB below the noise level from adjacent wind farms.

With mitigation, for some receptors sufficiently far from adjacent wind farms, 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 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. In particular, this relates to properties south and west of the western part of the proposed windfarm.

Table 7.22: Required Turbine Curtailment/Mitigation to Meet Daytime Noise Limits

Turbine ID	Required Noise Reduced Modes to meet Daytime Noise Limit L_{A90}	
	Standardised 10m Height Wind Speeds (m/s)	
	7	8
T8	Mode 7	Mode 8
T9	Mode 7	Mode 8

As discussed previously, the operational noise predictions have been carried out using the highest noise levels at each wind speed, for the proposed turbine models that have been selected to meet the dimensional range of the proposed project.

Therefore, the proposed mitigation measures only apply to the worst case turbine considered in this assessment, which itself is the combination of the worst case of all models on the market. It may be the case that mitigation will not be required for the turbine that is selected for the site.

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 be of no greater significance than the range used for the purposes of this assessment.

The noise modelling undertaken assesses a worst-case scenario with all noise sensitive locations downwind of all wind turbines. In practice, it is expected that the actual noise levels from the proposed project will be less than those predicted and hence, the extent of the mitigation will also be reduced. Ultimately, the derived noise limits in Section 7.4.2 will guide the turbine selection and operation, and noise limits will be complied with.

Should the project be granted permission, an operational noise survey will be undertaken to ensure the project complies with the noise limits. If an exceedance in the noise limit occurs, mitigation measures will be refined to ensure compliance with the noise limits is achieved at all noise sensitive locations. The requirements of the operational noise survey will be in accordance with any relevant planning conditions but will as a minimum involve noise monitoring at a number of representative noise sensitive locations over a period after the windfarm becomes operational.

7.6.3 Mitigation Measures during Decommissioning

The noise impact for construction works traffic will 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 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, typically 07:00 - 19:00 hours Monday to Friday and 07:00 - 13:00 on Saturdays.

7.7 Residual Impacts

Construction 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 impact with the duration of impact described as temporary.

There is potential for elevated noise levels due to the grid connection works resulting in a temporary significant impact. However, these works will be for a very short duration at a particular property (i.e. 3 days at any particular receptor, worst case) and where the works are to occur over an extended period (i.e. for longer than 3 days) at a given location, a temporary barrier or screen will be used to reduce noise level below the noise limit and reduce any potential impact resulting in a moderate short-term residual impact.

The operational wind farm noise levels meet the daytime and night-time noise limit 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 mitigation measures, cumulative operational noise levels of the proposed wind farm and adjacent wind farms meet the daytime and night-time noise limit derived using the Wind Energy Development Guidelines 2006 and are therefore not considered to be a significant impact. However, for some receptors 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 project with a long-term moderate significance of impact.

7.8 References

Irish Wind Energy Association, Best Practice Guidelines for the Irish Wind Energy Industry, 2012

Department of the Environment, Heritage, and Local Government, Wind Energy Development Guidelines, 2006

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

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

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

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

International Standard Organisation, ISO 9613-2, Acoustics – Attenuation of Sound during Propagation Outdoors, 1996

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

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

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)

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

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

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

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

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

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

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.

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

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

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

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

EirGrid Evidence Based Environmental Studies Study 8: Noise, Literature review and evidence based field study on the noise effects of high voltage transmission development (May 2016)

Oerlemans et al. (2008). Location and quantification of noise sources on a wind turbine

Hayes McKenzie Partnership Ltd. Report on "Analysis of How Noise Impacts are considered in the Determination of Wind Farm Planning Applications" Ref HM: 2293/R1 dated 6th April 2011

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