11 Acoustic Assessment

Introduction

11.1 This chapter contains an assessment of the acoustic impact of the proposed Carnbuck Wind Farm (hereafter referred to as the proposed development). The report assesses wind farm operational noise and construction noise at the nearest residential properties.

11.2 This chapter is supported by the following:

- Figure 11.1 – Predicted Noise Footprint due to Proposed Wind Farm;
- Figure 11.2 – Predicted Cumulative Noise Footprint;
- Figure 11.3 – Predicted Energy Storage Sound Footprint;
- Technical Appendix 11.1 - Assessment of Energy Storage Facility;
- Technical Appendix 11.2 – Scope of Assessment;
- Technical Appendix 11.3 – Calculating Standardised Wind Speed;
- Technical Appendix 11.4 – Propagation Height & Valley Effect;
- Technical Appendix 11.5 – Background Noise Survey Photos;
- Technical Appendix 11.6 – Instrumentation Records;
- Technical Appendix 11.7 – Charts;
- Technical Appendix 11.8 – Suggested Planning Conditions;
- Technical Appendix 11.9 – Cumulative Directional Predictions;
- Technical Appendix 11.10 – Directional Predictions for Proposed Development;
- Technical Appendix 11.11 – Directional Margins for Proposed Development;
- Technical Appendix 11.12 – Potential Noise Management Strategies;
- Technical Appendix 11.13 – Mitigated Directional Predictions;
- Technical Appendix 11.14 – Directional Margins with Mitigation; and
- Glossary.

11.3 Figures and Technical Appendices are referenced in the text where relevant.

Statement of Authority

11.4 This assessment has been undertaken by RES, with at least one in-house Member of the Institute of Acoustics involved in its production. RES has undertaken acoustic impact assessments in every single one of its UK wind farm development applications since 2000. RES has also carried out noise assessments and reported to several local planning authorities on operational wind energy projects, including taking measurements on newly constructed wind farms to ensure compliance with planning conditions.

11.5 Additionally, RES has been project co-ordinator for several Joule[1] projects, leading European research into wind turbine noise, was involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms'[2] for the DTI in 1996, acted as peer reviewer for the 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment

[1] DGXII European Commission funded projects in the field of Research and Technological Development in non-nuclear energy

[2] 'The Assessment and Rating of Noise from Wind Farms', The Working Group on Noise from Wind Turbines, ETSU Report for the DTI, ETSU-R-97, September 1996. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/49869/ETSU_Full_copy__Searchable_.pdf

and Rating of Wind Turbine Noise'[3], and contributed to the RenewableUK work on Amplitude Modulation[4]. Publications include:

- 'An Investigation of Blade Swish from Wind Turbines', P Dunbabin, Proceedings of the 1996 International Congress on Noise Control Engineering (Internoise '96), 30 July – 2 August 1996, Book 1, pp 463 – 469;
- 'An Automated System for Wind Turbine Tonal Assessment', R Ruffle, Proceedings of the 1996 International Congress on Noise Control Engineering (Internoise '96), 30 July – 2 August 1996, Book 6, pp 2997 – 3002;
- 'Wind Turbine Measurements for Noise Source Identification', ETSU W/13/003914/00.REP, 1999, Dr P Dunbabin, RES et al;
- 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU W/13/00385/REP, 2000 Dr J Bass, RES;
- 'Aerodynamic Noise Reduction for Variable Speed Turbines', ETSU/W/45/00504/REP, 2000, Dr P Dunbabin, RES;
- 'Fundamental research in amplitude modulation - a project by RenewableUK', Dr J Bass et al, Fourth International Meeting on Wind Turbine Noise, Rome, April 2011;
- 'Investigation of the 'Den Brook' Amplitude Modulation methodology for wind turbine noise', Dr J Bass, Acoustics Bulletin Vol 36 No 6 November/December 2011;
- 'How does noise influence the design of a wind farm?', Dr M Cassidy, Fifth International Conference on Wind Turbine Noise, Denver, 2013;
- 'Propagation of Noise from Wind Farms According to the Good Practice Guide', A Birchby, Sixth International Conference on Wind Turbine Noise, Glasgow, 2015;
- 'Addressing the Issue of Amplitude Modulation', Dr M Cassidy, Sixth International Conference on Wind Turbine Noise, Glasgow, 2015;
- 'A Method for Rating Amplitude Modulation in Wind Turbine Noise', Institute of Acoustics Noise Working Group, August 2016; and
- 'Pre-construction Site Prediction Tool for Wind Farm AM – Do We Now Know Enough?', A Birchby, Seventh International Conference on Wind Turbine Noise, Rotterdam, 2017.

Wind Turbine Noise

11.6 In the context of other sources of environmental noise, the noise levels produced by wind turbines are generally low and have greater dependence upon wind speed. The combination of these two factors implies that a degree of masking would often be provided by background noise.

11.7 As described by the Department of the Environment in Best Practice Guidance to Planning Policy Statement 18[5]:

"There are two quite distinct types of noise source within a wind turbine. The mechanical noise produced by the gearbox, generator and other parts of the drive train;

[3] 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise', Institute of Acoustics, May 2013. Available at: https://www.ioa.org.uk/publications/wind-turbine-noise

[4] 'Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects', RenewableUK, December 2013. Available at: http://usir.salford.ac.uk/id/eprint/33475/

[5] 'Best Practice Guidance to Planning Policy Statement 18: Renewable Energy', PPS18, August 2009

and the aerodynamic noise produced by the passage of the blades through the air. Since the early 1990s there has been a significant reduction in the mechanical noise generated by wind turbines and it is now usually less than, or of a similar level to, the aerodynamic noise. Aerodynamic noise from wind turbines is generally unobtrusive – it is broad-band in nature and in this respect is similar to, for example, the noise of wind in trees."

Construction Noise

11.8 The sources of construction noise, which are temporary, would vary both in location and duration as the different elements of the wind farm are constructed and would arise primarily through the operation of large items of plant.

11.9 Noise would also arise due to the temporary increase in construction traffic near the site. This level would also depend on the particular construction phase of the proposed development.

Scope of Assessment

11.10 Noise can have an effect on the environment and on the quality of life enjoyed by individuals and communities. The effect of noise, both in the construction and operational phase, is therefore a material consideration in the determination of planning applications.

Operational Noise

11.11 The main focus of the assessment of operational noise presented here is based on the most relevant type of noise emission for modern wind turbines: aerodynamic noise, which is broadband in nature. Mechanical noise, which can be tonal in nature, is also considered albeit less relevant to modern wind turbines. Implicitly incorporated within this assessment is the normal character of the noise associated with wind turbines (commonly referred to as 'blade swish') and consideration of a range of noise frequencies, including low frequencies.

11.12 An acoustic assessment considering the operation of the proposed Energy Storage Facility can be found in **Technical Appendix 11.1**.

11.13 Low frequency content of the noise from wind farms shall be considered through the use of octave band specific noise emission and propagation modelling, however it is considered that specific and targeted assessment on low frequency content of noise emissions from the proposed wind farm is unjustified. Details for scoping out low frequency noise from the acoustic assessment, as well as infrasound, sleep disturbance, vibration, amplitude modulation and wind turbine syndrome can be found in **Technical Appendix 11.2**.

11.14 A summary of the findings of a comprehensive study into wind turbine noise and associated health effects can be found in **Technical Appendix 11.2**.

Construction Noise

11.15 The acoustic impact assessment of construction noise from the wind farm presented here is based on RES's experience of constructing wind farms and calculated for the operation of the primary large items of construction equipment. Additionally, consideration is

given to the increased noise levels due to increased traffic flows during the construction phase to and from the site.

11.16 Whilst noise would also arise during decommissioning of the proposed development (through turbine deconstruction and breaking of the exposed part of the concrete bases) this is not discussed separately as noise levels resulting from it are expected to be lower than those during construction due to the number and type of activities involved. The impact of decommissioning can therefore be considered in light of the conclusions of the construction noise assessment.

Legislative Framework & Guidance

Operational Noise

11.17 Within Northern Ireland, noise from wind farms is defined within the planning context by Planning Policy Statement 18: Renewable Energy[6]. Best Practice Guidance to Planning Policy Statement 18: Renewable Energy[5] refers to the use of the Department of Trade and Industry's 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97). In relation to noise from wind farms the Planning Policy states:

"The report, 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97), describes a framework for the measurement of wind farm noise and gives indicative noise levels calculated to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development."

11.18 It is therefore considered that the use of ETSU-R-97, as a criterion for assessment of wind farm noise, fulfils the requirements of Planning Policy Statement 18.

11.19 The methodology described in ETSU-R-97 was developed by a working group comprised of a cross-section of interested persons including, amongst others, environmental health officers, wind farm operators and independent acoustic experts.

11.20 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that arise through the development of renewable energy resources. The principle of balancing development needs against protection of amenity may be considered common to any type of noise control guidance.

11.21 The basic aim of ETSU-R-97, in arriving at the recommendations contained within the report, is the intention to provide:

"Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities."

11.22 An article published in the Institute of Acoustics Bulletin (IoA Bulletin) Vol. 34 No. 2, March/April 2009[7], recommends a methodology for addressing issues not made explicit by, or outside the scope of, ETSU-R-97, such as in relation to wind shear or noise propagation modelling. Whilst this article does not represent formal legislation or guidance it was authored by a group of independent acousticians experienced in wind

[6] 'Planning Policy Statement 18: Renewable Energy', PPS18, August 2009

[7] 'Prediction and Assessment of Wind Turbine Noise', Bowdler et al, Acoustics Bulletin Vol 34 No 2 March/April 2009

farm noise issues who have undertaken work on behalf of wind farm developers, local planning authorities and third parties and as such is a good indicator of best practice techniques. The assessment presented herein adopts the recommendations made within this article.

11.23 A Good Practice Guide (IoA GPG) to the application of ETSU-R-97 for the assessment and rating of wind turbine noise[3], issued by the Institute of Acoustics in May 2013 and endorsed by the Northern Ireland Executive, along with the governments in England, Scotland and Wales, provides guidance on all aspects of the use of ETSU-R-97 and reaffirms the recommendations of the Acoustics Bulletin article with regard to propagation modelling and wind shear. The assessment presented herein adopts the recommendations of the Good Practice Guide.

11.24 Supplementary guidance notes were published by the Institute of Acoustics in July and September 2014, and these provide further details on specific areas of the IoA GPG[8]. The assessment presented herein adopts the recommendations made within these supplementary guidance notes.

11.25 ETSU-R-97 has been applied at the vast majority of wind farms currently operating in the UK and provides a robust basis for assessing the noise impact of a wind farm when used in accordance with the IoA GPG. It is the only relevant guidance referenced in Northern Irish planning policy for rating and assessing operational wind farm noise. Based on planning policy and guidance, as outlined above, a wind farm which can operate within noise limits derived according to ETSU-R-97 shall be considered acceptable. This approach has been agreed with Causeway Coast & Glens and Mid & East Antrim Borough Councils.

Construction Noise

11.26 In Northern Ireland, advice on construction noise assessment is referred to in 'The Control of Noise (Codes of Practice for Construction and Open Sites) Order (Northern Ireland) 2002'[9]. This legislation points to BS 5228: Part 1:1997 for guidance on appropriate methods for minimising noise from construction and open sites in Northern Ireland.

11.27 Since the 1997 version of BS 5228 has been superseded by BS 5228-1:2009 'Code of practice for noise and vibration control on construction and open sites - Part 1: Noise'[10] this has been identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities, and is adopted herein.

11.28 The Pollution Control and Local Government (NI) Order 1978 provides information on the need for ensuring that best practicable means are employed to minimise noise[11].

Consultation

11.29 Details of the consultation undertaken are outlined in **Table 1**.

[8] 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise - Supplementary Guidance Notes', Institute of Acoustics, July & September 2014. Available at https://www.ioa.org.uk/publications/wind-turbine-noise

[9] 'The Control of Noise (Codes of Practice for Construction and Open Sites) Order (Northern Ireland) 2002', The Department of the Environment, November 2002

[10] 'Code of Practice for Noise and vibration control on construction and open sites - Part 1: Noise', British Standards Institution, BS 5228-1:2009

[11] 'Pollution Control and Local Government (NI) Order 1978', published by Her Majesty's Stationary Office, 1978

Table 1: Acoustic Assessment Consultation

Consultees	Date of Consultation	Nature and Purpose of Consultation
Causeway Coast & Glens and Mid & East Antrim Borough Councils	07/12/21	Planned acoustic assessment at the proposed Gruig Extension wind farm (03090-3188736-01) sent to environmental health departments. Report details proposed assessment methodology along with suggested background noise survey locations.
Mid & East Antrim Borough Council	07/12/21	Response from Environmental Health Officer (EHO). Happy with proposed survey location in area 2. Suggested preferred locations in areas 3 and 4. Would like to attend setup. Asked whether using mast or remote sensing device.
Mid & East Antrim Borough Council	08/12/21	Response to EHO saying we'll keep them updated on where we get permission to measure in areas 3 and 4 and planned setup date. Also that we plan to use a LiDAR to measure wind speed.
Mid & East Antrim Borough Council	01/02/22	Email to EHO suggesting that proxy locations may need to be used in areas 3 & 4.
Mid & East Antrim Borough Council	01/02/22	Response from EHO saying that proxy locations are fine as long as they do not result in greater background levels.
Mid & East Antrim Borough Council	18/02/22	Email to EHO providing more detail on proxy locations and asking whether proxy location for area 3 could also be representative of area 4. Proposed setup date provided so arrangements can be made for EHO to attend.
Causeway Coast & Glens Borough Council	18/02/22	Email to EHO with proposed setup date so arrangements can be made for EHO to attend if they wish.
Mid & East Antrim Borough Council	03/03/22	EHO attended setup at three locations within their jurisdiction & was content with chosen locations.
Causeway Coast & Glens Borough Council	10/03/22	Email to EHO confirming that noise survey has commenced at proposed location and offer to meet at next visit.
Causeway Coast & Glens Borough Council	15/03/22	Email from EHO arranging to visit survey location at next opportunity.
Causeway Coast & Glens and Mid & East Antrim Borough Councils	15/03/22	Email to EHOs providing details of installed survey locations (03090-3699882-01).
Causeway Coast & Glens Borough Council	15/03/22	EHO attended survey location within their jurisdiction & was content with chosen location.

Methodology

Operational Noise

11.30 To ensure adequate assessment of the potential impacts of the operational noise from the proposed wind farm the following steps have been taken, in accordance with relevant guidance detailed above:

- The baseline noise conditions at each of the nearest residential properties to the wind farm are established by way of representative background noise surveys;
- The noise levels at the nearest residential properties from the operation of the proposed development are predicted using a sound propagation model considering: the locations of the wind turbines; the intervening terrain; and the likely noise emission characteristics of the wind turbines;
- With due regard to relevant guidance or regulations the acoustic assessment criteria are derived; and
- The evaluation of the acoustic impact is undertaken by comparing the predicted noise levels with the assessment criteria.

Establishing Baseline Conditions

11.31 Similar to other assessments of noise impacts (most notably BS 4142[12],which ETSU-R-97 identifies as forming the basis of its recommendations), the ETSU-R-97 methodology requires the comparison of predicted noise levels due to turbine emissions (which vary with hub height wind speed) with noise limits based upon the noise levels already existing under those same conditions (i.e. the baseline conditions).

11.32 Since background noise levels depend upon wind speed, as indeed do wind turbine noise emissions, it is important when making reference measurements to put them in that context. Thus, the assessment of background noise levels requires the measurement of not only noise levels, but concurrent wind conditions, covering a representative range of wind speeds. These wind measurements are made at the wind turbine site rather than at the residential properties, since it is this wind speed that would subsequently govern the wind farm's noise generation. Often the residential properties themselves will be sheltered from the wind and may consequently have relatively low background noise levels.

11.33 To establish the baseline conditions, sound level meters and associated apparatus are set-up to record the required acoustic information at a selection of the nearest residential properties geographically spread around the proposed wind farm site and which are likely to be representative of other residential properties in the locale.

11.34 Wind speed and direction are recorded as 10 minute averages for the same period as for the noise measurements, and are synchronised with the acoustic data to allow correlations to be established. The wind speed that is adopted for use is the same wind speed as that which drives the turbine noise levels.

11.35 The adoption of this wind speed was recommended within the article published in the IoA Bulletin and the subsequent IoA GPG. The methodology used to calculate standardised 10 m wind speed is described in **Technical Appendix 11.3**.

[12] 'Method for Rating Industrial Noise affecting Mixed Residential and Industrial Areas', British Standards Institution, 1997

11.36 Prior to establishing the baseline conditions the acoustic data is filtered as follows:

- For each background noise measurement location, the measured noise data is divided into two sets, as specified by ETSU-R-97 and shown in **Table 2**:

Table 2: Definition of Time of Day Periods

Time of Day	Definition
Quiet daytime	18:00 - 23:00 every day 13:00 - 18:00 Saturday 07:00 - 18:00 Sunday
Night-time	23:00 - 07:00 every day

- Rainfall affected data is systematically removed from the acoustic data set. To facilitate this, a rain gauge is deployed at the wind farm site to record 10 minute rainfall data and identify potentially affected noise data. Both the 10 minute period containing the bucket tip and the preceding 10 minute period are removed from the dataset as recommended in the IoA GPG to account for the time it takes for the rain gauge tipping bucket to fill.
- Periods of measured background noise data thought to be affected by extraneous, i.e. non-typical, noise sources are identified and removed from the data set. Whilst some 'extraneous' data may actually be real, it tends to bias any trend lines upwards so its removal is adopted as a conservative measure.
- In practice this means close inspection of the measured background noise levels, comparison with concurrent data measured at nearby locations and consideration of both directional and temporal variation.

Modelling Noise Propagation

11.37 Whilst there are several sound propagation models available, the ISO 9613 Part 2 model has been used[13], this being identified as most appropriate for use in such rural sites[14]. The specific interpretation of the ISO 9613 Part 2 propagation methodology recommended in the aforementioned IoA Bulletin and the subsequent IoA GPG has been employed.

11.38 To make noise predictions it is assumed that:

- the turbines are identical;
- the turbines radiate noise at the power specified in this report;
- each turbine can be modelled as a point source at hub-height;
- each residential property is assigned a reference height to simulate the presence of an observer.

11.39 The sound propagation model takes account of attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 ˚C and 70 % respectively, as recommended in the IoA Bulletin and IoA GPG. Ground effects are also taken into account by the propagation model with a ground factor of 0.5 and a receiver height of 4 m used as recommended in the IoA Bulletin and IoA GPG.

[13] 'Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation', International Organisation for Standardisation, ISO 9613-2:1996

[14] 'A Critical Appraisal of Wind Farm Noise Propagation', ETSU Report W/13/00385/REP, January 2000

11.40 The barrier attenuations predicted by ISO 9613 Part 2 have been shown to be significantly greater than those measured in practice under downwind conditions[14]. Therefore, barrier attenuation according to the ISO 9613 Part 2 method has been discounted. In lieu of this, where there is no direct line of sight between the residential property in question and any part of the wind turbine, 2 dB attenuation has been assumed as recommended in the IoA Bulletin and the IoA GPG.

11.41 Additionally, verification studies have also shown that ISO 9613 Part 2 tends to slightly underestimate noise levels at nearby dwellings in certain exceptional cases, notably in a valley type environment where the ground drops off between source and receiver. In these instances an addition of 3 dB(A) has been applied to the resulting overall A-weighted noise level as recommended by the IoA GPG. Further detail is provided in **Technical Appendix 11.4**.

11.42 To generate the ground cross sections between each turbine and each dwelling necessary for reliable propagation modelling, ground contours at 5 m intervals for the area of interest have been generated from 50 m grid resolution digital terrain data.

11.43 The predicted noise levels are calculated as L_{Aeq} noise levels and changed to the L_{A90} descriptor (to allow comparisons to be made) by subtraction of -2 dB, as specified by ETSU-R-97.

11.44 It has been shown by measurement-based verification studies that the ISO 9613 Part 2 model tends to slightly overestimate wind farm noise levels at nearby dwellings[14]. Examples of additional conservative assumptions modelled are:

- properties are assumed to be downwind of all noise sources simultaneously and at all times. In reality, this is not the case and additional attenuation would be expected when a property is upwind or crosswind of the proposed wind turbines;
- although, in reality, the ground is predominantly porous (acoustically absorptive) it has been modelled as 'mixed', i.e. a combination of hard and porous, corresponding to a ground absorption coefficient of 0.5 as recommended by the IoA Bulletin and IoA GPG;
- receiver heights are modelled at 4 m above local ground level, which equates roughly to first floor window level, as recommended by the IoA Bulletin and IoA GPG. This results in a predicted noise level anything up to 2 dB(A) higher than at the typical human ear height of 1.2-1.8 m;
- trees and other non-terrain shielding effects have not been considered;
- an allowance for measurement uncertainty has been included in the sound power levels for the presented turbine.

Operational Noise Impact Criteria

11.45 Noise is measured in decibels (dB) which is a measure of the sound pressure level, i.e. the magnitude of the pressure variations in the air. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.

11.46 ETSU-R-97 seeks to protect the internal and external amenity of wind farm neighbours by defining acceptable limits for operational noise from wind turbines. The test applied to operational noise is whether or not the noise levels produced by the combined

operation of the wind turbines lie below noise limits derived in accordance with ETSU-R-97 at nearby residential properties.

Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also provides a simplified methodology:

"if the noise is limited to an $L_{A90,10min}$ of 35dB(A) up to wind speeds of 10 m/s at 10 m height, then these conditions alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary".

11.47 In the detailed methodology, ETSU-R-97 states that different limits should be applied during daytime and night-time periods. The daytime limits, derived from the background noise levels measured during quiet daytime periods, are intended to preserve outdoor amenity, while the night-time limits are intended to prevent sleep disturbance. The general principle is that the noise limits should be based on existing background noise levels, except for very low background noise levels, in which case a fixed limit may be applied. The suggested limits are given in **Table 3** below, where L_B is the background $L_{A90,10min}$ and is a function of wind speed. During daytime periods and at low background noise levels, a lower fixed limit of 35–40 dB(A) is applicable. The exact value is dependent upon a number of factors: the number of nearby dwellings, the effect of the noise limits on energy produced, and the duration and level of exposure.

Table 3: Permissible Noise Level Criteria

Time of Day	Permissible Noise Level
Daytime	• 35-40 dB(A) for L_B less than 30-35 dB(A) • L_B + 5 dB, for L_B greater than 30-35 dB(A)
Night-time	• 43 dB(A) for L_B less than 38 dB(A) • L_B + 5 dB, for L_B greater than 38 dB(A)

11.48 Note that a higher noise level is permissible during the night than during the day as it is assumed that residents would be indoors. The night-time criterion is derived from sleep disturbance criterion referred to in ETSU-R-97, with an allowance of 10 dB for attenuation through an open window.

11.49 The wind speeds at which the acoustic impact is considered are less than or equal to 12 ms^{-1} at a height of 10 m and are likely to be the acoustically critical wind speeds. Above these wind speeds, as stated in ETSU-R-97, reliable measurements of background and turbine noise are difficult to make. However, if a wind farm meets the noise criteria at the wind speeds presented, it is most unlikely that it would cause any greater loss of amenity at higher wind speeds due to increasing background noise levels masking wind farm generated noise.

11.50 It is important to note that, since reactions to noise are subjective, it is not possible to guarantee that a given development would not result in any adverse comment with regard to noise as the response to any given noise will vary from person to person. Consequently, standards and guidance that relate to environmental noise are typically presented in terms of criteria that would be expected to be considered acceptable by the majority of the population.

Construction Noise

11.51 To ensure adequate assessment of the potential impacts of the construction noise from the proposed wind farm the following steps have been taken:

- Baseline noise criteria are established from the appropriate guidance BS 5228-1:2009;
- Noise levels due to on-site construction activities are predicted at nearby residential properties in accordance with the BS 5228-1:2009 standard;
- Predicted noise levels due to construction traffic at the same residential properties are made using the BS 5228-1:2009 standard; and
- The combined effect of on-site construction activities with construction traffic is compared with the target level specified by BS 5228-1:2009.

Baseline Conditions

Operational Noise

11.52 The proposed development is located in the townlands of Carnbuck, Magheraboy and Moneyneagh, near the village of Corkey, County Antrim. The surrounding area is predominantly rural in nature and used for agricultural grazing. The general noise character is typical of a rural environment with noise from farm machinery, sheep, cattle, and birds, with the occasional overhead aircraft.

11.53 Background noise measurements were undertaken at four locations in accordance with ETSU-R-97 as detailed in **Table 4**. Proxy locations for H27 and H33 were used as permission could not be obtained to measure at the properties themselves. The proxy locations were selected to be a similar distance or further from noise sources such as vegetation, roads and watercourses so would be expected to give conservative results, i.e. lower background noise levels, than if measurements had been made at the properties themselves. The proxy locations (500 m north of H27 and 200 north of H33) were agreed in consultation with the Environmental Health Department of Mid & East Antrim Borough Council.

Table 4 – RES Background Noise Survey Details

House ID	Measurement Period		
	Start	End	Duration (days)
H27	03/03/2022	05/04/2022	34
H33	03/03/2022	05/04/2022	34
H34	03/03/2022	05/04/2022	34
H94	03/03/2022	05/04/2022	34

11.54 Baseline data collected for the assessment of the consented Corkey Repowering scheme shall also be considered. Data was collected at houses H1, H2, H3 and H10 although the data from H10 was discounted due to a nearby watercourse.

11.55 The background noise monitoring equipment was housed in weather-proof enclosures and powered by lead-acid batteries. The microphones were placed at a height of approximately 1.2 m above ground and equipped with all-weather wind shields which also provide an element of water resistance.

11.56 The proprietary wind shields used are designed to reduce the effects of wind-generated noise at the microphone and accord with the recommendations of the IoA GPG in that they are the appropriate size and, in combination with the microphone, are certified by the manufacturer as meeting Type 1 / Class 1 precision standards.

11.57 Noise levels are monitored continuously, and summary statistics stored every 10 minutes in the internal memory of each meter. The relevant statistic measured is the $L_{A90,10min}$ (The A-weighted sound pressure level exceeded for 90 % of the 10 minute interval).

11.58 The sound level meters were placed away from reflecting walls and vegetation. Photos of the equipment, in situ, may be seen in **Technical Appendix 11.5**. The apparatus were calibrated before and after the survey period and the maximum drift detected was 0.2 dB, which is within the required range recommended in the IoA GPG. All instrumentation has been subject to laboratory calibration traceable to national standards within the last 24 months, as recommended in the IoA GPG. Details are provided in **Technical Appendix 11.6**.

11.59 **Chart 1** (see **Technical Appendix 11.7** for all charts) shows the measured wind rose over the background noise survey period, as measured by the LiDAR located on-site.

11.60 LIDAR (Light Detection and Ranging) is a remote sensing device that measures conditions in the atmosphere by using pulses from a LASER by applying the principle of the Doppler Effect, detecting the movement of air in the atmospheric boundary layer to measure wind speed and direction. LIDAR provides measurements at several heights, and this enables wind speed data to be obtained that describe the wind profile across a range of heights.

11.61 LIDAR has been successfully tested, by independent third parties using suitable test sites, against conventional anemometry[15, 16]. From the technical reports, these tests have demonstrated that, over a range of relevant heights, the accuracy of the LIDAR is comparable to that of the conventional anemometry.

11.62 For illustrative purposes, **Chart 2** shows the measured wind rose over an extended period (17/11/05 – 05/09/08) from a meteorological mast at the adjacent Gruig wind farm. As previously discussed, the noise prediction model employed is likely to overestimate the real noise immission levels for locations not downwind of the turbines. **Chart 2** therefore may aid the reader as to the likelihood of over-estimation due to this factor.

11.63 The noise data has been cross-referenced with rainfall data measured on-site using a rain gauge. Any noise data identified as having been affected by rainfall has been removed from the analysis as shown in **Charts 3 to 10.**

11.64 Short-term periods of increased noise levels considered to be atypical have been removed from the dataset. The excluded data is shown in **Charts 3 to 10.**

11.65 An analysis of the impact of noise from existing wind turbines on the datasets has also been performed. Predicted noise levels due to the existing wind turbines were calculated at each of the survey locations so that they could be subtracted from the measured noise levels to calculate the background noise level. The noise levels were calculated by direction and weighted by the survey wind rose to account for the reductions in noise that would occur when the measurement location is not downwind of the turbines.

11.66 The predicted noise levels due to the existing turbines are greater than the measured noise levels at three of the four measurement locations demonstrating that the prediction methodology is conservative. It was therefore not possible to accurately determine the background noise level using this method.

[15] "Evaluation of WINDCUBE", Albers et al, Deutsche WindGuard Consulting GmbH, Report PP 08007, 16 March 2008

[16] "Verification test for three WindCubeTM WLS7 LiDARs at the Høvsøre test site", Gottschall et al, DTU Report Risø-R-1732, May 2010

11.67 Given the conservatism of the predicted noise levels the influence of the existing turbines could be better accounted for by directional filtering. Whilst the measured noise levels were not consistently greater when the properties were downwind of the existing turbines, any periods of atypically high background levels were removed from the analysis.

11.68 **Charts 3 to 6** show $L_{A90,10min}$ correlated against wind speed for quiet daytime periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added. The equation of the regression polynomial has been provided in the charts.

11.69 **Charts 7 to 10** show $L_{A90,10min}$ correlated against the wind speed for night-time periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the noise limits added. The equation of the regression polynomial has been provided in the charts.

11.70 **Table 5** and **Table 6** detail the $L_{A90,10min}$ background noise levels calculated from the derived 'best fit' lines, as described above:

Table 5 - Quiet Daytime Noise Levels (dB(A) re 20 µPa)

House ID	Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	25.8	25.8	25.8	29.1	32.4	35.3	38.0	40.5	43.0	45.5	47.9	50.4
H2	26.2	26.2	26.2	29.0	32.0	34.7	37.3	39.8	42.4	45.0	47.6	50.4
H3	25.6	25.6	25.6	27.3	28.9	30.5	32.0	34.0	36.2	38.1	39.8	41.4
H27	19.0	20.6	22.1	23.6	25.1	26.7	28.5	30.5	32.8	35.4	38.4	38.4
H33	21.9	23.1	24.3	25.4	26.7	28.3	30.2	32.6	35.5	39.2	43.7	43.7
H34	28.9	30.5	31.3	31.6	31.6	31.7	32.0	33.0	34.7	37.6	41.8	41.8
H94	27.4	29.0	30.3	31.5	32.7	34.0	35.5	37.4	39.8	42.9	46.6	46.6

Table 6 - Night-time Noise Levels (dB(A) re 20 µPa)

House ID	Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	25.0	25.0	25.0	26.8	29.8	32.9	35.8	38.7	41.5	44.4	47.3	50.1
H2	24.4	24.4	24.4	26.8	30.3	33.3	36.2	38.9	41.7	44.4	47.1	49.7
H3	25.4	25.4	25.4	26.9	28.3	29.6	31.0	32.3	33.8	35.8	37.7	39.5
H27	17.9	18.9	20.0	21.3	22.8	24.4	26.3	28.3	30.6	33.1	35.8	38.7
H33	21.1	21.1	21.2	22.1	23.5	25.4	27.8	30.6	33.6	36.9	40.4	43.9
H34	26.4	26.4	26.4	26.7	27.4	28.5	30.0	31.8	33.9	36.3	39.0	41.9
H94	26.9	27.1	27.7	28.5	29.6	30.9	32.6	34.5	36.8	39.3	42.1	45.2

Construction Noise

11.71 For the on-site construction noise assessment, Annex E of BS 5228-1:2009 provides guidance on setting environmental noise targets. Several methods of assessing the significance of noise levels are presented in Annex E and the most applicable to the construction of the proposed development is the ABC method. The ABC method sets threshold noise levels for specific periods based on the ambient noise levels.

Potential Impacts

Potential Operational Impacts

Noise Propagation Modelling

11.72 The locations of the proposed turbines are provided in **Table 7** and shown in **Figure 11.1**.

Table 7: Location of Proposed Turbines

Turbine	Co-ordinates	
	X (m)	Y (m)
T1	310866	421041
T2	310942	420508
T3	311247	420105
T4	311927	420074
T5	311970	419561
T6	312344	419989
T7	312305	420580
T8	312715	420394
T9	312578	420871
T10	312971	420639
T11	312980	421211
T12	313321	421005

11.73 The locations of the nearest residential properties to the turbines have been determined by inspection of relevant maps and through site visits. The locations are listed in **Table 8** and are also shown in **Figure 11.1**. Properties identified as unoccupied/derelict are marked with an asterisk and not considered further.

Table 8: Location of Nearby Properties

House ID	Co-ordinates	
	X (m)	Y (m)
H1	309979	422676
H2	309761	422704
H3	309656	422220
H4	309384	421839
H5	309407	421621
H6	309586	421332
H7	309167	421187
H8	309123	421057
H9	309029	421557
H10	309697	420992
H11	309512	421032
H12	309551	421004
H13	309596	420995
H14	309508	420901
H15	309184	420771
H16	309474	420886
H17	309053	420566
H20	309783	419409
H21*	310392	419573
H22	310478	419181
H23*	311109	419025
H24	311566	418066
H25	312334	418089
H27	313138	419356
H28*	313333	418898
H33	314432	420189
H34	309622	420847
H35*	310090	420997
H36*	309902	420949
H38*	313158	419463
H39	314273	419792
H40*	314554	420352
H43	309697	419532
H44	309576	419580
H45	310324	419519
H46	314372	419583
H47	314293	419418
H48	314382	419275

House ID	Co-ordinates	
	X (m)	Y (m)
H49	313292	419204
H50*	313282	419096
H51	311890	418063
H52	312066	418151
H53	312140	418137
H54	312587	418096
H55	312729	418128
H56	309961	419417
H57	310008	419386
H58	310143	419408
H59	310238	419375
H64	313388	418560
H65*	313176	418109
H66	308889	420304
H67	308767	420327
H68	309354	419290
H69	309388	419253
H70	309323	419235
H71	309869	418861
H72	310313	418595
H73	310392	418561
H74	310404	418542
H75	310520	418414
H76	310567	418316
H77	310820	418168
H78	310970	418052
H79	311965	417916
H80	312767	418105
H82	313313	417885
H90	314285	418745
H91	311806	418089
H92	312861	418164
H94	311025	418993
H95	308928	421890
H97	308930	420281
H98	308931	421422
H99	308980	421965
H100	309077	421721
H101	309081	421714

House ID	Co-ordinates	
	X (m)	Y (m)
H102	309088	421703
H103	309090	421698
H104	309095	421688
H105	309100	421684
H106	309104	421674
H107	309107	421665
H108	309116	421745
H109	309120	421736
H110	309120	421666
H111	309125	421670
H112	309128	421726
H113	309132	421720
H114	309138	421708
H115	309140	421769
H116	309141	421702
H117	309145	421760
H118	309145	421684
H119	309151	421688
H120	309154	421740
H121	309156	421735
H122	309162	421534
H123	309162	421725
H124	309165	421718
H125	309170	421709
H126	309173	421703
H127	309178	421664
H128	309191	421643
H129	309194	421770
H130	309196	421634
H131	309197	421619
H132	309198	421762
H133	309206	421603
H134	309206	421763
H135	309210	421513
H136	309211	421590
H137	309217	421684
H138	309218	421566
H139	309222	421660
H140	309226	421651

House ID	Co-ordinates	
	X (m)	Y (m)
H141	309228	421751
H142	309228	421759
H143	309230	421745
H144	309233	421738
H145	309234	421634
H146	309238	421570
H147	309239	421626
H148	309246	421752
H149	309246	421576
H150	309250	421610
H151	309251	421754
H152	309256	421758
H153	309257	421594
H154	309275	421776
H155	309289	421252
H156	309294	421794
H157	309313	421801
H158	309337	421817
H159	309349	421625
H160	309356	419294
H161	309357	421597
H162	309385	421272
H163	309469	419562
H164	309513	421335
H165	309536	421306
H167	309870	418329
H168	310037	419469
H169	310200	418079
H170	310268	418051
H171	310275	418189
H172	310335	418587
H173	310346	419531
H174	310344	418553
H175	310367	418579
H176	310379	418543
H177	310382	418517
H178	310382	418517
H179	310387	418512
H181	310418	418488

House ID	Co-ordinates	
	X (m)	Y (m)
H182	310426	418152
H183	310431	417789
H184	310458	418425
H189	310459	417760
H190	310495	418438
H191	310497	417896
H192	310517	417872
H193	310599	418222
H194	310936	417804
H195	311225	417841
H196	311261	417768
H197	311318	417765
H198	311318	417765
H199*	311358	418047
H201	311420	417690
H202	311671	417522
H205	312205	418071
H208	313084	417748
H209	313135	419377
H210	313146	417667
H211	313154	417668
H212	314338	418605
H213	312608	418120
H214	312748	418102
H217	314391	418904
H218	314342	419019
H219	314198	418938
H220	314276	418803
H222	314326	420005
H223	312525	418085
H224	313231	419053

11.74 The large number of residential properties can be condensed by removing any properties which are adequately represented by other residential properties that are closer to the proposed development or the sites considered in the cumulative assessment. Such properties would be more critical to the outcome of the acoustic assessment i.e. if the noise criteria are met there then they would also be met at properties which are further away.

11.75 The properties considered in the assessment, along with distances from each property to the nearest turbine, are given in **Table 9**. It can be seen that the minimum house–to–turbine separation is 1000 m.

Table 9: Distances to Considered Properties

House ID	Distance to Nearest Turbine (m)	Nearest Turbine
H1	1860	T1
H2	1997	T1
H3	1689	T1
H4	1683	T1
H5	1570	T1
H6	1313	T1
H10	1170	T1
H11	1354	T1
H12	1316	T1
H13	1271	T1
H14	1365	T1
H16	1401	T1
H22	1202	T3
H24	1549	T5
H27	1015	T6
H33	1378	T12
H34	1259	T1
H39	1542	T12
H45	1093	T3
H49	1231	T6
H52	1413	T5
H91	1481	T5
H94	1103	T5
H158	1715	T1
H162	1499	T1
H164	1385	T1
H165	1356	T1
H168	1367	T3
H173	1068	T3
H209	1000	T6
H222	1418	T12
H224	1290	T6

11.76 The turbine type will be finalised prior to construction. However for the purposes of this assessment the Vestas V136 4.2 MW and Enercon E138 4.2 MW have been chosen as typical candidate turbine types. This report uses the acoustic data from the manufacturer's

general specification for all analysis[17]. The manufacturers have identified these values as warranted although no independent test reports are available to indicate whether any margin has been incorporated, therefore 2 dB has been added to the warranted levels as a conservative measure as recommended by the IoA GPG. Details used in this analysis are as follows:

- a hub height of 112 m for Vestas machine and 111 m for the Enercon;
- a rotor diameter of 136 m for Vestas machine and 138 m for the Enercon;
- sound power levels, L_{WA}, for standardised 10 m height wind speeds (v_{10}) as shown in **Table 10**;
- octave band sound power level data, at the wind speeds where it is available, as shown in **Table 11**;
- tonal emission characteristics such that no clearly audible tones are present at any wind speed.

Table 10 – A-Weighted Sound Power Levels (dB(A) re 1 pW) for the Considered Turbines

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	Vestas V136 4.2 MW	Enercon E138 4.2 MW
1	93.8	95.4
2	93.8	95.4
3	93.8	95.4
4	97.5	101.8
5	102.5	105.1
6	105.6	106.1
7	105.9	107.0
8	105.9	107.8
9	105.9	108.0
10	105.9	108.0
11	105.9	108.0
12	105.9	108.0

[17] 'Performance Specification V136 – 4.0/4.2 MW 50/60 Hz, Vestas, Document ID: 0067-7065 V06, 2018-05-02
'Data Sheet Enercon Wind Energy Converter E-138 EP3 E2 / 4200kW with TES', D0749845-6/DA, 2019-04-29

Table 11 - Octave Band A-Weighted Sound Power Levels (dB(A) re 1 pW) at a Standardised 10m Height Wind Speed of 8 ms^{-1} for the Considered Turbines

Octave Band (Hz)	Vestas V136 4.2 MW	Enercon E138 4.2 MW
63	87.0	89.2
125	94.6	95.0
250	99.2	97.7
500	101.0	100.2
1000	99.9	102.0
2000	95.9	102.9
4000	89.0	98.4
8000	79.2	83.5
OVERALL	105.9	108.0

Predictions of Noise Levels at Residential Properties

11.77 **Table 12** shows the predicted noise immission levels at the nearest residential properties, at each wind speed considered, for the Vestas machine. The property with the highest predicted noise immission level of 38.4 dB(A) is H209.

11.78 **Figure 11.1** shows an isobel (i.e. noise contour) plot for the Vestas machine at a standardised 10 m height wind speed of 8 ms^{-1}. Such plots are useful for evaluating the noise 'footprint' of a given development.

Table 12: Predicted Noise Levels for Vestas Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	16.9	16.9	16.9	20.6	25.6	28.7	29.0	29.0	29.0	29.0	29.0	29.0
H2	16.4	16.4	16.4	20.1	25.1	28.2	28.5	28.5	28.5	28.5	28.5	28.5
H3	17.9	17.9	17.9	21.6	26.6	29.7	30.0	30.0	30.0	30.0	30.0	30.0
H4	18.0	18.0	18.0	21.7	26.7	29.8	30.1	30.1	30.1	30.1	30.1	30.1
H5	18.8	18.8	18.8	22.5	27.5	30.6	30.9	30.9	30.9	30.9	30.9	30.9
H6	20.7	20.7	20.7	24.4	29.4	32.5	32.8	32.8	32.8	32.8	32.8	32.8
H10	22.1	22.1	22.1	25.8	30.8	33.9	34.2	34.2	34.2	34.2	34.2	34.2
H11	20.9	20.9	20.9	24.6	29.6	32.7	33.0	33.0	33.0	33.0	33.0	33.0
H12	21.1	21.1	21.1	24.8	29.8	32.9	33.2	33.2	33.2	33.2	33.2	33.2
H13	21.4	21.4	21.4	25.1	30.1	33.2	33.5	33.5	33.5	33.5	33.5	33.5
H14	21.0	21.0	21.0	24.7	29.7	32.8	33.1	33.1	33.1	33.1	33.1	33.1
H16	20.8	20.8	20.8	24.5	29.5	32.6	32.9	32.9	32.9	32.9	32.9	32.9
H22	23.1	23.1	23.1	26.8	31.8	34.9	35.2	35.2	35.2	35.2	35.2	35.2
H24	20.4	20.4	20.4	24.1	29.1	32.2	32.5	32.5	32.5	32.5	32.5	32.5
H27	26.2	26.2	26.2	29.9	34.9	38.0	38.3	38.3	38.3	38.3	38.3	38.3
H33	20.9	20.9	20.9	24.6	29.6	32.7	33.0	33.0	33.0	33.0	33.0	33.0
H34	21.8	21.8	21.8	25.5	30.5	33.6	33.9	33.9	33.9	33.9	33.9	33.9
H39	20.2	20.2	20.2	23.9	28.9	32.0	32.3	32.3	32.3	32.3	32.3	32.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H45	24.0	24.0	24.0	27.7	32.7	35.8	36.1	36.1	36.1	36.1	36.1	36.1
H49	24.4	24.4	24.4	28.1	33.1	36.2	36.5	36.5	36.5	36.5	36.5	36.5
H52	20.7	20.7	20.7	24.4	29.4	32.5	32.8	32.8	32.8	32.8	32.8	32.8
H91	21.0	21.0	21.0	24.7	29.7	32.8	33.1	33.1	33.1	33.1	33.1	33.1
H94	24.5	24.5	24.5	28.2	33.2	36.3	36.6	36.6	36.6	36.6	36.6	36.6
H158	17.9	17.9	17.9	21.6	26.6	29.7	30.0	30.0	30.0	30.0	30.0	30.0
H162	19.6	19.6	19.6	23.3	28.3	31.4	31.7	31.7	31.7	31.7	31.7	31.7
H164	20.3	20.3	20.3	24.0	29.0	32.1	32.4	32.4	32.4	32.4	32.4	32.4
H165	20.5	20.5	20.5	24.2	29.2	32.3	32.6	32.6	32.6	32.6	32.6	32.6
H168	21.9	21.9	21.9	25.6	30.6	33.7	34.0	34.0	34.0	34.0	34.0	34.0
H173	24.1	24.1	24.1	27.8	32.8	35.9	36.2	36.2	36.2	36.2	36.2	36.2
H209	26.3	26.3	26.3	30.0	35.0	38.1	38.4	38.4	38.4	38.4	38.4	38.4
H222	20.6	20.6	20.6	24.3	29.3	32.4	32.7	32.7	32.7	32.7	32.7	32.7
H224	24.1	24.1	24.1	27.8	32.8	35.9	36.2	36.2	36.2	36.2	36.2	36.2

11.79 **Table 13** shows the predicted noise immission levels at the nearest residential properties, at each wind speed considered, for the Enercon machine. The property with the highest predicted noise immission level of 38.7 dB(A) is H209.

Table 13: Predicted Noise Levels for Enercon Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	16.3	16.3	16.3	22.7	26.0	27.0	27.9	28.7	28.9	28.9	28.9	28.9
H2	15.7	15.7	15.7	22.1	25.4	26.4	27.3	28.1	28.3	28.3	28.3	28.3
H3	17.3	17.3	17.3	23.7	27.0	28.0	28.9	29.7	29.9	29.9	29.9	29.9
H4	17.4	17.4	17.4	23.8	27.1	28.1	29.0	29.8	30.0	30.0	30.0	30.0
H5	18.3	18.3	18.3	24.7	28.0	29.0	29.9	30.7	30.9	30.9	30.9	30.9
H6	20.2	20.2	20.2	26.6	29.9	30.9	31.8	32.6	32.8	32.8	32.8	32.8
H10	21.7	21.7	21.7	28.1	31.4	32.4	33.3	34.1	34.3	34.3	34.3	34.3
H11	20.4	20.4	20.4	26.8	30.1	31.1	32.0	32.8	33.0	33.0	33.0	33.0
H12	20.7	20.7	20.7	27.1	30.4	31.4	32.3	33.1	33.3	33.3	33.3	33.3
H13	21.0	21.0	21.0	27.4	30.7	31.7	32.6	33.4	33.6	33.6	33.6	33.6
H14	20.5	20.5	20.5	26.9	30.2	31.2	32.1	32.9	33.1	33.1	33.1	33.1
H16	20.3	20.3	20.3	26.7	30.0	31.0	31.9	32.7	32.9	32.9	32.9	32.9
H22	22.7	22.7	22.7	29.1	32.4	33.4	34.3	35.1	35.3	35.3	35.3	35.3
H24	19.8	19.8	19.8	26.2	29.5	30.5	31.4	32.2	32.4	32.4	32.4	32.4
H27	25.9	25.9	25.9	32.3	35.6	36.6	37.5	38.3	38.5	38.5	38.5	38.5
H33	20.5	20.5	20.5	26.9	30.2	31.2	32.1	32.9	33.1	33.1	33.1	33.1
H34	21.3	21.3	21.3	27.7	31.0	32.0	32.9	33.7	33.9	33.9	33.9	33.9
H39	19.7	19.7	19.7	26.1	29.4	30.4	31.3	32.1	32.3	32.3	32.3	32.3
H45	23.6	23.6	23.6	30.0	33.3	34.3	35.2	36.0	36.2	36.2	36.2	36.2

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H49	24.0	24.0	24.0	30.4	33.7	34.7	35.6	36.4	36.6	36.6	36.6	36.6
H52	20.2	20.2	20.2	26.6	29.9	30.9	31.8	32.6	32.8	32.8	32.8	32.8
H91	20.4	20.4	20.4	26.8	30.1	31.1	32.0	32.8	33.0	33.0	33.0	33.0
H94	24.2	24.2	24.2	30.6	33.9	34.9	35.8	36.6	36.8	36.8	36.8	36.8
H158	17.3	17.3	17.3	23.7	27.0	28.0	28.9	29.7	29.9	29.9	29.9	29.9
H162	19.1	19.1	19.1	25.5	28.8	29.8	30.7	31.5	31.7	31.7	31.7	31.7
H164	19.8	19.8	19.8	26.2	29.5	30.5	31.4	32.2	32.4	32.4	32.4	32.4
H165	20.0	20.0	20.0	26.4	29.7	30.7	31.6	32.4	32.6	32.6	32.6	32.6
H168	21.5	21.5	21.5	27.9	31.2	32.2	33.1	33.9	34.1	34.1	34.1	34.1
H173	23.8	23.8	23.8	30.2	33.5	34.5	35.4	36.2	36.4	36.4	36.4	36.4
H209	26.1	26.1	26.1	32.5	35.8	36.8	37.7	38.5	38.7	38.7	38.7	38.7
H222	20.1	20.1	20.1	26.5	29.8	30.8	31.7	32.5	32.7	32.7	32.7	32.7
H224	23.6	23.6	23.6	30.0	33.3	34.3	35.2	36.0	36.2	36.2	36.2	36.2

11.80 A comparison of the predicted noise levels for the Vestas and Enercon machines shows that the maximum predicted noise levels which occur at wind speeds of greater than 7 ms^{-1} are similar (within 0.4 dB(A) of each other). The predicted noise levels for the Vestas machine are greater at 1-3, 6 & 7 ms^{-1} whereas those for the Enercon are greater at 4-5 ms^{-1}.

11.81 For both machines the noise levels at 24 of the 32 nearest residential properties are below 35 dB(A), indicating that the noise immission levels would be regarded as acceptable and the residents amenity as receiving 'sufficient protection' without further assessment requiring to be undertaken.

11.82 There are 8 properties that have predicted noise levels greater than this simplified noise criteria. Therefore the 'full' acoustic assessment need only be considered at these. However, all of properties have been considered in the full acoustic assessment so as to provide a more comprehensive description of the acoustic impact of the proposed wind farm.

Acoustic Acceptance Criteria

11.83 As stated previously, during daytime periods and at low background noise levels, a lower fixed limit of 35-40 dB(A) is applicable with the exact value dependent upon a number of factors: the number of noise affected residential properties; the potential impact on the power output of the wind farm and the likely duration and level of exposure. Through consideration of these factors, and despite a higher value being potentially justifiable, RES have adopted a 35 dB(A) daytime lower limit as a conservative measure.

Table 14: Permissible Noise Level Criteria in Vicinity of Proposed Development

Time of Day	Permissible Noise Level
Daytime	• 35 dB(A) for L_B less than 30 dB(A) • L_B + 5 dB, for L_B greater than 30 dB(A)
Night-time	• 43 dB(A) for L_B less than 38 dB(A) • L_B + 5 dB, for L_B greater than 38 dB(A)

Calculation of Acceptable Noise Limits from Baseline Conditions

11.84 The 'best-fit' lines of **Charts 3-10** have been used to calculate the acceptable noise limits at the background noise measurement locations. **Table 15** shows the daytime noise limits and **Table 16** the night time noise limits.

Table 15 - Recommended Daytime Noise Limits (dB(A) re 20 µPa)

House ID	Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	35.0	35.0	35.0	35.0	37.4	40.3	43.0	45.5	48.0	50.5	52.9	55.4
H2	35.0	35.0	35.0	35.0	37.0	39.7	42.3	44.8	47.4	50.0	52.6	55.4
H3	35.0	35.0	35.0	35.0	35.0	35.5	37.0	39.0	41.2	43.1	44.8	46.4
H27	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.5	37.8	40.4	43.4	43.4
H33	35.0	35.0	35.0	35.0	35.0	35.0	35.2	37.6	40.5	44.2	48.7	48.7
H34	35.0	35.5	36.3	36.6	36.6	36.7	37.0	38.0	39.7	42.6	46.8	46.8
H94	35.0	35.0	35.3	36.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6

Table 16 - Recommended Night-time Noise Limits (dB(A) re 20 µPa)

House Name	Standardised 10 m Wind Speed (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	46.5	49.4	52.3	55.1
H2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	46.7	49.4	52.1	54.7
H3	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
H27	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7
H33	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.9
H34	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H94	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2

11.85 The recommendations of ETSU-R-97 state that where there are groups of properties that are likely to have a similar background noise environment, it is appropriate to use data from one representative location as the basis for assessment at the other properties. The survey results inferred to be representative for each property is shown in **Table 17**. The specific choice of noise survey chosen has been made considering the distance to the nearest survey location and the likelihood of experiencing a broadly similar exposure as the survey.

Table 17 - Assumed Representative Background Noise Survey Locations

House ID	Survey Location
H1	H1
H2	H2
H3	H3
H4	H3
H5	H3
H6	H34
H10	H34
H11	H34
H12	H34
H13	H34
H14	H34
H16	H34
H22	H94
H24	H94
H27	H27
H33	H33
H34	H34
H39	H33
H45	H94
H49	H27
H52	H94
H91	H94
H94	H94
H158	H3
H162	H34
H164	H34
H165	H34
H168	H94
H173	H94
H209	H27
H222	H33
H224	H27

11.86 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45 dB(A) if the occupant has a financial involvement in the wind farm. However, whilst some of the nearby properties may qualify for such an increase, these limits have not been adopted for the proposed development in isolation.

Acoustic Assessment

11.87 **Table 18** shows a comparison of the predicted noise levels for the Vestas machine with the recommended daytime noise limits for each residential property where the full

assessment procedure is being applied. The predicted noise levels at 1 ms^{-1} and 2 ms^{-1} have been assumed as equal to 3 ms^{-1} as a conservative measure as noise levels at these wind speeds would typically be less. The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit. A negative value indicates that the predicted noise level is within the limit. **Table 19** shows a comparison with the recommended night-time noise limits.

11.88 Noise levels at all locations are within the night-time noise limits at all wind speeds considered with a minimum margin of -4.6 dB(A). The noise levels are predicted to exceed the daytime noise limits at four properties by a maximum of 3.4 dB(A).

11.89 Predicted noise levels for the Enercon machine are compared to the daytime limit in **Table 20** and the night-time limit in **Table 21**. Noise levels at all locations are within the night-time noise limits at all wind speeds considered with a minimum margin of -4.3 dB(A). The noise levels are predicted to exceed the daytime noise limits at four properties by a maximum of 3.0 dB(A).

11.90 A noise mitigation strategy is proposed to reduce the noise levels such that the limit is met. This is described in detail in the section dealing with cumulative effects.

Table 18 - Comparison of Predicted Noise Levels for Vestas Option and Daytime Noise Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	16.9	35.0	-18.1	16.9	35.0	-18.1	16.9	35.0	-18.1	20.6	35.0	-14.4
H2	16.4	35.0	-18.6	16.4	35.0	-18.6	16.4	35.0	-18.6	20.1	35.0	-14.9
H3	17.9	35.0	-17.1	17.9	35.0	-17.1	17.9	35.0	-17.1	21.6	35.0	-13.4
H4	18.0	35.0	-17.0	18.0	35.0	-17.0	18.0	35.0	-17.0	21.7	35.0	-13.3
H5	18.8	35.0	-16.2	18.8	35.0	-16.2	18.8	35.0	-16.2	22.5	35.0	-12.5
H6	20.7	35.0	-14.3	20.7	35.5	-14.8	20.7	36.3	-15.6	24.4	36.6	-12.2
H10	22.1	35.0	-12.9	22.1	35.5	-13.4	22.1	36.3	-14.2	25.8	36.6	-10.8
H11	20.9	35.0	-14.1	20.9	35.5	-14.6	20.9	36.3	-15.4	24.6	36.6	-12.0
H12	21.1	35.0	-13.9	21.1	35.5	-14.4	21.1	36.3	-15.2	24.8	36.6	-11.8
H13	21.4	35.0	-13.6	21.4	35.5	-14.1	21.4	36.3	-14.9	25.1	36.6	-11.5
H14	21.0	35.0	-14.0	21.0	35.5	-14.5	21.0	36.3	-15.3	24.7	36.6	-11.9
H16	20.8	35.0	-14.2	20.8	35.5	-14.7	20.8	36.3	-15.5	24.5	36.6	-12.1
H22	23.1	35.0	-11.9	23.1	35.0	-11.9	23.1	35.3	-12.2	26.8	36.5	-9.7
H24	20.4	35.0	-14.6	20.4	35.0	-14.6	20.4	35.3	-14.9	24.1	36.5	-12.4
H27	26.2	35.0	-8.8	26.2	35.0	-8.8	26.2	35.0	-8.8	29.9	35.0	-5.1
H33	20.9	35.0	-14.1	20.9	35.0	-14.1	20.9	35.0	-14.1	24.6	35.0	-10.4
H34	21.8	35.0	-13.2	21.8	35.5	-13.7	21.8	36.3	-14.5	25.5	36.6	-11.1
H39	20.2	35.0	-14.8	20.2	35.0	-14.8	20.2	35.0	-14.8	23.9	35.0	-11.1
H45	24.0	35.0	-11.0	24.0	35.0	-11.0	24.0	35.3	-11.3	27.7	36.5	-8.8
H49	24.4	35.0	-10.6	24.4	35.0	-10.6	24.4	35.0	-10.6	28.1	35.0	-6.9
H52	20.7	35.0	-14.3	20.7	35.0	-14.3	20.7	35.3	-14.6	24.4	36.5	-12.1
H91	21.0	35.0	-14.0	21.0	35.0	-14.0	21.0	35.3	-14.3	24.7	36.5	-11.8
H94	24.5	35.0	-10.5	24.5	35.0	-10.5	24.5	35.3	-10.8	28.2	36.5	-8.3
H158	17.9	35.0	-17.1	17.9	35.0	-17.1	17.9	35.0	-17.1	21.6	35.0	-13.4
H162	19.6	35.0	-15.4	19.6	35.5	-15.9	19.6	36.3	-16.7	23.3	36.6	-13.3
H164	20.3	35.0	-14.7	20.3	35.5	-15.2	20.3	36.3	-16.0	24.0	36.6	-12.6
H165	20.5	35.0	-14.5	20.5	35.5	-15.0	20.5	36.3	-15.8	24.2	36.6	-12.4
H168	21.9	35.0	-13.1	21.9	35.0	-13.1	21.9	35.3	-13.4	25.6	36.5	-10.9
H173	24.1	35.0	-10.9	24.1	35.0	-10.9	24.1	35.3	-11.2	27.8	36.5	-8.7
H209	26.3	35.0	-8.7	26.3	35.0	-8.7	26.3	35.0	-8.7	30.0	35.0	-5.0
H222	20.6	35.0	-14.4	20.6	35.0	-14.4	20.6	35.0	-14.4	24.3	35.0	-10.7
H224	24.1	35.0	-10.9	24.1	35.0	-10.9	24.1	35.0	-10.9	27.8	35.0	-7.2

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	25.6	37.4	-11.8	28.7	40.3	-11.6	29.0	43.0	-14.0	29.0	45.5	-16.5
H2	25.1	37.0	-11.9	28.2	39.7	-11.5	28.5	42.3	-13.8	28.5	44.8	-16.3
H3	26.6	35.0	-8.4	29.7	35.5	-5.8	30.0	37.0	-7.0	30.0	39.0	-9.0
H4	26.7	35.0	-8.3	29.8	35.5	-5.7	30.1	37.0	-6.9	30.1	39.0	-8.9
H5	27.5	35.0	-7.5	30.6	35.5	-4.9	30.9	37.0	-6.1	30.9	39.0	-8.1
H6	29.4	36.6	-7.2	32.5	36.7	-4.2	32.8	37.0	-4.2	32.8	38.0	-5.2
H10	30.8	36.6	-5.8	33.9	36.7	-2.8	34.2	37.0	-2.8	34.2	38.0	-3.8
H11	29.6	36.6	-7.0	32.7	36.7	-4.0	33.0	37.0	-4.0	33.0	38.0	-5.0
H12	29.8	36.6	-6.8	32.9	36.7	-3.8	33.2	37.0	-3.8	33.2	38.0	-4.8
H13	30.1	36.6	-6.5	33.2	36.7	-3.5	33.5	37.0	-3.5	33.5	38.0	-4.5
H14	29.7	36.6	-6.9	32.8	36.7	-3.9	33.1	37.0	-3.9	33.1	38.0	-4.9
H16	29.5	36.6	-7.1	32.6	36.7	-4.1	32.9	37.0	-4.1	32.9	38.0	-5.1
H22	31.8	37.7	-5.9	34.9	39.0	-4.1	35.2	40.5	-5.3	35.2	42.4	-7.2
H24	29.1	37.7	-8.6	32.2	39.0	-6.8	32.5	40.5	-8.0	32.5	42.4	-9.9
H27	34.9	35.0	-0.1	38.0	35.0	3.0	38.3	35.0	3.3	38.3	35.5	2.8
H33	29.6	35.0	-5.4	32.7	35.0	-2.3	33.0	35.2	-2.2	33.0	37.6	-4.6
H34	30.5	36.6	-6.1	33.6	36.7	-3.1	33.9	37.0	-3.1	33.9	38.0	-4.1
H39	28.9	35.0	-6.1	32.0	35.0	-3.0	32.3	35.2	-2.9	32.3	37.6	-5.3
H45	32.7	37.7	-5.0	35.8	39.0	-3.2	36.1	40.5	-4.4	36.1	42.4	-6.3
H49	33.1	35.0	-1.9	36.2	35.0	1.2	36.5	35.0	1.5	36.5	35.5	1.0
H52	29.4	37.7	-8.3	32.5	39.0	-6.5	32.8	40.5	-7.7	32.8	42.4	-9.6
H91	29.7	37.7	-8.0	32.8	39.0	-6.2	33.1	40.5	-7.4	33.1	42.4	-9.3
H94	33.2	37.7	-4.5	36.3	39.0	-2.7	36.6	40.5	-3.9	36.6	42.4	-5.8
H158	26.6	35.0	-8.4	29.7	35.5	-5.8	30.0	37.0	-7.0	30.0	39.0	-9.0
H162	28.3	36.6	-8.3	31.4	36.7	-5.3	31.7	37.0	-5.3	31.7	38.0	-6.3
H164	29.0	36.6	-7.6	32.1	36.7	-4.6	32.4	37.0	-4.6	32.4	38.0	-5.6
H165	29.2	36.6	-7.4	32.3	36.7	-4.4	32.6	37.0	-4.4	32.6	38.0	-5.4
H168	30.6	37.7	-7.1	33.7	39.0	-5.3	34.0	40.5	-6.5	34.0	42.4	-8.4
H173	32.8	37.7	-4.9	35.9	39.0	-3.1	36.2	40.5	-4.3	36.2	42.4	-6.2
H209	35.0	35.0	0.0	38.1	35.0	3.1	38.4	35.0	3.4	38.4	35.5	2.9
H222	29.3	35.0	-5.7	32.4	35.0	-2.6	32.7	35.2	-2.5	32.7	37.6	-4.9
H224	32.8	35.0	-2.2	35.9	35.0	0.9	36.2	35.0	1.2	36.2	35.5	0.7

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	29.0	48.0	-19.0	29.0	50.5	-21.5	29.0	52.9	-23.9	29.0	55.4	-26.4
H2	28.5	47.4	-18.9	28.5	50.0	-21.5	28.5	52.6	-24.1	28.5	55.4	-26.9
H3	30.0	41.2	-11.2	30.0	43.1	-13.1	30.0	44.8	-14.8	30.0	46.4	-16.4
H4	30.1	41.2	-11.1	30.1	43.1	-13.0	30.1	44.8	-14.7	30.1	46.4	-16.3
H5	30.9	41.2	-10.3	30.9	43.1	-12.2	30.9	44.8	-13.9	30.9	46.4	-15.5
H6	32.8	39.7	-6.9	32.8	42.6	-9.8	32.8	46.8	-14.0	32.8	46.8	-14.0
H10	34.2	39.7	-5.5	34.2	42.6	-8.4	34.2	46.8	-12.6	34.2	46.8	-12.6
H11	33.0	39.7	-6.7	33.0	42.6	-9.6	33.0	46.8	-13.8	33.0	46.8	-13.8
H12	33.2	39.7	-6.5	33.2	42.6	-9.4	33.2	46.8	-13.6	33.2	46.8	-13.6
H13	33.5	39.7	-6.2	33.5	42.6	-9.1	33.5	46.8	-13.3	33.5	46.8	-13.3
H14	33.1	39.7	-6.6	33.1	42.6	-9.5	33.1	46.8	-13.7	33.1	46.8	-13.7
H16	32.9	39.7	-6.8	32.9	42.6	-9.7	32.9	46.8	-13.9	32.9	46.8	-13.9
H22	35.2	44.8	-9.6	35.2	47.9	-12.7	35.2	51.6	-16.4	35.2	51.6	-16.4
H24	32.5	44.8	-12.3	32.5	47.9	-15.4	32.5	51.6	-19.1	32.5	51.6	-19.1
H27	38.3	37.8	0.5	38.3	40.4	-2.1	38.3	43.4	-5.1	38.3	43.4	-5.1
H33	33.0	40.5	-7.5	33.0	44.2	-11.2	33.0	48.7	-15.7	33.0	48.7	-15.7
H34	33.9	39.7	-5.8	33.9	42.6	-8.7	33.9	46.8	-12.9	33.9	46.8	-12.9
H39	32.3	40.5	-8.2	32.3	44.2	-11.9	32.3	48.7	-16.4	32.3	48.7	-16.4
H45	36.1	44.8	-8.7	36.1	47.9	-11.8	36.1	51.6	-15.5	36.1	51.6	-15.5
H49	36.5	37.8	-1.3	36.5	40.4	-3.9	36.5	43.4	-6.9	36.5	43.4	-6.9
H52	32.8	44.8	-12.0	32.8	47.9	-15.1	32.8	51.6	-18.8	32.8	51.6	-18.8
H91	33.1	44.8	-11.7	33.1	47.9	-14.8	33.1	51.6	-18.5	33.1	51.6	-18.5
H94	36.6	44.8	-8.2	36.6	47.9	-11.3	36.6	51.6	-15.0	36.6	51.6	-15.0
H158	30.0	41.2	-11.2	30.0	43.1	-13.1	30.0	44.8	-14.8	30.0	46.4	-16.4
H162	31.7	39.7	-8.0	31.7	42.6	-10.9	31.7	46.8	-15.1	31.7	46.8	-15.1
H164	32.4	39.7	-7.3	32.4	42.6	-10.2	32.4	46.8	-14.4	32.4	46.8	-14.4
H165	32.6	39.7	-7.1	32.6	42.6	-10.0	32.6	46.8	-14.2	32.6	46.8	-14.2
H168	34.0	44.8	-10.8	34.0	47.9	-13.9	34.0	51.6	-17.6	34.0	51.6	-17.6
H173	36.2	44.8	-8.6	36.2	47.9	-11.7	36.2	51.6	-15.4	36.2	51.6	-15.4
H209	38.4	37.8	0.6	38.4	40.4	-2.0	38.4	43.4	-5.0	38.4	43.4	-5.0
H222	32.7	40.5	-7.8	32.7	44.2	-11.5	32.7	48.7	-16.0	32.7	48.7	-16.0
H224	36.2	37.8	-1.6	36.2	40.4	-4.2	36.2	43.4	-7.2	36.2	43.4	-7.2

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit

Table 19 - Comparison of Predicted Noise Levels for Vestas Option and Night Time Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	16.9	43.0	-26.1	16.9	43.0	-26.1	16.9	43.0	-26.1	20.6	43.0	-22.4
H2	16.4	43.0	-26.6	16.4	43.0	-26.6	16.4	43.0	-26.6	20.1	43.0	-22.9
H3	17.9	43.0	-25.1	17.9	43.0	-25.1	17.9	43.0	-25.1	21.6	43.0	-21.4
H4	18.0	43.0	-25.0	18.0	43.0	-25.0	18.0	43.0	-25.0	21.7	43.0	-21.3
H5	18.8	43.0	-24.2	18.8	43.0	-24.2	18.8	43.0	-24.2	22.5	43.0	-20.5
H6	20.7	43.0	-22.3	20.7	43.0	-22.3	20.7	43.0	-22.3	24.4	43.0	-18.6
H10	22.1	43.0	-20.9	22.1	43.0	-20.9	22.1	43.0	-20.9	25.8	43.0	-17.2
H11	20.9	43.0	-22.1	20.9	43.0	-22.1	20.9	43.0	-22.1	24.6	43.0	-18.4
H12	21.1	43.0	-21.9	21.1	43.0	-21.9	21.1	43.0	-21.9	24.8	43.0	-18.2
H13	21.4	43.0	-21.6	21.4	43.0	-21.6	21.4	43.0	-21.6	25.1	43.0	-17.9
H14	21.0	43.0	-22.0	21.0	43.0	-22.0	21.0	43.0	-22.0	24.7	43.0	-18.3
H16	20.8	43.0	-22.2	20.8	43.0	-22.2	20.8	43.0	-22.2	24.5	43.0	-18.5
H22	23.1	43.0	-19.9	23.1	43.0	-19.9	23.1	43.0	-19.9	26.8	43.0	-16.2
H24	20.4	43.0	-22.6	20.4	43.0	-22.6	20.4	43.0	-22.6	24.1	43.0	-18.9
H27	26.2	43.0	-16.8	26.2	43.0	-16.8	26.2	43.0	-16.8	29.9	43.0	-13.1
H33	20.9	43.0	-22.1	20.9	43.0	-22.1	20.9	43.0	-22.1	24.6	43.0	-18.4
H34	21.8	43.0	-21.2	21.8	43.0	-21.2	21.8	43.0	-21.2	25.5	43.0	-17.5
H39	20.2	43.0	-22.8	20.2	43.0	-22.8	20.2	43.0	-22.8	23.9	43.0	-19.1
H45	24.0	43.0	-19.0	24.0	43.0	-19.0	24.0	43.0	-19.0	27.7	43.0	-15.3
H49	24.4	43.0	-18.6	24.4	43.0	-18.6	24.4	43.0	-18.6	28.1	43.0	-14.9
H52	20.7	43.0	-22.3	20.7	43.0	-22.3	20.7	43.0	-22.3	24.4	43.0	-18.6
H91	21.0	43.0	-22.0	21.0	43.0	-22.0	21.0	43.0	-22.0	24.7	43.0	-18.3
H94	24.5	43.0	-18.5	24.5	43.0	-18.5	24.5	43.0	-18.5	28.2	43.0	-14.8
H158	17.9	43.0	-25.1	17.9	43.0	-25.1	17.9	43.0	-25.1	21.6	43.0	-21.4
H162	19.6	43.0	-23.4	19.6	43.0	-23.4	19.6	43.0	-23.4	23.3	43.0	-19.7
H164	20.3	43.0	-22.7	20.3	43.0	-22.7	20.3	43.0	-22.7	24.0	43.0	-19.0
H165	20.5	43.0	-22.5	20.5	43.0	-22.5	20.5	43.0	-22.5	24.2	43.0	-18.8
H168	21.9	43.0	-21.1	21.9	43.0	-21.1	21.9	43.0	-21.1	25.6	43.0	-17.4
H173	24.1	43.0	-18.9	24.1	43.0	-18.9	24.1	43.0	-18.9	27.8	43.0	-15.2
H209	26.3	43.0	-16.7	26.3	43.0	-16.7	26.3	43.0	-16.7	30.0	43.0	-13.0
H222	20.6	43.0	-22.4	20.6	43.0	-22.4	20.6	43.0	-22.4	24.3	43.0	-18.7
H224	24.1	43.0	-18.9	24.1	43.0	-18.9	24.1	43.0	-18.9	27.8	43.0	-15.2

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	25.6	43.0	-17.4	28.7	43.0	-14.3	29.0	43.0	-14.0	29.0	43.7	-14.7
H2	25.1	43.0	-17.9	28.2	43.0	-14.8	28.5	43.0	-14.5	28.5	43.9	-15.4
H3	26.6	43.0	-16.4	29.7	43.0	-13.3	30.0	43.0	-13.0	30.0	43.0	-13.0
H4	26.7	43.0	-16.3	29.8	43.0	-13.2	30.1	43.0	-12.9	30.1	43.0	-12.9
H5	27.5	43.0	-15.5	30.6	43.0	-12.4	30.9	43.0	-12.1	30.9	43.0	-12.1
H6	29.4	43.0	-13.6	32.5	43.0	-10.5	32.8	43.0	-10.2	32.8	43.0	-10.2
H10	30.8	43.0	-12.2	33.9	43.0	-9.1	34.2	43.0	-8.8	34.2	43.0	-8.8
H11	29.6	43.0	-13.4	32.7	43.0	-10.3	33.0	43.0	-10.0	33.0	43.0	-10.0
H12	29.8	43.0	-13.2	32.9	43.0	-10.1	33.2	43.0	-9.8	33.2	43.0	-9.8
H13	30.1	43.0	-12.9	33.2	43.0	-9.8	33.5	43.0	-9.5	33.5	43.0	-9.5
H14	29.7	43.0	-13.3	32.8	43.0	-10.2	33.1	43.0	-9.9	33.1	43.0	-9.9
H16	29.5	43.0	-13.5	32.6	43.0	-10.4	32.9	43.0	-10.1	32.9	43.0	-10.1
H22	31.8	43.0	-11.2	34.9	43.0	-8.1	35.2	43.0	-7.8	35.2	43.0	-7.8
H24	29.1	43.0	-13.9	32.2	43.0	-10.8	32.5	43.0	-10.5	32.5	43.0	-10.5
H27	34.9	43.0	-8.1	38.0	43.0	-5.0	38.3	43.0	-4.7	38.3	43.0	-4.7
H33	29.6	43.0	-13.4	32.7	43.0	-10.3	33.0	43.0	-10.0	33.0	43.0	-10.0
H34	30.5	43.0	-12.5	33.6	43.0	-9.4	33.9	43.0	-9.1	33.9	43.0	-9.1
H39	28.9	43.0	-14.1	32.0	43.0	-11.0	32.3	43.0	-10.7	32.3	43.0	-10.7
H45	32.7	43.0	-10.3	35.8	43.0	-7.2	36.1	43.0	-6.9	36.1	43.0	-6.9
H49	33.1	43.0	-9.9	36.2	43.0	-6.8	36.5	43.0	-6.5	36.5	43.0	-6.5
H52	29.4	43.0	-13.6	32.5	43.0	-10.5	32.8	43.0	-10.2	32.8	43.0	-10.2
H91	29.7	43.0	-13.3	32.8	43.0	-10.2	33.1	43.0	-9.9	33.1	43.0	-9.9
H94	33.2	43.0	-9.8	36.3	43.0	-6.7	36.6	43.0	-6.4	36.6	43.0	-6.4
H158	26.6	43.0	-16.4	29.7	43.0	-13.3	30.0	43.0	-13.0	30.0	43.0	-13.0
H162	28.3	43.0	-14.7	31.4	43.0	-11.6	31.7	43.0	-11.3	31.7	43.0	-11.3
H164	29.0	43.0	-14.0	32.1	43.0	-10.9	32.4	43.0	-10.6	32.4	43.0	-10.6
H165	29.2	43.0	-13.8	32.3	43.0	-10.7	32.6	43.0	-10.4	32.6	43.0	-10.4
H168	30.6	43.0	-12.4	33.7	43.0	-9.3	34.0	43.0	-9.0	34.0	43.0	-9.0
H173	32.8	43.0	-10.2	35.9	43.0	-7.1	36.2	43.0	-6.8	36.2	43.0	-6.8
H209	35.0	43.0	-8.0	38.1	43.0	-4.9	38.4	43.0	-4.6	38.4	43.0	-4.6
H222	29.3	43.0	-13.7	32.4	43.0	-10.6	32.7	43.0	-10.3	32.7	43.0	-10.3
H224	32.8	43.0	-10.2	35.9	43.0	-7.1	36.2	43.0	-6.8	36.2	43.0	-6.8

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	29.0	46.5	-17.5	29.0	49.4	-20.4	29.0	52.3	-23.3	29.0	55.1	-26.1
H2	28.5	46.7	-18.2	28.5	49.4	-20.9	28.5	52.1	-23.6	28.5	54.7	-26.2
H3	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	44.5	-14.5
H4	30.1	43.0	-12.9	30.1	43.0	-12.9	30.1	43.0	-12.9	30.1	44.5	-14.4
H5	30.9	43.0	-12.1	30.9	43.0	-12.1	30.9	43.0	-12.1	30.9	44.5	-13.6
H6	32.8	43.0	-10.2	32.8	43.0	-10.2	32.8	44.0	-11.2	32.8	46.9	-14.1
H10	34.2	43.0	-8.8	34.2	43.0	-8.8	34.2	44.0	-9.8	34.2	46.9	-12.7
H11	33.0	43.0	-10.0	33.0	43.0	-10.0	33.0	44.0	-11.0	33.0	46.9	-13.9
H12	33.2	43.0	-9.8	33.2	43.0	-9.8	33.2	44.0	-10.8	33.2	46.9	-13.7
H13	33.5	43.0	-9.5	33.5	43.0	-9.5	33.5	44.0	-10.5	33.5	46.9	-13.4
H14	33.1	43.0	-9.9	33.1	43.0	-9.9	33.1	44.0	-10.9	33.1	46.9	-13.8
H16	32.9	43.0	-10.1	32.9	43.0	-10.1	32.9	44.0	-11.1	32.9	46.9	-14.0
H22	35.2	43.0	-7.8	35.2	44.3	-9.1	35.2	47.1	-11.9	35.2	50.2	-15.0
H24	32.5	43.0	-10.5	32.5	44.3	-11.8	32.5	47.1	-14.6	32.5	50.2	-17.7
H27	38.3	43.0	-4.7	38.3	43.0	-4.7	38.3	43.0	-4.7	38.3	43.7	-5.4
H33	33.0	43.0	-10.0	33.0	43.0	-10.0	33.0	45.4	-12.4	33.0	48.9	-15.9
H34	33.9	43.0	-9.1	33.9	43.0	-9.1	33.9	44.0	-10.1	33.9	46.9	-13.0
H39	32.3	43.0	-10.7	32.3	43.0	-10.7	32.3	45.4	-13.1	32.3	48.9	-16.6
H45	36.1	43.0	-6.9	36.1	44.3	-8.2	36.1	47.1	-11.0	36.1	50.2	-14.1
H49	36.5	43.0	-6.5	36.5	43.0	-6.5	36.5	43.0	-6.5	36.5	43.7	-7.2
H52	32.8	43.0	-10.2	32.8	44.3	-11.5	32.8	47.1	-14.3	32.8	50.2	-17.4
H91	33.1	43.0	-9.9	33.1	44.3	-11.2	33.1	47.1	-14.0	33.1	50.2	-17.1
H94	36.6	43.0	-6.4	36.6	44.3	-7.7	36.6	47.1	-10.5	36.6	50.2	-13.6
H158	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	44.5	-14.5
H162	31.7	43.0	-11.3	31.7	43.0	-11.3	31.7	44.0	-12.3	31.7	46.9	-15.2
H164	32.4	43.0	-10.6	32.4	43.0	-10.6	32.4	44.0	-11.6	32.4	46.9	-14.5
H165	32.6	43.0	-10.4	32.6	43.0	-10.4	32.6	44.0	-11.4	32.6	46.9	-14.3
H168	34.0	43.0	-9.0	34.0	44.3	-10.3	34.0	47.1	-13.1	34.0	50.2	-16.2
H173	36.2	43.0	-6.8	36.2	44.3	-8.1	36.2	47.1	-10.9	36.2	50.2	-14.0
H209	38.4	43.0	-4.6	38.4	43.0	-4.6	38.4	43.0	-4.6	38.4	43.7	-5.3
H222	32.7	43.0	-10.3	32.7	43.0	-10.3	32.7	45.4	-12.7	32.7	48.9	-16.2
H224	36.2	43.0	-6.8	36.2	43.0	-6.8	36.2	43.0	-6.8	36.2	43.7	-7.5

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit

Table 20 - Comparison of Predicted Noise Levels for Enercon Option and Daytime Noise Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	16.3	35.0	-18.7	16.3	35.0	-18.7	16.3	35.0	-18.7	22.7	35.0	-12.3
H2	15.7	35.0	-19.3	15.7	35.0	-19.3	15.7	35.0	-19.3	22.1	35.0	-12.9
H3	17.3	35.0	-17.7	17.3	35.0	-17.7	17.3	35.0	-17.7	23.7	35.0	-11.3
H4	17.4	35.0	-17.6	17.4	35.0	-17.6	17.4	35.0	-17.6	23.8	35.0	-11.2
H5	18.3	35.0	-16.7	18.3	35.0	-16.7	18.3	35.0	-16.7	24.7	35.0	-10.3
H6	20.2	35.0	-14.8	20.2	35.5	-15.3	20.2	36.3	-16.1	26.6	36.6	-10.0
H10	21.7	35.0	-13.3	21.7	35.5	-13.8	21.7	36.3	-14.6	28.1	36.6	-8.5
H11	20.4	35.0	-14.6	20.4	35.5	-15.1	20.4	36.3	-15.9	26.8	36.6	-9.8
H12	20.7	35.0	-14.3	20.7	35.5	-14.8	20.7	36.3	-15.6	27.1	36.6	-9.5
H13	21.0	35.0	-14.0	21.0	35.5	-14.5	21.0	36.3	-15.3	27.4	36.6	-9.2
H14	20.5	35.0	-14.5	20.5	35.5	-15.0	20.5	36.3	-15.8	26.9	36.6	-9.7
H16	20.3	35.0	-14.7	20.3	35.5	-15.2	20.3	36.3	-16.0	26.7	36.6	-9.9
H22	22.7	35.0	-12.3	22.7	35.0	-12.3	22.7	35.3	-12.6	29.1	36.5	-7.4
H24	19.8	35.0	-15.2	19.8	35.0	-15.2	19.8	35.3	-15.5	26.2	36.5	-10.3
H27	25.9	35.0	-9.1	25.9	35.0	-9.1	25.9	35.0	-9.1	32.3	35.0	-2.7
H33	20.5	35.0	-14.5	20.5	35.0	-14.5	20.5	35.0	-14.5	26.9	35.0	-8.1
H34	21.3	35.0	-13.7	21.3	35.5	-14.2	21.3	36.3	-15.0	27.7	36.6	-8.9
H39	19.7	35.0	-15.3	19.7	35.0	-15.3	19.7	35.0	-15.3	26.1	35.0	-8.9
H45	23.6	35.0	-11.4	23.6	35.0	-11.4	23.6	35.3	-11.7	30.0	36.5	-6.5
H49	24.0	35.0	-11.0	24.0	35.0	-11.0	24.0	35.0	-11.0	30.4	35.0	-4.6
H52	20.2	35.0	-14.8	20.2	35.0	-14.8	20.2	35.3	-15.1	26.6	36.5	-9.9
H91	20.4	35.0	-14.6	20.4	35.0	-14.6	20.4	35.3	-14.9	26.8	36.5	-9.7
H94	24.2	35.0	-10.8	24.2	35.0	-10.8	24.2	35.3	-11.1	30.6	36.5	-5.9
H158	17.3	35.0	-17.7	17.3	35.0	-17.7	17.3	35.0	-17.7	23.7	35.0	-11.3
H162	19.1	35.0	-15.9	19.1	35.5	-16.4	19.1	36.3	-17.2	25.5	36.6	-11.1
H164	19.8	35.0	-15.2	19.8	35.5	-15.7	19.8	36.3	-16.5	26.2	36.6	-10.4
H165	20.0	35.0	-15.0	20.0	35.5	-15.5	20.0	36.3	-16.3	26.4	36.6	-10.2
H168	21.5	35.0	-13.5	21.5	35.0	-13.5	21.5	35.3	-13.8	27.9	36.5	-8.6
H173	23.8	35.0	-11.2	23.8	35.0	-11.2	23.8	35.3	-11.5	30.2	36.5	-6.3
H209	26.1	35.0	-8.9	26.1	35.0	-8.9	26.1	35.0	-8.9	32.5	35.0	-2.5
H222	20.1	35.0	-14.9	20.1	35.0	-14.9	20.1	35.0	-14.9	26.5	35.0	-8.5
H224	23.6	35.0	-11.4	23.6	35.0	-11.4	23.6	35.0	-11.4	30.0	35.0	-5.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	26.0	37.4	-11.4	27.0	40.3	-13.3	27.9	43.0	-15.1	28.7	45.5	-16.8
H2	25.4	37.0	-11.6	26.4	39.7	-13.3	27.3	42.3	-15.0	28.1	44.8	-16.7
H3	27.0	35.0	-8.0	28.0	35.5	-7.5	28.9	37.0	-8.1	29.7	39.0	-9.3
H4	27.1	35.0	-7.9	28.1	35.5	-7.4	29.0	37.0	-8.0	29.8	39.0	-9.2
H5	28.0	35.0	-7.0	29.0	35.5	-6.5	29.9	37.0	-7.1	30.7	39.0	-8.3
H6	29.9	36.6	-6.7	30.9	36.7	-5.8	31.8	37.0	-5.2	32.6	38.0	-5.4
H10	31.4	36.6	-5.2	32.4	36.7	-4.3	33.3	37.0	-3.7	34.1	38.0	-3.9
H11	30.1	36.6	-6.5	31.1	36.7	-5.6	32.0	37.0	-5.0	32.8	38.0	-5.2
H12	30.4	36.6	-6.2	31.4	36.7	-5.3	32.3	37.0	-4.7	33.1	38.0	-4.9
H13	30.7	36.6	-5.9	31.7	36.7	-5.0	32.6	37.0	-4.4	33.4	38.0	-4.6
H14	30.2	36.6	-6.4	31.2	36.7	-5.5	32.1	37.0	-4.9	32.9	38.0	-5.1
H16	30.0	36.6	-6.6	31.0	36.7	-5.7	31.9	37.0	-5.1	32.7	38.0	-5.3
H22	32.4	37.7	-5.3	33.4	39.0	-5.6	34.3	40.5	-6.2	35.1	42.4	-7.3
H24	29.5	37.7	-8.2	30.5	39.0	-8.5	31.4	40.5	-9.1	32.2	42.4	-10.2
H27	35.6	35.0	0.6	36.6	35.0	1.6	37.5	35.0	2.5	38.3	35.5	2.8
H33	30.2	35.0	-4.8	31.2	35.0	-3.8	32.1	35.2	-3.1	32.9	37.6	-4.7
H34	31.0	36.6	-5.6	32.0	36.7	-4.7	32.9	37.0	-4.1	33.7	38.0	-4.3
H39	29.4	35.0	-5.6	30.4	35.0	-4.6	31.3	35.2	-3.9	32.1	37.6	-5.5
H45	33.3	37.7	-4.4	34.3	39.0	-4.7	35.2	40.5	-5.3	36.0	42.4	-6.4
H49	33.7	35.0	-1.3	34.7	35.0	-0.3	35.6	35.0	0.6	36.4	35.5	0.9
H52	29.9	37.7	-7.8	30.9	39.0	-8.1	31.8	40.5	-8.7	32.6	42.4	-9.8
H91	30.1	37.7	-7.6	31.1	39.0	-7.9	32.0	40.5	-8.5	32.8	42.4	-9.6
H94	33.9	37.7	-3.8	34.9	39.0	-4.1	35.8	40.5	-4.7	36.6	42.4	-5.8
H158	27.0	35.0	-8.0	28.0	35.5	-7.5	28.9	37.0	-8.1	29.7	39.0	-9.3
H162	28.8	36.6	-7.8	29.8	36.7	-6.9	30.7	37.0	-6.3	31.5	38.0	-6.5
H164	29.5	36.6	-7.1	30.5	36.7	-6.2	31.4	37.0	-5.6	32.2	38.0	-5.8
H165	29.7	36.6	-6.9	30.7	36.7	-6.0	31.6	37.0	-5.4	32.4	38.0	-5.6
H168	31.2	37.7	-6.5	32.2	39.0	-6.8	33.1	40.5	-7.4	33.9	42.4	-8.5
H173	33.5	37.7	-4.2	34.5	39.0	-4.5	35.4	40.5	-5.1	36.2	42.4	-6.2
H209	35.8	35.0	0.8	36.8	35.0	1.8	37.7	35.0	2.7	38.5	35.5	3.0
H222	29.8	35.0	-5.2	30.8	35.0	-4.2	31.7	35.2	-3.5	32.5	37.6	-5.1
H224	33.3	35.0	-1.7	34.3	35.0	-0.7	35.2	35.0	0.2	36.0	35.5	0.5

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	28.9	48.0	-19.1	28.9	50.5	-21.6	28.9	52.9	-24.0	28.9	55.4	-26.5
H2	28.3	47.4	-19.1	28.3	50.0	-21.7	28.3	52.6	-24.3	28.3	55.4	-27.1
H3	29.9	41.2	-11.3	29.9	43.1	-13.2	29.9	44.8	-14.9	29.9	46.4	-16.5
H4	30.0	41.2	-11.2	30.0	43.1	-13.1	30.0	44.8	-14.8	30.0	46.4	-16.4
H5	30.9	41.2	-10.3	30.9	43.1	-12.2	30.9	44.8	-13.9	30.9	46.4	-15.5
H6	32.8	39.7	-6.9	32.8	42.6	-9.8	32.8	46.8	-14.0	32.8	46.8	-14.0
H10	34.3	39.7	-5.4	34.3	42.6	-8.3	34.3	46.8	-12.5	34.3	46.8	-12.5
H11	33.0	39.7	-6.7	33.0	42.6	-9.6	33.0	46.8	-13.8	33.0	46.8	-13.8
H12	33.3	39.7	-6.4	33.3	42.6	-9.3	33.3	46.8	-13.5	33.3	46.8	-13.5
H13	33.6	39.7	-6.1	33.6	42.6	-9.0	33.6	46.8	-13.2	33.6	46.8	-13.2
H14	33.1	39.7	-6.6	33.1	42.6	-9.5	33.1	46.8	-13.7	33.1	46.8	-13.7
H16	32.9	39.7	-6.8	32.9	42.6	-9.7	32.9	46.8	-13.9	32.9	46.8	-13.9
H22	35.3	44.8	-9.5	35.3	47.9	-12.6	35.3	51.6	-16.3	35.3	51.6	-16.3
H24	32.4	44.8	-12.4	32.4	47.9	-15.5	32.4	51.6	-19.2	32.4	51.6	-19.2
H27	38.5	37.8	0.7	38.5	40.4	-1.9	38.5	43.4	-4.9	38.5	43.4	-4.9
H33	33.1	40.5	-7.4	33.1	44.2	-11.1	33.1	48.7	-15.6	33.1	48.7	-15.6
H34	33.9	39.7	-5.8	33.9	42.6	-8.7	33.9	46.8	-12.9	33.9	46.8	-12.9
H39	32.3	40.5	-8.2	32.3	44.2	-11.9	32.3	48.7	-16.4	32.3	48.7	-16.4
H45	36.2	44.8	-8.6	36.2	47.9	-11.7	36.2	51.6	-15.4	36.2	51.6	-15.4
H49	36.6	37.8	-1.2	36.6	40.4	-3.8	36.6	43.4	-6.8	36.6	43.4	-6.8
H52	32.8	44.8	-12.0	32.8	47.9	-15.1	32.8	51.6	-18.8	32.8	51.6	-18.8
H91	33.0	44.8	-11.8	33.0	47.9	-14.9	33.0	51.6	-18.6	33.0	51.6	-18.6
H94	36.8	44.8	-8.0	36.8	47.9	-11.1	36.8	51.6	-14.8	36.8	51.6	-14.8
H158	29.9	41.2	-11.3	29.9	43.1	-13.2	29.9	44.8	-14.9	29.9	46.4	-16.5
H162	31.7	39.7	-8.0	31.7	42.6	-10.9	31.7	46.8	-15.1	31.7	46.8	-15.1
H164	32.4	39.7	-7.3	32.4	42.6	-10.2	32.4	46.8	-14.4	32.4	46.8	-14.4
H165	32.6	39.7	-7.1	32.6	42.6	-10.0	32.6	46.8	-14.2	32.6	46.8	-14.2
H168	34.1	44.8	-10.7	34.1	47.9	-13.8	34.1	51.6	-17.5	34.1	51.6	-17.5
H173	36.4	44.8	-8.4	36.4	47.9	-11.5	36.4	51.6	-15.2	36.4	51.6	-15.2
H209	38.7	37.8	0.9	38.7	40.4	-1.7	38.7	43.4	-4.7	38.7	43.4	-4.7
H222	32.7	40.5	-7.8	32.7	44.2	-11.5	32.7	48.7	-16.0	32.7	48.7	-16.0
H224	36.2	37.8	-1.6	36.2	40.4	-4.2	36.2	43.4	-7.2	36.2	43.4	-7.2

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit

Table 21 - Comparison of Predicted Noise Levels for Enercon Option and Night Time Limits - (dB(A) re 20 µPa)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1			2			3			4		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	16.3	43.0	-26.7	16.3	43.0	-26.7	16.3	43.0	-26.7	22.7	43.0	-20.3
H2	15.7	43.0	-27.3	15.7	43.0	-27.3	15.7	43.0	-27.3	22.1	43.0	-20.9
H3	17.3	43.0	-25.7	17.3	43.0	-25.7	17.3	43.0	-25.7	23.7	43.0	-19.3
H4	17.4	43.0	-25.6	17.4	43.0	-25.6	17.4	43.0	-25.6	23.8	43.0	-19.2
H5	18.3	43.0	-24.7	18.3	43.0	-24.7	18.3	43.0	-24.7	24.7	43.0	-18.3
H6	20.2	43.0	-22.8	20.2	43.0	-22.8	20.2	43.0	-22.8	26.6	43.0	-16.4
H10	21.7	43.0	-21.3	21.7	43.0	-21.3	21.7	43.0	-21.3	28.1	43.0	-14.9
H11	20.4	43.0	-22.6	20.4	43.0	-22.6	20.4	43.0	-22.6	26.8	43.0	-16.2
H12	20.7	43.0	-22.3	20.7	43.0	-22.3	20.7	43.0	-22.3	27.1	43.0	-15.9
H13	21.0	43.0	-22.0	21.0	43.0	-22.0	21.0	43.0	-22.0	27.4	43.0	-15.6
H14	20.5	43.0	-22.5	20.5	43.0	-22.5	20.5	43.0	-22.5	26.9	43.0	-16.1
H16	20.3	43.0	-22.7	20.3	43.0	-22.7	20.3	43.0	-22.7	26.7	43.0	-16.3
H22	22.7	43.0	-20.3	22.7	43.0	-20.3	22.7	43.0	-20.3	29.1	43.0	-13.9
H24	19.8	43.0	-23.2	19.8	43.0	-23.2	19.8	43.0	-23.2	26.2	43.0	-16.8
H27	25.9	43.0	-17.1	25.9	43.0	-17.1	25.9	43.0	-17.1	32.3	43.0	-10.7
H33	20.5	43.0	-22.5	20.5	43.0	-22.5	20.5	43.0	-22.5	26.9	43.0	-16.1
H34	21.3	43.0	-21.7	21.3	43.0	-21.7	21.3	43.0	-21.7	27.7	43.0	-15.3
H39	19.7	43.0	-23.3	19.7	43.0	-23.3	19.7	43.0	-23.3	26.1	43.0	-16.9
H45	23.6	43.0	-19.4	23.6	43.0	-19.4	23.6	43.0	-19.4	30.0	43.0	-13.0
H49	24.0	43.0	-19.0	24.0	43.0	-19.0	24.0	43.0	-19.0	30.4	43.0	-12.6
H52	20.2	43.0	-22.8	20.2	43.0	-22.8	20.2	43.0	-22.8	26.6	43.0	-16.4
H91	20.4	43.0	-22.6	20.4	43.0	-22.6	20.4	43.0	-22.6	26.8	43.0	-16.2
H94	24.2	43.0	-18.8	24.2	43.0	-18.8	24.2	43.0	-18.8	30.6	43.0	-12.4
H158	17.3	43.0	-25.7	17.3	43.0	-25.7	17.3	43.0	-25.7	23.7	43.0	-19.3
H162	19.1	43.0	-23.9	19.1	43.0	-23.9	19.1	43.0	-23.9	25.5	43.0	-17.5
H164	19.8	43.0	-23.2	19.8	43.0	-23.2	19.8	43.0	-23.2	26.2	43.0	-16.8
H165	20.0	43.0	-23.0	20.0	43.0	-23.0	20.0	43.0	-23.0	26.4	43.0	-16.6
H168	21.5	43.0	-21.5	21.5	43.0	-21.5	21.5	43.0	-21.5	27.9	43.0	-15.1
H173	23.8	43.0	-19.2	23.8	43.0	-19.2	23.8	43.0	-19.2	30.2	43.0	-12.8
H209	26.1	43.0	-16.9	26.1	43.0	-16.9	26.1	43.0	-16.9	32.5	43.0	-10.5
H222	20.1	43.0	-22.9	20.1	43.0	-22.9	20.1	43.0	-22.9	26.5	43.0	-16.5
H224	23.6	43.0	-19.4	23.6	43.0	-19.4	23.6	43.0	-19.4	30.0	43.0	-13.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	5			6			7			8		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	26.0	43.0	-17.0	27.0	43.0	-16.0	27.9	43.0	-15.1	28.7	43.7	-15.0
H2	25.4	43.0	-17.6	26.4	43.0	-16.6	27.3	43.0	-15.7	28.1	43.9	-15.8
H3	27.0	43.0	-16.0	28.0	43.0	-15.0	28.9	43.0	-14.1	29.7	43.0	-13.3
H4	27.1	43.0	-15.9	28.1	43.0	-14.9	29.0	43.0	-14.0	29.8	43.0	-13.2
H5	28.0	43.0	-15.0	29.0	43.0	-14.0	29.9	43.0	-13.1	30.7	43.0	-12.3
H6	29.9	43.0	-13.1	30.9	43.0	-12.1	31.8	43.0	-11.2	32.6	43.0	-10.4
H10	31.4	43.0	-11.6	32.4	43.0	-10.6	33.3	43.0	-9.7	34.1	43.0	-8.9
H11	30.1	43.0	-12.9	31.1	43.0	-11.9	32.0	43.0	-11.0	32.8	43.0	-10.2
H12	30.4	43.0	-12.6	31.4	43.0	-11.6	32.3	43.0	-10.7	33.1	43.0	-9.9
H13	30.7	43.0	-12.3	31.7	43.0	-11.3	32.6	43.0	-10.4	33.4	43.0	-9.6
H14	30.2	43.0	-12.8	31.2	43.0	-11.8	32.1	43.0	-10.9	32.9	43.0	-10.1
H16	30.0	43.0	-13.0	31.0	43.0	-12.0	31.9	43.0	-11.1	32.7	43.0	-10.3
H22	32.4	43.0	-10.6	33.4	43.0	-9.6	34.3	43.0	-8.7	35.1	43.0	-7.9
H24	29.5	43.0	-13.5	30.5	43.0	-12.5	31.4	43.0	-11.6	32.2	43.0	-10.8
H27	35.6	43.0	-7.4	36.6	43.0	-6.4	37.5	43.0	-5.5	38.3	43.0	-4.7
H33	30.2	43.0	-12.8	31.2	43.0	-11.8	32.1	43.0	-10.9	32.9	43.0	-10.1
H34	31.0	43.0	-12.0	32.0	43.0	-11.0	32.9	43.0	-10.1	33.7	43.0	-9.3
H39	29.4	43.0	-13.6	30.4	43.0	-12.6	31.3	43.0	-11.7	32.1	43.0	-10.9
H45	33.3	43.0	-9.7	34.3	43.0	-8.7	35.2	43.0	-7.8	36.0	43.0	-7.0
H49	33.7	43.0	-9.3	34.7	43.0	-8.3	35.6	43.0	-7.4	36.4	43.0	-6.6
H52	29.9	43.0	-13.1	30.9	43.0	-12.1	31.8	43.0	-11.2	32.6	43.0	-10.4
H91	30.1	43.0	-12.9	31.1	43.0	-11.9	32.0	43.0	-11.0	32.8	43.0	-10.2
H94	33.9	43.0	-9.1	34.9	43.0	-8.1	35.8	43.0	-7.2	36.6	43.0	-6.4
H158	27.0	43.0	-16.0	28.0	43.0	-15.0	28.9	43.0	-14.1	29.7	43.0	-13.3
H162	28.8	43.0	-14.2	29.8	43.0	-13.2	30.7	43.0	-12.3	31.5	43.0	-11.5
H164	29.5	43.0	-13.5	30.5	43.0	-12.5	31.4	43.0	-11.6	32.2	43.0	-10.8
H165	29.7	43.0	-13.3	30.7	43.0	-12.3	31.6	43.0	-11.4	32.4	43.0	-10.6
H168	31.2	43.0	-11.8	32.2	43.0	-10.8	33.1	43.0	-9.9	33.9	43.0	-9.1
H173	33.5	43.0	-9.5	34.5	43.0	-8.5	35.4	43.0	-7.6	36.2	43.0	-6.8
H209	35.8	43.0	-7.2	36.8	43.0	-6.2	37.7	43.0	-5.3	38.5	43.0	-4.5
H222	29.8	43.0	-13.2	30.8	43.0	-12.2	31.7	43.0	-11.3	32.5	43.0	-10.5
H224	33.3	43.0	-9.7	34.3	43.0	-8.7	35.2	43.0	-7.8	36.0	43.0	-7.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	9			10			11			12		
	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL	L_p	Limit	ΔL
H1	28.9	46.5	-17.6	28.9	49.4	-20.5	28.9	52.3	-23.4	28.9	55.1	-26.2
H2	28.3	46.7	-18.4	28.3	49.4	-21.1	28.3	52.1	-23.8	28.3	54.7	-26.4
H3	29.9	43.0	-13.1	29.9	43.0	-13.1	29.9	43.0	-13.1	29.9	44.5	-14.6
H4	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	43.0	-13.0	30.0	44.5	-14.5
H5	30.9	43.0	-12.1	30.9	43.0	-12.1	30.9	43.0	-12.1	30.9	44.5	-13.6
H6	32.8	43.0	-10.2	32.8	43.0	-10.2	32.8	44.0	-11.2	32.8	46.9	-14.1
H10	34.3	43.0	-8.7	34.3	43.0	-8.7	34.3	44.0	-9.7	34.3	46.9	-12.6
H11	33.0	43.0	-10.0	33.0	43.0	-10.0	33.0	44.0	-11.0	33.0	46.9	-13.9
H12	33.3	43.0	-9.7	33.3	43.0	-9.7	33.3	44.0	-10.7	33.3	46.9	-13.6
H13	33.6	43.0	-9.4	33.6	43.0	-9.4	33.6	44.0	-10.4	33.6	46.9	-13.3
H14	33.1	43.0	-9.9	33.1	43.0	-9.9	33.1	44.0	-10.9	33.1	46.9	-13.8
H16	32.9	43.0	-10.1	32.9	43.0	-10.1	32.9	44.0	-11.1	32.9	46.9	-14.0
H22	35.3	43.0	-7.7	35.3	44.3	-9.0	35.3	47.1	-11.8	35.3	50.2	-14.9
H24	32.4	43.0	-10.6	32.4	44.3	-11.9	32.4	47.1	-14.7	32.4	50.2	-17.8
H27	38.5	43.0	-4.5	38.5	43.0	-4.5	38.5	43.0	-4.5	38.5	43.7	-5.2
H33	33.1	43.0	-9.9	33.1	43.0	-9.9	33.1	45.4	-12.3	33.1	48.9	-15.8
H34	33.9	43.0	-9.1	33.9	43.0	-9.1	33.9	44.0	-10.1	33.9	46.9	-13.0
H39	32.3	43.0	-10.7	32.3	43.0	-10.7	32.3	45.4	-13.1	32.3	48.9	-16.6
H45	36.2	43.0	-6.8	36.2	44.3	-8.1	36.2	47.1	-10.9	36.2	50.2	-14.0
H49	36.6	43.0	-6.4	36.6	43.0	-6.4	36.6	43.0	-6.4	36.6	43.7	-7.1
H52	32.8	43.0	-10.2	32.8	44.3	-11.5	32.8	47.1	-14.3	32.8	50.2	-17.4
H91	33.0	43.0	-10.0	33.0	44.3	-11.3	33.0	47.1	-14.1	33.0	50.2	-17.2
H94	36.8	43.0	-6.2	36.8	44.3	-7.5	36.8	47.1	-10.3	36.8	50.2	-13.4
H158	29.9	43.0	-13.1	29.9	43.0	-13.1	29.9	43.0	-13.1	29.9	44.5	-14.6
H162	31.7	43.0	-11.3	31.7	43.0	-11.3	31.7	44.0	-12.3	31.7	46.9	-15.2
H164	32.4	43.0	-10.6	32.4	43.0	-10.6	32.4	44.0	-11.6	32.4	46.9	-14.5
H165	32.6	43.0	-10.4	32.6	43.0	-10.4	32.6	44.0	-11.4	32.6	46.9	-14.3
H168	34.1	43.0	-8.9	34.1	44.3	-10.2	34.1	47.1	-13.0	34.1	50.2	-16.1
H173	36.4	43.0	-6.6	36.4	44.3	-7.9	36.4	47.1	-10.7	36.4	50.2	-13.8
H209	38.7	43.0	-4.3	38.7	43.0	-4.3	38.7	43.0	-4.3	38.7	43.7	-5.0
H222	32.7	43.0	-10.3	32.7	43.0	-10.3	32.7	45.4	-12.7	32.7	48.9	-16.2
H224	36.2	43.0	-6.8	36.2	43.0	-6.8	36.2	43.0	-6.8	36.2	43.7	-7.5

The term L_p is used to denote the predicted noise level due to the operation of the proposed wind farm
The term ΔL is used to denote the difference between the predicted wind farm noise level and the recommended limit

Potential Construction Impacts

Construction Noise Assessment

11.91 Primary activities creating noise during the construction period are from the construction of the turbine foundations, crane hard standings, site compounds, water crossings and access tracks. Noise from vehicles on local roads and access tracks would also arise due to the delivery of turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

11.92 It should be noted that the exact methodology and timing of construction activities cannot be predicted at this time, this assessment is therefore based on assumptions representing a worst-case approach.

Construction Noise Predictions

11.93 The plant assumed for each construction activity is shown in **Table 22**. The number of items indicates how many of each plant are required for the specified activity, and the duration of activity is a percentage of a given 12 hour day period needed for that plant to operate. Overall sound power levels are based upon the data in Annex C of BS 52281:2009.

Table 22: Construction Phases and Sound Power Levels

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Construction Compound	Tracked excavator	113	2	100	119
	Dump truck	113	2	100	
	Tipper lorry	107	2	50	
	Vibratory roller	102	1	75	
	Lorry	108	1	75	
Construct Site Tracks	Tracked excavator	113	3	100	122
	Dump truck	113	2	75	
	Tipper lorry	107	4	50	
	Dozer	109	1	100	
	Vibratory roller	102	1	75	
	Excavator mounted rock breaker	121	1	33	
Construct Substations	Tracked excavator	113	1	100	117
	Concrete mixer truck	108	2	50	
	Lorry	108	1	50	
	Telescopic Handler	99	1	100	
	Piling rig	117	1	50	
Construct crane hard-standings	Tracked excavator	113	3	100	120
	Dump truck	113	2	100	
	Tipper lorry	107	4	50	
	Vibratory roller	102	1	50	
	Tracked excavator	113	2	75	123

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
Construct Turbine Foundations	Dump truck	113	2	75	
	Concrete mixer truck	108	4	50	
	Mobile telescopic crane	110	1	50	
	Concrete pump	106	2	50	
	Water pump	93	1	100	
	Compressor	103	1	75	
	Piling rig	117	3	50	
	Poker vibrator	106	1	100	
	Excavator mounted rock breaker	121	3	50	
Excavate and Lay Site Cables	Tracked excavator	113	2	100	122
	Dump truck	113	2	75	
	Tractor (Towing Equipment)	108	1	75	
	Tractor (Towing Trailer)	107	1	75	
	Vibratory plate	108	1	50	
	Excavator mounted rock breaker	121	1	50	
Erect Turbine	Mobile telescopic crane	110	2	75	119
	Lorry	108	1	75	
	Diesel generator	102	1	100	
	Torque guns	111	4	100	
Reinstate Crane Bases	Tracked excavator	113	1	75	115
	Dump truck	113	1	75	
Lay Cable to Substations	Wheeled loader	108	1	100	118
	Saw	114	1	50	
	Hand-held pneumatic breaker	111	1	50	
	Dump truck	113	1	75	
	Tipper lorry	107	1	50	
	Vibratory plate	108	1	75	
	Tandem roller	102	1	75	
	Tractor (Towing Trailer)	107	1	50	
	Lorry	108	1	75	
Construct New Water Crossing	Tracked Excavator	113	1	100	120
	Dump Truck	113	1	100	
	Tipper lorry	107	4	50	
	Dozer	109	1	75	
	Vibratory Roller	102	1	75	
	Telescopic Handler	99	1	100	
	Piling Rig	117	1	50	

Activities	Plant	Sound Power (L_{WA})	No. Items	Activity Duration (%)	Effective Sound Power (L_{WA})
	Concrete Pump	106	1	50	
	Concrete mixer truck	108	3	50	
	Poker vibrator	106	2	50	
	Water pump	93	2	100	

11.94 Predictions of construction noise levels have been carried out using the methods prescribed in Annex F of BS 5228-1:2009[18]. The worst case scenario, where each construction activity takes place at the nearest proposed location to the residential property being assessed, is considered. The locations of the construction activities are taken from the infrastructure drawing. The results of these predictions, made at six representative residential properties, are shown in **Table 23**.

11.95 In all cases average noise levels over the construction period would be lower as the worst case is presented for when the activities are closest to the residential property.

Table 23: Predicted Sound Pressure Level due to Construction Noise (dB L_{Aeq})

Activity	H1	H27	H33	H34	H45	H94
Construct Temporary site compounds	35.0	43.8	43.0	35.5	36.8	37.8
Construct site tracks	43.6	49.6	46.6	47.4	48.8	48.7
Construct Substations	33.1	41.4	40.9	33.5	34.7	35.7
Construct crane hardstandings	42.2	48.2	45.2	46.0	47.4	47.3
Construct Turbine Foundations	45.1	51.1	48.1	48.9	50.3	50.2
Excavate and Lay Site Cables	43.4	49.4	46.4	47.2	48.6	48.5
Erect Turbine	40.5	46.5	43.5	44.3	45.7	45.6
Reinstate Crane Bases	36.5	42.5	39.5	40.3	41.7	41.6
Lay Cable to Substations	39.3	45.3	42.3	43.1	44.5	44.4
Construct New Water Crossing	40.8	47.9	44.9	43.8	43.4	46.9

Construction Traffic

11.96 Due to the delivery of construction material and wind farm components, vehicle movements either into or away from the site shall increase levels of traffic flow on public roads in the area. Traffic regularly accessing the site is shown in **Chapter 12: Traffic and Transport** and is assumed to be characterised by the sound power levels of Dump Trucks, Lorries and Concrete Mixers as a worst case. It is estimated that a total of 260 vehicle movements per day would be required during the most intense period of construction activity although this would only be the case for a maximum of 12 days during foundation pouring.

11.97 Construction traffic noise has been quantified using the method described in BS 5228:2009 Part 1. Using the distances from residential properties to the centre of the relevant carriageway where site traffic would be, the noise levels predicted are presented in

[18] A 50% mixed ground attenuation has been used throughout to conservatively account for the arable nature of ground conditions in the vicinity of the proposed development

Table 24. The maximum sound pressure level due to traffic flows during the most intensive period of activity is predicted to be 43.0 dB L_{Aeq}.

Table 24: Traffic Noise Predictions by Activity (dB L_{Aeq})

House ID	Dump Truck	Lorries	Concrete Mixer	Total
H1	36.9	32.3	36.3	40.4
H27	39.6	34.9	38.9	43.0
H33	38.2	33.6	37.6	41.7
H34	38.6	34.0	38.0	42.1
H45	39.2	34.6	38.6	42.7
H94	39.2	34.6	38.6	42.7

General Construction Noise in Conjunction with Traffic Noise

11.98 Worst case construction noise levels may arise when the following simultaneous activities occur: construction of the turbine foundations, crane hard standings and access tracks. Therefore cumulative predictions of these construction activities and the additional noise contribution from construction traffic have been calculated and are shown in **Table 25**.

11.99 It should be noted that the predictions exclude the screening effects of local topography therefore actual levels of noise experienced at nearby residential properties could be lower.

Table 25: Predicted Noise Due to Combined Traffic Noise and Turbine Construction (dB L_{Aeq})

House ID	Construction Plant Noise	Traffic Noise	Combined Noise
H1	48.6	40.4	49.2
H27	54.6	43.0	54.6
H33	51.6	41.7	52.0
H34	52.4	42.1	52.4
H45	53.8	42.7	53.8
H94	53.7	42.7	53.7

Assessment of Construction Noise

11.100 In accordance with the ABC method of Annex E of BS 5228-1:2009, due to the relatively low levels of ambient noise in the vicinity of the proposed development, a Category A assessment is appropriate. This category sets significant effect threshold L_{Aeq} criteria of: 65 dB(A) during weekdays (0700-1900) and Saturdays (0700-1300); 55 dB(A) at evenings and weekends; and 45 dB(A) for night-time (2300-0700) periods.

11.101 **Table 25** shows that predicted noise levels from the combined effect of increased traffic flows and activities associated with the peak of construction activities are below the 65 dB(A) daytime threshold specified by BS 5228-1:2009 at all of the assessed residential properties.

11.102 Peak construction noise levels are also predicted to meet the 55 dB(A) threshold for evenings and weekends at all of the assessed properties.

11.103 An assessment against the night-time threshold has not been undertaken as construction work is not scheduled to take place during the night with the exception of turbine erection

and commissioning or periods of emergency work. Predicted noise levels of 46.5 dB(A) due to turbine erection imply that this activity should be avoided at night as far as possible.

11.104 The predictions made represent the worst-case combination of most intensive traffic activity with simultaneous construction activity at the nearest possible location to each residential property.

Mitigation

Operational Noise

11.105 One of the key constraints and considerations in designing the layout of the turbines was the minimisation of potential noise impacts at the nearest residential receptors. As such the turbine layout was designed to ensure that there is an adequate separation distance between any of the proposed turbines and the nearest residential property.

11.106 Due to this consideration of the noise impacts in the design of the wind farm, embedding mitigation measures in the turbine layout, when a conservative candidate machine is modelled a limited amount of noise management is required to meet noise limits derived in accordance with ETSU-R-97.

11.107 Noise management involves altering the operational mode of the turbines in certain conditions by changing the pitch of the blades, resulting in a trade-off between power production and noise reduction. .

11.108 If planning permission is granted for the proposed development, planning conditions can be proposed to provide a degree of protection to nearby residents in the form of limits relating to noise level and tonality.

11.109 **Technical Appendix 11.8** contains a set of conditions that RES considers appropriate.

Construction Noise

11.110 For all activities, measures would be taken to reduce noise levels with due regard to practicality and cost as per the concept of 'best practicable means' as defined in Pollution Control and Local Government (NI) Order 1978.

11.111 BS 5228-1:2009 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authority and Community Liaison Group is advised to inform residents of intended activity. Non-acoustic factors, which influence the overall level of complaints such as mud on roads and dust generation, would also be controlled through construction practices adopted on the site.

11.112 Furthermore, the following noise mitigation options could be implemented where appropriate:

- Consideration would be given to noise emissions when selecting plant and equipment to be used on site;
- All equipment should be maintained in good working order and fitted with the appropriate silencers, mufflers or acoustic covers where applicable;
- Stationary noise sources would be sited as far away as reasonably possible from residential properties; and

- The movement of vehicles to and from the site would be controlled and employees instructed to ensure compliance with the noise control measures adopted.

11.113 Site operations would be limited to 0700-1900 Monday to Saturday except during turbine erection and commissioning or during periods of emergency work.

Residual Effects

Operational

11.114 The acoustic assessment demonstrates that predicted noise levels at all residential properties do not exceed the derived noise limits across all wind speeds with a noise management strategy applied. No significant impacts are therefore expected. This should not be interpreted to mean that wind farm operational noise would be inaudible (or masked by background noise) under all conditions, but that the levels of noise are acceptable under ETSU-R-97 and associated guidance.

Construction

11.115 Predicted noise from worst case combination of increased traffic and site construction noise would not exceed relevant criteria and therefore no significant impacts are expected.

Cumulative Effects

Cumulative Operational Noise Assessment

11.116 An assessment of the cumulative acoustic impact of the proposed development in conjunction with the existing Gruig and consented Corkey repowering wind farms along with five single turbine schemes has been undertaken in accordance with the guidance on wind farm noise assessment; ETSU-R-97 and the IoA GPG.

11.117 ETSU-R-97 states:

"It is clearly unreasonable to suggest that, because a wind farm has been constructed in the vicinity in the past which resulted in increased noise levels at some properties, the residents of those properties are now able to tolerate higher noise levels still. The existing wind farm should not be considered as part of the prevailing background noise."

11.118 The locations of the turbines making up the proposed development, along with the other turbines considered in the cumulative assessment, are shown in **Figure 11.2**. The planning references for the single turbine schemes are detailed in **Table 26**.

Table 26: Single Turbine Planning Details

Turbine ID	Planning Reference
S1	D/2013/0081/F
B1	LA01/2020/0078/F
D1	LA01/2017/0016/F
E1	LA02/2021/0788/F
F1	LA02/2021/0791/F

11.119 The residential properties considered in the cumulative assessment are those detailed in **Table 8.** The distances to the nearest turbine included in the cumulative assessment are given in **Table 27**.

Table 27: Distances from Residential Properties to Nearest Cumulative Turbine

House ID	Distance to Nearest Turbine (m)	Nearest Turbine
H1	525	B1
H2	540	B1
H3	191	B1
H4	563	B1
H5	699	B1
H6	876	B1
H10	1170	T1
H11	1184	B1
H12	1201	B1
H13	1200	B1
H14	1231	D1
H16	1236	D1
H22	745	D1
H24	253	F1
H27	1015	T6
H33	1378	T12
H34	1128	D1
H39	1542	T12
H45	374	D1
H49	1231	T6
H52	331	E1
H91	237	E1
H94	878	F1
H158	615	B1
H162	1007	B1
H164	897	B1
H165	916	B1

House ID	Distance to Nearest Turbine (m)	Nearest Turbine
H168	391	D1
H173	375	D1
H209	1000	T6
H222	1418	T12
H224	1290	T6

Turbines prefixed "T" are the turbines belonging to the proposed development. Those prefixed "A" & "P" are the existing Gruig turbines. Turbines prefixed "C" are the Corkey repowering turbines. Those prefixed "S", "B", "D", "E" or "F" are single turbines with planning references as per Table 26.

Cumulative Assessment Methodology

11.120 ETSU-R-97 recommends that the derived noise limits applicable at nearby residential properties shall relate to the cumulative effects of noise from all wind turbines that may affect a particular location.

11.121 The methodology is therefore to:

- Identify appropriate overall ETSU-R-97 noise limits for each receptor;
- Predict the level of noise resulting from the operation of the turbines being considered in the cumulative assessment without the proposed development;
- Subtract the predicted noise levels calculated in step 2 from the ETSU-R-97 limits identified in step 1 to determine the limit remaining for the proposed development; and
- Compare the predicted noise levels due to the proposed development to the limit calculated in step 3 to determine whether the proposed development complies with ETSU R-97.

11.122 The methodology outlined above is in accordance with the appropriate guidance on cumulative wind farm noise assessment as described in ETSU-R-97 and the IoA GPG.

Predictions of Noise Levels at Residential Properties

Gruig

11.123 The noise limits contained in the Decision Notice[19] are used to calculate the worst case predicted noise levels from the existing Gruig Wind Farm as follows:

- Predictions are made using appropriate turbine noise data;
- Comparison is made between the predictions and the limits from the planning conditions in order to identify the controlling property; and
- The predictions are scaled by the minimum margin between the predictions and the conditioned noise limits at the controlling property. This yields predicted noise levels which do not exceed the conditioned noise limits at any property and are equal to the conditioned noise limit at the controlling property and wind speed.

11.124 This method is referred to as the 'Controlling Property' method in the IoA GPG. Scaling can lead to unrealistic assumptions where significant headroom exists. The scaling factor has been restricted to a maximum of 2 dB to avoid this scenario.

[19] Planning Permission, Application No.: D/2004/0790/F, 18th October 2004.

11.125 The turbine installed at Gruig Wind Farm is the Nordex N80/2500 turbine. Warranted acoustic data for this turbine is taken from the manufacturer's general specification for this machine and an allowance for uncertainty has been included[20]. Details used in this analysis are as follows:

- a hub height of 60 m;
- a rotor diameter of 80 m;
- sound power levels, L_{WA}, for standardised 10 m height wind speeds (v_{10}) as shown in **Table 28**; and
- octave band sound power level data, at the wind speeds where it is available, as shown in **Table 29**.

Table 28: A-Weighted Sound Power Levels (dB(A) re 1 pW) for the Nordex N80/2500 Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	Acoustic Emission
1	98.0
2	98.0
3	98.0
4	98.0
5	100.5
6	102.5
7	103.0
8	103.5
9	104.0
10	104.0
11	104.5
12	105.0

[20] "Noise Emission Nordex N80", Document ID: F008_158_EN Revision 2, 2005-10-18

Table 29: Octave Band A-Weighted Sound Power Levels (dB(A) re 1 pW) at 10m Standardised Wind Speeds for the Nordex N80/2500 Wind Turbine

Octave Band (Hz)	8 ms^{-1}	10 ms^{-1}
63	84.4	86.4
125	92.4	94.0
250	97.2	98.8
500	99.3	99.4
1000	96.3	94.9
2000	93.0	93.4
4000	84.6	84.4
8000	72.9	73.0
OVERALL	103.5	104.0

11.126 The predicted noise levels due to the existing Gruig wind farm are shown in **Table 30**. The results are shown scaled to the conditioned noise limits.

Table 30: Predicted Noise Levels for Gruig, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	24.0	24.0	24.0	24.0	26.5	28.5	29.0	29.5	30.4	30.4	30.9	31.4
H2	23.9	23.9	23.9	23.9	26.4	28.4	28.9	29.4	30.3	30.3	30.8	31.3
H3	25.0	25.0	25.0	25.0	27.5	29.5	30.0	30.5	31.3	31.3	31.8	32.3
H4	24.0	24.0	24.0	24.0	26.5	28.5	29.0	29.5	30.4	30.4	30.9	31.4
H5	24.9	24.9	24.9	24.9	27.4	29.4	29.9	30.4	31.3	31.3	31.8	32.3
H6	26.5	26.5	26.5	26.5	29.0	31.0	31.5	32.0	32.9	32.9	33.4	33.9
H10	27.6	27.6	27.6	27.6	30.1	32.1	32.6	33.1	33.9	33.9	34.4	34.9
H11	26.6	26.6	26.6	26.6	29.1	31.1	31.6	32.1	32.9	32.9	33.4	33.9
H12	26.8	26.8	26.8	26.8	29.3	31.3	31.8	32.3	33.1	33.1	33.6	34.1
H13	27.0	27.0	27.0	27.0	29.5	31.5	32.0	32.5	33.3	33.3	33.8	34.3
H14	26.6	26.6	26.6	26.6	29.1	31.1	31.6	32.1	33.0	33.0	33.5	34.0
H16	26.4	26.4	26.4	26.4	28.9	30.9	31.4	31.9	32.8	32.8	33.3	33.8
H22	26.0	26.0	26.0	26.0	28.5	30.5	31.0	31.5	32.4	32.4	32.9	33.4
H24	25.8	25.8	25.8	25.8	28.3	30.3	30.8	31.3	32.2	32.2	32.7	33.2
H27	27.9	27.9	27.9	27.9	30.4	32.4	32.9	33.4	34.3	34.3	34.8	35.3
H33	24.9	24.9	24.9	24.9	27.4	29.4	29.9	30.4	31.3	31.3	31.8	32.3
H34	27.2	27.2	27.2	27.2	29.7	31.7	32.2	32.7	33.5	33.5	34.0	34.5
H39	24.2	24.2	24.2	24.2	26.7	28.7	29.2	29.7	30.6	30.6	31.1	31.6
H45	27.6	27.6	27.6	27.6	30.1	32.1	32.6	33.1	33.9	33.9	34.4	34.9
H49	26.2	26.2	26.2	26.2	28.7	30.7	31.2	31.7	32.6	32.6	33.1	33.6
H52	24.0	24.0	24.0	24.0	26.5	28.5	29.0	29.5	30.5	30.5	31.0	31.5
H91	25.6	25.6	25.6	25.6	28.1	30.1	30.6	31.1	32.0	32.0	32.5	33.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H94	28.6	28.6	28.6	28.6	31.1	33.1	33.6	34.1	34.9	34.9	35.4	35.9
H158	24.4	24.4	24.4	24.4	26.9	28.9	29.4	29.9	30.8	30.8	31.3	31.8
H162	25.7	25.7	25.7	25.7	28.2	30.2	30.7	31.2	32.1	32.1	32.6	33.1
H164	26.3	26.3	26.3	26.3	28.8	30.8	31.3	31.8	32.6	32.6	33.1	33.6
H165	26.4	26.4	26.4	26.4	28.9	30.9	31.4	31.9	32.8	32.8	33.3	33.8
H168	24.3	24.3	24.3	24.3	26.8	28.8	29.3	29.8	30.7	30.7	31.2	31.7
H173	27.7	27.7	27.7	27.7	30.2	32.2	32.7	33.2	34.0	34.0	34.5	35.0
H209	28.0	28.0	28.0	28.0	30.5	32.5	33.0	33.5	34.4	34.4	34.9	35.4
H222	25.0	25.0	25.0	25.0	27.5	29.5	30.0	30.5	31.4	31.4	31.9	32.4
H224	25.3	25.3	25.3	25.3	27.8	29.8	30.3	30.8	31.7	31.7	32.2	32.7

Corkey Repowering

11.127 The noise limits contained in the Decision Notice[21] are used to calculate the worst case predicted noise levels from the consented Corkey Repowering Wind Farm using the 'Controlling Property' method as detailed in paragraph 11.123.

11.128 The candidate turbine used in the Corkey repowering Environmental Statement is the Vestas V117 4.2MW turbine. Warranted acoustic data for this turbine is taken from the manufacturer's general specification for this machine and an uncertainty of 2 dB has been included[22]. Details used in this analysis are as follows:

- a hub height of 80 m;
- a rotor diameter of 117 m;
- sound power levels, L_{WA}, for standardised 10 m height wind speeds (v_{10}) as shown in **Table 31**; and
- octave band sound power level data, at the wind speeds where it is available, as shown in **Table 32**.

[21] Approval of Planning Permission, Application No.: LA01/2019/0772/F, 9th July 2019.

[22] "Performance Specification V117-4.0/4.2 MW 50/60 Hz Strong Wind", Document no.: 0067-7063 V05, 2018-09-10

Table 31: A-Weighted Sound Power Levels (dB(A) re 1 pW) for the Vestas V117 4.2 MW Wind Turbine

Standardised 10m Height Wind Speed, v_{10} (ms^{-1})	Acoustic Emission
1	95.1
2	95.1
3	95.1
4	97.8
5	101.8
6	105.6
7	107.7
8	108.0
9	108.0
10	108.0
11	108.0
12	108.0

Table 32: Octave Band A-Weighted Sound Power Levels (dB(A) re 1 pW) at 10m Standardised Wind Speeds for the Vestas V117 4.2 MW Wind Turbine

Octave Band (Hz)	8 ms^{-1}
63	88.3
125	95.5
250	100.3
500	102.6
1000	102.4
2000	99.7
4000	94.6
8000	87.0
OVERALL	108.0

11.129 The predicted noise levels due to the consented Corkey Repowering scheme are shown in **Table 33** & **Table 34**. The results are shown scaled to the conditioned noise limits. The predictions differ for day and night-time periods due to the different limits that apply.

Table 33: Predicted Daytime Noise Levels for Corkey Repowering, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	30.0	30.0	30.0	32.7	33.7	38.4	40.6	42.6	42.9	42.9	42.9	42.9
H2	27.8	27.8	27.8	30.5	31.5	36.2	38.4	40.4	40.7	40.7	40.7	40.7
H3	26.4	26.4	26.4	29.1	30.1	34.8	37.0	39.0	39.3	39.3	39.3	39.3
H4	23.9	23.9	23.9	26.6	27.6	32.3	34.5	36.5	36.8	36.8	36.8	36.8
H5	23.7	23.7	23.7	26.3	27.3	32.0	34.3	36.3	36.6	36.6	36.6	36.6
H6	24.0	24.0	24.0	26.7	27.7	32.4	34.6	36.6	36.9	36.9	36.9	36.9

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H10	23.3	23.3	23.3	25.9	26.9	31.6	33.9	35.9	36.2	36.2	36.2	36.2
H11	22.4	22.4	22.4	25.1	26.1	30.8	33.0	35.0	35.3	35.3	35.3	35.3
H12	22.5	22.5	22.5	25.2	26.2	30.9	33.1	35.1	35.4	35.4	35.4	35.4
H13	22.7	22.7	22.7	25.4	26.4	31.1	33.3	35.3	35.6	35.6	35.6	35.6
H14	21.9	21.9	21.9	24.6	25.6	30.3	32.5	34.5	34.8	34.8	34.8	34.8
H16	22.8	22.8	22.8	25.5	26.5	31.2	33.5	35.5	35.7	35.7	35.7	35.7
H22	16.3	16.3	16.3	19.0	20.0	24.7	26.9	28.9	29.2	29.2	29.2	29.2
H24	15.6	15.6	15.6	18.3	19.3	24.0	26.3	28.3	28.5	28.5	28.5	28.5
H27	16.3	16.3	16.3	19.0	20.0	24.7	26.9	28.9	29.2	29.2	29.2	29.2
H33	14.2	14.2	14.2	16.9	17.9	22.6	24.9	26.9	27.1	27.1	27.1	27.1
H34	22.2	22.2	22.2	24.9	25.9	30.6	32.8	34.8	35.1	35.1	35.1	35.1
H39	14.0	14.0	14.0	16.7	17.7	22.4	24.6	26.6	26.9	26.9	26.9	26.9
H45	18.7	18.7	18.7	21.4	22.4	27.1	29.3	31.3	31.6	31.6	31.6	31.6
H49	15.0	15.0	15.0	17.7	18.7	23.4	25.6	27.6	27.9	27.9	27.9	27.9
H52	13.6	13.6	13.6	16.3	17.3	22.0	24.2	26.2	26.5	26.5	26.5	26.5
H91	15.6	15.6	15.6	18.3	19.3	24.0	26.2	28.2	28.5	28.5	28.5	28.5
H94	16.8	16.8	16.8	19.5	20.5	25.2	27.5	29.5	29.7	29.7	29.7	29.7
H158	23.5	23.5	23.5	26.2	27.2	31.9	34.1	36.1	36.4	36.4	36.4	36.4
H162	22.5	22.5	22.5	25.2	26.2	30.9	33.2	35.2	35.4	35.4	35.4	35.4
H164	23.6	23.6	23.6	26.2	27.2	31.9	34.2	36.2	36.5	36.5	36.5	36.5
H165	23.6	23.6	23.6	26.3	27.3	32.0	34.2	36.2	36.5	36.5	36.5	36.5
H168	16.1	16.1	16.1	18.8	19.8	24.5	26.8	28.8	29.0	29.0	29.0	29.0
H173	18.8	18.8	18.8	21.5	22.5	27.2	29.4	31.4	31.7	31.7	31.7	31.7
H209	16.4	16.4	16.4	19.1	20.1	24.8	27.0	29.0	29.3	29.3	29.3	29.3
H222	14.2	14.2	14.2	16.9	17.9	22.6	24.8	26.8	27.1	27.1	27.1	27.1
H224	14.7	14.7	14.7	17.4	18.4	23.1	25.3	27.3	27.6	27.6	27.6	27.6

Table 34: Predicted Night-time Noise Levels for Corkey Repowering, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	30.0	30.0	30.0	32.7	36.7	40.5	41.9	42.5	42.9	42.9	42.9	42.0
H2	27.8	27.8	27.8	30.5	34.5	38.3	39.7	40.3	40.7	40.7	40.7	39.8
H3	26.4	26.4	26.4	29.1	33.1	36.9	38.3	38.9	39.3	39.3	39.3	38.4
H4	23.9	23.9	23.9	26.6	30.6	34.4	35.8	36.4	36.8	36.8	36.8	35.9
H5	23.7	23.7	23.7	26.3	30.4	34.1	35.5	36.1	36.6	36.6	36.6	35.7
H6	24.0	24.0	24.0	26.7	30.7	34.5	35.9	36.5	36.9	36.9	36.9	36.0
H10	23.3	23.3	23.3	25.9	30.0	33.7	35.1	35.7	36.2	36.2	36.2	35.3
H11	22.4	22.4	22.4	25.1	29.2	32.9	34.3	34.9	35.3	35.3	35.3	34.4
H12	22.5	22.5	22.5	25.2	29.2	33.0	34.4	35.0	35.4	35.4	35.4	34.5

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H13	22.7	22.7	22.7	25.4	29.5	33.2	34.6	35.2	35.6	35.6	35.6	34.7
H14	21.9	21.9	21.9	24.6	28.6	32.4	33.8	34.4	34.8	34.8	34.8	33.9
H16	22.8	22.8	22.8	25.5	29.6	33.3	34.7	35.3	35.7	35.7	35.7	34.9
H22	16.3	16.3	16.3	19.0	23.0	26.8	28.2	28.8	29.2	29.2	29.2	28.3
H24	15.6	15.6	15.6	18.3	22.4	26.1	27.5	28.1	28.5	28.5	28.5	27.7
H27	16.3	16.3	16.3	19.0	23.0	26.8	28.2	28.8	29.2	29.2	29.2	28.3
H33	14.2	14.2	14.2	16.9	21.0	24.7	26.1	26.7	27.1	27.1	27.1	26.3
H34	22.2	22.2	22.2	24.9	28.9	32.7	34.1	34.7	35.1	35.1	35.1	34.2
H39	14.0	14.0	14.0	16.7	20.7	24.5	25.9	26.5	26.9	26.9	26.9	26.0
H45	18.7	18.7	18.7	21.4	25.4	29.2	30.6	31.2	31.6	31.6	31.6	30.7
H49	15.0	15.0	15.0	17.7	21.7	25.5	26.9	27.5	27.9	27.9	27.9	27.0
H52	13.6	13.6	13.6	16.3	20.3	24.1	25.5	26.1	26.5	26.5	26.5	25.6
H91	15.6	15.6	15.6	18.3	22.3	26.1	27.5	28.1	28.5	28.5	28.5	27.6
H94	16.8	16.8	16.8	19.5	23.6	27.3	28.7	29.3	29.7	29.7	29.7	28.9
H158	23.5	23.5	23.5	26.2	30.2	34.0	35.4	36.0	36.4	36.4	36.4	35.5
H162	22.5	22.5	22.5	25.2	29.3	33.0	34.4	35.0	35.4	35.4	35.4	34.6
H164	23.6	23.6	23.6	26.2	30.3	34.0	35.4	36.0	36.5	36.5	36.5	35.6
H165	23.6	23.6	23.6	26.3	30.3	34.1	35.5	36.1	36.5	36.5	36.5	35.6
H168	16.1	16.1	16.1	18.8	22.9	26.6	28.0	28.6	29.0	29.0	29.0	28.2
H173	18.8	18.8	18.8	21.5	25.5	29.3	30.7	31.3	31.7	31.7	31.7	30.8
H209	16.4	16.4	16.4	19.1	23.1	26.9	28.3	28.9	29.3	29.3	29.3	28.4
H222	14.2	14.2	14.2	16.9	21.0	24.7	26.1	26.7	27.1	27.1	27.1	26.2
H224	14.7	14.7	14.7	17.4	21.4	25.2	26.6	27.2	27.6	27.6	27.6	26.7

Single Turbines

11.130 Details of the single turbine schemes considered are as follows:

- Turbine types and hub heights as detailed in **Table 35**;
- Sound power levels as shown in **Table 36**; and
- Octave band sound power level data as shown in **Table 37**.

Table 35: Single Turbine Types

Turbine ID	Model	Hub Height (m)
S1	Enercon E44 900kW	45
B1	Vestas V52 850kW	55
D1	Vestas V52 850kW 100dB Mode	40
E1	EWT DW54 250kW	40
F1	EWT DW54 250kW	40

Table 36: A-Weighted Sound Power Levels (dB(A) re 1 pW) plus Uncertainty for Single Turbines

v_{10} (ms^{-1})	S1	B1	D1	E1	F1
1	103.1	95.6	96.0	97.0	97.0
2	103.1	95.6	96.0	97.0	97.0
3	103.1	95.6	96.0	97.0	97.0
4	103.1	95.8	96.0	97.0	97.0
5	103.1	98.6	96.8	97.0	97.0
6	103.1	102.7	97.6	98.2	98.2
7	103.1	105.0	98.5	98.4	98.4
8	104.3	105.5	99.5	98.6	98.6
9	104.9	105.6	100.1	99.1	99.1
10	105.0	104.6	100.7	100.3	100.3
11	105.0	103.8	101.1	100.8	100.8
12	105.0	103.5	101.6	101.3	101.3

Table 37: Octave Band A-Weighted Sound Power Levels (dB(A) re 1 pW) at 8 ms^{-1} for Single Turbines

Octave Band (Hz)	S1	B1	D1	E1	F1
63	86.4	81.7	82.1	81.2	81.2
125	91.9	89.6	88.1	86.8	86.8
250	95.4	95.4	92.6	88.4	88.4
500	97.6	101.0	94.0	91.1	91.1
1000	99.6	100.7	93.1	93.8	93.8
2000	96.9	96.8	91.2	92.0	92.0
4000	89.6	90.4	86.0	87.0	87.0
8000	83.5	80.2	77.1	81.0	81.0
OVERALL	104.3	105.5	99.5	98.6	98.6

11.131 The existing and consented single turbine schemes are conditioned to the noise limits specified in their Decision Notices. These noise limits are used to calculate the worst case predicted noise levels using the 'Controlling Property' method outlined in paragraph 11.123.

11.132 The predicted noise levels due to the single turbine schemes are shown in **Table 38** to **Table 42**. The results are shown scaled to the conditioned noise limits.

Table 38: Predicted Noise Levels for S1, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	29.2	29.2	29.2	29.2	29.2	29.2	29.2	30.8	31.5	31.5	31.5	31.5
H2	26.5	26.5	26.5	26.5	26.5	26.5	26.5	28.0	28.7	28.8	28.8	28.8
H3	23.1	23.1	23.1	23.1	23.1	23.1	23.1	24.6	25.4	25.4	25.4	25.4
H4	17.5	17.5	17.5	17.5	17.5	17.5	17.5	18.9	19.7	19.8	19.8	19.8
H5	16.7	16.7	16.7	16.7	16.7	16.7	16.7	18.1	18.9	18.9	18.9	18.9
H6	16.0	16.0	16.0	16.0	16.0	16.0	16.0	17.4	18.2	18.2	18.2	18.2

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H10	14.7	14.7	14.7	14.7	14.7	14.7	14.7	16.0	16.9	16.9	16.9	16.9
H11	16.4	16.4	16.4	16.4	16.4	16.4	16.4	17.7	18.6	18.6	18.6	18.6
H12	16.4	16.4	16.4	16.4	16.4	16.4	16.4	17.7	18.6	18.6	18.6	18.6
H13	16.4	16.4	16.4	16.4	16.4	16.4	16.4	17.8	18.6	18.6	18.6	18.6
H14	15.8	15.8	15.8	15.8	15.8	15.8	15.8	17.2	18.0	18.0	18.0	18.0
H16	15.6	15.6	15.6	15.6	15.6	15.6	15.6	17.0	17.9	17.9	17.9	17.9
H22	7.9	7.9	7.9	7.9	7.9	7.9	7.9	9.2	10.1	10.0	10.0	10.0
H24	7.2	7.2	7.2	7.2	7.2	7.2	7.2	8.6	9.5	9.4	9.4	9.4
H27	5.9	5.9	5.9	5.9	5.9	5.9	5.9	7.2	8.1	8.0	8.0	8.0
H33	7.9	7.9	7.9	7.9	7.9	7.9	7.9	9.3	10.2	10.1	10.1	10.1
H34	15.8	15.8	15.8	15.8	15.8	15.8	15.8	17.2	18.0	18.0	18.0	18.0
H39	7.6	7.6	7.6	7.6	7.6	7.6	7.6	8.9	9.9	9.7	9.7	9.7
H45	9.0	9.0	9.0	9.0	9.0	9.0	9.0	10.4	11.3	11.2	11.2	11.2
H49	5.2	5.2	5.2	5.2	5.2	5.2	5.2	6.6	7.5	7.4	7.4	7.4
H52	7.1	7.1	7.1	7.1	7.1	7.1	7.1	8.5	9.4	9.3	9.3	9.3
H91	7.1	7.1	7.1	7.1	7.1	7.1	7.1	8.5	9.4	9.3	9.3	9.3
H94	7.2	7.2	7.2	7.2	7.2	7.2	7.2	8.5	9.4	9.3	9.3	9.3
H158	17.2	17.2	17.2	17.2	17.2	17.2	17.2	18.6	19.4	19.5	19.5	19.5
H162	15.1	15.1	15.1	15.1	15.1	15.1	15.1	16.4	17.3	17.3	17.3	17.3
H164	15.8	15.8	15.8	15.8	15.8	15.8	15.8	17.2	18.0	18.0	18.0	18.0
H165	15.7	15.7	15.7	15.7	15.7	15.7	15.7	17.1	17.9	17.9	17.9	17.9
H168	8.7	8.7	8.7	8.7	8.7	8.7	8.7	10.1	11.0	10.9	10.9	10.9
H173	9.1	9.1	9.1	9.1	9.1	9.1	9.1	10.4	11.3	11.3	11.3	11.3
H209	5.9	5.9	5.9	5.9	5.9	5.9	5.9	7.3	8.2	8.1	8.1	8.1
H222	7.8	7.8	7.8	7.8	7.8	7.8	7.8	9.2	10.1	10.0	10.0	10.0
H224	5.0	5.0	5.0	5.0	5.0	5.0	5.0	6.3	7.3	7.1	7.1	7.1

Table 39: Predicted Noise Levels for B1, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	31.1	31.1	31.1	31.1	32.1	32.7	33.3	34.2	33.9	34.2	32.6	32.6
H2	30.8	30.8	30.8	30.8	31.8	32.4	33.0	33.9	33.6	33.9	32.3	32.3
H3	40.4	40.4	40.4	40.4	41.4	42.0	42.6	43.5	43.2	43.5	41.9	41.9
H4	30.2	30.2	30.2	30.2	31.2	31.8	32.4	33.3	33.0	33.3	31.7	31.7
H5	28.0	28.0	28.0	28.0	29.0	29.6	30.2	31.1	30.8	31.1	29.5	29.5
H6	25.7	25.7	25.7	25.7	26.7	27.3	27.8	28.7	28.4	28.7	27.1	27.1
H10	22.4	22.4	22.4	22.4	23.4	24.0	24.5	25.3	25.0	25.3	23.7	23.7
H11	22.4	22.4	22.4	22.4	23.4	24.0	24.5	25.3	25.0	25.3	23.7	23.7
H12	22.3	22.3	22.3	22.3	23.3	23.9	24.3	25.2	24.9	25.2	23.6	23.6

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H13	22.3	22.3	22.3	22.3	23.3	23.9	24.4	25.2	24.9	25.2	23.6	23.6
H14	21.3	21.3	21.3	21.3	22.3	22.9	23.3	24.2	23.9	24.2	22.6	22.6
H16	21.1	21.1	21.1	21.1	22.1	22.7	23.1	24.0	23.7	24.0	22.4	22.4
H22	9.6	9.6	9.6	9.6	10.6	11.2	11.4	11.9	11.6	11.9	10.3	10.3
H24	6.6	6.6	6.6	6.6	7.6	8.2	8.4	8.6	8.3	8.6	7.0	7.0
H27	5.0	5.0	5.0	5.0	6.0	6.6	6.8	7.0	6.7	7.0	5.4	5.4
H33	6.0	6.0	6.0	6.0	7.0	7.6	7.7	7.8	7.5	7.8	6.2	6.2
H34	21.0	21.0	21.0	21.0	22.0	22.6	23.1	23.9	23.6	23.9	22.3	22.3
H39	2.9	2.9	2.9	2.9	3.9	4.5	4.7	4.7	4.4	4.7	3.1	3.1
H45	14.1	14.1	14.1	14.1	15.1	15.7	16.0	16.6	16.3	16.6	15.0	15.0
H49	4.3	4.3	4.3	4.3	5.3	5.9	6.1	6.3	6.0	6.3	4.7	4.7
H52	4.2	4.2	4.2	4.2	5.2	5.8	6.0	6.1	5.8	6.1	4.5	4.5
H91	6.4	6.4	6.4	6.4	7.4	8.0	8.2	8.3	8.0	8.3	6.7	6.7
H94	8.2	8.2	8.2	8.2	9.2	9.8	10.1	10.5	10.2	10.5	8.9	8.9
H158	29.3	29.3	29.3	29.3	30.3	30.9	31.5	32.4	32.1	32.4	30.8	30.8
H162	24.2	24.2	24.2	24.2	25.2	25.8	26.3	27.2	26.9	27.2	25.6	25.6
H164	25.4	25.4	25.4	25.4	26.4	27.0	27.6	28.4	28.1	28.4	26.8	26.8
H165	25.2	25.2	25.2	25.2	26.2	26.8	27.3	28.2	27.9	28.2	26.6	26.6
H168	14.0	14.0	14.0	14.0	15.0	15.6	15.9	16.5	16.2	16.5	14.9	14.9
H173	14.1	14.1	14.1	14.1	15.1	15.7	16.0	16.6	16.3	16.6	15.0	15.0
H209	5.0	5.0	5.0	5.0	6.0	6.6	6.8	7.0	6.7	7.0	5.4	5.4
H222	6.1	6.1	6.1	6.1	7.1	7.7	7.8	7.9	7.6	7.9	6.3	6.3
H224	4.2	4.2	4.2	4.2	5.2	5.8	5.9	6.1	5.8	6.1	4.5	4.5

Table 40: Predicted Noise Levels for D1, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	13.5	13.5	14.3	15.1	16.0	16.9	17.0	17.5	17.9	18.4	18.4	18.4
H2	13.3	13.3	14.1	14.9	15.8	16.7	16.8	17.3	17.7	18.2	18.2	18.2
H3	15.3	15.3	16.1	16.9	17.8	18.7	18.9	19.4	19.7	20.2	20.2	20.2
H4	13.7	13.7	14.5	15.3	16.2	17.1	17.3	17.8	18.1	18.6	18.6	18.6
H5	14.9	14.9	15.7	16.5	17.4	18.3	18.4	18.9	19.2	19.7	19.7	19.7
H6	16.9	16.9	17.7	18.5	19.4	20.3	20.4	20.9	21.2	21.7	21.7	21.7
H10	19.5	19.5	20.3	21.1	22.0	22.9	23.0	23.5	23.9	24.4	24.4	24.4
H11	18.5	18.5	19.3	20.1	21.0	21.9	22.0	22.5	22.9	23.4	23.4	23.4
H12	18.8	18.8	19.6	20.4	21.3	22.2	22.4	22.9	23.2	23.7	23.7	23.7
H13	19.1	19.1	19.9	20.7	21.6	22.5	22.6	23.1	23.5	24.0	24.0	24.0
H14	17.4	17.4	18.2	19.0	19.9	20.8	21.0	21.5	21.8	22.3	22.3	22.3
H16	17.4	17.4	18.2	19.0	19.9	20.8	20.9	21.4	21.8	22.3	22.3	22.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H22	24.8	24.8	25.6	26.4	27.3	28.2	28.3	28.8	29.3	29.8	29.8	29.8
H24	16.0	16.0	16.8	17.6	18.5	19.4	19.5	20.0	20.4	20.9	20.9	20.9
H27	12.7	12.7	13.5	14.3	15.2	16.1	16.2	16.7	17.0	17.5	17.5	17.5
H33	6.4	6.4	7.2	8.0	8.9	9.8	9.9	10.4	10.8	11.3	11.3	11.3
H34	18.4	18.4	19.2	20.0	20.9	21.8	21.9	22.4	22.8	23.3	23.3	23.3
H39	6.9	6.9	7.7	8.5	9.4	10.3	10.4	10.9	11.3	11.8	11.8	11.8
H45	31.6	31.6	32.4	33.2	34.1	35.0	35.1	35.6	36.3	36.8	36.8	36.8
H49	10.0	10.0	10.8	11.6	12.5	13.4	13.5	14.0	14.4	14.9	14.9	14.9
H52	14.7	14.7	15.5	16.3	17.2	18.1	18.2	18.7	19.0	19.5	19.5	19.5
H91	15.3	15.3	16.1	16.9	17.8	18.7	18.9	19.4	19.7	20.2	20.2	20.2
H94	22.5	22.5	23.3	24.1	25.0	25.9	26.0	26.5	26.9	27.4	27.4	27.4
H158	13.8	13.8	14.6	15.4	16.3	17.2	17.3	17.8	18.1	18.6	18.6	18.6
H162	16.7	16.7	17.5	18.3	19.2	20.1	20.2	20.7	21.0	21.5	21.5	21.5
H164	16.7	16.7	17.5	18.3	19.2	20.1	20.2	20.7	21.0	21.5	21.5	21.5
H165	16.9	16.9	17.7	18.5	19.4	20.3	20.4	20.9	21.3	21.8	21.8	21.8
H168	31.1	31.1	31.9	32.7	33.6	34.5	34.6	35.1	35.8	36.3	36.3	36.3
H173	31.6	31.6	32.4	33.2	34.1	35.0	35.1	35.6	36.3	36.8	36.8	36.8
H209	12.7	12.7	13.5	14.3	15.2	16.1	16.3	16.8	17.1	17.6	17.6	17.6
H222	6.7	6.7	7.5	8.3	9.2	10.1	10.3	10.8	11.1	11.6	11.6	11.6
H224	10.1	10.1	10.9	11.7	12.6	13.5	13.6	14.1	14.5	15.0	15.0	15.0

Table 41: Predicted Noise Levels for E1, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	1.0	1.0	1.0	1.0	0.7	-0.2	-0.6	-0.9	-0.8	-0.9	-0.9	-0.9
H2	2.7	2.7	2.7	2.7	2.4	1.5	1.1	0.8	0.9	0.8	0.8	0.8
H3	1.8	1.8	1.8	1.8	1.4	0.5	0.2	-0.2	-0.1	-0.1	-0.1	-0.1
H4	2.3	2.3	2.3	2.3	1.9	1.0	0.7	0.4	0.5	0.4	0.4	0.4
H5	2.8	2.8	2.8	2.8	2.5	1.6	1.3	1.0	1.0	1.0	1.0	1.0
H6	3.9	3.9	3.9	3.9	3.5	2.7	2.4	2.1	2.1	2.1	2.1	2.1
H10	5.0	5.0	5.0	5.0	4.6	3.9	3.6	3.2	3.3	3.3	3.3	3.3
H11	4.5	4.5	4.5	4.5	4.1	3.4	3.1	2.7	2.8	2.7	2.7	2.7
H12	4.6	4.6	4.6	4.6	4.3	3.5	3.2	2.9	2.9	2.9	2.9	2.9
H13	4.8	4.8	4.8	4.8	4.4	3.6	3.4	3.0	3.1	3.0	3.0	3.0
H14	4.8	4.8	4.8	4.8	4.5	3.7	3.4	3.1	3.1	3.1	3.1	3.1
H16	4.8	4.8	4.8	4.8	4.4	3.7	3.4	3.0	3.1	3.0	3.0	3.0
H22	15.4	15.4	15.4	15.4	15.0	14.6	14.5	14.2	14.2	14.2	14.2	14.2
H24	27.8	27.8	27.8	27.8	27.4	27.5	27.6	27.5	27.5	27.6	27.6	27.6
H27	11.5	11.5	11.5	11.5	11.2	10.8	10.6	10.3	10.3	10.3	10.3	10.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H33	5.5	5.5	5.5	5.5	5.2	4.4	4.2	3.8	3.9	3.8	3.8	3.8
H34	5.2	5.2	5.2	5.2	4.9	4.1	3.8	3.5	3.5	3.5	3.5	3.5
H39	3.8	3.8	3.8	3.8	3.5	2.8	2.6	2.2	2.2	2.2	2.2	2.2
H45	13.5	13.5	13.5	13.5	13.1	12.7	12.5	12.2	12.2	12.2	12.2	12.2
H49	11.3	11.3	11.3	11.3	10.9	10.5	10.3	10.0	10.0	10.0	10.0	10.0
H52	28.1	28.1	28.1	28.1	27.8	27.9	27.9	27.9	27.9	27.9	27.9	27.9
H91	31.2	31.2	31.2	31.2	30.8	30.9	31.1	31.0	31.1	31.1	31.1	31.1
H94	16.9	16.9	16.9	16.9	16.5	16.3	16.2	16.0	16.0	16.0	16.0	16.0
H158	2.2	2.2	2.2	2.2	1.9	1.0	0.7	0.3	0.4	0.4	0.4	0.4
H162	3.6	3.6	3.6	3.6	3.3	2.5	2.2	1.8	1.9	1.8	1.8	1.8
H164	3.7	3.7	3.7	3.7	3.4	2.6	2.3	1.9	2.0	1.9	1.9	1.9
H165	3.8	3.8	3.8	3.8	3.5	2.7	2.4	2.0	2.1	2.1	2.1	2.1
H168	12.4	12.4	12.4	12.4	12.0	11.5	11.3	11.0	11.0	11.0	11.0	11.0
H173	13.5	13.5	13.5	13.5	13.2	12.7	12.5	12.2	12.2	12.2	12.2	12.2
H209	11.5	11.5	11.5	11.5	11.1	10.7	10.5	10.2	10.2	10.2	10.2	10.2
H222	6.2	6.2	6.2	6.2	5.9	5.2	4.9	4.6	4.6	4.6	4.6	4.6
H224	10.0	10.0	10.0	10.0	9.7	9.3	9.1	8.9	8.8	8.8	8.8	8.8

Table 42: Predicted Noise Levels for F1, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	0.2	0.2	0.2	0.2	-0.1	-0.9	-1.3	-1.8	-1.7	-1.8	-1.8	-1.8
H2	2.0	2.0	2.0	2.0	1.7	0.8	0.4	-0.1	0.0	-0.1	-0.1	-0.1
H3	1.0	1.0	1.0	1.0	0.7	-0.1	-0.5	-1.0	-0.9	-1.0	-1.0	-1.0
H4	1.6	1.6	1.6	1.6	1.3	0.5	0.1	-0.4	-0.3	-0.4	-0.4	-0.4
H5	2.2	2.2	2.2	2.2	1.9	1.1	0.7	0.2	0.3	0.2	0.2	0.2
H6	3.2	3.2	3.2	3.2	2.9	2.2	1.8	1.4	1.4	1.4	1.4	1.4
H10	4.4	4.4	4.4	4.4	4.1	3.5	3.1	2.6	2.6	2.6	2.6	2.6
H11	3.9	3.9	3.9	3.9	3.6	2.9	2.6	2.1	2.1	2.1	2.1	2.1
H12	4.1	4.1	4.1	4.1	3.8	3.1	2.7	2.2	2.3	2.2	2.2	2.2
H13	4.2	4.2	4.2	4.2	3.9	3.2	2.9	2.4	2.4	2.4	2.4	2.4
H14	4.3	4.3	4.3	4.3	4.0	3.3	2.9	2.4	2.5	2.4	2.4	2.4
H16	4.2	4.2	4.2	4.2	3.9	3.3	2.9	2.4	2.4	2.4	2.4	2.4
H22	12.4	12.4	12.4	12.4	12.1	11.9	11.6	11.2	11.2	11.2	11.2	11.2
H24	29.6	29.6	29.6	29.6	29.3	29.5	29.5	29.3	29.4	29.4	29.4	29.4
H27	9.6	9.6	9.6	9.6	9.3	8.9	8.7	8.2	8.2	8.2	8.2	8.2
H33	1.0	1.0	1.0	1.0	0.7	0.0	-0.4	-0.9	-0.8	-0.9	-0.9	-0.9
H34	4.7	4.7	4.7	4.7	4.4	3.7	3.4	2.9	2.9	2.9	2.9	2.9
H39	2.2	2.2	2.2	2.2	1.9	1.3	0.9	0.4	0.4	0.4	0.4	0.4

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H45	13.3	13.3	13.3	13.3	13.0	12.7	12.4	12.0	12.0	11.9	11.9	11.9
H49	9.3	9.3	9.3	9.3	9.0	8.6	8.3	7.9	7.9	7.9	7.9	7.9
H52	23.0	23.0	23.0	23.0	22.7	22.8	22.7	22.5	22.5	22.5	22.5	22.5
H91	27.6	27.6	27.6	27.6	27.3	27.4	27.4	27.2	27.3	27.3	27.3	27.3
H94	17.4	17.4	17.4	17.4	17.1	17.0	16.9	16.5	16.5	16.5	16.5	16.5
H158	1.6	1.6	1.6	1.6	1.3	0.5	0.1	-0.4	-0.3	-0.4	-0.4	-0.4
H162	3.0	3.0	3.0	3.0	2.7	2.0	1.6	1.1	1.2	1.1	1.1	1.1
H164	3.1	3.1	3.1	3.1	2.8	2.1	1.7	1.2	1.3	1.2	1.2	1.2
H165	3.2	3.2	3.2	3.2	2.9	2.2	1.8	1.3	1.4	1.3	1.3	1.3
H168	12.3	12.3	12.3	12.3	12.0	11.6	11.3	10.8	10.8	10.8	10.8	10.8
H173	13.4	13.4	13.4	13.4	13.1	12.7	12.5	12.0	12.0	12.0	12.0	12.0
H209	9.6	9.6	9.6	9.6	9.3	8.9	8.6	8.2	8.2	8.1	8.1	8.1
H222	1.6	1.6	1.6	1.6	1.3	0.7	0.3	-0.2	-0.2	-0.2	-0.2	-0.2
H224	8.0	8.0	8.0	8.0	7.7	7.3	7.1	6.6	6.6	6.6	6.6	6.6

11.133 The cumulative predicted noise levels for day and night time periods due to the operation of the sites considered in the cumulative assessment, excluding the proposed development, are detailed in **Table 43** & **Table 44**.

11.134 The methodology used to calculate the cumulative predicted noise levels makes the assumption that the properties in question are downwind of all of the considered wind farms simultaneously which is not the case in practice. The cumulative predicted noise levels are conservative due to the reductions in noise that would be expected when a property is situated crosswind or upwind of a noise source.

Table 43: Cumulative Predicted Daytime Noise Levels excluding Proposed Development at Nearby Properties, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	35.3	35.3	35.3	36.3	37.2	40.2	41.9	43.6	43.9	43.9	43.8	43.8
H2	34.0	34.0	34.0	34.8	35.8	38.5	40.1	41.7	42.0	42.1	41.9	41.9
H3	40.7	40.7	40.7	40.9	41.9	43.0	43.9	45.1	45.0	45.2	44.2	44.2
H4	32.1	32.1	32.1	32.7	33.9	36.0	37.4	38.8	39.0	39.1	38.8	38.9
H5	31.0	31.0	31.0	31.7	33.0	35.5	36.8	38.3	38.6	38.6	38.5	38.6
H6	30.7	30.7	30.7	31.5	33.0	35.7	37.1	38.5	38.9	38.9	38.9	39.1
H10	30.3	30.3	30.4	31.1	32.8	35.5	36.8	38.1	38.6	38.6	38.7	38.9
H11	29.6	29.6	29.7	30.4	32.0	34.7	35.9	37.3	37.7	37.8	37.9	38.0
H12	29.8	29.8	29.8	30.5	32.2	34.8	36.1	37.4	37.9	37.9	38.0	38.2
H13	29.9	29.9	30.0	30.7	32.4	35.0	36.3	37.6	38.1	38.1	38.2	38.4
H14	29.3	29.3	29.3	30.0	31.7	34.3	35.6	36.9	37.4	37.4	37.5	37.7
H16	29.3	29.3	29.4	30.2	31.9	34.6	36.0	37.4	37.8	37.9	38.0	38.2
H22	29.1	29.1	29.4	29.9	31.4	33.3	34.0	34.8	35.4	35.5	35.7	36.0

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H24	33.0	33.0	33.0	33.1	33.5	34.6	35.0	35.5	36.0	36.0	36.2	36.4
H27	28.5	28.5	28.6	28.8	31.0	33.2	34.0	34.9	35.5	35.6	35.9	36.3
H33	25.5	25.5	25.5	25.8	28.0	30.3	31.1	32.0	32.8	32.8	33.1	33.5
H34	29.7	29.7	29.8	30.4	32.2	34.8	36.0	37.3	37.8	37.8	37.9	38.1
H39	24.9	24.9	24.9	25.2	27.4	29.7	30.6	31.5	32.2	32.2	32.6	33.0
H45	33.4	33.4	33.9	34.5	35.7	37.2	37.8	38.5	39.1	39.3	39.5	39.6
H49	26.9	26.9	26.9	27.2	29.4	31.6	32.4	33.2	34.0	34.0	34.3	34.7
H52	30.7	30.7	30.7	30.8	31.3	32.4	32.9	33.4	33.9	33.9	34.1	34.4
H91	33.7	33.7	33.7	33.8	34.1	35.0	35.4	35.8	36.3	36.3	36.5	36.7
H94	30.2	30.2	30.4	30.7	32.6	34.5	35.2	36.0	36.6	36.7	37.0	37.4
H158	31.6	31.6	31.6	32.1	33.4	35.6	37.0	38.4	38.7	38.7	38.5	38.6
H162	29.5	29.5	29.6	30.3	31.8	34.5	35.8	37.2	37.6	37.7	37.7	37.8
H164	30.4	30.4	30.4	31.2	32.7	35.3	36.7	38.1	38.5	38.5	38.6	38.7
H165	30.4	30.4	30.4	31.2	32.7	35.4	36.7	38.2	38.6	38.6	38.6	38.8
H168	32.2	32.2	32.8	33.5	34.5	35.8	36.3	36.9	37.6	37.9	38.0	38.1
H173	33.4	33.4	33.9	34.5	35.8	37.2	37.8	38.5	39.1	39.4	39.5	39.7
H209	28.6	28.6	28.6	28.9	31.1	33.3	34.1	34.9	35.6	35.6	36.0	36.4
H222	25.6	25.6	25.6	25.8	28.1	30.4	31.2	32.1	32.8	32.8	33.2	33.6
H224	26.1	26.1	26.1	26.4	28.5	30.8	31.7	32.5	33.2	33.3	33.6	34.0

Table 44: Cumulative Predicted Night Time Noise Levels excluding Proposed Development at Nearby Properties, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	35.3	35.3	35.3	36.3	38.8	41.7	42.9	43.5	43.9	43.9	43.8	43.1
H2	34.0	34.0	34.0	34.8	37.2	39.8	41.0	41.7	42.0	42.1	41.9	41.3
H3	40.7	40.7	40.7	40.9	42.2	43.4	44.2	45.0	45.0	45.2	44.2	43.9
H4	32.1	32.1	32.1	32.7	34.8	37.1	38.1	38.8	39.0	39.1	38.8	38.4
H5	31.0	31.0	31.0	31.7	34.1	36.5	37.6	38.2	38.6	38.7	38.5	38.1
H6	30.7	30.7	30.7	31.5	34.1	36.8	37.8	38.5	38.9	38.9	38.9	38.6
H10	30.3	30.3	30.4	31.1	33.8	36.5	37.5	38.1	38.6	38.6	38.7	38.4
H11	29.6	29.6	29.7	30.4	33.1	35.7	36.6	37.2	37.7	37.8	37.9	37.6
H12	29.8	29.8	29.8	30.5	33.2	35.8	36.8	37.4	37.9	37.9	38.0	37.7
H13	29.9	29.9	30.0	30.7	33.4	36.0	37.0	37.6	38.1	38.1	38.2	37.9
H14	29.3	29.3	29.3	30.0	32.7	35.3	36.3	36.8	37.4	37.4	37.5	37.3
H16	29.3	29.3	29.4	30.2	33.0	35.7	36.8	37.3	37.9	37.9	38.0	37.7
H22	29.1	29.1	29.4	29.9	31.8	33.7	34.3	34.8	35.4	35.5	35.8	35.9
H24	33.0	33.0	33.0	33.1	33.7	34.8	35.2	35.5	36.0	36.0	36.2	36.3
H27	28.5	28.5	28.6	28.8	31.4	33.6	34.3	34.8	35.6	35.6	35.9	36.2

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H33	25.5	25.5	25.5	25.8	28.4	30.7	31.5	32.0	32.8	32.8	33.1	33.3
H34	29.7	29.7	29.8	30.4	33.1	35.7	36.7	37.2	37.8	37.8	37.9	37.7
H39	24.9	24.9	24.9	25.2	27.8	30.2	30.9	31.5	32.2	32.3	32.6	32.8
H45	33.4	33.4	33.9	34.6	36.1	37.6	38.0	38.5	39.2	39.4	39.6	39.6
H49	26.9	26.9	26.9	27.2	29.7	32.0	32.7	33.2	34.0	34.0	34.3	34.5
H52	30.7	30.7	30.7	30.8	31.5	32.7	33.1	33.4	33.9	33.9	34.2	34.3
H91	33.7	33.7	33.7	33.8	34.2	35.2	35.6	35.8	36.3	36.3	36.5	36.6
H94	30.2	30.2	30.4	30.7	32.9	34.9	35.5	36.0	36.6	36.7	37.0	37.2
H158	31.6	31.6	31.6	32.1	34.3	36.7	37.7	38.3	38.7	38.7	38.5	38.1
H162	29.5	29.5	29.6	30.3	32.9	35.5	36.6	37.2	37.6	37.7	37.7	37.4
H164	30.4	30.4	30.4	31.2	33.8	36.4	37.5	38.1	38.5	38.6	38.6	38.2
H165	30.4	30.4	30.4	31.2	33.8	36.5	37.5	38.1	38.6	38.6	38.6	38.3
H168	32.2	32.2	32.9	33.6	34.8	36.1	36.5	37.0	37.7	38.0	38.1	38.1
H173	33.4	33.4	33.9	34.6	36.1	37.6	38.0	38.6	39.2	39.5	39.6	39.7
H209	28.6	28.6	28.6	28.9	31.4	33.7	34.4	34.9	35.6	35.6	36.0	36.2
H222	25.6	25.6	25.6	25.9	28.5	30.8	31.5	32.1	32.8	32.8	33.2	33.4
H224	26.1	26.1	26.1	26.4	29.0	31.3	32.0	32.5	33.2	33.3	33.6	33.8

Derived Acoustic Acceptance Criteria

11.135 Due to the greater generation capacity and therefore increased planning merit of the cumulative development, and in accordance with the guidance provided by ETSU-R-97 and the IoA GPG, a 37.5 dB(A) daytime lower limit has been adopted. Justification for this limit is as follows:

- Number of noise affected residential properties: 32 of the considered residential properties are predicted to experience cumulative noise levels of greater than 35 dB(A), a number proportional to the scale of the cumulative development which would generate significant social, economic and environmental benefits, suggesting a limit in the middle of the range would be appropriate;
- Potential impact on the power output of the wind farm: The rated power of the cumulative development would be 99.5 MW should the turbine types considered in the acoustic assessment be installed, large in comparison with other wind farm developments in Northern Ireland, suggesting that a lower limit in the middle of the range would be appropriate. Restricting the lower limit to 35 dB(A) could limit the number and size of turbine installed or result in additional noise management being required, thereby impacting the amount of energy generated by such a scheme; and
- The likely duration and level of exposure: The amount of the time that noise levels of greater than 35 dB(A) are predicted is limited to periods of sufficiently high wind speed. Furthermore, the noise levels experienced would be less in practice as it has been assumed that properties can be downwind of all wind turbines simultaneously

which would not be the case in reality. It would therefore be suggested that a daytime lower limit in the middle of the range is applied.

11.136 As detailed in paragraph 11.85, the background noise survey locations inferred to be representative for each property are shown in **Table 17**.

11.137 As recommended in ETSU-R-97, the absolute lower noise limits may be increased up to 45 dB(A) if the occupant has a financial involvement in the wind farm. This has been applied at H3 where the occupants have financial involvement with single turbine B1[23] and at H45 & H173 where the occupants have financial involvement with single turbine D1[24].

11.138 The total ETSU-R-97 noise limits for daytime and night-time periods, for each residential property, can be found in **Table 49** and **Table 50**.

Table 45: Total ETSU-R-97 Daytime Noise Limit, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	37.5	37.5	37.5	37.5	37.5	40.3	43.0	45.5	48.0	50.5	52.9	55.4
H2	37.5	37.5	37.5	37.5	37.5	39.7	42.3	44.8	47.4	50.0	52.6	55.4
H3	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.4
H4	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.0	41.2	43.1	44.8	46.4
H5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.0	41.2	43.1	44.8	46.4
H6	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H10	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H11	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H12	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H13	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H14	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H16	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H22	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H24	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H27	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.8	40.4	43.4	43.4
H33	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.6	40.5	44.2	48.7	48.7
H34	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H39	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.6	40.5	44.2	48.7	48.7
H45	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.9	51.6	51.6
H49	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.8	40.4	43.4	43.4
H52	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H91	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H94	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H158	37.5	37.5	37.5	37.5	37.5	37.5	37.5	39.0	41.2	43.1	44.8	46.4

[23] CD Consulting, 'Noise Impact Assessment', Ballure Wind Ltd, LA01/2020/0078/F, 13 January 2020

[24] KRM Acoustics, 'Noise Assessment for Single Wind Turbine', LA01/2017/0016/F, 28 December 2018

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H162	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H164	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H165	37.5	37.5	37.5	37.5	37.5	37.5	37.5	38.0	39.7	42.6	46.8	46.8
H168	37.5	37.5	37.5	37.5	37.7	39.0	40.5	42.4	44.8	47.9	51.6	51.6
H173	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.9	51.6	51.6
H209	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.8	40.4	43.4	43.4
H222	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.6	40.5	44.2	48.7	48.7
H224	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.8	40.4	43.4	43.4

Table 46: Total ETSU-R-97 Night Time Noise Limit, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	46.5	49.4	52.3	55.1
H2	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	46.7	49.4	52.1	54.7
H3	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
H4	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
H5	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
H6	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H10	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H11	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H12	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H13	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H14	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H16	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H22	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H24	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H27	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7
H33	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.9
H34	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H39	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.9
H45	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.1	50.2
H49	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7
H52	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H91	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H94	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H158	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.5
H162	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H164	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9
H165	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.0	46.9

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H168	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.3	47.1	50.2
H173	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.1	50.2
H209	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7
H222	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	45.4	48.9
H224	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7

11.139 The limit remaining for the proposed development for day and night time periods, calculated by subtracting the cumulative predicted noise levels due to the other sites considered in the cumulative assessment from the total ETSU-R-97 limit, is shown in **Table 47** & **Table 48**. The resulting limits are restricted from exceeding those identified as being appropriate for the proposed development alone i.e. a daytime lower limit of 35 dB(A) and no financial beneficiary status at houses H3, H45 & H173.

Table 47: Daytime Limit Remaining, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	33.5	33.5	33.5	31.3	27.5	30.3	36.6	40.9	45.9	49.4	52.3	55.1
H2	34.9	34.9	34.9	34.1	32.5	33.6	38.3	41.8	45.9	49.2	52.2	55.2
H3	35.0	35.0	35.0	35.0	35.0	35.5	37.0	35.1	35.0	35.2	37.4	42.4
H4	35.0	35.0	35.0	35.0	35.0	32.1	27.5	29.0	37.1	40.9	43.5	45.5
H5	35.0	35.0	35.0	35.0	35.0	33.2	29.0	30.7	37.7	41.2	43.6	45.6
H6	35.0	35.5	36.3	36.3	35.6	32.9	27.5	28.5	32.0	40.2	46.0	46.0
H10	35.0	35.5	36.3	36.4	35.7	33.2	29.4	28.1	33.4	40.4	46.1	46.0
H11	35.0	35.5	36.3	36.6	36.0	34.3	32.3	29.7	35.3	40.9	46.2	46.2
H12	35.0	35.5	36.3	36.5	36.0	34.2	32.0	28.9	35.1	40.8	46.2	46.2
H13	35.0	35.5	36.3	36.5	35.9	33.9	31.4	28.0	34.7	40.7	46.2	46.1
H14	35.0	35.5	36.3	36.6	36.2	34.6	33.0	31.5	35.9	41.0	46.3	46.2
H16	35.0	35.5	36.3	36.6	36.1	34.3	32.1	29.0	35.1	40.8	46.2	46.2
H22	35.0	35.0	35.3	36.5	36.5	37.7	39.4	41.6	44.3	47.6	51.5	51.5
H24	35.0	35.0	35.3	35.6	35.6	37.1	39.1	41.4	44.2	47.6	51.5	51.5
H27	35.0	35.0	35.0	35.0	35.0	35.0	34.9	34.1	33.9	38.7	42.5	42.5
H33	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.2	39.7	43.9	48.6	48.6
H34	35.0	35.5	36.3	36.6	36.0	34.2	32.2	29.7	35.3	40.9	46.2	46.2
H39	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.4	39.8	43.9	48.6	48.6
H45	35.0	35.0	35.3	36.5	37.7	39.0	40.5	42.4	43.7	47.2	51.3	51.3
H49	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.5	35.5	39.3	42.8	42.8
H52	35.0	35.0	35.3	36.5	36.6	37.9	39.7	41.8	44.4	47.7	51.5	51.5
H91	35.0	35.0	35.2	35.1	35.2	36.8	38.9	41.3	44.1	47.6	51.5	51.5
H94	35.0	35.0	35.3	36.5	36.1	37.1	39.0	41.3	44.1	47.6	51.4	51.4
H158	35.0	35.0	35.0	35.0	35.0	32.9	28.1	30.0	37.7	41.1	43.6	45.6

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H162	35.0	35.5	36.3	36.6	36.1	34.5	32.6	30.1	35.5	40.9	46.2	46.2
H164	35.0	35.5	36.3	36.4	35.8	33.4	29.8	28.1	33.5	40.4	46.1	46.1
H165	35.0	35.5	36.3	36.3	35.8	33.4	29.5	28.2	33.4	40.4	46.1	46.1
H168	35.0	35.0	35.3	35.3	34.8	36.2	38.4	41.0	43.9	47.4	51.4	51.4
H173	35.0	35.0	35.3	36.5	37.7	39.0	40.5	42.4	43.7	47.2	51.3	51.3
H209	35.0	35.0	35.0	35.0	35.0	35.0	34.8	34.0	33.8	38.6	42.5	42.4
H222	35.0	35.0	35.0	35.0	35.0	35.0	35.2	36.2	39.7	43.9	48.6	48.6
H224	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.5	35.9	39.5	42.9	42.9

Table 48: Night Time Limit Remaining, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	42.2	42.2	42.2	42.0	40.9	37.2	33.0	33.7	43.0	47.9	51.6	54.8
H2	42.4	42.4	42.4	42.3	41.7	40.1	38.7	40.0	44.9	48.5	51.7	54.5
H3	43.0	43.0	43.0	42.9	41.8	40.0	37.3	35.0	35.0	35.2	37.4	38.4
H4	42.6	42.6	42.6	42.6	42.3	41.7	41.3	41.0	40.8	40.7	40.9	43.3
H5	42.7	42.7	42.7	42.7	42.4	41.9	41.5	41.2	41.0	41.0	41.1	43.4
H6	42.7	42.7	42.7	42.7	42.4	41.8	41.4	41.1	40.9	40.8	42.4	46.2
H10	42.8	42.8	42.8	42.7	42.4	41.9	41.6	41.3	41.1	41.0	42.5	46.2
H11	42.8	42.8	42.8	42.8	42.5	42.1	41.9	41.7	41.5	41.5	42.8	46.4
H12	42.8	42.8	42.8	42.7	42.5	42.1	41.8	41.6	41.4	41.4	42.7	46.3
H13	42.8	42.8	42.8	42.7	42.5	42.0	41.8	41.5	41.3	41.3	42.7	46.3
H14	42.8	42.8	42.8	42.8	42.6	42.2	42.0	41.8	41.6	41.6	42.9	46.4
H16	42.8	42.8	42.8	42.8	42.5	42.1	41.8	41.6	41.4	41.4	42.7	46.3
H22	42.8	42.8	42.8	42.8	42.7	42.5	42.4	42.3	42.2	43.7	46.8	50.0
H24	42.5	42.5	42.5	42.5	42.5	42.3	42.2	42.2	42.0	43.6	46.7	50.0
H27	42.8	42.8	42.8	42.8	42.7	42.5	42.4	42.3	42.1	42.1	42.0	42.9
H33	42.9	42.9	42.9	42.9	42.8	42.7	42.7	42.6	42.6	42.6	45.1	48.8
H34	42.8	42.8	42.8	42.8	42.5	42.1	41.9	41.7	41.5	41.4	42.8	46.3
H39	42.9	42.9	42.9	42.9	42.9	42.8	42.7	42.7	42.6	42.6	45.2	48.8
H45	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.6	46.3	49.8
H49	42.9	42.9	42.9	42.9	42.8	42.6	42.6	42.5	42.4	42.4	42.4	43.1
H52	42.7	42.7	42.7	42.7	42.7	42.6	42.5	42.5	42.4	43.9	46.9	50.1
H91	42.5	42.5	42.5	42.4	42.4	42.2	42.1	42.1	42.0	43.6	46.7	50.0
H94	42.8	42.8	42.8	42.7	42.6	42.3	42.2	42.0	41.9	43.5	46.7	50.0
H158	42.7	42.7	42.7	42.6	42.4	41.9	41.5	41.2	41.0	41.0	41.1	43.4
H162	42.8	42.8	42.8	42.8	42.6	42.1	41.9	41.7	41.5	41.5	42.8	46.4
H164	42.8	42.8	42.8	42.7	42.4	41.9	41.6	41.3	41.1	41.1	42.5	46.3
H165	42.8	42.8	42.8	42.7	42.4	41.9	41.6	41.3	41.1	41.0	42.5	46.3

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H168	42.6	42.6	42.6	42.5	42.3	42.0	41.9	41.7	41.5	43.1	46.5	49.9
H173	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.6	46.2	49.8
H209	42.8	42.8	42.8	42.8	42.7	42.5	42.4	42.3	42.1	42.1	42.0	42.8
H222	42.9	42.9	42.9	42.9	42.8	42.7	42.7	42.6	42.6	42.6	45.1	48.8
H224	42.9	42.9	42.9	42.9	42.8	42.7	42.6	42.6	42.5	42.5	42.5	43.2

Cumulative Acoustic Assessment

11.140 A comparison of the predicted noise levels for the proposed development (Vestas options) with the recommended daytime noise limits for the nearby residential properties is shown in **Table 49**. A negative value indicates that the predicted noise level is within the limit. **Table 50** shows a comparison with the recommended night-time noise limits.

11.141 Noise levels at all residential properties are within the night-time noise limit at all wind speeds considered with the smallest margin being -3.6 dB(A). The noise levels are predicted to exceed the limit at 18 properties during daytime periods by a maximum of 6.1 dB(A).

11.142 A comparison of the predicted noise levels for the Enercon option with the day and night-time limits is shown in **Table 51** and **Table 52**. The limit is predicted to be exceeded at 18 properties during daytime periods by a maximum of 6.0 dB(A) but is met at night by a minimum margin of -3.3 dB(A).

11.143 **Figure 11.2** shows a cumulative noise contour plot for the proposed development (Vestas option) and the other projects considered in the cumulative assessment calculated using the ISO 9613 Part 2 propagation model. The plot is provided to illustrate the cumulative noise 'footprint' and should be considered indicative only. Where properties are located such that they cannot be downwind of all turbines simultaneously, the predictions made using a downwind propagation model such as ISO 9613-2 are conservative given that reductions in noise would be expected when a property is crosswind or upwind of a noise source.

Table 49: Comparison of Predicted Noise Levels and Daytime Noise Limits for Vestas Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-16.6	-16.6	-16.6	-10.7	-1.9	-1.6	-7.6	-11.9	-16.9	-20.4	-23.3	-26.1
H2	-18.5	-18.5	-18.5	-14.0	-7.4	-5.4	-9.8	-13.3	-17.4	-20.8	-23.7	-26.7
H3	-17.1	-17.1	-17.1	-13.4	-8.4	-5.8	-7.0	-5.0	-5.0	-5.1	-7.4	-12.4
H4	-17.0	-17.0	-17.0	-13.3	-8.3	-2.3	2.6	1.1	-7.1	-10.8	-13.5	-15.5
H5	-16.2	-16.2	-16.2	-12.5	-7.5	-2.6	1.9	0.2	-6.8	-10.2	-12.7	-14.7
H6	-14.3	-14.8	-15.6	-11.8	-6.2	-0.3	5.3	4.3	0.8	-7.4	-13.2	-13.2
H10	-12.9	-13.4	-14.2	-10.5	-4.9	0.8	4.9	6.1	0.9	-6.2	-11.8	-11.8
H11	-14.1	-14.6	-15.4	-12.0	-6.5	-1.7	0.7	3.2	-2.4	-7.9	-13.3	-13.2
H12	-13.9	-14.4	-15.2	-11.7	-6.2	-1.2	1.3	4.3	-1.9	-7.6	-13.0	-12.9
H13	-13.6	-14.1	-14.9	-11.3	-5.8	-0.7	2.1	5.5	-1.1	-7.2	-12.6	-12.6
H14	-14.0	-14.5	-15.3	-11.9	-6.5	-1.9	0.0	1.6	-2.8	-8.0	-13.2	-13.2
H16	-14.2	-14.7	-15.5	-12.1	-6.7	-1.8	0.7	3.9	-2.2	-8.0	-13.3	-13.3
H22	-11.9	-11.9	-12.2	-9.7	-4.7	-2.7	-4.2	-6.3	-9.0	-12.4	-16.2	-16.2
H24	-14.6	-14.6	-14.9	-11.5	-6.5	-4.9	-6.6	-8.9	-11.7	-15.1	-19.0	-19.0
H27	-8.8	-8.8	-8.8	-5.1	-0.1	3.0	3.4	4.2	4.4	-0.4	-4.2	-4.2
H33	-14.1	-14.1	-14.1	-10.4	-5.4	-2.3	-2.2	-3.2	-6.7	-10.9	-15.6	-15.6
H34	-13.2	-13.7	-14.5	-11.1	-5.5	-0.6	1.7	4.2	-1.4	-7.0	-12.3	-12.3
H39	-14.8	-14.8	-14.8	-11.1	-6.1	-3.0	-2.9	-4.0	-7.5	-11.6	-16.2	-16.2
H45	-11.0	-11.0	-11.3	-8.8	-5.0	-3.2	-4.4	-6.3	-7.7	-11.2	-15.3	-15.3
H49	-10.6	-10.6	-10.6	-6.9	-1.9	1.2	1.5	1.1	1.0	-2.8	-6.3	-6.2
H52	-14.3	-14.3	-14.6	-12.0	-7.1	-5.4	-6.8	-9.0	-11.6	-14.9	-18.7	-18.7
H91	-14.0	-14.0	-14.2	-10.4	-5.6	-4.0	-5.8	-8.2	-11.1	-14.5	-18.4	-18.4
H94	-10.5	-10.5	-10.8	-8.3	-2.9	-0.8	-2.4	-4.7	-7.5	-10.9	-14.8	-14.8
H158	-17.1	-17.1	-17.1	-13.4	-8.4	-3.2	1.9	0.0	-7.7	-11.1	-13.7	-15.6
H162	-15.4	-15.9	-16.7	-13.2	-7.8	-3.1	-0.8	1.6	-3.8	-9.2	-14.5	-14.5
H164	-14.7	-15.2	-16.0	-12.4	-6.8	-1.4	2.6	4.2	-1.1	-8.1	-13.7	-13.7
H165	-14.5	-15.0	-15.8	-12.2	-6.6	-1.1	3.0	4.4	-0.8	-7.8	-13.5	-13.5
H168	-13.1	-13.1	-13.4	-9.7	-4.2	-2.5	-4.4	-6.9	-9.9	-13.4	-17.4	-17.4
H173	-10.9	-10.9	-11.2	-8.7	-4.9	-3.1	-4.3	-6.2	-7.5	-11.0	-15.1	-15.1
H209	-8.7	-8.7	-8.7	-5.0	0.0	3.1	3.6	4.4	4.7	-0.2	-4.1	-4.0
H222	-14.4	-14.4	-14.4	-10.7	-5.7	-2.6	-2.5	-3.5	-7.0	-11.2	-15.9	-15.9
H224	-10.9	-10.9	-10.9	-7.2	-2.2	0.9	1.2	0.7	0.2	-3.3	-6.8	-6.7

Table 50: Comparison of Predicted Noise Levels and Night Time Limits for Vestas Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-25.3	-25.3	-25.3	-21.4	-15.3	-8.5	-4.0	-4.7	-14.0	-18.9	-22.6	-25.8
H2	-26.0	-26.0	-26.0	-22.2	-16.6	-11.9	-10.2	-11.5	-16.4	-20.0	-23.2	-26.0
H3	-25.0	-25.0	-25.0	-21.3	-15.2	-10.2	-7.2	-5.0	-5.0	-5.1	-7.4	-8.4
H4	-24.7	-24.7	-24.7	-20.9	-15.6	-12.0	-11.3	-10.9	-10.7	-10.7	-10.8	-13.2
H5	-23.9	-23.9	-23.9	-20.1	-14.9	-11.3	-10.6	-10.3	-10.1	-10.1	-10.2	-12.4
H6	-22.0	-22.0	-22.0	-18.3	-13.0	-9.3	-8.6	-8.3	-8.1	-8.0	-9.6	-13.4
H10	-20.6	-20.6	-20.6	-16.9	-11.6	-8.0	-7.3	-7.1	-6.8	-6.8	-8.2	-12.0
H11	-21.9	-21.9	-21.9	-18.2	-13.0	-9.5	-8.9	-8.7	-8.5	-8.5	-9.8	-13.4
H12	-21.7	-21.7	-21.7	-17.9	-12.7	-9.1	-8.6	-8.4	-8.2	-8.2	-9.5	-13.1
H13	-21.3	-21.3	-21.3	-17.6	-12.4	-8.8	-8.2	-8.0	-7.8	-7.8	-9.1	-12.8
H14	-21.8	-21.8	-21.8	-18.1	-12.9	-9.4	-8.9	-8.7	-8.6	-8.5	-9.8	-13.3
H16	-22.0	-22.0	-22.0	-18.3	-13.1	-9.5	-9.0	-8.8	-8.6	-8.5	-9.9	-13.5
H22	-19.7	-19.7	-19.7	-15.9	-10.8	-7.5	-7.1	-7.1	-6.9	-8.4	-11.5	-14.8
H24	-22.2	-22.2	-22.2	-18.5	-13.4	-10.1	-9.7	-9.7	-9.6	-11.1	-14.3	-17.5
H27	-16.6	-16.6	-16.6	-12.9	-7.8	-4.5	-4.1	-4.0	-3.8	-3.8	-3.8	-4.6
H33	-22.0	-22.0	-22.0	-18.3	-13.2	-10.0	-9.7	-9.6	-9.6	-9.6	-12.1	-15.8
H34	-21.0	-21.0	-21.0	-17.3	-12.1	-8.5	-8.0	-7.8	-7.6	-7.6	-8.9	-12.5
H39	-22.7	-22.7	-22.7	-19.0	-13.9	-10.7	-10.4	-10.3	-10.3	-10.3	-12.8	-16.4
H45	-19.0	-19.0	-19.0	-15.3	-10.3	-7.2	-6.9	-6.9	-6.9	-7.5	-10.2	-13.7
H49	-18.5	-18.5	-18.5	-14.8	-9.7	-6.4	-6.1	-6.0	-5.9	-5.9	-5.8	-6.6
H52	-22.0	-22.0	-22.0	-18.3	-13.2	-10.0	-9.7	-9.7	-9.6	-11.0	-14.0	-17.2
H91	-21.5	-21.5	-21.5	-17.8	-12.7	-9.4	-9.1	-9.0	-8.9	-10.5	-13.6	-16.9
H94	-18.3	-18.3	-18.2	-14.5	-9.3	-6.0	-5.5	-5.4	-5.2	-6.9	-10.0	-13.4
H158	-24.8	-24.8	-24.8	-21.1	-15.8	-12.2	-11.5	-11.2	-11.0	-11.0	-11.1	-13.4
H162	-23.2	-23.2	-23.2	-19.4	-14.2	-10.7	-10.1	-9.9	-9.8	-9.8	-11.1	-14.6
H164	-22.5	-22.5	-22.5	-18.7	-13.5	-9.9	-9.2	-9.0	-8.7	-8.7	-10.2	-13.9
H165	-22.3	-22.3	-22.3	-18.5	-13.3	-9.6	-9.0	-8.7	-8.5	-8.5	-10.0	-13.7
H168	-20.7	-20.7	-20.6	-16.9	-11.7	-8.3	-7.9	-7.7	-7.5	-9.1	-12.5	-15.9
H173	-18.9	-18.9	-18.9	-15.2	-10.2	-7.1	-6.8	-6.8	-6.8	-7.3	-10.0	-13.6
H209	-16.5	-16.5	-16.5	-12.8	-7.6	-4.3	-3.9	-3.8	-3.7	-3.7	-3.6	-4.4
H222	-22.4	-22.4	-22.4	-18.7	-13.6	-10.4	-10.0	-10.0	-9.9	-9.9	-12.5	-16.1
H224	-18.9	-18.9	-18.9	-15.2	-10.1	-6.8	-6.5	-6.4	-6.4	-6.4	-6.3	-7.1

Table 51: Comparison of Predicted Noise Levels and Daytime Noise Limits for Enercon Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-17.2	-17.2	-17.2	-8.6	-1.5	-3.3	-8.7	-12.2	-17.0	-20.5	-23.4	-26.2
H2	-19.2	-19.2	-19.2	-12.0	-7.1	-7.2	-11.0	-13.7	-17.6	-20.9	-23.9	-26.9
H3	-17.7	-17.7	-17.7	-11.3	-8.0	-7.5	-8.1	-5.4	-5.1	-5.3	-7.5	-12.5
H4	-17.6	-17.6	-17.6	-11.2	-7.9	-4.0	1.5	0.8	-7.1	-10.9	-13.5	-15.5
H5	-16.7	-16.7	-16.7	-10.3	-7.0	-4.2	0.9	0.0	-6.8	-10.3	-12.7	-14.7
H6	-14.8	-15.3	-16.1	-9.7	-5.7	-2.0	4.3	4.1	0.8	-7.4	-13.2	-13.2
H10	-13.3	-13.8	-14.6	-8.3	-4.3	-0.8	3.9	6.0	0.9	-6.1	-11.8	-11.7
H11	-14.6	-15.1	-15.9	-9.8	-5.9	-3.2	-0.3	3.1	-2.3	-7.9	-13.2	-13.2
H12	-14.3	-14.8	-15.6	-9.4	-5.6	-2.8	0.3	4.2	-1.8	-7.5	-12.9	-12.9
H13	-14.0	-14.5	-15.3	-9.1	-5.2	-2.2	1.2	5.4	-1.1	-7.1	-12.6	-12.5
H14	-14.5	-15.0	-15.8	-9.7	-6.0	-3.4	-0.9	1.4	-2.8	-7.9	-13.2	-13.1
H16	-14.7	-15.2	-16.0	-9.9	-6.1	-3.3	-0.2	3.7	-2.2	-7.9	-13.3	-13.3
H22	-12.3	-12.3	-12.6	-7.4	-4.1	-4.3	-5.1	-6.5	-9.0	-12.3	-16.2	-16.2
H24	-15.2	-15.2	-15.5	-9.4	-6.1	-6.6	-7.7	-9.2	-11.8	-15.2	-19.1	-19.1
H27	-9.1	-9.1	-9.1	-2.7	0.6	1.6	2.6	4.2	4.6	-0.2	-4.0	-4.0
H33	-14.5	-14.5	-14.5	-8.1	-4.8	-3.8	-3.1	-3.3	-6.6	-10.8	-15.5	-15.5
H34	-13.7	-14.2	-15.0	-8.9	-5.0	-2.2	0.7	4.0	-1.4	-7.0	-12.3	-12.3
H39	-15.3	-15.3	-15.3	-8.9	-5.6	-4.6	-3.9	-4.3	-7.5	-11.6	-16.3	-16.3
H45	-11.4	-11.4	-11.7	-6.5	-4.4	-4.7	-5.3	-6.4	-7.5	-11.0	-15.1	-15.1
H49	-11.0	-11.0	-11.0	-4.6	-1.3	-0.3	0.6	0.9	1.1	-2.7	-6.2	-6.2
H52	-14.8	-14.8	-15.1	-9.9	-6.7	-7.0	-7.9	-9.2	-11.6	-14.9	-18.7	-18.7
H91	-14.6	-14.6	-14.8	-8.3	-5.1	-5.7	-6.9	-8.5	-11.1	-14.6	-18.5	-18.5
H94	-10.8	-10.8	-11.1	-5.9	-2.2	-2.2	-3.2	-4.7	-7.3	-10.8	-14.6	-14.6
H158	-17.7	-17.7	-17.7	-11.3	-8.0	-4.9	0.8	-0.3	-7.8	-11.2	-13.7	-15.7
H162	-15.9	-16.4	-17.2	-11.1	-7.3	-4.7	-1.9	1.4	-3.8	-9.2	-14.5	-14.5
H164	-15.2	-15.7	-16.5	-10.2	-6.3	-2.9	1.6	4.1	-1.1	-8.0	-13.7	-13.7
H165	-15.0	-15.5	-16.3	-9.9	-6.1	-2.7	2.1	4.2	-0.8	-7.8	-13.5	-13.5
H168	-13.5	-13.5	-13.8	-7.4	-3.6	-4.0	-5.3	-7.1	-9.8	-13.3	-17.3	-17.3
H173	-11.2	-11.2	-11.5	-6.3	-4.2	-4.5	-5.1	-6.2	-7.3	-10.8	-14.9	-14.9
H209	-8.9	-8.9	-8.9	-2.5	0.8	1.8	2.9	4.5	4.9	0.1	-3.8	-3.7
H222	-14.9	-14.9	-14.9	-8.5	-5.2	-4.2	-3.5	-3.7	-7.0	-11.2	-15.9	-15.9
H224	-11.4	-11.4	-11.4	-5.0	-1.7	-0.7	0.2	0.5	0.3	-3.3	-6.7	-6.7

Table 52: Comparison of Predicted Noise Levels and Night Time Limits for Enercon Option, dB(A)

House ID	Reference Wind Speed, Standardised v_{10} (ms^{-1})											
	1	2	3	4	5	6	7	8	9	10	11	12
H1	-25.9	-25.9	-25.9	-19.3	-14.9	-10.2	-5.1	-5.0	-14.1	-19.0	-22.7	-25.9
H2	-26.7	-26.7	-26.7	-20.2	-16.3	-13.7	-11.4	-11.9	-16.6	-20.2	-23.4	-26.2
H3	-25.7	-25.7	-25.7	-19.2	-14.8	-12.0	-8.4	-5.3	-5.1	-5.3	-7.5	-8.5
H4	-25.2	-25.2	-25.2	-18.8	-15.2	-13.6	-12.3	-11.2	-10.8	-10.7	-10.9	-13.3
H5	-24.4	-24.4	-24.4	-18.0	-14.4	-12.9	-11.6	-10.5	-10.1	-10.1	-10.2	-12.5
H6	-22.5	-22.5	-22.5	-16.1	-12.5	-10.9	-9.6	-8.5	-8.1	-8.0	-9.6	-13.4
H10	-21.1	-21.1	-21.1	-14.6	-11.0	-9.5	-8.3	-7.2	-6.8	-6.7	-8.2	-11.9
H11	-22.4	-22.4	-22.4	-16.0	-12.4	-11.0	-9.9	-8.9	-8.5	-8.5	-9.8	-13.4
H12	-22.1	-22.1	-22.1	-15.6	-12.1	-10.7	-9.5	-8.5	-8.1	-8.1	-9.4	-13.0
H13	-21.8	-21.8	-21.8	-15.3	-11.8	-10.3	-9.2	-8.1	-7.7	-7.7	-9.1	-12.7
H14	-22.3	-22.3	-22.3	-15.9	-12.4	-11.0	-9.9	-8.9	-8.5	-8.5	-9.8	-13.3
H16	-22.5	-22.5	-22.5	-16.1	-12.5	-11.1	-9.9	-8.9	-8.5	-8.5	-9.8	-13.4
H22	-20.1	-20.1	-20.1	-13.7	-10.3	-9.1	-8.1	-7.2	-6.9	-8.4	-11.5	-14.7
H24	-22.7	-22.7	-22.7	-16.3	-13.0	-11.8	-10.8	-10.0	-9.6	-11.2	-14.3	-17.6
H27	-16.9	-16.9	-16.9	-10.5	-7.1	-5.9	-4.9	-4.0	-3.6	-3.6	-3.5	-4.4
H33	-22.4	-22.4	-22.4	-16.0	-12.6	-11.5	-10.6	-9.7	-9.5	-9.5	-12.0	-15.7
H34	-21.5	-21.5	-21.5	-15.1	-11.5	-10.1	-9.0	-8.0	-7.6	-7.5	-8.9	-12.4
H39	-23.2	-23.2	-23.2	-16.8	-13.5	-12.4	-11.4	-10.6	-10.3	-10.3	-12.9	-16.5
H45	-19.4	-19.4	-19.4	-13.0	-9.7	-8.7	-7.8	-7.0	-6.8	-7.4	-10.1	-13.6
H49	-18.9	-18.9	-18.9	-12.5	-9.1	-7.9	-7.0	-6.1	-5.8	-5.8	-5.8	-6.5
H52	-22.5	-22.5	-22.5	-16.1	-12.8	-11.7	-10.7	-9.9	-9.6	-11.1	-14.1	-17.3
H91	-22.1	-22.1	-22.1	-15.6	-12.3	-11.1	-10.1	-9.3	-9.0	-10.6	-13.7	-17.0
H94	-18.6	-18.6	-18.6	-12.1	-8.7	-7.4	-6.4	-5.4	-5.1	-6.7	-9.9	-13.2
H158	-25.4	-25.4	-25.4	-18.9	-15.4	-13.9	-12.6	-11.5	-11.1	-11.1	-11.2	-13.5
H162	-23.7	-23.7	-23.7	-17.3	-13.8	-12.3	-11.2	-10.2	-9.8	-9.8	-11.1	-14.7
H164	-23.0	-23.0	-23.0	-16.5	-12.9	-11.4	-10.2	-9.1	-8.7	-8.7	-10.1	-13.9
H165	-22.8	-22.8	-22.8	-16.3	-12.7	-11.2	-10.0	-8.9	-8.5	-8.4	-9.9	-13.7
H168	-21.1	-21.1	-21.1	-14.6	-11.1	-9.8	-8.8	-7.8	-7.4	-9.0	-12.4	-15.8
H173	-19.2	-19.2	-19.2	-12.8	-9.5	-8.5	-7.6	-6.8	-6.6	-7.2	-9.8	-13.4
H209	-16.7	-16.7	-16.7	-10.3	-6.9	-5.7	-4.7	-3.8	-3.4	-3.4	-3.3	-4.1
H222	-22.8	-22.8	-22.8	-16.4	-13.0	-11.9	-11.0	-10.1	-9.9	-9.9	-12.4	-16.1
H224	-19.3	-19.3	-19.3	-12.9	-9.5	-8.4	-7.4	-6.6	-6.3	-6.3	-6.3	-7.0

Cumulative Directional Assessment

11.144 Rather than making the conservative assumption that properties are downwind of all of the turbines considered in the cumulative assessment simultaneously, a more detailed and realistic assessment, accounting for the fact that noise levels will be less when

properties are upwind and crosswind of the turbines, has been undertaken. The directional attenuation factors applied, detailed in **Table 53**, are consistent with the recommendations of the IoA GPG, with reductions in noise of 2 dB(A) when a receiver is crosswind, and 10 dB(A) when a receiver is upwind of a noise source respectively and a polynomial interpolation in the intermediate directions.

Table 53: Directional Attenuation Factors

Directional Offset from Directly Downwind (º)	Directional Attenuation Factor (dB)
0	0.0
30	0.0
60	0.0
90	-2.0
120	-6.7
150	-9.3
180	-10.0
210	-9.3
240	-6.7
270	-2.0
300	0.0
330	0.0

11.145 The IoA GPG goes on to state that such reductions would only come into play gradually at distances of between five and ten tip heights. As such, the attenuation factors applied have been adjusted by the separation distance between the source and receiver accordingly.

11.146 The methodology followed in the directional assessment is as per the cumulative assessment with the consented and existing sites scaled to their conditioned noise limits. The resulting predicted noise levels for each of the twelve direction sectors for the sites considered in the cumulative assessment (not including the proposed development) are provided in **Technical Appendix 11.9**.

11.147 The directional predicted noise levels are then subtracted from the total ETSU-R-97 limit to determine the limit remaining for the proposed development for each direction sector. The results are shown in **Technical Appendix 11.8.** The limits for the proposed development are restricted from exceeding those identified as being appropriate for the proposed development alone i.e. a daytime lower limit of 35 dB(A) and no financial beneficiary status at houses H3, H45 & H173.

11.148 The directional predicted noise levels for the proposed development, detailed in **Technical Appendix 11.10** are then compared to this limit. The margins at each property for each direction sector are shown in **Technical Appendix 11.11**. A summary of the maximum margins by direction for the Vestas machine is provided in **Table 54** and **Table 55** for day and night-time periods respectively. The daytime limit is exceeded by a maximum of 6.2 dB(A) in the 60 to 120 degree sectors but the margin of exceedance is

less in other direction sectors. The night-time limit is met in all direction sectors by a minimum of -3.6 dB(A).

11.149 A summary of the maximum margins by direction for the Vestas machine is provided in **Table 56** and **Table 57** for day and night-time periods respectively. The daytime limit is exceeded by a maximum of 6.1 dB(A) in the 60 to 120 degree sectors but the margin of exceedance is less in other direction sectors. The night-time limit is met in all direction sectors by a minimum of -3.4 dB(A).

Table 54: Directional Assessment Daytime Margins - Vestas

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-8.7	-8.7	-8.7	-5.0	0.7	3.3	3.6	4.5	4.7	-0.2	-4.1	-4.0
30	-9.1	-9.1	-9.1	-5.4	0.7	3.1	4.1	6.0	4.2	-0.6	-4.5	-4.4
60	-9.7	-9.7	-9.7	-6.0	0.0	2.2	5.0	6.2	1.3	-2.1	-5.5	-5.5
90	-10.2	-10.2	-10.5	-6.6	-0.5	1.6	5.3	6.2	0.8	-3.8	-7.0	-7.0
120	-10.7	-10.7	-11.0	-7.2	-1.4	0.5	3.3	6.2	-0.1	-5.0	-7.4	-8.1
150	-11.3	-11.3	-11.6	-8.3	-1.9	-0.3	1.3	2.1	-2.5	-5.1	-7.5	-8.3
180	-11.7	-11.7	-11.7	-8.0	-3.0	0.1	0.4	-0.1	-2.0	-4.8	-7.9	-7.9
210	-10.6	-10.6	-10.6	-6.9	-1.9	1.2	1.5	1.0	-0.5	-3.4	-6.6	-6.6
240	-9.7	-9.7	-9.7	-6.0	-1.0	2.1	2.4	2.4	2.3	-1.7	-5.3	-5.3
270	-8.9	-8.9	-8.9	-5.2	-0.2	2.9	3.8	4.3	4.5	-0.4	-4.3	-4.2
300	-8.7	-8.7	-8.7	-5.0	0.0	3.1	4.0	4.5	4.7	-0.2	-4.1	-4.0
330	-8.7	-8.7	-8.7	-5.0	0.0	3.1	3.7	4.5	4.7	-0.2	-4.1	-4.0

Table 55: Directional Assessment Night Margins - Vestas

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-16.5	-16.5	-16.5	-12.8	-7.7	-4.3	-3.9	-3.8	-3.7	-3.7	-3.6	-4.4
30	-16.9	-16.9	-16.9	-13.2	-8.1	-4.8	-4.4	-4.2	-3.8	-4.1	-4.0	-4.8
60	-17.6	-17.6	-17.6	-13.9	-8.8	-5.2	-4.7	-4.3	-3.9	-5.1	-5.1	-5.8
90	-17.9	-17.9	-17.9	-14.1	-8.8	-5.3	-4.9	-4.5	-4.2	-5.1	-6.6	-7.3
120	-18.3	-18.3	-18.2	-14.5	-9.3	-5.8	-5.4	-4.7	-4.9	-5.1	-7.4	-7.3
150	-19.0	-19.0	-18.9	-15.1	-10.0	-6.7	-6.4	-4.7	-5.0	-5.1	-7.5	-7.4
180	-19.6	-19.6	-19.6	-15.9	-10.9	-7.8	-4.0	-4.7	-5.0	-5.0	-7.4	-8.2
210	-18.5	-18.5	-18.5	-14.8	-9.8	-6.6	-4.3	-6.1	-6.2	-6.2	-6.2	-6.9
240	-17.6	-17.6	-17.6	-13.9	-8.8	-5.5	-5.1	-5.0	-4.9	-4.9	-4.9	-5.6
270	-16.7	-16.7	-16.7	-13.0	-7.9	-4.6	-4.1	-4.0	-3.9	-3.9	-3.8	-4.6
300	-16.5	-16.5	-16.5	-12.8	-7.7	-4.3	-3.9	-3.8	-3.7	-3.7	-3.6	-4.4
330	-16.5	-16.5	-16.5	-12.8	-7.7	-4.3	-3.9	-3.8	-3.7	-3.7	-3.6	-4.4

Table 56: Directional Assessment Daytime Margins - Enercon

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-8.9	-8.9	-8.9	-2.5	1.4	1.9	2.8	4.5	4.9	0.0	-3.9	-3.8
30	-9.3	-9.3	-9.3	-2.9	1.4	1.7	3.2	5.9	4.4	-0.4	-4.3	-4.2
60	-9.9	-9.9	-9.9	-3.5	0.7	0.9	4.1	6.1	1.6	-1.9	-5.3	-5.2
90	-10.5	-10.5	-10.8	-4.2	0.2	0.2	4.3	6.1	0.8	-3.6	-6.7	-6.7
120	-11.0	-11.0	-11.3	-4.8	-0.7	-0.9	2.4	6.1	0.0	-4.7	-7.5	-7.8
150	-11.6	-11.6	-11.9	-5.9	-1.5	-1.6	0.2	1.9	-2.2	-4.9	-7.6	-8.0
180	-11.9	-11.9	-11.9	-5.5	-2.2	-1.2	-0.3	0.0	-1.7	-4.5	-7.6	-7.6
210	-10.8	-10.8	-10.8	-4.4	-1.1	-0.1	0.8	1.1	-0.2	-3.2	-6.4	-6.3
240	-10.0	-10.0	-10.0	-3.6	-0.3	0.7	1.6	2.4	2.6	-1.5	-5.1	-5.0
270	-9.2	-9.2	-9.2	-2.8	0.5	1.5	3.0	4.3	4.7	-0.2	-4.1	-4.0
300	-8.9	-8.9	-8.9	-2.5	0.8	1.8	3.3	4.6	4.9	0.0	-3.9	-3.8
330	-8.9	-8.9	-8.9	-2.5	0.8	1.8	2.9	4.6	4.9	0.0	-3.9	-3.8

Table 57: Directional Assessment Night Margins - Enercon

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-16.8	-16.8	-16.8	-10.4	-6.9	-5.7	-4.7	-3.8	-3.5	-3.5	-3.4	-4.1
30	-17.2	-17.2	-17.2	-10.8	-7.3	-6.1	-5.1	-4.2	-3.5	-3.9	-3.8	-4.5
60	-17.8	-17.8	-17.8	-11.4	-8.1	-6.6	-5.5	-4.3	-3.7	-4.9	-4.8	-5.5
90	-18.2	-18.2	-18.2	-11.7	-8.1	-6.7	-5.7	-4.5	-4.0	-5.2	-6.3	-7.0
120	-18.6	-18.6	-18.5	-12.1	-8.5	-7.2	-6.2	-5.0	-4.7	-5.2	-7.4	-7.4
150	-19.2	-19.2	-19.2	-12.7	-9.3	-8.1	-7.2	-5.0	-5.1	-5.2	-7.6	-7.5
180	-19.8	-19.8	-19.8	-13.4	-10.1	-9.1	-5.1	-5.0	-5.1	-5.1	-7.2	-7.9
210	-18.7	-18.7	-18.7	-12.3	-9.0	-8.0	-5.4	-6.2	-6.0	-6.0	-5.9	-6.7
240	-17.8	-17.8	-17.8	-11.4	-8.0	-6.8	-5.8	-5.0	-4.7	-4.7	-4.6	-5.4
270	-17.0	-17.0	-17.0	-10.6	-7.1	-5.9	-4.9	-4.0	-3.7	-3.7	-3.6	-4.4
300	-16.8	-16.8	-16.8	-10.4	-6.9	-5.7	-4.7	-3.8	-3.4	-3.4	-3.4	-4.1
330	-16.8	-16.8	-16.8	-10.4	-6.9	-5.7	-4.7	-3.8	-3.5	-3.5	-3.4	-4.1

11.150 A noise management strategy can be implemented to reduce the predicted noise levels so that they meet the daytime noise limit. Such a strategy involves operating certain turbines in reduced noise modes for specific wind speeds and directions. The available reduced noise modes for the Vestas machine are outlined in **Table 58** with those for the Enercon machine detailed in **Table 59**.

Table 58: Vestas V136 4.2 MW Reduced Operational Modes

Standardised 10m Wind speed, ms^{-1}	SO1	SO2	SO11	SO12	SO13
1	93.8	93.8	93.8	93.8	93.1
2	93.8	93.8	93.8	93.8	93.1
3	93.8	93.8	93.8	93.8	93.1
4	97.5	97.5	96.2	96.6	94.2
5	102.2	101.1	98.0	99.6	95.4
6	103.8	101.4	99.7	101.5	97.4
7	103.8	101.5	100.9	101.9	98.6
8	104.0	101.5	101.2	101.9	99.0
9	104.0	101.5	101.2	101.9	99.0
10	104.0	101.5	101.2	101.9	99.0
11	104.0	101.5	101.2	101.9	99.0
12	104.0	101.5	101.2	101.9	99.0

Table 59: Enercon E138 4.2 MW Reduced Operational Modes

10m Wind speed, ms^{-1}	Is	IIs	4000 kW	3500 kW	3000 kW	2500 kW	2000 kW	1500 kW	1000 kW	500 kW
1	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
2	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
3	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4
4	101.8	101.5	101.8	101.8	101.8	101.8	101.8	101.8	101.8	99.9
5	104.0	103.0	105.1	105.1	105.1	105.1	105.1	105.2	104.3	100.0
6	105.0	104.0	106.1	106.1	106.4	106.4	106.2	105.5	104.3	100.0
7	105.9	104.6	107.0	107.3	107.2	106.7	106.2	105.5	104.3	100.0
8	106.6	105.1	107.9	107.5	107.2	106.7	106.2	105.5	104.3	100.0
9	107.0	106.0	107.9	107.5	107.2	106.7	106.2	105.5	104.3	100.0
10	107.0	106.0	107.9	107.5	107.2	106.7	106.2	105.5	104.3	100.0
11	107.0	106.0	107.9	107.5	107.2	106.7	106.2	105.5	104.3	100.0
12	107.0	106.0	107.9	107.5	107.2	106.7	106.2	105.5	104.3	100.0

11.151 Directional noise management strategies for the Vestas and Enercon machines are provided in **Technical Appendix 11.12**. Note for any wind speeds not shown the turbines would operate unconstrained ('M0' represents unconstrained operation for the Vestas machine, '0s' for the Enercon). There will be many different combinations of turbine management that result in predicted noise levels below the specified criteria. The presented strategies demonstrate the principle of using noise management to mitigate noise levels but any strategy that results in the noise limits being met would be acceptable.

11.152 The directional predicted noise levels with the above noise management strategies in place are provided in **Technical Appendix 11.13**. A comparison of the mitigated

predicted noise levels to the daytime limit at each property for each direction sector is shown in **Technical Appendix 11.14**. A summary of the maximum margins by direction for the Vestas machine is provided in **Table 60**. A summary of the maximum margins by direction for the Enercon machine is provided in **Table 61**. It can be seen that the daytime limit can be met at all wind speeds and direction sectors by implementing a noise management strategy.

Table 60: Directional Assessment Daytime Margins – Vestas with Mitigation

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-8.7	-8.7	-8.7	-5.0	-0.3	0.0	-0.1	0.0	0.0	-0.2	-4.1	-4.0
30	-9.1	-9.1	-9.1	-5.4	-0.7	-0.1	-0.3	-0.2	-0.1	-0.6	-4.5	-4.4
60	-9.7	-9.7	-9.7	-6.0	-1.3	-0.1	-0.1	0.0	0.0	-2.1	-5.5	-5.5
90	-10.7	-10.7	-10.8	-7.1	-2.5	-0.4	0.0	-0.1	-0.1	-3.8	-7.0	-7.0
120	-11.2	-11.2	-11.5	-8.2	-2.2	-1.4	0.0	0.0	-0.1	-5.0	-7.4	-8.1
150	-12.0	-12.0	-12.1	-8.4	-2.2	-1.8	-0.2	-0.2	-2.5	-5.1	-7.5	-8.3
180	-11.7	-11.7	-11.7	-8.0	-3.3	-1.3	-0.7	-0.1	-2.0	-4.8	-7.9	-7.9
210	-10.6	-10.6	-10.6	-6.9	-2.2	-0.3	-0.1	-0.1	-0.7	-3.4	-6.6	-6.6
240	-9.7	-9.7	-9.7	-6.0	-1.3	-0.3	0.0	-0.1	0.0	-1.7	-5.3	-5.3
270	-8.9	-8.9	-8.9	-5.2	-0.5	0.0	0.0	0.0	0.0	-0.4	-4.3	-4.2
300	-8.7	-8.7	-8.7	-5.0	-0.3	0.0	0.0	-0.1	-0.1	-0.2	-4.1	-4.0
330	-8.7	-8.7	-8.7	-5.0	-0.3	0.0	0.0	-0.1	0.0	-0.2	-4.1	-4.0

Table 61: Directional Assessment Daytime Margins – Enercon with Mitigation

Direction Sector (°)	Standardised 10 m Wind Speed, ms^{-1}											
	1	2	3	4	5	6	7	8	9	10	11	12
0	-8.9	-8.9	-8.9	-2.5	0.0	0.0	0.0	-0.1	0.0	0.0	-3.9	-3.8
30	-9.3	-9.3	-9.3	-2.9	0.0	0.0	0.0	-0.1	0.0	-0.4	-4.3	-4.2
60	-9.9	-9.9	-9.9	-3.5	-0.2	0.0	0.0	0.0	0.0	-1.9	-5.3	-5.2
90	-11.0	-11.0	-11.1	-4.7	-1.4	-0.4	0.0	-0.1	-0.1	-3.6	-6.7	-6.7
120	-11.6	-11.6	-11.9	-5.7	-1.5	-1.3	0.0	0.0	-0.1	-4.7	-7.5	-7.8
150	-12.3	-12.3	-12.3	-5.9	-1.5	-1.6	0.0	0.0	-2.2	-4.9	-7.6	-8.0
180	-11.9	-11.9	-11.9	-5.5	-2.2	-1.2	-0.3	-0.2	-1.7	-4.5	-7.6	-7.6
210	-10.8	-10.8	-10.8	-4.4	-1.1	-0.1	0.0	0.0	-0.2	-3.2	-6.4	-6.3
240	-10.0	-10.0	-10.0	-3.6	-0.3	0.0	0.0	0.0	0.0	-1.5	-5.1	-5.0
270	-9.2	-9.2	-9.2	-2.8	-0.1	0.0	0.0	0.0	0.0	-0.2	-4.1	-4.0
300	-8.9	-8.9	-8.9	-2.5	0.0	0.0	0.0	0.0	-0.1	-0.1	-3.9	-3.8
330	-8.9	-8.9	-8.9	-2.5	0.0	0.0	0.0	-0.1	0.0	-0.1	-3.9	-3.8

Cumulative Construction Noise Assessment

11.153 Any noise due to the construction of the other sites considered in the cumulative operational noise assessment is unlikely to be ongoing at the same time as the construction of the proposed development. In the event that this scenario did occur, the activities would be far enough away from each other so as not to have a cumulative impact.

Summary

11.154 The acoustic impact for the operation of the proposed development on nearby residential properties has been assessed in accordance with the guidance on wind farm noise as issued in the DTI publication "The Assessment and Rating of Noise from Wind Farms", otherwise known as ETSU-R-97, and Institute of Acoustics Good Practice Guide (IoA GPG), as recommended for use by relevant planning policy.

11.155 To establish baseline conditions, background noise surveys were carried out at nearby properties and the measured background noise levels used to determine appropriate noise limits, as specified by ETSU-R-97 and the IoA GPG.

11.156 Operational noise levels were predicted using a noise propagation model, the proposed wind farm layout, terrain data and turbine emission data for two candidate turbines.

11.157 A cumulative operational noise assessment was completed to determine the potential impact of the proposed development in conjunction with the existing Gruig and consented Corkey repowering wind farms along with five single turbine schemes. The predicted noise levels, with appropriate mitigation measures applied to the proposed development, are within noise limits derived in accordance with ETSU-R-97 at all properties at all considered wind speeds.

11.158 A construction noise assessment carried out in accordance with BS 5228-1:2009 "Noise control on construction and open sites Part 1 - Noise" found that construction noise levels are predicted to meet construction noise criteria at nearby properties.

11.159 The potential impact of the proposed development, along with the mitigation proposed and any residual impact, is summarised in **Table 62**.

Table 62: Summary of Potential Impacts, Mitigation and Residual Impacts

Potential Impact	Mitigation Proposed	Means of Implementation	Outcome/ Residual Impact
Operation			
Potential impact on residential amenity due to operational noise	Impact is deemed to be acceptable as wind farm meets noise limits specified by relevant guidance with a noise management strategy in place No additional mitigation measures are required due to absence of identified significant effect	The limits specified in the conditions proposed in Technical Appendix 11.8.	Not significant
Construction			
Potential for noise to be created during general construction activities and by construction traffic	Due regard for 'best practicable means' (defined by Section 72 of the Control of Pollution Act 1974) A range of noise mitigation measures are proposed for the construction phase in accordance with measures outlined in BS 5228-1:2009 Site operations to be limited to 0700-1900 Monday to Saturday (except during turbine erection and commissioning/periods of emergency work)	Noise mitigation measures would be implemented as part of the Construction and Environmental Management Plan which would be required to be agreed as a condition of consent	Not significant

Glossary

A-weighting

A frequency-response function providing good correlation with the sensitivity of the human ear.

Broadband Noise

Noise which covers a wide range of frequencies (see Frequency).

Decibel dB(A)

The decibel (dB) is a logarithmic unit used in acoustics to quantify sound levels relative to a 0 dB reference (e.g. a sound pressure level of $2*10^{-5}$ Pa). The 'A' signifies A-weighting.

Equivalent Continuous Sound Level (L_{eq})

The equivalent continuous sound level is a notional steady noise level, which over a given time would provide the same energy as the intermittent noise.

Frequency

Refers to how quickly the air vibrates, or how close the sound waves are to each other and is measured in cycles per second, or Hertz (Hz). The lowest frequency audible to humans is 20 Hz and the highest is 20,000 Hz. The human ear is most sensitive to the 1 kHz, 2 kHz and 4 kHz octave bands and much less sensitive at lower audible frequencies.

Frequency Spectrum

Description of the sound pressure level of a source as a function of frequency.

Percentile Sound Level (L_{90})

Sound pressure level exceeded for 90% of the time for any given time interval. For example, $L_{(A)90,10min}$ means the A-weighted level that is exceeded for 90% of a ten minute interval. This indicates the noise levels during quieter periods, or the background noise level. It represents the lower estimate of the prevailing noise level and is useful for excluding such effects as aircraft or dogs barking on background noise levels.

Noise Emission

The noise energy emitted by a source (e.g. a wind turbine).

Noise Immission

The sound pressure level detected at a given location (e.g. nearest dwelling).

Octave Band

Range of frequencies between one frequency ($f_0*2^{-1/2}$) and a second frequency ($f_0*2^{+1/2}$). The quoted centre frequency of the octave band is f_0.

Sound Power Level

Sound power level is the acoustic power radiated from a sound source and is independent of the surroundings. It is a logarithmic measure in comparison to a reference level (10^{-12} watts).

Sound Pressure Level

A logarithmic measure of the effective sound pressure of a sound relative to a reference value which is for minimum audible field conditions ($20*10^{-6}$Pa).

Third Octave Band

The range of frequencies between one frequency ($f_0*2^{-1/6}$) and a second frequency equal to ($f_0*2^{+1/6}$). The quoted centre frequency of the third octave band is f_0.

Tonal Noise

A noise that contains a noticeable or discrete, continuous note and includes noises such as hums, hisses, screeches.