Chapter 12 Acoustic Assessment

Contents

12 Acoustic Assessment

12.1 Introduction

12.1.1 This chapter considers the likely significant noise effects associated with the construction, operation and decommissioning of the proposed Torfichen Wind Farm (herein referred to as the 'Proposed Development') and associated battery storage facilities on residents of nearby properties. The specific objectives of the chapter are to:

- describe the current baseline;
- describe the assessment methodology and significance criteria used in completing the impact assessment;
- describe the potential effects, including direct, indirect and cumulative effects;
- describe the mitigation measures proposed to address the likely significant effects (if any); and
- assess the residual effects remaining following the implementation of mitigation measures.

12.1.2 This assessment has been undertaken by RES, with three in-house Members of the Institute of Acoustics (MIOA) involved in its production. RES has undertaken acoustic impact assessments in every single one of its UK wind farm development applications since 2000 and has also reported to several local planning authorities on operational wind energy projects, and various other renewable energy developments, including taking measurements on newly constructed wind farms to ensure compliance with planning conditions, investigating sources of complaint and determining relevant remedial action where necessary.

12.1.3 Additionally, RES has been project co-ordinator for several Joule projects (DGXII European Commission funded projects in the field of Research and Technological Development in non-nuclear energy); led European research into wind turbine noise; was involved in producing the guideline 'The Assessment and Rating of Noise from Wind Farms' ETSU for the DTI in 1996; acted as peer reviewer for the 'Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (IOA GPG), and contributed to works conducted via RenewableUK work on Amplitude Modulation (AM).

12.1.4 A list of relevant publications is provided in **Technical Appendix 12.1:** Renewable Energy Systems (RES) Publications.

12.1.5 This chapter is supported by the following Technical Appendices and Figures:

- **Technical Appendix 12.1**: Renewable Energy Systems (RES) Publications
- **Technical Appendix 12.2:** Issues Scoped Out
- **Technical Appendix 12.3**: BESS Acoustic Assessment
- **Technical Appendix 12.4**: Background Noise Survey Locations
- **Technical Appendix 12.5**: Instrumentation Records
- **Technical Appendix 12.6**: Derived Background Noise Levels & Limits
- **Technical Appendix 12.7:** Assessment Charts
- **Technical Appendix 12.8**: Draft Planning Condition
- **Figure 12.1**: Noise Contour Plot
- **Figure 12.2**: Cumulative Contour Plot

12.1.6 The relevant Figures and Technical Appendices are referenced in the text where necessary.

12.2 Legislation, Policy and Guidance

Operation

Planning Advice Note 1/2011

Within Scotland, noise is defined within the planning context by 'Planning Advice Note 1/2011: Planning and Noise'[1]. This Planning Advice Note provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise. The Planning Advice Note 1/2011 states that:

"Good acoustical design and siting of turbines is essential to minimise the potential to generate noise."

Planning Advice Note 1/2011 refers to the use of the Department of Trade and Industry's 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97), noting that further guidance is provided in the web-based planning advice on renewable technologies for onshore wind turbines. In relation to noise from wind farms the web-based renewables advice states:

"The Report, 'The Assessment and Rating of Noise from Wind Farms' describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available."

[1] 'Planning Advice Note 1/2011: Planning and Noise', Scottish Government, March 2011. Available at: https://www.gov.scot/publications/planning-advice-note-1-2011-planning-noise/

Onshore Wind Turbines: Planning Advice

As described by the Scottish Governments' Planning Advice for Onshore Wind Turbines[2]:

"Technically, there are two quite distinct types of noise sources within a wind turbine - the mechanical noise produced by the gearbox, generator and other parts of the drive train; and the aerodynamic noise produced by the passage of the blades through the air. There has been significant reduction in the mechanical noise generated by wind turbines through improved turbine design."

ETSU-R-97 The Assessment & Rating of Noise from Wind Farms

The operational noise assessment methodology described in ETSU-R-97[3] was developed by a working group comprised of a cross section of interested persons including Environmental Health Officers (EHOs), wind farm operators and independent acoustic experts amongst others.

ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the local environmental impact 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.

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".

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 relevant supplementary guidance. It is the only guidance referenced in Welsh planning policy for rating and assessing operational noise from wind turbines. 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 in respect of operational noise.

[2] 'Onshore wind turbines: planning advice', Scottish Government, May 2014. Available at: https://www.gov.scot/publications/onshore-wind-turbines-planning-advice/

[3] '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

It is therefore considered that the use of ETSU-R-97, as criteria for assessment of wind farm noise, fulfils the requirements of Planning Advice Note 1/2011.

A Good Practice Guide to the Assessment & Rating of Noise from Wind Farms

A Good Practice Guide[4] (IOA GPG) to the application of ETSU-R-97 for the assessment and rating of wind turbine noise, issued by the IOA in May 2013 and endorsed by the Scottish Government along with the governments in England, Wales and Northern Ireland, provides guidance on all aspects of the use of ETSU-R-97 and reaffirms the recommendations of an IOA Acoustics Bulletin article in relation to issues not made explicit by, or outside the scope of ETSU-R-97, including propagation modelling and wind shear. The document also includes further information regarding cumulative noise impacts, compliance measurements and other relevant topics.

Supplementary guidance notes were published by the Institute of Acoustics (IOA) in July and September 2014, and these provide further details on specific areas of the IOA GPG. The assessment presented herein adopts the recommendations of the IOA GPG and the Supplementary Guidance Notes (SGN).

BS 8233 Guidance on Sound Insulation and Noise Reduction for Buildings

BS 8233:2014 Guidance on sound insulation and noise reduction for buildings[5] states that it:

"draws on the results of research and experience to provide information on the design of buildings that have internal acoustic environments appropriate to their functions. It deals with control of noise from outside the building, noise from plant and services within it, and room acoustics for non-critical situations".

The standard provides recommended average noise levels for internal spaces such as living rooms and bedrooms. The standard also provides a section on noise from wind farms, recommending the use of ETSU-R-97 and the IOA GPG for assessment purposes and states that:

"A particular feature of aerodynamic noise, which is often cited as an adverse feature of medium to large wind turbines, is that of amplitude modulation (AM), which is the modulation or rhythmic swish. Excess AM can sometimes occur. However, it cannot be predicted at the planning stage with the current state of the art".

[4] '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

[5] 'Guidance on sound insulation and noise reduction for buildings', British Standards Institution, BS 8233:2014, February 2014

Construction

Assessment of Noise: Technical Advice Note

Web based technical advice on construction noise assessment provided by the Scottish Government in 'Appendix 1: Legislative Background, Technical Standards and Codes of Practice'[6] states that:

"… under Environmental Impact Assessments and for planning purposes i.e. not in regard to the Control of Pollution Act 1974, the 2009 version of BS 5228 is applicable."

BS 5228-1 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise

BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites - Part 1: Noise[7] has been identified as being the appropriate source of guidance on appropriate methods for minimising noise from construction activities and is adopted herein. The document provides guidance on construction noise limits, noise modelling techniques and best practicable measures for the reduction of noise generated during construction activities including overpressure from blasting at borrow pits.

BS 5228-2 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 2: Vibration

BS 5228-2:2009 Code of practice for noise and vibration control on construction and open sites - Part 2: Vibration[8], provides a method for predicting levels of vibration. The document provides guidance on construction vibration limits, vibration modelling techniques and best practicable measures for the reduction of vibration generated during construction activities including blasting at borrow pits.

BS 6472-2 Guide to evaluation of human exposure to vibration in buildings - Part 2: Blast-induced vibration

BS 6472-2:2008 Guide to evaluation of human exposure to vibration in buildings - Part 2: Blast-induced vibration[9] provides criteria for satisfactory magnitudes of vibration at nearby residential properties to ensure compliance with respect to human response.

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[6] 'Assessment of noise: technical advice note', Scottish Government, March 2011. Available at: http://www.gov.scot/publications/technical-advice-note-assessment-noise/

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

[8] 'Code of Practice for Noise and vibration control on construction and open sites - Part 2: Vibration', British Standards Institution, BS 5228-2:2009

[9] 'Guide to evaluation of human exposure to vibration in buildings. Blast-induced vibration', British Standards Institution, BS 6472-2:2008

The Control of Pollution Act (CoPA)

The Control of Pollution Act[10] (CoPA) 1974 provides information as to the need for ensuring that the 'best practicable means' are employed to minimise noise.

12.3 Consultation

12.3.1 Details of the consultation undertaken are outlined at **Table 12.1**.

Table 12.1 Acoustic Assessment Consultation

Consultees	Date of Consultation	Type	Nature and Purpose of Consultation
Energy Consents Unit (ECU)	16 January 2023	Digital submission	Environmental Impact Assessment (EIA) Scoping report detailing proposed approach to the acoustic assessment for the Proposed Development.
ECU	13 April 2023	Digital response	Response from ECU confirming general agreement with the EIA Scoping report regarding the acoustic assessment. Confirmation that Midlothian Council are content that the scope and methodology proposed in the EIA Scoping report is acceptable. Details provided about constraints on the Proposed Development due to the Eskdalemuir Seismological Recording Station.
Midlothian Council	5 June 2023	Email	Environmental health department contacted to notify them of the background sound survey taking place and agree the survey methodology.
Midlothian Council	6 June 2023	Email	Response received providing contact details for the EHO dealing with the Proposed Development.
Midlothian Council	14 June 2023	Email	'Planned Acoustic Assessment at the Proposed Torfichen Wind Farm' report (04726-5856115) sent to the EHO to confirm acceptance with the background sound survey methodology. EHO invited to attend installation of survey equipment.
Midlothian Council	26 June 2023	Email	Response received from EHO. Confirmed agreement with the background sound survey methodology.
Midlothian Council	26 June 2023	Email	Provided practical arrangements for the survey to EHO.
Midlothian Council	28 June 2023	Email	EHO unable to attend background sound survey equipment installation. Survey will proceed as planned.
Midlothian Council	13 September 2023	Email	'Noise Survey Locations for the Acoustic Assessment of the Proposed Torfichen Wind Farm' (04726-5947264) sent to EHO for comment.

[10] 'Control of Pollution Act', published by Her Majesty's Stationary Office, July 1974. Available at: https://www.legislation.gov.uk/ukpga/1974/40

12.4 Methodology

Scope of Assessment

Operation

12.4.1 The noise which may be generated by the operation of the Proposed Development in isolation, and cumulatively with other potential developments in the area, has been assessed in full according to documentation referenced within relevant planning policy on noise.

12.4.2 The assessment incorporates the assessment of operational noise for a range of frequencies most relevant to turbine operation, including that generated at relatively low frequencies. A specific and targeted assessment of low frequency noise (in the frequency range of approximately 20 to 200 Hz) and infrasound (less than 20 Hz) has not been undertaken as this is not required by current planning policy and is considered unjustified based on various research and relevant documentation on these topics.

12.4.3 The assessment also accounts for the inherent character of noise generated by turbine blades as they pass through the air known as 'blade swish' or amplitude modulation (AM); factors in the effects of wind shear (i.e. the rate of change in wind speed with height above ground level) according to best practice in this regard; accounts for relevant noise propagation effects in terms of topographical valley and shielding considerations and is based on information provided by the manufacturer for a candidate turbine considered for the purposes of this assessment.

12.4.4 A discussion of relevant research and documentation relating to low frequency noise; infrasound; sleep disturbance; vibration; amplitude modulation; 'wind turbine syndrome'; and health effects associated with the operation of wind turbines in general is provided in **Technical Appendix 12.2**. These topics have not been assessed in any further detail herein other than that required under current planning guidance in this regard.

12.4.5 An acoustic assessment considering the operation of the proposed battery energy storage system (BESS) associated with the Proposed Development, including consideration of the cumulative impact with the proposed wind turbines, is provided in **Technical Appendix 12.3**.

Construction

12.4.6 The construction of turbines, ancillary electrical equipment, compounds and the corresponding access tracks typically occurs at very large distances from neighbouring residences. The resultant noise and vibration, which would be temporary in nature, is only very rarely cause for concern in terms of the potential for disturbing the inhabitants of neighbouring residences. Whilst the noise associated with the construction of these aspects may well be audible to people residing in the area, the levels would be below established noise limits and planning requirements in this respect. Nevertheless, typical mitigation measures, including the use of 'best practicable means' would be incorporated into the construction practices for the Proposed Development with a view to reducing noise levels where possible and practical. As a result, this aspect is discussed in generalised terms with reference to standard noise limiting requirements; typical working practices; hours of work, and standard mitigation measures in this respect. A detailed assessment has not been undertaken and a similar rationale can be applied for noise impacts associated with decommissioning of the Proposed Development.

12.4.7 Construction relating to the provision of access to the site, including the upgrade of local roads and their use thereof, may well occur at locations near to residences. As a result, and in instances where this is likely to occur, consideration of enhanced mitigation measures which would be reasonably possible to implement, have been discussed. In any event, typical noise limiting requirements would apply and the contractor undertaking the works would be responsible for potential issues and taking appropriate and reasonable steps to address these should they occur. As a result, this aspect is also discussed in generalised terms and a detailed assessment has not been undertaken as this would require a detailed construction plan to provide confidence in the results, which is not available at this time. However, certain details as to construction practices would be provided within a Construction Environmental Management Plan (CEMP), with reference to potential noise and vibration impacts, where necessary. An outline CEMP is provided in **Technical Appendix 3.1**.

12.4.8 Noise and vibration associated with the movement of additional vehicles, including heavy goods vehicles (HGVs) along local roads and access routes may well be noticeable to residents adjacent to these. However, this would essentially only result in a minor increase in the average noise levels from existing roads, with the most noticeable noise and perceptible

vibration effects resulting from the sporadic and increased number of HGV pass-bys at residences along the access routes, with resulting levels for individual events being similar to that created by existing HGV movements.

12.4.9 In order to release materials at proposed 'borrow-pit' locations, the use of specifically designed explosives may be used, this is also known as blasting. The resultant noise, vibration and air overpressure from blasting cannot be reliably predicted. However, these aspects may well be perceptible to neighbouring residents. The vibration generated by each blast would be well below levels that would be expected to cause damage to the nearest housing and/or structures nearby. As a result, the impacts resulting from blasting is not considered in any detail other than the provision of discussion as to the steps to limit any resulting impact through appropriate blast design and best practice, which also involves keeping residents informed as to planned blasting activities.

Baseline Characterisation

Study Area

12.4.10 The study area is limited to properties located within approximately 2.5 km of the Proposed Development and dwellings directly adjacent to access tracks and delivery routes.

Field Survey

12.4.11 The ETSU-R-97 and IOA GPG 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). This is similar, in principle, to the assessment of other noise generating facilities which are required to be assessed according to BS 4142 Methods for rating and assessing industrial and commercial sound[11] for which ETSU-R-97 identifies the 1997 version[12] as forming the basis of its recommendations.

12.4.12 Since background noise levels in rural environments often vary with induced noise generated by the wind passing through trees and foliage surrounding dwellings and that wind turbine noise emissions also vary with

[11] 'Methods for rating and assessing industrial and commercial sound', British Standards Institution, BS 4142:2014 + A1:2019, June 2019

[12] 'Method for Rating Industrial Noise affecting Mixed Residential and Industrial Areas', British Standards Institution, BS4142, 1997

wind speed, it is important that this context is considered when conducting reference measurements.

12.4.13 Thus, the assessment of background noise levels at potentially sensitive residential properties 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 site rather than at the residential properties since it is this wind speed that would subsequently govern the Proposed Development's sound generation. Occasionally, the residential properties themselves will be sheltered from the wind and may consequently have relatively low background sound levels, even at high wind speeds.

12.4.14 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 site, as agreed with EHO representing the council, which are likely to be representative of other residential properties in the locale.

12.4.15 In order to establish the background/baseline noise levels considered representative of properties neighbouring the Proposed Development, the measurement data is separated in to two sets, as specified by ETSU-R-97 and shown in **Table 12.2**.

Table 12.2 Definition of Quiet Daytime & Night-time 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 to 07:00 every day

12.4.16 Any data affected by the pattering of rainfall at the measurement location and on the measurement equipment itself, which can result in increased measured noise levels, is systematically removed from the acoustic data set. To facilitate this, a tipping bucket rain gauge is deployed at the 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. This is to account for the time it takes for the tipping bucket to fill.

12.4.17 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,

this tends to bias trend lines upwards, so is removed as a conservative measure.

12.4.18 In practice, the above 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 in the measured noise levels. This may include filtering of data to remove any data affected by dawn chorus, the presence of boiler flues, increased traffic movements during certain times and obvious effects correlated to the wind direction experienced during the survey with due regard to the location of the property relative to the Proposed Development site.

Significance Criteria

Operation

12.4.19 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.

12.4.20 Whilst ETSU-R-97 presents a comprehensive and detailed assessment methodology for wind farm noise, it also provides a simplified methodology, stating that *"if the noise is limited to an $L_{A90,10min}$ of 35 dB(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"*.

12.4.21 As part of 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 low background noise levels, in which case a fixed limit may be applied. The suggested limits are given in **Table 12.3**, where L_B is the average background $L_{A90,10min}$ as a function of wind speed. During daytime periods and at low background noise levels, a lower fixed limit of 35-40 dB L_{A90} is applicable. The exact value is dependent upon factors including the number of nearby dwellings, the effect of the noise limits on energy produced and the duration and level of exposure.

Table 12.3 Permissible Noise Criteria

Time of Day	Definition
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)

12.4.22 It should be noted that a higher noise level is permissible during the night than during the day as it is assumed that residents would be indoors during the night-time. 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.

12.4.23 Further to the above, the absolute lower noise limits may be increased up to 45 dB(A) for both daytime and night-time periods if the occupant of a property has a financial involvement in the proposed wind farm.

12.4.24 The wind speeds considered for the impact assessment are less than or equal to a standardised 10 m height wind speed of 12 $m.s^{-1}$ as these are expected to be the wind speeds that are critical to the assessment. 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 the potential noise generated by the wind farm.

12.4.25 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 regarding 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.

12.4.26 As a result of the above, where turbine noise levels are predicted to meet the noise limits specified as part of ETSU-R-97, these are considered not significant.

Construction

12.4.27 Construction noise is discussed with reference to Annex E of BS 5228-1:2009, which 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.

12.4.28 The ABC method sets threshold noise levels for construction noise for specific periods based on the pre-existing ambient noise levels, subject to average lower Category A limiting values of 65, 55 and 45 dB L_{Aeq} for daytime (07:00 - 19:00 weekdays and Saturdays 07:00 – 13:00), evenings and weekends (19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays) and night-time (23:00 – 07:00) periods respectively, for instances where existing ambient noise levels are relatively low, which is the case here.

12.4.29 BS 5228-2:2009 provides guidance on the assessment of vibration due to blasting. A scaled distance graph is shown in **Figure E.1** within Annex E which provides an indication of likely vibration magnitudes at various distances. This Figure can be used to determine the level of vibration which would not be expected to be exceeded in 95 % of blasts for a given distance and charge size.

12.4.30 BS 6472-2:2008 details the maximum satisfactory magnitudes for vibration measured on a firm surface outside buildings with respect to human response. For up to three blast vibration events per day, the generally accepted maximum satisfactory magnitude at residential premises during daytime periods (08:00 – 18:00 Monday to Friday and 08:00 – 13:00 on Saturdays), is a peak particle velocity (ppv) of 6.0 to 10.0 $mm.s^{-1}$. In practice, the lower satisfactory magnitude should be used with the higher magnitude being justified on a case-by-case basis.

12.4.31 Where it is considered that the levels of construction noise and vibration, including that from blasting, can meet the relevant limits for each aspect or that appropriate controls or mitigation can be put in place, the resultant impact is considered not significant.

Predictions

Operation

12.4.32 Whilst there are several sound propagation models available, the ISO 9613 Part 2[13] model has been used, this being identified as most appropriate for use in such rural sites[14]. The specific interpretation of the ISO 9613 Part 2

[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

propagation methodology recommended in the IOA GPG has been employed.

12.4.33 To carry out noise predictions it is assumed that:

- the turbines at the Proposed Development are identical;
- the turbines radiate noise at the sound power levels specified in this report;
- the turbines are modelled as a point source at the hub-height of each; and,
- each residential property is assigned a reference height to simulate the presence of an observer.

12.4.34 The sound propagation model takes account of attenuation due to geometric spreading and atmospheric absorption corresponding to 10 ˚C and 70 % respectively, as provided within ISO 9613-1[15]. 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 GPG.

12.4.35 The barrier attenuations predicted by ISO 9613-2 have been shown to be significantly greater than those measured in practice under downwind conditions[14]. Therefore, barrier attenuation according to the ISO 9613-2 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 also recommended in the IOA GPG.

12.4.36 Verification studies have also shown that ISO 9613-2 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[16]. Where this is the case, 3 dB has been added to the overall A weighted noise level, as recommended by the IOA GPG. 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.

12.4.37 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 as part of ETSU-R-97 and reaffirmed within the IOA GPG.

[15] 'Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere', International Organisation for Standardisation, June 1993

[16] 'Development of a Wind Farm Noise Propagation Prediction Model', J H Bass, A J Bullmore, E Sloth, JOR3-CT95-0051, May 1998

12.4.38 It has been shown by measurement-based verification studies[16] that the ISO 9613-2 model can provide a high degree of accuracy when calculating far field noise levels from elevated sources when the exceptional cases identified above are corrected for. Examples of conservative assumptions modelled which increase the likelihood of the calculated noise levels being an overestimate are that:

- 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 GPG;
- receiver heights are modelled at 4 m above local ground level;
- trees and other non-terrain shielding effects have not been considered; and
- an allowance for measurement uncertainty has been included in the sound power levels for the presented turbine models.

12.4.39 The locations of the turbines which make up the Proposed Development, and two neighbouring developments - Carcant Wind Farm (operational), and Wull Muir Wind Farm (proposed) are provided in **Table 12.4** and shown in **Figure 12.1**. The co-ordinates for these cumulative sites are taken from publicly available information.

12.4.40 The locations of the nearest residential properties to the turbines have been determined by inspection of relevant maps, address databases and via site visits. More residential properties may have been identified but have not been considered critical to this acoustic assessment and/or may be adequately represented by another residential property. The locations considered are listed in **Table 12.5** and are also shown in **Figure 12.1**.

Table 12.4 Turbine Locations

Turbine ID	OSGB Co-Ordinates		Turbine ID	OSGB Co-Ordinates	
	X (m)	Y (m)		X (m)	Y (m)
Torfichen Wind Farm			T16	334907	655992
T1	332373	652918	T17	335349	655780
T2	332205	653468	T18	335667	655453
T3	331970	653859	Wull Muir Wind Farm		
T4	332926	653190	T1	337376	654228
T5	333071	653937	T2	337795	654327
T6	333364	653586	T3	338544	654336
T7	332784	654287	T4	338083	654107
T8	333680	654148	T5	337551	653817

Turbine ID	OSGB Co-Ordinates		Turbine ID	OSGB Co-Ordinates	
	X (m)	Y (m)		X (m)	Y (m)
T9	333296	654627	T6	338583	653904
T10	333992	653817	T7	337889	653736
T11	334246	654297	T8	338222	653607
T12	333970	654732	Carcant Wind Farm		
T13	334697	654797	T1	335754	653195
T14	334467	655447	T2	336088	653568
T15	335122	655203	T3	336122	652929

Table 12.5 House Locations

House ID	House Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H1	Garvald Farmhouse	335211	651228
H2	Blackhope Farmhouse	333864	651644
H3	Blackhope Cottage	333927	651737
H4	1 Moorfoot Farm Cottages	329773	652291
H5	Moorfoot House	329718	652441
H6	Tathieknowe Chalet	336065	652476
H7	Nithlea	336575	652517
H8	Huntly Cottage	330111	652629
H9	Mauldslie Farm	330824	653018
H10	Mauldslie West Cottage	331001	653064
H11	Mauldslie Hill Cottage	331016	653079
H12	Heriot Cleuch	337672	654098
H13	Gladhouse Reservoir House	330006	654361
H14	The Small Cottage	329955	654369
H15	White Cottage	330051	654438
H16	2 Gladhouse Mains Cottage	330084	655029
H17	1 Gladhouse Mains Cottage	330141	655106
H18	Howburn Cottage	330939	655225
H19	Outerston Hill	333529	655670
H20	Whitelaw	336353	656439
H21	5 Yorkston Cottages	331592	656572
H22	Shepherds Cottage	331519	656578
H23	North Cottage	331593	656601
H24	Yorkston Farm	331495	656669
H25	Thimble Cottage	332786	656889

House ID	House Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H26	1 Outerston Cottages	332808	656898
H27	Esperston Farm	333817	656968
H28	Broadhead Cottage	331896	657057
H29	1 Esperston Cottage	334031	657125
H30	1 Kiln Cottage	333995	657506
H31	8 South Middleton Cottage	336436	657845
H32	2 Wester Middleton Cottage	336207	658023
H33	1 Halkerston Cottage	334936	658313
H34	Halkerston Farm	334700	658336
H35	1 Castleton Cottages	333141	658387
H36	Fala House	339075	656058
H37	Falahill Farmhouse	339085	656040
H38	7 South Middleton Cottage	336430	657852
H39	6 South Middleton Cottage	336426	657858
H40	5 South Middleton Cottage	336420	657865
H41	4 South Middleton Cottage	336415	657873
H42	3 South Middleton Cottage	336409	657880
H43	1 South Middleton Cottage	336397	657893
H44	Wester Middleton	336296	657964
H45	The Arches	336274	657979
H46	Graceview	336229	657997
H47	1 Wester Middleton Cottage	336214	658015
H48	2 Halkerston Cottage	334933	658319
H49	3 Halkerston Cottage	334931	658329
H50	2 Kiln Cottage	334004	657507
H51	3 Kiln Cottage	334017	657507
H52	4 Kiln Cottage	334026	657507
H53	2 Esperston Cottage	334043	657142
H54	3 Esperston Cottage	334054	657158
H55	4 Esperston Cottage	334064	657172
H56	Outerston Farm House	332990	657078
H57	3 Yorkston Farm Cottages	331546	656603
H58	2 Yorkston Farm Cottages	331562	656603
H59	1 Yorkston Farm Cottages	331573	656603
H60	4 Yorkston Cottages	331592	656580
H61	3 Yorkston Cottages	331592	656587

House ID	House Name	OSGB Co-Ordinates	
		X (m)	Y (m)
H62	2 Yorkston Cottages	331592	656593
H63	Toxside Schoolhouse	328868	653805
H64	Toxside Smithy	328594	653288
H65	Huntly Lodge	330051	652636
H66	2 Moorfoot Farm Cottages	329787	652295
H67	Peggies Cottage	329734	652313
H68	Smithy Cottage	329715	652322
H69	Gladhouse Cottage	329555	651439
H70	The Hirsel	336351	652397
H71	The Hayloft of Carcant House	336485	652464
H72	Carcant House	336489	652465
H73	Carcant House	336558	652416
H74	Outerston Farm Cottage	333022	657020
H75	2 Outerston Cottages	332797	656895

12.4.41 The candidate turbine model for the Proposed Development is the Vestas V150 6.0 MW, with a hub-height of 105 m and serrated trailing edge (STE) blade modifications. The assumed turbine model at the proposed Wull Muir Wind Farm site is the Vestas V136 4.5 MW STE with a hub height of 82 m, and the turbine model at the operational Carcant Wind Farm site is the Siemens SWT-2.3-101 with a hub-height of 80 m.

12.4.42 Acoustic emission data from the manufacturer's general specification for each of the machines discussed above are used in the analysis and have been identified as typically warranted. However, no independent test reports are currently available to indicate whether any margin for uncertainty has been incorporated into the levels. As a result, 2 dB has been added to the specified levels for all turbine models as a conservative measure and as recommended by the IOA GPG.

12.4.43 The assumed source noise levels for the Siemens SWT-2.3-101 installed at the operational Carcant Wind Farm are 2 dB or more higher than that assumed for the original planning application for the site and that assumed as part of the various Wull Muir Wind Farm planning submissions. The lower source noise levels appear to have been accepted by representatives of the local council and the levels used here therefore represent a particularly conservative basis of assessment.

12.4.44 **Table 12.6** shows the overall sound power levels over a range of standardised 10 m height wind speeds for the turbine models considered

as part of the isolative and cumulative assessments provided herein. **Table 12.7** shows the octave band noise levels corresponding to the maximum noise output for each respective turbine model, as also based on manufacturer's specifications, as provided separately, and including for the relevant uncertainty.

Table 12.6 Sound Power Levels, dB L_{WA}

Turbine	Standardised 10 m Height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
V150 6.0 MW	95.0	98.3	102.5	105.9	106.7	106.9	106.9	106.9	106.9	106.9
V136 4.5 MW	93.4	96.6	101.4	105.2	105.9	105.9	105.9	105.9	105.9	105.9
SWT-2.3-101	93.0	97.2	101.8	106.5	108.0	108.0	108.0	108.0	108.0	108.0

Table 12.7 Octave Band Sound Power Levels, dB L_{WA}

Turbine	Overall, dB L_{WA}	Standardised 10 m Height Wind Speed, $m.s^{-1}$							
		63	125	250	500	1k	2k	4k	8k
V150 6.0 MW	106.9	87.9	95.6	100.3	102.0	100.9	96.8	89.8	79.8
V136 4.5 MW	105.9	85.2	93.5	98.7	101.0	100.3	96.5	89.8	80.0
SWT-2.3-101	108.0	87.0	93.5	98.1	100.4	103.7	101.8	96.4	82.8

12.4.45 The turbine models are assumed not to have any tonal noise output that would attract a penalty at neighbouring residences as per the requirements of ETSU-R-97. Nevertheless, a warranty or guarantee would be obtained from the manufacturer which limits the level of tonal noise associated with the operation of the individual turbines (or the site as a whole), should the site be granted planning consent and a finalised turbine model is procured. This would also help to provide appropriate recourse with the turbine manufacturer should a tonal character be present in the noise generated by the site.

Construction

12.4.46 BS 5228 provides various means of predicting construction noise and vibration levels from various plant and supplies a wide range of generic plant source noise levels for this purpose. However, as discussed earlier, the construction of the Proposed Development is not expected to have any significant impacts given the distance of the turbines from neighbouring properties and the generic nature of the works. As a result, specific construction noise predictions have not been undertaken and only a discursive assessment is provided.

12.5 Baseline

12.5.1 The Proposed Development is located approximately 3 km south-west of North Middleton, Borthwick, Midlothian. The general noise character is typical of a rural environment with noise from farm machinery, sheep, cattle, and birds, with the occasional overhead aircraft and noise associated with traffic movements along local roads and the A7 passing to the north-east of the Proposed Development.

12.5.2 Background noise measurements were undertaken at the residential property locations called Mauldslie West Cottage (H10), Whitelaw (H20) & 1 Esperston Cottage (H29) in accordance with ETSU-R-97. These three locations are detailed in **Table 12.8** and shown at **Figure 12.1**.

Table 12.8 Background Noise Survey Locations

House ID	House Name	OSGB Co-Ordinates		Measurement Period		
		X (m)	Y (m)	Start	End	Duration (days)
H10	Mauldslie West Cottage	331001	653064	28/06/2023	18/09/2023	83
H20	Whitelaw	336353	656439	28/06/2023	18/09/2023	83
H29	1 Esperston Cottage	334031	657125	28/06/2023	18/09/2023	83

12.5.3 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 - 1.5 m above ground and equipped with all-weather wind shields which also provide an element of water resistance.

12.5.4 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.

12.5.5 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 $L_{A90,10min}$ which is the A-weighted sound pressure level exceeded for 90% of each collected 10-minute sample.

12.5.6 The sound level meters were placed away from reflecting walls and vegetation. Photos of the equipment, in situ, can be seen in **Technical Appendix 12.4**. The apparatus was calibrated before and after the survey period and the maximum drift detected was 0.2 dB, which is within the required range/tolerance 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 12.5**.

12.5.7 A remote sensing device employing LiDAR to measure wind conditions was located at the Proposed Development site. Average wind speed and wind direction were measured for during consecutive 10-minute time periods at a variety of heights above ground level, including directly at the hub height of the proposed turbines (105 m). The measurement data generated by the remote sensing device has been filtered to check its validity and to remove any anomalous results. Prior to use in the data analysis, wind speed at the hub height has been converted to standardised 10 m height wind speed using the formula for roughness length shear profile as defined in Annex A of the IOA GPG. The wind direction used in the data analysis was measured at the 105 m hub height.

12.5.8 A 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.

12.5.9 LiDAR has been successfully tested by independent third parties using suitable test sites against conventional anemometry[17,18]. 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.

12.5.10 The wind direction experienced throughout the survey, as measured by the LiDAR device, was predominantly west-south-westerly which is typical of the longer-term wind direction in the area.

12.5.11 All measurement data was referenced to Greenwich Mean Time (GMT). Wind speed, wind direction and acoustic measurements were made with the time marker at the start of each 10-minute measurement interval and the rain measurements were made with the time marker at the end of the 10-minute measurement interval. Data analysis was undertaken according to local time, with all data synchronised appropriately.

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

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

12.5.12 The noise data has been cross-referenced with rainfall data measured at H10 using a tipping bucket rain gauge. Any noise data identified as having been affected by rainfall has been removed from the analysis. Short-term periods of increased noise levels considered to be atypical have been also removed from the datasets.

12.5.13 The survey locations are sufficiently far from the existing Carcant Wind Farm so as not to have been significantly influenced by operational noise from this existing site.

12.5.14 The charts provided in **Technical Appendix 12.6** show the respective $L_{A90,10min}$ data correlated against the standardised 10 m height wind speed for both quiet daytime and night-time periods at each survey location. In each case, a 'best fit' line has been fitted to the data and the corresponding noise limits calculated. The equation of the regression polynomial has been provided in the charts. All excluded and remaining valid data points are also shown.

Current Baseline

Operation

12.5.15 **Table 12.9** shows the derived background noise levels from the 'best fit' lines, as described above.

12.5.16 The corresponding daytime and night-time operational noise limits for the survey locations for the same range of wind speeds are provided in **Table 12.10**. In accordance with the definitions given in **Table 12.3**, operational noise limits are determined as L_B + 5 dB, with a lower fixed limit of 35 dB L_{A90} applied for quiet daytime and a lower fixed limit of 43 dB L_{A90} applied for night-time for all three locations.

Table 12.9 Background Noise Levels, dB L_{A90}

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
Quiet Daytime										
H10	23.5	25.5	28.3	31.5	35.1	38.6	42	44.9	47.1	48.5
H20	28.0	29.7	32.1	34.9	38.0	41.1	43.9	46.3	48.1	48.9
H29	25.0	26.5	28.7	31.4	34.4	37.5	40.4	42.8	44.6	45.5

Night-time										
H10	19.3	21.4	24.3	27.9	31.8	35.8	39.7	43.1	45.9	47.6
H20	24.2	26.1	28.5	31.3	34.3	37.3	40.2	42.7	44.8	46.3
H29	20.2	21.8	23.9	26.6	29.5	32.4	35.3	37.8	39.8	41.0

Table 12.10 Operational Noise Limits, dB L_{A90}

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H10	35.0	35.0	35.0	36.5	40.1	43.6	47	49.9	52.1	53.5
H20	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H29	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
Night-time										
H10	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H20	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H29	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0

12.5.17 The derived noise limits are applied to each of the assessment locations identified in **Table 12.11** based on the relative proximity of the monitoring location to the assessment locations. Where there is ambiguity in this respect, the applied noise limits are applied on a basis that is considered conservative.

Table 12.11 Application of Noise Limits

House ID	OSGB Co-Ordinates		Applied Noise Limit
	X (m)	Y (m)	
H1	335211	651228	H10 - MAULDSLIE WEST COTTAGE
H2	333864	651644	H10 - MAULDSLIE WEST COTTAGE
H3	333927	651737	H10 - MAULDSLIE WEST COTTAGE
H4	329773	652291	H10 - MAULDSLIE WEST COTTAGE
H5	329718	652441	H10 - MAULDSLIE WEST COTTAGE
H6	336065	652476	H20 - WHITELAW
H7	336575	652517	H20 - WHITELAW
H8	330111	652629	H10 - MAULDSLIE WEST COTTAGE
H9	330824	653018	H10 - MAULDSLIE WEST COTTAGE
H10	331001	653064	H10 - MAULDSLIE WEST COTTAGE
H11	331016	653079	H10 - MAULDSLIE WEST COTTAGE

House ID	OSGB Co-Ordinates		Applied Noise Limit
	X (m)	Y (m)	
H12	337672	654098	H20 - WHITELAW
H13	330006	654361	H10 - MAULDSLIE WEST COTTAGE
H14	329955	654369	H10 - MAULDSLIE WEST COTTAGE
H15	330051	654438	H10 - MAULDSLIE WEST COTTAGE
H16	330084	655029	H10 - MAULDSLIE WEST COTTAGE
H17	330141	655106	H10 - MAULDSLIE WEST COTTAGE
H18	330939	655225	H10 - MAULDSLIE WEST COTTAGE
H19	333529	655670	H29 - 1 ESPERSTON COTTAGE
H20	336353	656439	H20 - WHITELAW
H21	331592	656572	H29 - 1 ESPERSTON COTTAGE
H22	331519	656578	H29 - 1 ESPERSTON COTTAGE
H23	331593	656601	H29 - 1 ESPERSTON COTTAGE
H24	331495	656669	H29 - 1 ESPERSTON COTTAGE
H25	332786	656889	H29 - 1 ESPERSTON COTTAGE
H26	332808	656898	H29 - 1 ESPERSTON COTTAGE
H27	333817	656968	H29 - 1 ESPERSTON COTTAGE
H28	331896	657057	H29 - 1 ESPERSTON COTTAGE
H29	334031	657125	H29 - 1 ESPERSTON COTTAGE
H30	333995	657506	H29 - 1 ESPERSTON COTTAGE
H31	336436	657845	H20 - WHITELAW
H32	336207	658023	H20 - WHITELAW
H33	334936	658313	H29 - 1 ESPERSTON COTTAGE
H34	334700	658336	H29 - 1 ESPERSTON COTTAGE
H35	333141	658387	H29 - 1 ESPERSTON COTTAGE
H36	339075	656058	H20 - WHITELAW
H37	339085	656040	H20 - WHITELAW
H38	336430	657852	H20 - WHITELAW
H39	336426	657858	H20 - WHITELAW
H40	336420	657865	H20 - WHITELAW
H41	336415	657873	H20 - WHITELAW
H42	336409	657880	H20 - WHITELAW
H43	336397	657893	H20 - WHITELAW
H44	336296	657964	H20 - WHITELAW
H45	336274	657979	H20 - WHITELAW
H46	336229	657997	H20 - WHITELAW
H47	336214	658015	H20 - WHITELAW

House ID	OSGB Co-Ordinates		Applied Noise Limit
	X (m)	Y (m)	
H48	334933	658319	H29 - 1 ESPERSTON COTTAGE
H49	334931	658329	H29 - 1 ESPERSTON COTTAGE
H50	334004	657507	H29 - 1 ESPERSTON COTTAGE
H51	334017	657507	H29 - 1 ESPERSTON COTTAGE
H52	334026	657507	H29 - 1 ESPERSTON COTTAGE
H53	334043	657142	H29 - 1 ESPERSTON COTTAGE
H54	334054	657158	H29 - 1 ESPERSTON COTTAGE
H55	334064	657172	H29 - 1 ESPERSTON COTTAGE
H56	332990	657078	H29 - 1 ESPERSTON COTTAGE
H57	331546	656603	H29 - 1 ESPERSTON COTTAGE
H58	331562	656603	H29 - 1 ESPERSTON COTTAGE
H59	331573	656603	H29 - 1 ESPERSTON COTTAGE
H60	331592	656580	H29 - 1 ESPERSTON COTTAGE
H61	331592	656587	H29 - 1 ESPERSTON COTTAGE
H62	331592	656593	H29 - 1 ESPERSTON COTTAGE
H63	328868	653805	H10 - MAULDSLIE WEST COTTAGE
H64	328594	653288	H10 - MAULDSLIE WEST COTTAGE
H65	330051	652636	H10 - MAULDSLIE WEST COTTAGE
H66	329787	652295	H10 - MAULDSLIE WEST COTTAGE
H67	329734	652313	H10 - MAULDSLIE WEST COTTAGE
H68	329715	652322	H10 - MAULDSLIE WEST COTTAGE
H69	329555	651439	H10 - MAULDSLIE WEST COTTAGE
H70	336351	652397	H20 - WHITELAW
H71	336485	652464	H20 - WHITELAW
H72	336489	652465	H20 - WHITELAW
H73	336558	652416	H20 - WHITELAW
H74	333022	657020	H29 - 1 ESPERSTON COTTAGE
H75	332797	656895	H29 - 1 ESPERSTON COTTAGE

12.5.18 **Table 12.12** shows the corresponding daytime and night-time noise limits at the residential assessment locations considered here. These limits are intended to apply to the combined impact of the Proposed Development with other existing, planned or permitted developments near the site for the purposes of assessment the overall planning acceptability in terms of wind farm operational noise.

12.5.19 Where the residents of a particular dwelling are expected or known to have a financial involvement with the Proposed Development the noise

limits have been increased to 45 dB L_{A90} or the derived background noise level plus 5 dB, whichever is the greater, for both daytime and night-time periods respectively.

Table 12.12 Overall Noise Limits, dB L_{A90}

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H1	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H2	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H3	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H4	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H5	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H6	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H7	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H8	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H9	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H10	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H11	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H12	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H13	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H14	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H15	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H16	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H17	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H18	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H19	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.1	49.8	50.6
H20	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H21	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H22	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H23	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H24	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H25	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H26	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H27	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H28	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H29	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H30	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H31	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H32	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H33	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H34	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H35	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H36	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H37	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H38	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H39	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H40	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H41	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H42	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H43	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H44	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H45	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H46	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H47	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H48	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H49	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H50	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H51	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H52	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H53	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H54	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H55	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H56	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H57	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H58	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H59	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H60	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H61	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H62	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H63	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H64	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H65	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H66	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H67	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H68	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H69	35.0	35.0	35.0	36.5	40.1	43.6	47.0	49.9	52.1	53.5
H70	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H71	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H72	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H73	35.0	35.0	37.1	39.9	43.0	46.1	48.9	51.3	53.1	53.9
H74	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
H75	35.0	35.0	35.0	36.5	39.6	42.7	45.6	48.1	49.8	50.6
Night-time										
H1	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H2	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H3	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H4	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H5	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H6	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H7	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H8	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H9	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H10	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H11	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H12	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H13	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H14	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H15	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H16	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H17	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H18	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H19	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	46.0
H20	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H21	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H22	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H23	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H24	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H25	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H26	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H27	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H28	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H29	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H30	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H31	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H32	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H33	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H34	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H35	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H36	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H37	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H38	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H39	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H40	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H41	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H42	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H43	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H44	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H45	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H46	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H47	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H48	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H49	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H50	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H51	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H52	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H53	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H54	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H55	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H56	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H57	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H58	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H59	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H60	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H61	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H62	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H63	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H64	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H65	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H66	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H67	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H68	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H69	43.0	43.0	43.0	43.0	43.0	43.0	44.7	48.1	50.9	52.6
H70	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H71	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H72	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H73	43.0	43.0	43.0	43.0	43.0	43.0	45.2	47.7	49.8	51.3
H74	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0
H75	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	46.0

Construction

12.5.20 The background/baseline noise levels detailed above are relatively low during low wind speeds, as would be expected for a rural area such as that considered here, and the corresponding existing ambient noise levels are also considered low. As a result, lower limiting values, as discussed previously with reference to the 'ABC method' provided within BS 5228-1, are used to inform discussion as to the potential impacts during construction.

12.5.21 Existing sources of vibration in the area are expected to be related to HGV movements along local roads, localised construction/maintenance activities and the very occasional earthquake and/or tremor, which may well be perceptible to people in the locale but with a certain level of habituation for some residents depending on the source. In general, existing sources of vibration are expected to be intermittent and would not be expected to be significant in terms of normal guidance in this respect.

Future Baseline

12.5.22 The baseline conditions would not be expected to change under the "do nothing" scenario i.e. in the event that the Proposed Development does not go ahead.

12.6 Assessment of Potential Effects

Operational Effects

12.6.1 **Table 12.13** shows the maximum predicted operational noise levels resulting from the introduction of the Proposed Development operating in isolation, over a range of standardised 10 m height wind speeds and assuming downwind propagation at the nearest residential properties using the prediction methodology detailed in **Section 12.4.**

Table 12.13 Torfichen Wind Farm Predicted Operational Noise Levels, dB L_{A90}

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H1	16.9	20.1	24.4	27.7	28.6	28.7	28.8	28.8	28.8	28.8
H2	20.1	23.4	27.6	30.9	31.8	32.0	32.0	32.0	32.0	32.0
H3	20.4	23.7	27.9	31.3	32.1	32.3	32.3	32.3	32.3	32.3
H4	17.2	20.5	24.8	28.1	29.0	29.1	29.1	29.1	29.1	29.1
H5	17.3	20.6	24.8	28.1	29.0	29.2	29.2	29.2	29.2	29.2
H6	17.8	21.1	25.3	28.7	29.5	29.7	29.7	29.7	29.7	29.7
H7	16.5	19.8	24.0	27.4	28.2	28.4	28.4	28.4	28.4	28.4
H8	19.1	22.3	26.6	29.9	30.8	30.9	31.0	31.0	31.0	31.0
H9	23.3	26.5	30.8	34.1	35.0	35.1	35.2	35.2	35.2	35.2
H10	24.5	27.7	32.0	35.3	36.2	36.4	36.4	36.4	36.4	36.4
H11	24.6	27.9	32.1	35.5	36.3	36.5	36.5	36.5	36.5	36.5
H12	16.1	19.4	23.6	27.0	27.8	28.0	28.0	28.0	28.0	28.0
H13	19.2	22.5	26.7	30.1	30.9	31.1	31.1	31.1	31.1	31.1
H14	19.0	22.3	26.5	29.8	30.7	30.9	30.9	30.9	30.9	30.9
H15	19.3	22.6	26.8	30.2	31.0	31.2	31.2	31.2	31.2	31.2
H16	18.6	21.9	26.1	29.5	30.4	30.5	30.5	30.5	30.5	30.5
H17	18.7	22.0	26.2	29.6	30.4	30.6	30.6	30.6	30.6	30.6
H18	21.5	24.7	29.0	32.3	33.2	33.3	33.4	33.4	33.4	33.4
H19	28.5	31.8	36.0	39.4	40.2	40.4	40.4	40.4	40.4	40.4
H20	24.4	27.7	32.0	35.3	36.2	36.3	36.3	36.3	36.3	36.3
H21	19.4	22.7	26.9	30.3	31.2	31.3	31.3	31.3	31.3	31.3
H22	19.2	22.5	26.8	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H23	19.4	22.6	26.9	30.2	31.1	31.2	31.3	31.3	31.3	31.3
H24	18.9	22.2	26.4	29.8	30.7	30.8	30.8	30.8	30.8	30.8
H25	21.1	24.4	28.6	31.9	32.8	33.0	33.0	33.0	33.0	33.0
H26	21.1	24.4	28.6	32.0	32.8	33.0	33.0	33.0	33.0	33.0

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H27	23.2	26.5	30.7	34.0	34.9	35.1	35.1	35.1	35.1	35.1
H28	18.7	22.0	26.2	29.6	30.4	30.6	30.6	30.6	30.6	30.6
H29	22.9	26.2	30.4	33.8	34.6	34.8	34.8	34.8	34.8	34.8
H30	21.0	24.3	28.6	31.9	32.8	32.9	32.9	32.9	32.9	32.9
H31	18.2	21.5	25.7	29.1	29.9	30.1	30.1	30.1	30.1	30.1
H32	17.1	20.3	24.6	27.9	28.8	28.9	29.0	29.0	29.0	29.0
H33	18.1	21.4	25.6	29.0	29.9	30.0	30.0	30.0	30.0	30.0
H34	18.2	21.4	25.7	29.0	29.9	30.1	30.1	30.1	30.1	30.1
H35	16.8	20.1	24.3	27.6	28.5	28.7	28.7	28.7	28.7	28.7
H36	12.5	15.8	20.0	23.4	24.2	24.4	24.4	24.4	24.4	24.4
H37	12.7	16.0	20.2	23.6	24.5	24.6	24.6	24.6	24.6	24.6
H38	18.2	21.5	25.7	29.0	29.9	30.1	30.1	30.1	30.1	30.1
H39	18.2	21.4	25.7	29.0	29.9	30.1	30.1	30.1	30.1	30.1
H40	18.2	21.4	25.7	29.0	29.9	30.0	30.1	30.1	30.1	30.1
H41	18.1	21.4	25.6	29.0	29.8	30.0	30.0	30.0	30.0	30.0
H42	18.2	21.5	25.7	29.1	29.9	30.1	30.1	30.1	30.1	30.1
H43	18.2	21.5	25.7	29.0	29.9	30.1	30.1	30.1	30.1	30.1
H44	17.7	21.0	25.3	28.6	29.5	29.6	29.6	29.6	29.6	29.6
H45	17.6	20.9	25.1	28.4	29.3	29.5	29.5	29.5	29.5	29.5
H46	17.5	20.7	25.0	28.3	29.2	29.3	29.4	29.4	29.4	29.4
H47	17.4	20.7	24.9	28.3	29.1	29.3	29.3	29.3	29.3	29.3
H48	18.1	21.4	25.6	29.0	29.8	30.0	30.0	30.0	30.0	30.0
H49	18.1	21.3	25.6	28.9	29.8	30.0	30.0	30.0	30.0	30.0
H50	21.1	24.3	28.6	31.9	32.8	32.9	33.0	33.0	33.0	33.0
H51	21.1	24.3	28.6	31.9	32.8	33.0	33.0	33.0	33.0	33.0
H52	21.1	24.4	28.6	31.9	32.8	33.0	33.0	33.0	33.0	33.0
H53	22.9	26.1	30.4	33.7	34.6	34.7	34.8	34.8	34.8	34.8
H54	22.8	26.1	30.3	33.7	34.5	34.7	34.7	34.7	34.7	34.7
H55	22.8	26.0	30.3	33.6	34.5	34.6	34.7	34.7	34.7	34.7
H56	20.8	24.1	28.4	31.7	32.6	32.7	32.7	32.7	32.7	32.7
H57	19.2	22.5	26.7	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H58	19.3	22.6	26.8	30.1	31.0	31.2	31.2	31.2	31.2	31.2
H59	19.3	22.6	26.8	30.2	31.0	31.2	31.2	31.2	31.2	31.2
H60	19.4	22.7	26.9	30.3	31.1	31.3	31.3	31.3	31.3	31.3
H61	19.4	22.7	26.9	30.2	31.1	31.3	31.3	31.3	31.3	31.3
H62	19.4	22.7	26.9	30.2	31.1	31.3	31.3	31.3	31.3	31.3

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H63	15.4	18.7	23.0	26.3	27.2	27.3	27.3	27.3	27.3	27.3
H64	14.5	17.8	22.1	25.4	26.3	26.4	26.4	26.4	26.4	26.4
H65	18.8	22.1	26.3	29.7	30.5	30.7	30.7	30.7	30.7	30.7
H66	17.3	20.6	24.8	28.2	29.0	29.2	29.2	29.2	29.2	29.2
H67	17.1	20.4	24.7	28.0	28.9	29.0	29.0	29.0	29.0	29.0
H68	17.1	20.4	24.6	28.0	28.8	29.0	29.0	29.0	29.0	29.0
H69	15.1	18.4	22.6	26.0	26.9	27.0	27.0	27.0	27.0	27.0
H70	16.8	20.1	24.3	27.7	28.5	28.7	28.7	28.7	28.7	28.7
H71	16.6	19.9	24.1	27.5	28.4	28.5	28.5	28.5	28.5	28.5
H72	16.6	19.9	24.1	27.5	28.3	28.5	28.5	28.5	28.5	28.5
H73	16.3	19.6	23.8	27.2	28.0	28.2	28.2	28.2	28.2	28.2
H74	21.1	24.4	28.6	32.0	32.8	33.0	33.0	33.0	33.0	33.0
H75	21.1	24.4	28.6	31.9	32.8	33.0	33.0	33.0	33.0	33.0

12.6.2 **Table 12.14** shows the margin by which the predicted operational noise levels resulting from the introduction of the Proposed Development meets the noise limits set out in **Table 12.12**. A negative number indicates that predicted levels are below the relevant noise limits at each residence.

Table 12.14 Torfichen Wind Farm Predicted Margin of Compliance, dB

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H1	-18.1	-14.9	-10.6	-8.8	-11.5	-14.9	-18.2	-21.1	-23.3	-24.7
H2	-14.9	-11.6	-7.4	-5.6	-8.3	-11.6	-15.0	-17.9	-20.1	-21.5
H3	-14.6	-11.3	-7.1	-5.2	-8.0	-11.3	-14.7	-17.6	-19.8	-21.2
H4	-17.8	-14.5	-10.2	-8.4	-11.1	-14.5	-17.9	-20.8	-23.0	-24.4
H5	-17.7	-14.4	-10.2	-8.4	-11.1	-14.4	-17.8	-20.7	-22.9	-24.3
H6	-17.2	-13.9	-11.8	-11.2	-13.5	-16.4	-19.2	-21.6	-23.4	-24.2
H7	-18.5	-15.2	-13.1	-12.5	-14.8	-17.7	-20.5	-22.9	-24.7	-25.5
H8	-15.9	-12.7	-8.4	-6.6	-9.3	-12.7	-16.0	-18.9	-21.1	-22.5
H9	-11.7	-8.5	-4.2	-2.4	-5.1	-8.5	-11.8	-14.7	-16.9	-18.3
H10	-10.5	-7.3	-3.0	-1.2	-3.9	-7.2	-10.6	-13.5	-15.7	-17.1
H11	-10.4	-7.1	-2.9	-1.0	-3.8	-7.1	-10.5	-13.4	-15.6	-17.0
H12	-18.9	-15.6	-13.5	-12.9	-15.2	-18.1	-20.9	-23.3	-25.1	-25.9
H13	-15.8	-12.5	-8.3	-6.4	-9.2	-12.5	-15.9	-18.8	-21.0	-22.4

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H14	-16.0	-12.7	-8.5	-6.7	-9.4	-12.7	-16.1	-19.0	-21.2	-22.6
H15	-15.7	-12.4	-8.2	-6.3	-9.1	-12.4	-15.8	-18.7	-20.9	-22.3
H16	-16.4	-13.1	-8.9	-7.0	-9.7	-13.1	-16.5	-19.4	-21.6	-23.0
H17	-16.3	-13.0	-8.8	-6.9	-9.7	-13.0	-16.4	-19.3	-21.5	-22.9
H18	-13.5	-10.3	-6.0	-4.2	-6.9	-10.3	-13.6	-16.5	-18.7	-20.1
H19	-16.5	-13.2	-9.0	-5.6	-4.8	-4.6	-5.2	-7.7	-9.4	-10.2
H20	-10.6	-7.3	-5.1	-4.6	-6.8	-9.8	-12.6	-15.0	-16.8	-17.6
H21	-15.6	-12.3	-8.1	-6.2	-8.4	-11.4	-14.3	-16.8	-18.5	-19.3
H22	-15.8	-12.5	-8.2	-6.4	-8.6	-11.6	-14.5	-17.0	-18.7	-19.5
H23	-15.6	-12.4	-8.1	-6.3	-8.5	-11.5	-14.3	-16.8	-18.5	-19.3
H24	-16.1	-12.8	-8.6	-6.7	-8.9	-11.9	-14.8	-17.3	-19.0	-19.8
H25	-13.9	-10.6	-6.4	-4.6	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
H26	-13.9	-10.6	-6.4	-4.5	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
H27	-11.8	-8.5	-4.3	-2.5	-4.7	-7.6	-10.5	-13.0	-14.7	-15.5
H28	-16.3	-13.0	-8.8	-6.9	-9.2	-12.1	-15.0	-17.5	-19.2	-20.0
H29	-12.1	-8.8	-4.6	-2.7	-5.0	-7.9	-10.8	-13.3	-15.0	-15.8
H30	-14.0	-10.7	-6.4	-4.6	-6.8	-9.8	-12.7	-15.2	-16.9	-17.7
H31	-16.8	-13.5	-11.4	-10.8	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H32	-17.9	-14.7	-12.5	-12.0	-14.2	-17.2	-19.9	-22.3	-24.1	-24.9
H33	-16.9	-13.6	-9.4	-7.5	-9.7	-12.7	-15.6	-18.1	-19.8	-20.6
H34	-16.8	-13.6	-9.3	-7.5	-9.7	-12.6	-15.5	-18.0	-19.7	-20.5
H35	-18.2	-14.9	-10.7	-8.9	-11.1	-14.0	-16.9	-19.4	-21.1	-21.9
H36	-22.5	-19.2	-17.1	-16.5	-18.8	-21.7	-24.5	-26.9	-28.7	-29.5
H37	-22.3	-19.0	-16.9	-16.3	-18.5	-21.5	-24.3	-26.7	-28.5	-29.3
H38	-16.8	-13.5	-11.4	-10.9	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H39	-16.8	-13.6	-11.4	-10.9	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H40	-16.8	-13.6	-11.4	-10.9	-13.1	-16.1	-18.8	-21.2	-23.0	-23.8
H41	-16.9	-13.6	-11.5	-10.9	-13.2	-16.1	-18.9	-21.3	-23.1	-23.9
H42	-16.8	-13.5	-11.4	-10.8	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H43	-16.8	-13.5	-11.4	-10.9	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H44	-17.3	-14.0	-11.8	-11.3	-13.5	-16.5	-19.3	-21.7	-23.5	-24.3
H45	-17.4	-14.1	-12.0	-11.5	-13.7	-16.6	-19.4	-21.8	-23.6	-24.4
H46	-17.5	-14.3	-12.1	-11.6	-13.8	-16.8	-19.5	-21.9	-23.7	-24.5
H47	-17.6	-14.3	-12.2	-11.6	-13.9	-16.8	-19.6	-22.0	-23.8	-24.6
H48	-16.9	-13.6	-9.4	-7.5	-9.8	-12.7	-15.6	-18.1	-19.8	-20.6
H49	-16.9	-13.7	-9.4	-7.6	-9.8	-12.7	-15.6	-18.1	-19.8	-20.6

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H50	-13.9	-10.7	-6.4	-4.6	-6.8	-9.8	-12.6	-15.1	-16.8	-17.6
H51	-13.9	-10.7	-6.4	-4.6	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
H52	-13.9	-10.6	-6.4	-4.6	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
H53	-12.1	-8.9	-4.6	-2.8	-5.0	-8.0	-10.8	-13.3	-15.0	-15.8
H54	-12.2	-8.9	-4.7	-2.8	-5.1	-8.0	-10.9	-13.4	-15.1	-15.9
H55	-12.2	-9.0	-4.7	-2.9	-5.1	-8.1	-10.9	-13.4	-15.1	-15.9
H56	-14.2	-10.9	-6.6	-4.8	-7.0	-10.0	-12.9	-15.4	-17.1	-17.9
H57	-15.8	-12.5	-8.3	-6.4	-8.6	-11.6	-14.5	-17.0	-18.7	-19.5
H58	-15.7	-12.4	-8.2	-6.4	-8.6	-11.5	-14.4	-16.9	-18.6	-19.4
H59	-15.7	-12.4	-8.2	-6.3	-8.6	-11.5	-14.4	-16.9	-18.6	-19.4
H60	-15.6	-12.3	-8.1	-6.2	-8.5	-11.4	-14.3	-16.8	-18.5	-19.3
H61	-15.6	-12.3	-8.1	-6.3	-8.5	-11.4	-14.3	-16.8	-18.5	-19.3
H62	-15.6	-12.3	-8.1	-6.3	-8.5	-11.4	-14.3	-16.8	-18.5	-19.3
H63	-19.6	-16.3	-12.0	-10.2	-12.9	-16.3	-19.7	-22.6	-24.8	-26.2
H64	-20.5	-17.2	-12.9	-11.1	-13.8	-17.2	-20.6	-23.5	-25.7	-27.1
H65	-16.2	-12.9	-8.7	-6.8	-9.6	-12.9	-16.3	-19.2	-21.4	-22.8
H66	-17.7	-14.4	-10.2	-8.3	-11.1	-14.4	-17.8	-20.7	-22.9	-24.3
H67	-17.9	-14.6	-10.3	-8.5	-11.2	-14.6	-18.0	-20.9	-23.1	-24.5
H68	-17.9	-14.6	-10.4	-8.5	-11.3	-14.6	-18.0	-20.9	-23.1	-24.5
H69	-19.9	-16.6	-12.4	-10.5	-13.2	-16.6	-20.0	-22.9	-25.1	-26.5
H70	-18.2	-14.9	-12.8	-12.2	-14.5	-17.4	-20.2	-22.6	-24.4	-25.2
H71	-18.4	-15.1	-13.0	-12.4	-14.6	-17.6	-20.4	-22.8	-24.6	-25.4
H72	-18.4	-15.1	-13.0	-12.4	-14.7	-17.6	-20.4	-22.8	-24.6	-25.4
H73	-18.7	-15.4	-13.3	-12.7	-15.0	-17.9	-20.7	-23.1	-24.9	-25.7
H74	-13.9	-10.6	-6.4	-4.5	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
H75	-13.9	-10.6	-6.4	-4.6	-6.8	-9.7	-12.6	-15.1	-16.8	-17.6
Night-time										
H1	-26.1	-22.9	-18.6	-15.3	-14.4	-14.3	-15.9	-19.3	-22.1	-23.8
H2	-22.9	-19.6	-15.4	-12.1	-11.2	-11.0	-12.7	-16.1	-18.9	-20.6
H3	-22.6	-19.3	-15.1	-11.7	-10.9	-10.7	-12.4	-15.8	-18.6	-20.3
H4	-25.8	-22.5	-18.2	-14.9	-14.0	-13.9	-15.6	-19.0	-21.8	-23.5
H5	-25.7	-22.4	-18.2	-14.9	-14.0	-13.8	-15.5	-18.9	-21.7	-23.4
H6	-25.2	-21.9	-17.7	-14.3	-13.5	-13.3	-15.5	-18.0	-20.1	-21.6
H7	-26.5	-23.2	-19.0	-15.6	-14.8	-14.6	-16.8	-19.3	-21.4	-22.9
H8	-23.9	-20.7	-16.4	-13.1	-12.2	-12.1	-13.7	-17.1	-19.9	-21.6
H9	-19.7	-16.5	-12.2	-8.9	-8.0	-7.9	-9.5	-12.9	-15.7	-17.4

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H10	-18.5	-15.3	-11.0	-7.7	-6.8	-6.6	-8.3	-11.7	-14.5	-16.2
H11	-18.4	-15.1	-10.9	-7.5	-6.7	-6.5	-8.2	-11.6	-14.4	-16.1
H12	-26.9	-23.6	-19.4	-16.0	-15.2	-15.0	-17.2	-19.7	-21.8	-23.3
H13	-23.8	-20.5	-16.3	-12.9	-12.1	-11.9	-13.6	-17.0	-19.8	-21.5
H14	-24.0	-20.7	-16.5	-13.2	-12.3	-12.1	-13.8	-17.2	-20.0	-21.7
H15	-23.7	-20.4	-16.2	-12.8	-12.0	-11.8	-13.5	-16.9	-19.7	-21.4
H16	-24.4	-21.1	-16.9	-13.5	-12.6	-12.5	-14.2	-17.6	-20.4	-22.1
H17	-24.3	-21.0	-16.8	-13.4	-12.6	-12.4	-14.1	-17.5	-20.3	-22.0
H18	-21.5	-18.3	-14.0	-10.7	-9.8	-9.7	-11.3	-14.7	-17.5	-19.2
H19	-16.5	-13.2	-9.0	-5.6	-4.8	-4.6	-4.6	-4.6	-4.6	-5.6
H20	-18.6	-15.3	-11.0	-7.7	-6.8	-6.7	-8.9	-11.4	-13.5	-15.0
H21	-23.6	-20.3	-16.1	-12.7	-11.8	-11.7	-11.7	-11.7	-13.5	-14.7
H22	-23.8	-20.5	-16.2	-12.9	-12.0	-11.9	-11.9	-11.9	-13.7	-14.9
H23	-23.6	-20.4	-16.1	-12.8	-11.9	-11.8	-11.7	-11.7	-13.5	-14.7
H24	-24.1	-20.8	-16.6	-13.2	-12.3	-12.2	-12.2	-12.2	-14.0	-15.2
H25	-21.9	-18.6	-14.4	-11.1	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0
H26	-21.9	-18.6	-14.4	-11.0	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0
H27	-19.8	-16.5	-12.3	-9.0	-8.1	-7.9	-7.9	-7.9	-9.7	-10.9
H28	-24.3	-21.0	-16.8	-13.4	-12.6	-12.4	-12.4	-12.4	-14.2	-15.4
H29	-20.1	-16.8	-12.6	-9.2	-8.4	-8.2	-8.2	-8.2	-10.0	-11.2
H30	-22.0	-18.7	-14.4	-11.1	-10.2	-10.1	-10.1	-10.1	-11.9	-13.1
H31	-24.8	-21.5	-17.3	-13.9	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H32	-25.9	-22.7	-18.4	-15.1	-14.2	-14.1	-16.2	-18.7	-20.8	-22.3
H33	-24.9	-21.6	-17.4	-14.0	-13.1	-13.0	-13.0	-13.0	-14.8	-16.0
H34	-24.8	-21.6	-17.3	-14.0	-13.1	-12.9	-12.9	-12.9	-14.7	-15.9
H35	-26.2	-22.9	-18.7	-15.4	-14.5	-14.3	-14.3	-14.3	-16.1	-17.3
H36	-30.5	-27.2	-23.0	-19.6	-18.8	-18.6	-20.8	-23.3	-25.4	-26.9
H37	-30.3	-27.0	-22.8	-19.4	-18.5	-18.4	-20.6	-23.1	-25.2	-26.7
H38	-24.8	-21.5	-17.3	-14.0	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H39	-24.8	-21.6	-17.3	-14.0	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H40	-24.8	-21.6	-17.3	-14.0	-13.1	-13.0	-15.1	-17.6	-19.7	-21.2
H41	-24.9	-21.6	-17.4	-14.0	-13.2	-13.0	-15.2	-17.7	-19.8	-21.3
H42	-24.8	-21.5	-17.3	-13.9	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H43	-24.8	-21.5	-17.3	-14.0	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H44	-25.3	-22.0	-17.7	-14.4	-13.5	-13.4	-15.6	-18.1	-20.2	-21.7
H45	-25.4	-22.1	-17.9	-14.6	-13.7	-13.5	-15.7	-18.2	-20.3	-21.8

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H46	-25.5	-22.3	-18.0	-14.7	-13.8	-13.7	-15.8	-18.3	-20.4	-21.9
H47	-25.6	-22.3	-18.1	-14.7	-13.9	-13.7	-15.9	-18.4	-20.5	-22.0
H48	-24.9	-21.6	-17.4	-14.0	-13.2	-13.0	-13.0	-13.0	-14.8	-16.0
H49	-24.9	-21.7	-17.4	-14.1	-13.2	-13.0	-13.0	-13.0	-14.8	-16.0
H50	-21.9	-18.7	-14.4	-11.1	-10.2	-10.1	-10.0	-10.0	-11.8	-13.0
H51	-21.9	-18.7	-14.4	-11.1	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0
H52	-21.9	-18.6	-14.4	-11.1	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0
H53	-20.1	-16.9	-12.6	-9.3	-8.4	-8.3	-8.2	-8.2	-10.0	-11.2
H54	-20.2	-16.9	-12.7	-9.3	-8.5	-8.3	-8.3	-8.3	-10.1	-11.3
H55	-20.2	-17.0	-12.7	-9.4	-8.5	-8.4	-8.3	-8.3	-10.1	-11.3
H56	-22.2	-18.9	-14.6	-11.3	-10.4	-10.3	-10.3	-10.3	-12.1	-13.3
H57	-23.8	-20.5	-16.3	-12.9	-12.0	-11.9	-11.9	-11.9	-13.7	-14.9
H58	-23.7	-20.4	-16.2	-12.9	-12.0	-11.8	-11.8	-11.8	-13.6	-14.8
H59	-23.7	-20.4	-16.2	-12.8	-12.0	-11.8	-11.8	-11.8	-13.6	-14.8
H60	-23.6	-20.3	-16.1	-12.7	-11.9	-11.7	-11.7	-11.7	-13.5	-14.7
H61	-23.6	-20.3	-16.1	-12.8	-11.9	-11.7	-11.7	-11.7	-13.5	-14.7
H62	-23.6	-20.3	-16.1	-12.8	-11.9	-11.7	-11.7	-11.7	-13.5	-14.7
H63	-27.6	-24.3	-20.0	-16.7	-15.8	-15.7	-17.4	-20.8	-23.6	-25.3
H64	-28.5	-25.2	-20.9	-17.6	-16.7	-16.6	-18.3	-21.7	-24.5	-26.2
H65	-24.2	-20.9	-16.7	-13.3	-12.5	-12.3	-14.0	-17.4	-20.2	-21.9
H66	-25.7	-22.4	-18.2	-14.8	-14.0	-13.8	-15.5	-18.9	-21.7	-23.4
H67	-25.9	-22.6	-18.3	-15.0	-14.1	-14.0	-15.7	-19.1	-21.9	-23.6
H68	-25.9	-22.6	-18.4	-15.0	-14.2	-14.0	-15.7	-19.1	-21.9	-23.6
H69	-27.9	-24.6	-20.4	-17.0	-16.1	-16.0	-17.7	-21.1	-23.9	-25.6
H70	-26.2	-22.9	-18.7	-15.3	-14.5	-14.3	-16.5	-19.0	-21.1	-22.6
H71	-26.4	-23.1	-18.9	-15.5	-14.6	-14.5	-16.7	-19.2	-21.3	-22.8
H72	-26.4	-23.1	-18.9	-15.5	-14.7	-14.5	-16.7	-19.2	-21.3	-22.8
H73	-26.7	-23.4	-19.2	-15.8	-15.0	-14.8	-17.0	-19.5	-21.6	-23.1
H74	-21.9	-18.6	-14.4	-11.0	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0
H75	-21.9	-18.6	-14.4	-11.1	-10.2	-10.0	-10.0	-10.0	-11.8	-13.0

12.6.3 The assessment shows that predicted noise levels meet the limiting requirements of ETSU-R-97 at all properties and are considered not significant as a result. Charts showing the predicted noise levels compared with the applied daytime and night-time noise limits are provided within **Technical Appendix 12.7** and a contour plot corresponding to the

maximum noise levels resulting from the Proposed Development is provided in **Figure 12.1**.

Construction & Decommissioning Effects

12.6.4 Primary activities creating noise during the construction period of wind farm developments include the construction of the turbine bases; the erection of the turbines; the excavation of trenches for cables; and the construction of associated hard standings, access tracks and construction compound(s). 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.

12.6.5 The exact methodology and timing of construction activities for the Proposed Development have not yet been defined and a reliable assessment of expected construction noise levels is not possible as a result. However, as discussed in **Section 12.4**, works expected to be undertaken at or around the proposed turbine locations would occur at distances that are unlikely to result in noise levels that would breach typical criteria at neighbouring residences in this regard.

12.6.6 The access route for the Proposed Development is expected to pass reasonably close to some dwellings and with some upgrade works to existing access tracks and local roads also expected to occur in close proximity to some dwellings. In these instances, the level of noise generated by construction works could be close to the limits defined as part of the 'ABC method', as discussed earlier. As a result, typical construction noise mitigation measures are provided in **Section 12.7** which aim to minimise noise as far as reasonably practicable and/or reasonable.

12.6.7 The movement of additional vehicles, including HGVs, along local roads and access routes may well be noticeable to residents adjacent to these in terms of the noise and vibration generated by them. The resultant impacts on local roads, that are already well used by local traffic and existing HGV movements, would be relatively minor in terms of the increase in average noise levels resulting from the additional vehicles on the roads. However, the individual events may well be noticeable to residents, with resulting levels for individual events being similar to that created by existing HGV movements. The resultant noise levels on parts of the route that are less well used by existing traffic would be noticeable to residents located along the route. However, the resultant noise and vibration levels from vehicles passing the dwellings would be unlikely to breach the adopted construction noise limits and accepted vibration thresholds.

12.6.8 The noise associated with blasting at 'borrow pit' locations may well be audible to neighbouring residents. However, the level of noise, overpressure and vibration generated by each blast would be well below levels that would be expected to cause damage to the nearest housing and/or structures. **Section 12.7** provides details as to standard mitigation measures to be incorporated into the blasting processes and may also be included within the CEMP.

12.7 Mitigation

Operation

12.7.1 Predicted operational noise levels associated with the introduction of the Proposed Development, as shown at **Section 12.6**, and cumulative noise levels resulting from the Proposed Development operating at the same time as the existing Carcant Wind Farm and proposed Wull Muir Wind Farm, as shown at **Section 12.9**, meet the limiting requirements of ETSU-R-97 in all instances subject to the caveats discussed as part of the cumulative assessment. Furthermore, the predicted levels assume downwind propagation conditions in all directions which cannot occur in practice and represents a particularly conservative basis of assessment for certain residences. As a result, operational noise mitigation is not required to reduce the potential operational noise impacts.

Construction & Decommissioning

12.7.2 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 Section 72 of the Control of Pollution Act 1974[10].

12.7.3 BS 5228-1 states that the 'attitude of the contractor' is important in minimising the likelihood of complaints and therefore consultation with the local authority along with letter drops are 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 and managed via a CEMP. 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 at the site;

- All equipment to 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;
- The movement of vehicles to and from the site would be controlled and employees instructed to ensure compliance with the noise control measures adopted; and
- Site construction operations would be limited to 07:00 – 19:00 Monday to Friday, and 07:00 – 13:00 on Saturdays except during turbine erection and commissioning or during periods of emergency work.

12.7.4 There are many strategies to reduce construction noise by the limitation of activities that would result in predicted noise levels being lower than the specified targets. Any such measures should be considered in proportionate terms and the mitigation adopted should not be limited to the measures proposed here.

12.7.5 With specific regard to blasting, it is proposed that the following mitigation measures are implemented:

- Good practice on blasting shall be followed;
- The vibration and air overpressure reduction methods outlined in **Section 8.6.9.2** of BS 5228-2:2009 shall be adhered to where appropriate and/or necessary;
- Advance warning shall be given to nearby residents;
- Blasting should only occur between the hours of 08:00 - 18:00 on Mondays-Fridays or between the hours of 08:00 - 13:00 on Saturdays; and
- No more than three blasts per day should occur.

12.7.6 Depending upon the charge sizes required it may be prudent to perform trial blasts with smaller amounts of explosive and measure vibration magnitudes at various distances to more accurately determine how vibration propagates at the site.

12.7.7 As with operational noise, if planning permission is granted for the Proposed Development, planning conditions can be proposed so that appropriate noise mitigation measures and construction practices are included within a CEMP.

12.8 Assessment of Residual Effects

Operational Effects

12.8.1 The operational acoustic assessment demonstrates that predicted noise levels from the Proposed Development at residential properties do not exceed the derived noise limits across all wind speeds for the isolative scenario detailed in **Section 12.6** and cumulative scenario detailed in **Section 12.9**, subject to the caveats discussed in terms of cumulative impacts. Therefore, no significant impacts in terms of operational noise are expected. This should not be interpreted to mean that 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.

12.8.2 A suggested planning condition to control the noise levels associated with the introduction and operation of the Proposed Development is provided within **Technical Appendix 12.8**.

Construction & Decommissioning Effects

12.8.3 Noise and vibration during the construction and decommissioning of the Proposed Development may well be audible and/or perceptible to people residing in the area, but the levels would be below established noise limits and planning requirements in this respect due to the large distances between the site and the surrounding dwellings. Where construction noise relating to the provision of access to the site, including the upgrade of local roads and their use thereof, is expected to occur in close proximity to residences, enhanced mitigation measures would be adopted to reduce noise and vibration where necessary. The impacts resulting from blasting at 'borrow pits' are only considered in terms of the steps to limit any resulting impact through appropriate blast design and best practice, which also involves keeping residents informed as to planned blasting activities, with no significant impacts being expected.

12.9 Assessment of Cumulative Effects

Operation

12.9.1 **Table 12.15** shows the maximum predicted operational noise levels resulting from the introduction of the Proposed Development operating cumulatively with the exiting Carcant Wind Farm and proposed Wull Muir Wind Farm, over a range of standardised 10 m height wind speeds,

assuming downwind propagation at the nearest residential properties and using the prediction methodology and assumptions detailed at **Section 12.4.**

Table 12.15 Cumulative Predicted Operational Noise Levels, dB L_{A90}

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H1	18.6	22.1	26.5	30.2	31.2	31.3	31.3	31.3	31.3	31.3
H2	20.7	24.1	28.4	31.9	32.9	33.0	33.0	33.0	33.0	33.0
H3	21.1	24.5	28.8	32.4	33.3	33.4	33.5	33.5	33.5	33.5
H4	17.3	20.6	24.9	28.3	29.1	29.3	29.3	29.3	29.3	29.3
H5	17.4	20.7	24.9	28.3	29.2	29.3	29.3	29.3	29.3	29.3
H6	27.4	31.5	36.1	40.6	42.0	42.0	42.0	42.0	42.0	42.0
H7	25.7	29.7	34.3	38.7	40.1	40.1	40.1	40.1	40.1	40.1
H8	19.1	22.4	26.7	30.0	30.9	31.1	31.1	31.1	31.1	31.1
H9	23.3	26.6	30.8	34.2	35.1	35.2	35.2	35.2	35.2	35.2
H10	24.5	27.8	32.0	35.4	36.3	36.4	36.4	36.4	36.4	36.4
H11	24.6	27.9	32.2	35.5	36.4	36.5	36.6	36.6	36.6	36.6
H12	37.3	40.5	45.3	49.1	49.8	49.8	49.8	49.8	49.8	49.8
H13	19.3	22.6	26.8	30.2	31.0	31.2	31.2	31.2	31.2	31.2
H14	19.1	22.3	26.6	30.0	30.8	31.0	31.0	31.0	31.0	31.0
H15	19.4	22.7	26.9	30.3	31.2	31.3	31.3	31.3	31.3	31.3
H16	18.7	22.0	26.3	29.6	30.5	30.7	30.7	30.7	30.7	30.7
H17	18.8	22.1	26.3	29.7	30.6	30.7	30.8	30.8	30.8	30.8
H18	21.5	24.8	29.1	32.4	33.3	33.4	33.5	33.5	33.5	33.5
H19	28.6	31.8	36.1	39.4	40.3	40.5	40.5	40.5	40.5	40.5
H20	24.9	28.2	32.4	35.9	36.7	36.9	36.9	36.9	36.9	36.9
H21	19.6	22.9	27.1	30.5	31.4	31.5	31.5	31.5	31.5	31.5
H22	19.4	22.7	26.9	30.3	31.2	31.3	31.3	31.3	31.3	31.3
H23	19.5	22.8	27.0	30.4	31.3	31.4	31.5	31.5	31.5	31.5
H24	19.1	22.4	26.6	30.0	30.9	31.0	31.0	31.0	31.0	31.0
H25	21.2	24.5	28.8	32.2	33.0	33.2	33.2	33.2	33.2	33.2
H26	21.3	24.5	28.8	32.2	33.0	33.2	33.2	33.2	33.2	33.2
H27	23.3	26.6	30.8	34.2	35.1	35.2	35.3	35.3	35.3	35.3
H28	18.9	22.2	26.4	29.8	30.7	30.8	30.9	30.9	30.9	30.9
H29	23.1	26.4	30.6	34.0	34.9	35.0	35.0	35.0	35.0	35.0
H30	21.2	24.5	28.8	32.1	33.0	33.2	33.2	33.2	33.2	33.2
H31	19.0	22.3	26.7	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H32	18.0	21.3	25.6	29.1	29.9	30.1	30.1	30.1	30.1	30.1

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H33	18.6	21.8	26.1	29.6	30.4	30.6	30.6	30.6	30.6	30.6
H34	18.6	21.9	26.2	29.6	30.4	30.6	30.6	30.6	30.6	30.6
H35	17.0	20.3	24.6	28.0	28.8	29.0	29.0	29.0	29.0	29.0
H36	19.5	22.8	27.4	31.2	32.0	32.0	32.0	32.0	32.0	32.0
H37	19.6	22.8	27.5	31.3	32.0	32.1	32.1	32.1	32.1	32.1
H38	19.0	22.3	26.6	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H39	19.0	22.3	26.6	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H40	19.0	22.3	26.6	30.1	30.9	31.1	31.1	31.1	31.1	31.1
H41	18.9	22.2	26.6	30.0	30.9	31.0	31.0	31.0	31.0	31.0
H42	19.0	22.3	26.6	30.1	31.0	31.1	31.1	31.1	31.1	31.1
H43	19.0	22.3	26.6	30.1	30.9	31.1	31.1	31.1	31.1	31.1
H44	18.6	21.9	26.2	29.7	30.5	30.7	30.7	30.7	30.7	30.7
H45	18.4	21.7	26.1	29.5	30.4	30.5	30.5	30.5	30.5	30.5
H46	18.3	21.6	25.9	29.4	30.3	30.4	30.4	30.4	30.4	30.4
H47	18.3	21.6	25.9	29.4	30.2	30.3	30.4	30.4	30.4	30.4
H48	18.5	21.8	26.1	29.5	30.4	30.5	30.6	30.6	30.6	30.6
H49	18.5	21.8	26.1	29.5	30.4	30.5	30.5	30.5	30.5	30.5
H50	21.2	24.5	28.8	32.2	33.0	33.2	33.2	33.2	33.2	33.2
H51	21.2	24.5	28.8	32.2	33.0	33.2	33.2	33.2	33.2	33.2
H52	21.3	24.5	28.8	32.2	33.1	33.2	33.2	33.2	33.2	33.2
H53	23.0	26.3	30.6	33.9	34.8	35.0	35.0	35.0	35.0	35.0
H54	23.0	26.2	30.5	33.9	34.7	34.9	34.9	34.9	34.9	34.9
H55	22.9	26.2	30.4	33.8	34.7	34.8	34.9	34.9	34.9	34.9
H56	21.0	24.3	28.5	31.9	32.8	32.9	33.0	33.0	33.0	33.0
H57	19.4	22.7	26.9	30.3	31.2	31.3	31.3	31.3	31.3	31.3
H58	19.4	22.7	27.0	30.3	31.2	31.4	31.4	31.4	31.4	31.4
H59	19.4	22.7	27.0	30.4	31.2	31.4	31.4	31.4	31.4	31.4
H60	19.5	22.8	27.1	30.5	31.3	31.5	31.5	31.5	31.5	31.5
H61	19.5	22.8	27.1	30.5	31.3	31.5	31.5	31.5	31.5	31.5
H62	19.5	22.8	27.1	30.4	31.3	31.5	31.5	31.5	31.5	31.5
H63	15.6	18.9	23.1	26.5	27.4	27.5	27.5	27.5	27.5	27.5
H64	14.7	18.0	22.2	25.6	26.5	26.6	26.6	26.6	26.6	26.6
H65	18.9	22.2	26.4	29.8	30.7	30.8	30.8	30.8	30.8	30.8
H66	17.4	20.7	24.9	28.3	29.2	29.3	29.3	29.3	29.3	29.3
H67	17.3	20.5	24.8	28.2	29.0	29.2	29.2	29.2	29.2	29.2
H68	17.2	20.5	24.7	28.1	29.0	29.1	29.1	29.1	29.1	29.1

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H69	15.3	18.6	22.8	26.2	27.1	27.2	27.2	27.2	27.2	27.2
H70	25.5	29.5	34.1	38.6	39.9	39.9	39.9	39.9	39.9	39.9
H71	25.6	29.6	34.2	38.7	40.0	40.0	40.0	40.0	40.0	40.0
H72	25.6	29.6	34.2	38.6	40.0	40.0	40.0	40.0	40.0	40.0
H73	24.9	28.9	33.5	37.9	39.3	39.3	39.3	39.3	39.3	39.3
H74	21.3	24.6	28.8	32.2	33.1	33.2	33.2	33.2	33.2	33.2
H75	21.2	24.5	28.8	32.2	33.0	33.2	33.2	33.2	33.2	33.2

12.9.2 **Table 12.16** shows the margin by which the predicted operational noise levels resulting from combined operation of the Proposed Development with the existing Carcant Wind Farm and proposed Wull Muir Wind Farm meets the noise limits set out in **Table 12.12**. A negative number shows that predicted levels are below the relevant noise limits at each residence.

Table 12.16 Cumulative Predicted Margin of Compliance, dB

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
Daytime										
H1	-16.4	-12.9	-8.5	-6.3	-8.9	-12.3	-15.7	-18.6	-20.8	-22.2
H2	-14.3	-10.9	-6.6	-4.6	-7.2	-10.6	-14.0	-16.9	-19.1	-20.5
H3	-13.9	-10.5	-6.2	-4.1	-6.8	-10.2	-13.5	-16.4	-18.6	-20.0
H4	-17.7	-14.4	-10.1	-8.2	-11.0	-14.3	-17.7	-20.6	-22.8	-24.2
H5	-17.6	-14.3	-10.1	-8.2	-10.9	-14.3	-17.7	-20.6	-22.8	-24.2
H6	-7.6	-3.5	-1.0	0.7	-1.0	-4.1	-6.9	-9.3	-11.1	-11.9
H7	-9.3	-5.3	-2.8	-1.2	-2.9	-6.0	-8.8	-11.2	-13.0	-13.8
H8	-15.9	-12.6	-8.3	-6.5	-9.2	-12.5	-15.9	-18.8	-21.0	-22.4
H9	-11.7	-8.4	-4.2	-2.3	-5.0	-8.4	-11.8	-14.7	-16.9	-18.3
H10	-10.5	-7.2	-3.0	-1.1	-3.8	-7.2	-10.6	-13.5	-15.7	-17.1
H11	-10.4	-7.1	-2.8	-1.0	-3.7	-7.1	-10.4	-13.3	-15.5	-16.9
H12	2.3	5.5	8.2	9.2	6.8	3.7	0.9	-1.5	-3.3	-4.1
H13	-15.7	-12.4	-8.2	-6.3	-9.1	-12.4	-15.8	-18.7	-20.9	-22.3
H14	-15.9	-12.7	-8.4	-6.5	-9.3	-12.6	-16.0	-18.9	-21.1	-22.5
H15	-15.6	-12.3	-8.1	-6.2	-8.9	-12.3	-15.7	-18.6	-20.8	-22.2
H16	-16.3	-13.0	-8.7	-6.9	-9.6	-12.9	-16.3	-19.2	-21.4	-22.8
H17	-16.2	-12.9	-8.7	-6.8	-9.5	-12.9	-16.2	-19.1	-21.3	-22.7

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H18	-13.5	-10.2	-5.9	-4.1	-6.8	-10.2	-13.5	-16.4	-18.6	-20.0
H19	-16.4	-13.2	-8.9	-5.6	-4.7	-4.5	-5.1	-7.6	-9.3	-10.1
H20	-10.1	-6.8	-4.7	-4.0	-6.3	-9.2	-12.0	-14.4	-16.2	-17.0
H21	-15.4	-12.1	-7.9	-6.0	-8.2	-11.2	-14.1	-16.6	-18.3	-19.1
H22	-15.6	-12.3	-8.1	-6.2	-8.4	-11.4	-14.3	-16.8	-18.5	-19.3
H23	-15.5	-12.2	-8.0	-6.1	-8.3	-11.3	-14.1	-16.6	-18.3	-19.1
H24	-15.9	-12.6	-8.4	-6.5	-8.7	-11.7	-14.6	-17.1	-18.8	-19.6
H25	-13.8	-10.5	-6.2	-4.3	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
H26	-13.7	-10.5	-6.2	-4.3	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
H27	-11.7	-8.4	-4.2	-2.3	-4.5	-7.5	-10.3	-12.8	-14.5	-15.3
H28	-16.1	-12.8	-8.6	-6.7	-8.9	-11.9	-14.7	-17.2	-18.9	-19.7
H29	-11.9	-8.6	-4.4	-2.5	-4.7	-7.7	-10.6	-13.1	-14.8	-15.6
H30	-13.8	-10.5	-6.2	-4.4	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
H31	-16.0	-12.7	-10.4	-9.8	-12.0	-15.0	-17.8	-20.2	-22.0	-22.8
H32	-17.0	-13.7	-11.5	-10.8	-13.1	-16.0	-18.8	-21.2	-23.0	-23.8
H33	-16.4	-13.2	-8.9	-6.9	-9.2	-12.1	-15.0	-17.5	-19.2	-20.0
H34	-16.4	-13.1	-8.8	-6.9	-9.2	-12.1	-15.0	-17.5	-19.2	-20.0
H35	-18.0	-14.7	-10.4	-8.5	-10.8	-13.7	-16.6	-19.1	-20.8	-21.6
H36	-15.5	-12.2	-9.7	-8.7	-11.0	-14.1	-16.9	-19.3	-21.1	-21.9
H37	-15.4	-12.2	-9.6	-8.6	-11.0	-14.0	-16.8	-19.2	-21.0	-21.8
H38	-16.0	-12.7	-10.5	-9.8	-12.0	-15.0	-17.8	-20.2	-22.0	-22.8
H39	-16.0	-12.7	-10.5	-9.8	-12.0	-15.0	-17.8	-20.2	-22.0	-22.8
H40	-16.0	-12.7	-10.5	-9.8	-12.1	-15.0	-17.8	-20.2	-22.0	-22.8
H41	-16.1	-12.8	-10.5	-9.9	-12.1	-15.1	-17.9	-20.3	-22.1	-22.9
H42	-16.0	-12.7	-10.5	-9.8	-12.0	-15.0	-17.8	-20.2	-22.0	-22.8
H43	-16.0	-12.7	-10.5	-9.8	-12.1	-15.0	-17.8	-20.2	-22.0	-22.8
H44	-16.4	-13.1	-10.9	-10.2	-12.5	-15.4	-18.2	-20.6	-22.4	-23.2
H45	-16.6	-13.3	-11.0	-10.4	-12.6	-15.6	-18.4	-20.8	-22.6	-23.4
H46	-16.7	-13.4	-11.2	-10.5	-12.7	-15.7	-18.5	-20.9	-22.7	-23.5
H47	-16.7	-13.4	-11.2	-10.5	-12.8	-15.8	-18.5	-20.9	-22.7	-23.5
H48	-16.5	-13.2	-8.9	-7.0	-9.2	-12.2	-15.0	-17.5	-19.2	-20.0
H49	-16.5	-13.2	-8.9	-7.0	-9.2	-12.2	-15.1	-17.6	-19.3	-20.1
H50	-13.8	-10.5	-6.2	-4.3	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
H51	-13.8	-10.5	-6.2	-4.3	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
H52	-13.7	-10.5	-6.2	-4.3	-6.5	-9.5	-12.4	-14.9	-16.6	-17.4
H53	-12.0	-8.7	-4.4	-2.6	-4.8	-7.7	-10.6	-13.1	-14.8	-15.6

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H54	-12.0	-8.8	-4.5	-2.6	-4.9	-7.8	-10.7	-13.2	-14.9	-15.7
H55	-12.1	-8.8	-4.6	-2.7	-4.9	-7.9	-10.7	-13.2	-14.9	-15.7
H56	-14.0	-10.7	-6.5	-4.6	-6.8	-9.8	-12.6	-15.1	-16.8	-17.6
H57	-15.6	-12.3	-8.1	-6.2	-8.4	-11.4	-14.3	-16.8	-18.5	-19.3
H58	-15.6	-12.3	-8.0	-6.2	-8.4	-11.3	-14.2	-16.7	-18.4	-19.2
H59	-15.6	-12.3	-8.0	-6.1	-8.4	-11.3	-14.2	-16.7	-18.4	-19.2
H60	-15.5	-12.2	-7.9	-6.0	-8.3	-11.2	-14.1	-16.6	-18.3	-19.1
H61	-15.5	-12.2	-7.9	-6.0	-8.3	-11.2	-14.1	-16.6	-18.3	-19.1
H62	-15.5	-12.2	-7.9	-6.1	-8.3	-11.2	-14.1	-16.6	-18.3	-19.1
H63	-19.4	-16.1	-11.9	-10.0	-12.7	-16.1	-19.5	-22.4	-24.6	-26.0
H64	-20.3	-17.0	-12.8	-10.9	-13.6	-17.0	-20.4	-23.3	-25.5	-26.9
H65	-16.1	-12.8	-8.6	-6.7	-9.4	-12.8	-16.2	-19.1	-21.3	-22.7
H66	-17.6	-14.3	-10.1	-8.2	-10.9	-14.3	-17.7	-20.6	-22.8	-24.2
H67	-17.7	-14.5	-10.2	-8.3	-11.1	-14.4	-17.8	-20.7	-22.9	-24.3
H68	-17.8	-14.5	-10.3	-8.4	-11.1	-14.5	-17.9	-20.8	-23.0	-24.4
H69	-19.7	-16.4	-12.2	-10.3	-13.0	-16.4	-19.8	-22.7	-24.9	-26.3
H70	-9.5	-5.5	-3.0	-1.3	-3.1	-6.2	-9.0	-11.4	-13.2	-14.0
H71	-9.4	-5.4	-2.9	-1.2	-3.0	-6.1	-8.9	-11.3	-13.1	-13.9
H72	-9.4	-5.4	-2.9	-1.3	-3.0	-6.1	-8.9	-11.3	-13.1	-13.9
H73	-10.1	-6.1	-3.6	-2.0	-3.7	-6.8	-9.6	-12.0	-13.8	-14.6
H74	-13.7	-10.4	-6.2	-4.3	-6.5	-9.5	-12.4	-14.9	-16.6	-17.4
H75	-13.8	-10.5	-6.2	-4.3	-6.6	-9.5	-12.4	-14.9	-16.6	-17.4
Night-time										
H1	-24.4	-20.9	-16.5	-12.8	-11.8	-11.7	-13.4	-16.8	-19.6	-21.3
H2	-22.3	-18.9	-14.6	-11.1	-10.1	-10.0	-11.7	-15.1	-17.9	-19.6
H3	-21.9	-18.5	-14.2	-10.6	-9.7	-9.6	-11.2	-14.6	-17.4	-19.1
H4	-25.7	-22.4	-18.1	-14.7	-13.9	-13.7	-15.4	-18.8	-21.6	-23.3
H5	-25.6	-22.3	-18.1	-14.7	-13.8	-13.7	-15.4	-18.8	-21.6	-23.3
H6	-15.6	-11.5	-6.9	-2.4	-1.0	-1.0	-3.2	-5.7	-7.8	-9.3
H7	-17.3	-13.3	-8.7	-4.3	-2.9	-2.9	-5.1	-7.6	-9.7	-11.2
H8	-23.9	-20.6	-16.3	-13.0	-12.1	-11.9	-13.6	-17.0	-19.8	-21.5
H9	-19.7	-16.4	-12.2	-8.8	-7.9	-7.8	-9.5	-12.9	-15.7	-17.4
H10	-18.5	-15.2	-11.0	-7.6	-6.7	-6.6	-8.3	-11.7	-14.5	-16.2
H11	-18.4	-15.1	-10.8	-7.5	-6.6	-6.5	-8.1	-11.5	-14.3	-16.0
H12	-5.7	-2.5	2.3	6.1	6.8	6.8	4.6	2.1	0.0	-1.5

House ID	Standardised 10 m height Wind Speed, m.s^{-1}									
	3	4	5	6	7	8	9	10	11	12
H13	-23.7	-20.4	-16.2	-12.8	-12.0	-11.8	-13.5	-16.9	-19.7	-21.4
H14	-23.9	-20.7	-16.4	-13.0	-12.2	-12.0	-13.7	-17.1	-19.9	-21.6
H15	-23.6	-20.3	-16.1	-12.7	-11.8	-11.7	-13.4	-16.8	-19.6	-21.3
H16	-24.3	-21.0	-16.7	-13.4	-12.5	-12.3	-14.0	-17.4	-20.2	-21.9
H17	-24.2	-20.9	-16.7	-13.3	-12.4	-12.3	-13.9	-17.3	-20.1	-21.8
H18	-21.5	-18.2	-13.9	-10.6	-9.7	-9.6	-11.2	-14.6	-17.4	-19.1
H19	-16.4	-13.2	-8.9	-5.6	-4.7	-4.5	-4.5	-4.5	-4.5	-5.5
H20	-18.1	-14.8	-10.6	-7.1	-6.3	-6.1	-8.3	-10.8	-12.9	-14.4
H21	-23.4	-20.1	-15.9	-12.5	-11.6	-11.5	-11.5	-11.5	-13.3	-14.5
H22	-23.6	-20.3	-16.1	-12.7	-11.8	-11.7	-11.7	-11.7	-13.5	-14.7
H23	-23.5	-20.2	-16.0	-12.6	-11.7	-11.6	-11.5	-11.5	-13.3	-14.5
H24	-23.9	-20.6	-16.4	-13.0	-12.1	-12.0	-12.0	-12.0	-13.8	-15.0
H25	-21.8	-18.5	-14.2	-10.8	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8
H26	-21.7	-18.5	-14.2	-10.8	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8
H27	-19.7	-16.4	-12.2	-8.8	-7.9	-7.8	-7.7	-7.7	-9.5	-10.7
H28	-24.1	-20.8	-16.6	-13.2	-12.3	-12.2	-12.1	-12.1	-13.9	-15.1
H29	-19.9	-16.6	-12.4	-9.0	-8.1	-8.0	-8.0	-8.0	-9.8	-11.0
H30	-21.8	-18.5	-14.2	-10.9	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8
H31	-24.0	-20.7	-16.3	-12.9	-12.0	-11.9	-14.1	-16.6	-18.7	-20.2
H32	-25.0	-21.7	-17.4	-13.9	-13.1	-12.9	-15.1	-17.6	-19.7	-21.2
H33	-24.4	-21.2	-16.9	-13.4	-12.6	-12.4	-12.4	-12.4	-14.2	-15.4
H34	-24.4	-21.1	-16.8	-13.4	-12.6	-12.4	-12.4	-12.4	-14.2	-15.4
H35	-26.0	-22.7	-18.4	-15.0	-14.2	-14.0	-14.0	-14.0	-15.8	-17.0
H36	-23.5	-20.2	-15.6	-11.8	-11.0	-11.0	-13.2	-15.7	-17.8	-19.3
H37	-23.4	-20.2	-15.5	-11.7	-11.0	-10.9	-13.1	-15.6	-17.7	-19.2
H38	-24.0	-20.7	-16.4	-12.9	-12.0	-11.9	-14.1	-16.6	-18.7	-20.2
H39	-24.0	-20.7	-16.4	-12.9	-12.0	-11.9	-14.1	-16.6	-18.7	-20.2
H40	-24.0	-20.7	-16.4	-12.9	-12.1	-11.9	-14.1	-16.6	-18.7	-20.2
H41	-24.1	-20.8	-16.4	-13.0	-12.1	-12.0	-14.2	-16.7	-18.8	-20.3
H42	-24.0	-20.7	-16.4	-12.9	-12.0	-11.9	-14.1	-16.6	-18.7	-20.2
H43	-24.0	-20.7	-16.4	-12.9	-12.1	-11.9	-14.1	-16.6	-18.7	-20.2
H44	-24.4	-21.1	-16.8	-13.3	-12.5	-12.3	-14.5	-17.0	-19.1	-20.6
H45	-24.6	-21.3	-16.9	-13.5	-12.6	-12.5	-14.7	-17.2	-19.3	-20.8
H46	-24.7	-21.4	-17.1	-13.6	-12.7	-12.6	-14.8	-17.3	-19.4	-20.9
H47	-24.7	-21.4	-17.1	-13.6	-12.8	-12.7	-14.8	-17.3	-19.4	-20.9
H48	-24.5	-21.2	-16.9	-13.5	-12.6	-12.5	-12.4	-12.4	-14.2	-15.4

House ID	Standardised 10 m height Wind Speed, $m.s^{-1}$									
	3	4	5	6	7	8	9	10	11	12
H49	-24.5	-21.2	-16.9	-13.5	-12.6	-12.5	-12.5	-12.5	-14.3	-15.5
H50	-21.8	-18.5	-14.2	-10.8	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8
H51	-21.8	-18.5	-14.2	-10.8	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8
H52	-21.7	-18.5	-14.2	-10.8	-9.9	-9.8	-9.8	-9.8	-11.6	-12.8
H53	-20.0	-16.7	-12.4	-9.1	-8.2	-8.0	-8.0	-8.0	-9.8	-11.0
H54	-20.0	-16.8	-12.5	-9.1	-8.3	-8.1	-8.1	-8.1	-9.9	-11.1
H55	-20.1	-16.8	-12.6	-9.2	-8.3	-8.2	-8.1	-8.1	-9.9	-11.1
H56	-22.0	-18.7	-14.5	-11.1	-10.2	-10.1	-10.0	-10.0	-11.8	-13.0
H57	-23.6	-20.3	-16.1	-12.7	-11.8	-11.7	-11.7	-11.7	-13.5	-14.7
H58	-23.6	-20.3	-16.0	-12.7	-11.8	-11.6	-11.6	-11.6	-13.4	-14.6
H59	-23.6	-20.3	-16.0	-12.6	-11.8	-11.6	-11.6	-11.6	-13.4	-14.6
H60	-23.5	-20.2	-15.9	-12.5	-11.7	-11.5	-11.5	-11.5	-13.3	-14.5
H61	-23.5	-20.2	-15.9	-12.5	-11.7	-11.5	-11.5	-11.5	-13.3	-14.5
H62	-23.5	-20.2	-15.9	-12.6	-11.7	-11.5	-11.5	-11.5	-13.3	-14.5
H63	-27.4	-24.1	-19.9	-16.5	-15.6	-15.5	-17.2	-20.6	-23.4	-25.1
H64	-28.3	-25.0	-20.8	-17.4	-16.5	-16.4	-18.1	-21.5	-24.3	-26.0
H65	-24.1	-20.8	-16.6	-13.2	-12.3	-12.2	-13.9	-17.3	-20.1	-21.8
H66	-25.6	-22.3	-18.1	-14.7	-13.8	-13.7	-15.4	-18.8	-21.6	-23.3
H67	-25.7	-22.5	-18.2	-14.8	-14.0	-13.8	-15.5	-18.9	-21.7	-23.4
H68	-25.8	-22.5	-18.3	-14.9	-14.0	-13.9	-15.6	-19.0	-21.8	-23.5
H69	-27.7	-24.4	-20.2	-16.8	-15.9	-15.8	-17.5	-20.9	-23.7	-25.4
H70	-17.5	-13.5	-8.9	-4.4	-3.1	-3.1	-5.3	-7.8	-9.9	-11.4
H71	-17.4	-13.4	-8.8	-4.3	-3.0	-3.0	-5.2	-7.7	-9.8	-11.3
H72	-17.4	-13.4	-8.8	-4.4	-3.0	-3.0	-5.2	-7.7	-9.8	-11.3
H73	-18.1	-14.1	-9.5	-5.1	-3.7	-3.7	-5.9	-8.4	-10.5	-12.0
H74	-21.7	-18.4	-14.2	-10.8	-9.9	-9.8	-9.8	-9.8	-11.6	-12.8
H75	-21.8	-18.5	-14.2	-10.8	-10.0	-9.8	-9.8	-9.8	-11.6	-12.8

12.9.3 The assessment shows that predicted cumulative/combined noise levels meet the limiting requirements of ETSU-R-97 at all properties with H6 & H12 as exceptions.

12.9.4 H12 is located within the Wull Muir Wind Farm development boundary and will be taken out of use should the Proposed Development be granted planning permission and becomes operational. If the Wull Muir Wind Farm development does not become operational then the combined operational noise levels from the existing Carcant Wind Farm and the Proposed

Development will be well within the limiting requirements of ETSU-R-97 at this location.

12.9.5 H6 has predicted noise levels that meet the night-time requirements of ETSU-R-97 and very marginally exceed the daytime noise limits for a specific standardised 10 m height wind speed. This dwelling is located in relatively close proximity to the existing Carcant Wind Farm development and noise levels associated with this wind farm will still be the dominant source of operational wind farm noise should the Proposed Development become operational. The predicted noise levels associated with the operation of the Proposed Development will be around 10 dB lower than that associated with Carcant Wind Farm and can be considered insignificant as a result. The exceedance would also only be expected to occur for northerly wind directions which will happen relatively rarely in practice. Furthermore, the predicted noise levels for the Carcant Wind Farm site are undertaken on a particularly conservative basis (see **Paragraph 12.4.43** and **Table 12.6**), substantially more conservative than that provided for the Carcant Wind Farm and Wull Muir Wind Farm planning applications.

12.9.6 Due to the factors discussed above, the operational noise levels resulting from the operation of the Proposed Development in combination with the Carcant Wind Farm and Wull Muir Wind Farm developments are considered not significant.

12.9.7 Charts showing the predicted noise levels from the Proposed Development, the existing Carcant Wind Farm, the proposed Wull Muir Wind Farm development and the combined total, as compared with the applied overall ETSU-R-97 daytime and night-time noise limits, are provided within **Technical Appendix 12.7.** A contour plot corresponding to the maximum noise levels resulting from the Proposed Development in this cumulative context is provided in **Figure 12.2**.

Construction & Decommissioning

12.9.8 Noise due to the potential construction of the Wull Muir Wind Farm is unlikely to be present at the same time as the construction of the Proposed Development. However, if construction activities are undertaken concurrently this would generally amount to an increase in the frequency of traffic (including HGVs) entering the various sites and passing local residences as a result; an increase in the number of blasting events (if borrow pits are to be proposed as part of the cumulative wind farm schemes); and a slight increase in the overall construction noise levels

when building out the infrastructure at each site. As a result, a detailed assessment has not been undertaken and the effect is considered not significant provided that all usual controls and best practice is followed in terms of construction techniques.

12.10 Summary

12.10.1 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.

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

12.10.3 Operational noise levels were predicted using the recommended noise propagation model. The predicted noise levels for the Proposed Development operating in isolation and cumulatively with the existing Carcant Wind Farm and proposed Wull Muir Wind Farm are within the adopted noise limits for all relevant wind speeds and all properties with the exception of a very marginal potential exceedance at one location and subject to the corresponding caveats. The Proposed Development therefore complies with the relevant guidance on wind farm noise and the resultant impact is considered not significant as a result.

12.10.4 Construction noise has been discussed with reference to BS 5228 and it has been determined that onsite construction noise levels are highly unlikely to exceed typical limiting noise criteria at nearby properties although appropriate mitigation measures will be adopted as a matter of due course. The access route for the proposed wind farm is expected to pass reasonably close to some dwellings and with some upgrade works to existing access tracks and local roads potentially occurring in close proximity to some dwellings. In these instances, the level of noise generated by construction works could be close to typical limits for relatively brief periods. As a result, typical and enhanced construction noise mitigation measures are provided in **Section 12.7** which aim to minimise noise as far as reasonably practicable and/or reasonable.

12.10.5 Vibration and air overpressure due to blasting are not expected to have a significant impact on nearby residents should the mitigation measures described within the chapter be adopted.

12.10.6 The potential impact of the Proposed Development, along with the mitigation proposed and any residual impact, is summarised in **Table 12.17**.

Table 12.17 Summary of Residual Effects

Likely Significant Effect	Mitigation	Means of Implementation	Residual Effect
Operation			
Potential impact on residential amenity due to operational noise	The Proposed Development operating in isolation and cumulatively with other existing operational and proposed wind farm developments meet the limiting requirements of ETSU-R-97. As a result, no mitigation is required.	Not applicable	Not significant
Construction & Decommissioning			
Potential for noise and vibration 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 07:00 – 19:00 Mondays and 07:00 – 13:00 on Saturdays Saturday (except during wind turbine delivery/erection and commissioning/periods of emergency work). Good practice on blasting shall be followed along with guidance on blast frequency and timing.	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

Word	Definition
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 0dB 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 20Hz and the highest is 20,000Hz. The human ear is most sensitive to the 1kHz, 2kHz and 4kHz 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.

12.11 References

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