# Chapter 11 Noise

## Contents


11.1. Executive Summary ..... 1
11.2. Introduction ..... 1
11.3. Legislation, Policy and Guidelines ..... 2
11.4. Consultation ..... 10
11.5. Assessment Methodology ..... 10
11.6. Baseline Conditions ..... 16
11.7. Standard Mitigation ..... 17
11.8. Potential Effects ..... 17
11.9. Cumulative Effects with other Wind Developments ..... 21
11.10. Cumulative Effects with Beauly Denny line at Ard-Aluin ..... 21
11.11. Summary ..... 21


## List of Abbreviations

| Abbreviation | Description |
|---|---|
| BNL | Basic Noise Level |
| BPM | Best Practicable Means |
| BS | British Standard |
| CEMP | Construction Environmental Management Plan |
| dB | Decibels |
| DECC | Department of Energy & Climate Change |
| DMOY | do-minimum opening year |
| DSFY | do-something future year |
| DSOY | do-something opening year |
| DMRB | Design Manual for Roads and Bridges |
| EHO | Environmental Health Officer |
| EIA | Environmental Impact Assessment |
| GIS | Geographic Information System |

| | |
|---|---|
| GPG | Good Practice Guide |
| IoA | Institute of Acoustics |
| ISO | International Organization for Standardization |
| kWh | Kilowatt hour |
| ms-1 | Meters per second |
| MW | Megawatt |
| NWG | Noise Working Group |
| NSRs | Noise Sensitive Receptors |
| PAN | Planning Advice Note |
| SGN | Supplementary Guidance Note |
| TAN | Technical Advice Note |
| THC | The Highland Council |

# 11. Noise

## 11.1. Executive Summary

11.1.1. Potential noise effects of the Proposed Development have been evaluated in accordance with appropriate criteria. The assessment has comprised derivation of operational noise limits and evaluation of operational noise from turbines and fixed (non-turbine) plant against proposed limits.

11.1.2. Noise effects associated with construction and decommissioning have been scoped out, in consultation with THC, on the basis that these phases will be of relatively short duration and noise from the works can be restricted to meet appropriate limits by implementation of suitable controls.

11.1.3. Predicted operational noise levels are more than 10dB below the derived noise limits and noise effects, in isolation and cumulative, have therefore been determined to be not significant. No specific mitigation is proposed beyond appropriate specification of the final turbine model and transformer plant and development of a Construction Environmental Management Plan (CEMP) to address construction noise.

## 11.2. Introduction

11.2.1. This chapter provides an assessment of the potential effects of the Proposed Development on receptors sensitive to noise during the operational phase. Vibration associated with the Proposed Development will be negligible at sensitive receptors given the distance between construction locations and receptors, therefore assessment of vibration has been scoped out, in consultation with THC.

11.2.2. Noise from construction and decommissioning activities will occur at locations remote from Noise Sensitive Receptors (NSRs) (the closest NSR being approximately 3.6km distant) and can be minimised by implementing appropriate controls on working hours and by adoption of good practices in the specification of construction plant and methods. Noise from construction traffic can be minimised using a traffic management plan, and in any case is unlikely to be significant compared with baseline flows. Construction traffic will therefore fall below the significance criteria in the Design Manual for Roads and Bridges (DMRB) (refer to **Paragraph 11.3.53**). Detailed evaluation of construction and decommissioning noise has therefore been scoped out in consultation with THC.

11.2.3. No potential vibration effects have been identified and consideration of vibration has therefore been scoped out.

11.2.4. This assessment has considered the development layout as described in **Chapter 3: Proposed Development Description**. The Proposed Development will consist of 8 turbines. The candidate turbine considered as part of this assessment is the Vestas 162 7.2 MW, with a rotor diameter of 162 m and a hub height of 119 m (approximate dimensions). As noted in **Chapter 1**, the final selection of turbine model will be made post-consent following a tendering exercise.

11.2.5. This chapter has been written by Alasdair Baxter BSc (Hons) Dunelm, MSc, MIOA. Alasdair is a full member of the Institute of Acoustics (IoA) and has over 20 years' experience in environmental noise assessment.

11.2.6. The chapter has been reviewed by Simon Waddell BSc (Hons) MIOA. Simon is an acoustics consultant with more than eleven years' experience of wind farm noise assessments. He is a full member of the Institute of Acoustics and has completed the IoA Postgraduate Diploma in Acoustics and Noise Control.

11.2.7. This chapter is supported by the following figures and appendices:

- **Figure 11.1** - study area, NSRs, Proposed Turbine Layout and 35 decibel (dB) Contour
- **Appendix 11.1** – Correspondence with The Highland Council;

## 11.3. Legislation, Policy and Guidelines

11.3.1. Relevant legislation and guidance documents have been reviewed and taken into account as part of this assessment. Legislation of particular relevance is outlined below.

11.3.2. For a development of this nature, there is no specific all-encompassing legislation relating to the standards associated with noise emission/effects. Noise legislation, where it does exist, tends to be either EU-derived and focussed on specific items of noise-emitting plant or on more general nuisance, such as that addressed by the provisions of the Environmental Protection Act 1990 (UK Government, 1990).

11.3.3. In lieu of any specific legislation, assessing the effect of such a development must draw on information from a variety of sources. This assessment therefore makes reference to a number of British Standards, official planning policy and advice notes and national guidance.

### *Environmental Protection Act 1990*

11.3.4. Section 79 of the Act defines statutory nuisance with regard to noise and determines that local planning authorities have a duty to detect such nuisances in their area and, where a complaint of a statutory nuisance is made to it by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint.

11.3.5. Section 80 of the Act provides local planning authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence. It is a potential defence against failure to comply with an abatement notice where Best Practicable Means were used to prevent or counteract the effects of the nuisance.

11.3.6. The Act also defines the concept of “Best Practicable Means” (BPM):

- ‘practicable’ means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;
- the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;
- the test is to apply only so far as compatible with any duty imposed by law; and
- the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances.

### *Scottish Government Online Planning Advice: Planning Advice Note 1/2011 and Technical Advice Note*

11.3.7. Published in March 2011 and last updated in 2014, Planning Advice Note 1/2011 (Scottish Government (2014b)) (PAN 1/2011) provides advice on the role of the planning system in helping to prevent and limit adverse effects of noise. Information and advice on noise assessment methods are provided in the accompanying Technical Advice Note: Assessment of Noise (Scottish Government (2011b)) (TAN). Included within the PAN document and the accompanying TAN are details of the legislation, technical standards, and codes of practice for specific noise issues.

11.3.8. Regarding noise from wind turbines, paragraph 29 of PAN 1/2011 states the following:

*"There are two sources of noise from wind turbines – the mechanical noise from the turbines and the aerodynamic noise from the blades. Mechanical noise is related to engineering design. Aerodynamic noise varies with rotor design and wind speed and is generally greatest at low speeds. Good acoustical design and siting of turbines is essential to minimise the potential to generate noise. Web based planning advice on renewable technologies for onshore wind turbines provides advice on 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) published by the former Department of Trade and Industry (DTI) and the findings of the Salford University report into Aerodynamic Modulation of Wind Turbine Noise."*

11.3.9. Regarding appropriate assessment methods, the 'web-based planning advice' referred to in PAN 1/2011 is contained in an online document titled 'Onshore Wind Turbines', published by the Scottish Government (updated 2014). The document is summarised in the corresponding section below, and also refers to the use of ETSU-R 97 The Assessment and Rating of Noise from Wind Farms (The Working Group on Noise from Wind Turbines, 1996) assessment guidance (discussed in Paragraphs 12.28-12.41).

11.3.10. The IoA has since published 'a Good Practice Guide to the application of ETSU R-97 for the assessment and rating of wind turbine noise' (IoA, 2013), which is summarised in Paragraphs 12.42-12.50.

11.3.11. Neither PAN 1/2011 nor the associated TAN provide specific guidance on the assessment of noise from fixed plant, but the TAN includes an example assessment scenario for 'New noisy development (incl. commercial and recreation) affecting a noise sensitive building', which is based on BS4142:1997: 'Method for rating industrial noise affecting mixed residential and industrial areas'. This British Standard has been superseded by BS4142:2014+A1:2019 'Methods for rating and assessing industrial and commercial sound' (BSi, 2019). The standard is summarised in Paragraphs 12.60-12.66.

11.3.12. In summary, national planning policy on the assessment of operational noise impacts from wind farms stipulates the use of the ETSU-R-97 assessment method and application of the IoA Good Practice Guide (IoA GPG). These guidance documents, and others relevant to the assessment of possible noise impacts generated by the Proposed Development, are summarised below.

### *Onshore Wind – Policy Statement 2022*

11.3.13. The Scottish Government has provided an updated onshore wind policy statement, published in December 2022 following a consultation process which sought views on how to tackle barriers to deployment of wind turbines and securing the maximum economic benefit from developments. The Statement confirms a requirement for a substantial increase in installed capacity of all renewable technologies, and the aim to maintain the supportive policy and regulatory framework to enable an increase specifically in onshore wind deployment.

11.3.14. Regarding noise, the Statement notes that, "the UK Government has been considering the extent to which ETSU-R-97 may require updating to ensure it is aligned with the potential effects from more modern turbines. The Scottish Government supports this work and we anticipate the results of a short-term review project in due course." However, the Statement goes on to say, "Until such time as new guidance is produced, ETSU-R-97 should continue to be followed by applicants and used to assess and rate noise from wind energy developments."

11.3.15. Regarding the IoA Good Practice Guide to the application of ETSU R-97 the Statement notes that "The Scottish Government recognises this guide as a useful tool which developers can use in conjunction with ETSU-R-97."

### *Regional and Local Planning Policy*

11.3.16. National, Regional and Local planning policy is discussed in **Chapter 5: Planning and Energy Policy** of this EIA Report. Policies relevant to noise within THC's planning guidance are briefly summarised below.

#### *The Highland Council (THC) - Onshore Wind Energy Supplementary Guidance*

11.3.17. THC's supplementary guidance notes that ETSU-R-97 and the IoA GPG are the appropriate guidance for the evaluation of noise from 'large' wind turbines (those with a rotor diameter of greater than 16 m). The guidance further notes that all wind farm proposals should seek the lower end of the range indicated in the ETSU-R-97 guidance, and THC may seek limits which are lower still in certain circumstances.

### *Guidance*

11.3.18. This assessment has been undertaken in accordance with the following best practice guidelines and guidance.

#### *ETSU-R-97: The Assessment and Rating of Noise from Windfarms (ETSU-R-97)*

11.3.19. As referenced for use in PAN/2011 and the online planning advice for renewable technologies: Onshore wind turbines, this document was written by a Noise Working Group including developers, noise consultants and environmental health officers, set up in 1995 by the Department of Trade and Industry through ETSU (the Energy Technology Support Unit).

11.3.20. ETSU-R-97 presents a consensus view of the working group and was prepared to present a common approach to the assessment of noise from wind turbines. The document states that noise from wind turbines or wind farms should be assessed against site specific noise limits.

11.3.21. Noise limits are derived based on a series of acceptable lower limits and based on an allowable exceedance above the prevailing background noise level, including consideration of a variety of different prevailing wind speed conditions. The noise limits should be derived for external areas used for relaxation, or areas where a quiet noise environment is highly desirable. Separate limits are required for night-time and daytime periods. Night-time limits are derived drawing upon measured night-time background noise levels, whilst daytime limits are derived drawing upon the background noise levels arising during 'quiet daytime' periods.

11.3.22. Night-time is defined as the period between 23:00 and 07:00 hours, whilst quiet daytime periods are defined as:

- 18:00 to 23:00 hours on all days;
- 13:00 to 18:00 hours on Saturdays and Sundays; and
- 07:00 to 13:00 hours on Sundays.

11.3.23. For daytime, the suggested limits are 5 dB above the prevailing background noise level determined during quiet daytime periods, or 35 to 40 dB(A), whichever is the higher. The absolute criterion between the 35 to 40 dB(A) range is selected taking account of:

- the site environs (e.g. number of local receptors);
- the energy generation capacity (e.g. number of kWh that can be generated) of the Proposed Development; and
- the associated duration and level of exposure.

11.3.24. During night-time, the suggested limits are 5 dB above the prevailing night time background noise level or 43 dB(A), whichever is the higher. The absolute criterion for the night-time is

higher than that for the daytime, as the derivation of this limit is based on preventing sleep disturbance within a building whereas for the daytime, limits are based on occupation of external spaces used for relaxation.

11.3.25. It is required that the prevailing background noise levels be determined in terms of the $L_{A90,10min}$ noise index for both quiet daytime and night-time periods, for wind conditions ranging from 2 $ms^{-1}$ to 12 $ms^{-1}$.

11.3.26. The noise limits are calculated by undertaking a regression analysis of the $L_{A90,10min}$ noise levels and the prevailing average wind speed for the same 10-minute period, when measured or determined at 10 m above ground at the location of the proposed turbines. The allowable limit is then defined at +5 dB above the average noise level at each wind speed (as defined by the regression analysis), or the absolute noise level lower limit, whichever is the higher (assuming no financial involvement within the scheme).

11.3.27. ETSU-R-97 also provides a simplified fixed noise limit of 35 $dBL_{A90,10min}$ at all wind speeds, which may be applied to avoid the need to measure background noise levels. The 'simplified ETSU limit' typically applies both during the daytime and night time period.

11.3.28. Where a property has a financial involvement in the scheme, the document allows a relaxation of the derived noise limits, stating that "It is widely accepted that the level of disturbance or annoyance caused by a noise source is not only dependent upon the level and character of noise but also the receiver's attitude towards the noise source in general. If the residents at the noise-sensitive properties were financially involved in the project, then higher noise limits will be appropriate". The guidance goes on to state that it is "recommended that both the day and night-time lower fixed limits can be increased to 45 dB(A) and the consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm". The amount by which the permissible margin above background can be relaxed is not specified, but the allowable relaxation to 45 dB(A) of the lower limits is an increase of (at least) 5 dB during the daytime and 2 dB during the night-time, so similar levels of relaxation might also be applied to the background related element of the noise level limits.

11.3.29. The ETSU guidance states that the derived limits should be applied to noise from the proposed wind farm or turbines in terms of the $L_{A90,T}$ index, and that the $L_{A90,T}$ of the wind farm noise is typically 1.5 dB to 2.5 dB lower than the $L_{Aeq,T}$ measured over the same period.

11.3.30. The derived noise limits are applicable to both the aerodynamic (e.g. 'blade swish') and mechanical (e.g. generator related) components of wind farm noise.

11.3.31. Where noise from the wind farm is tonal, a correction of between 2 dB and 5 dB is to be applied to the wind farm noise. Guidance is provided on how to determine the level of correction required, but typically, for Proposed Developments, the need for any applicable correction is confirmed by the independent wind turbine-specific noise tests, following standard test procedures, provided by manufacturers.

11.3.32. It is stated within the ETSU-R-97 guidance that "The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area which contribute to the noise received at the properties in question. It is clearly unreasonable to suggest that because a wind farm was constructed in the vicinity in the past which resulted in increased noise levels at some properties, that residents of those properties are now able to tolerate still higher noise levels. The existing wind farm should not be considered as part of the prevailing background noise". Accordingly, where an existing wind farm contributes to the prevailing background noise levels, it is necessary to either include for the contribution of this wind farm when comparing against the allowable noise limit or correct for this contribution when deriving a limit applicable to the Proposed Development acting alone.

### *Good Practice Guide to the Application of ETSU-R-97 (IoA GPG)*

11.3.33. The IoA GPG presents the report of a 'noise working group' (NWG) assembled in response to a request from the former Department of Energy & Climate Change (DECC). The guide is intended to represent current good practice in applying the ETSU-R-97 method to assessing the noise impact of wind turbine developments with a power rating of over 50 kW.

11.3.34. In addition to detailed consideration of various issues and factors concerned with current 'state of the art' knowledge of UK wind turbine noise assessment, a series of 'summary boxes' (SBs) highlighting key guidance points are included.

11.3.35. The SBs provide clarification and updated guidance on a range of matters relating to ETSU R-97 noise assessments, including consultation with relevant stakeholders, background noise survey methodology, noise survey data analysis, derivation of noise limits, noise prediction model input data, algorithms and parameters, cumulative impact assessment procedures, assessment reporting, planning conditions and amplitude modulation. A set of supplementary guidance notes (SGNs) also form part of the publication and include further specific detail for different technical areas.

11.3.36. The detail of the IoA GPG has been considered in the preparation of this assessment. Some of the key considerations relevant to this assessment are summarised as follows:

11.3.37. Background noise surveys should be carried out for sufficient duration to obtain a suitably-sized dataset; as a guideline, it is suggested that no fewer than 200 data points be obtained within each of the night-time and amenity hour periods for a given survey location, with no fewer than five data points within each contiguous wind speed integer interval (for pitch regulated turbines), up to the wind speed at which the maximum sound power level is reached. Where the data has been filtered by wind direction the guideline values are reduced.

11.3.38. Background noise survey data should be analysed, and anomalous periods of noise removed from the dataset; anomalous noise might include rain-affected periods and increased noise from watercourses following rainfall, seasonal effects such as early-morning birdsong ('dawn chorus'), atypical traffic movements and other unusual noise sources affecting measured levels.

11.3.39. Due to the potential for non-standard site-specific wind shear (i.e. differences in wind speed at different heights above the ground – a 'standard' profile increases logarithmically with height) background noise levels should be correlated with 10 m height wind speeds derived using a method that 'standardises' the wind speeds using the assumed shear profile. Since wind turbine sound power levels are determined using the same shear profile, this procedure ensures a link between the predicted sound levels at a given hub height wind speed and the background noise levels at receptors near the ground under the same wind speed conditions (obtained using the 'standardised' 10 m height wind speed).

11.3.40. Derivation of the prevailing background noise levels should be carried out using polynomial regression analysis, of order one to four, depending on the nature of the noise environment. The regression curve used should reach minimum and maximum values at the lowest and highest wind speeds for which the dataset is valid, respectively.

11.3.41. Calculations of predicted wind turbine noise may be carried out using ISO 9613 2: Acoustics – Attenuation of Sound during Propagation Outdoors (International Organization for Standardization, 1996); preferred receptor heights, meteorological and ground absorption input parameters for this calculation procedure are given.

11.3.42. Turbine sound power level source data should include appropriate uncertainty corrections. Guidance is given for determining when such uncertainty corrections have been inherently included in turbine source emission data.

11.3.43. A correction for topographic screening of a maximum -2 dB may be applied where there is no line of sight between the turbine (tip) and the receptor (4 m above ground level).

11.3.44. A correction for constructive reflection within valleys of +3 dB should apply where concave topography is determined to lie between the turbine and the receptor point.

11.3.45. 'Excess amplitude modulation' (i.e. where the wind turbine noise has higher variability with momentary time than the 2 – 3 dB(A) considered within ETSU-R-97) is still the subject of research; current practice (at the time of publishing of the IoA GPG) in relation to determining applications for wind turbine developments is to not impose a planning condition specific to this phenomenon.

11.3.46. In addition to the above, the IoA GPG confirms that the ETSU-R-97 noise level limits should be applied cumulatively and provides guidance on appropriate assessment methods for a variety of different cumulative scenarios. These scenarios include 'concurrent applications', 'existing wind farm consented with less than total ETSU-R-97 limits', 'existing wind farm/s consented to the total ETSU-R-97 limits currently operating', and 'permitted wind farms consented to total ETSU-R-97 limits but not yet constructed'.

11.3.47. In the section titled 'existing wind farm/s, consented to the total ETSU-R-97 limits, currently operating' it is stated that "In the first instance, the consented noise limits should be used within the cumulative noise impact calculations unless otherwise agreed with the local authority. Provided the sum of the noise limits derived for the the site when added to those already consented for the operational sites does not exceed the limits that would otherwise be within the requirements of ETSU R-97 for the cumulative impact, then the noise limits derived for the the site can be applied directly".

11.3.48. In practical terms this can be achieved by ensuring that the noise limit for the Proposed Development is set 10 dB or more below that permitted to be generated by the existing development.

11.3.49. It is, however, then discussed that this may not always be necessary, e.g. where there is a 'controlling property', whereby compliance with the noise limit at that controlling property would result in noise levels never realising the noise level limit 'in full' at another property (e.g. because the second property is further removed from the existing development), thereby leaving a proportion of the limits available for use at the second property by the subsequently Proposed Development. Another reason that is discussed is where there is no realistic prospect of the existing wind farm producing noise levels up to the consented limit, again thereby leaving a proportion of the limit available for the subsequently Proposed Development.

11.3.50. The process provided in the IoA GPG for determining appropriate noise limits applicable at specific properties is summarised as follows:

- Identify cumulative developments, i.e. those from which the predicted level at properties within the study area are within 10 dB of the Proposed Development. Developments from which the predicted levels are 10 dB or greater different to that of the Proposed Development may be scoped out of further analysis;
- Determine the consented noise limits for other developments applicable at properties where cumulative effects may occur;
- Predict noise levels from cumulative developments and identify controlling properties (typically those closest to the specific wind farm/turbine without financial involvement; assuming compliance with noise limits at these properties will limit the maximum noise level possible at more distant properties); and
- Confirm that the predicted levels from cumulative developments do not exceed noise limits at controlling properties.

### *Design Manual for Roads and Bridges (DMRB) – Chapter LA111 Noise and Vibration*

11.3.51. DMRB provides standards and advice regarding the assessment, design and operation of roads in the UK. DMRB provides screening criteria, by which percentage changes in traffic flow can be related to a predicted change in road traffic noise and vibration. The guidance also provides significance criteria, by which the percentage of people adversely affected by traffic noise can be related to the total noise or vibration level due to road traffic, or the increase over an existing level.

11.3.52. DMRB provides a method for predicting the Basic Noise Level (BNL), a measure of the source noise level of a road. The BNL is a function of the composition, flow and speed of traffic and the quality of the road surface. Changes in the BNL, arising from changes in traffic flow, may be used as a means of determining the significance of operational noise effects.

11.3.53. The following scoping criteria are provided for the evaluation of operational noise from a road:

- Is the project likely to cause a change in the BNL of 1 dB $L_{A10,18hour}$ in the do-minimum opening year (DMOY) compared to the do-something opening year (DSOY)?
- Is the project likely to cause a change in the BNL of 3 dB $L_{A10,18hour}$ in the do-something future year (DSFY) compared to the DMOY?
- Does the project involve the construction of new road links within 600 m of noise sensitive receptors?
- Would there be a reasonable stakeholder expectation that an assessment would be undertaken?

11.3.54. Regarding a 'reasonable stakeholder expectation' for an operational noise assessment, DMRB notes an example where works involve changes to infrastructure but are not expected to give rise to significant environmental effect, such as smart motorway projects.

11.3.55. Where the response to any of the above scoping questions is 'yes' the scoping assessment shall make a recommendation on the scope of further assessment.

### *BS5228:2009+A1:2014 – Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1 (noise)*

11.3.56. Part 1 of BS5228 sets out techniques to predict the likely noise effects from construction works, based on detailed information on the type and number of plant items being used, their location and the length of time they are in operation.

11.3.57. The noise prediction methods can be used to establish likely noise levels in terms of the $L_{Aeq,T}$ over the core working day. This standard also documents a database of information, including previously measured sound pressure level data for a variety of different construction plant undertaking various common activities.

11.3.58. Three example methods are presented for determining the significance of construction noise impacts. In summary, these methods adopt either a series of fixed noise level limits, are concerned with ambient noise level changes as a result of the construction operations or a combination of the two.

11.3.59. One of the example methods for determining the significance of construction noise levels by considering the change in the ambient noise level that would arise as a result of the construction activities is the 'ABC method'. This method is shown in **Table 11.1.**

**Table 11.1 - Threshold of Potential Significant Effect at Dwellings (construction noise) – ABC Method**

| Assessment Category and Threshold Value Period | Threshold Value in Decibels (dB) ($L_{Aeq,T}$) | | |
|---|---|---|---|
| | Category (A) | Category (B) | Category (C) |
| Night-Time (23:00 – 07:00) | 45 | 50 | 55 |
| Evenings and Weekends (D) | 55 | 60 | 65 |
| Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00) | 65 | 70 | 75 |

*NOTE 1: A potential significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.*

*NOTE 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a potential significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.*

### *BS4142:2014+A1:2019 – Methods for Rating and Assessing Industrial and Commercial Sound*

11.3.60. BS4142 is applicable for use in the assessment of control building / substation and transformer noise. It sets out a method for rating and assessing sound of an industrial and/or commercial nature, including “sound from fixed installations which comprise mechanical and electrical plant and equipment”.

11.3.61. The assessment procedure contained within BS4142 requires that initially the ‘rating level’ ($L_{Ar,Tr}$) that is (or would be) generated by the source under assessment is determined, externally, at the assessment location. Where this source does not include any acoustic features, such as tonality, impulsivity or intermittency etc., then the rating level equals the specific sound level ($L_s$), which is the sound pressure level produced by the source using the $L_{Aeq,T}$ noise index. Where the source under assessment does include acoustic characteristics, then a series of corrections are added to the specific sound level to determine the rating level. The degree of correction applied to determine the rating level depends upon the results of either subjective or objective appraisals.

11.3.62. The background sound level at the assessment location, measured using the $L_{A90,T}$ index, is then subtracted from the rating level. The result provides an indication of the magnitude of impact, where the greater the difference, the greater the magnitude of impact.

11.3.63. The following guidance is presented regarding the difference between the rating and background levels:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

11.3.64. The degree of impact is also dependent upon the context in which the sound arises. Factors that are considered with respect to context include: the absolute level of sound, and the character and level of the residual sound (that in absence of the source under assessment) compared to the character and level of the specific sound.

11.3.65. With regard to the absolute level the guidance states, that "where background sound levels and rating levels are low, absolute levels might be as, or more relevant than the margin by which the rating level exceeds the background. This is especially true at night".

11.3.66. Earlier iterations of BS4142 have recommended that background noise levels of 30 $dBL_{A90}$ and below and rating levels of 35 $dBL_{Ar,Tr}$ and below may be considered objectively low.

## 11.4. Consultation

11.4.1. **Table 11.2** provides details of consultations undertaken with relevant regulatory bodies, together with action undertaken by the Applicant in response to consultation feedback.

**Table 11.2 - List of Consultee Responses**

| Consultee | Summary of Consultation | Applicant Response |
|---|---|---|
| THC | Meeting with THC EHO to discuss potential cumulative noise with Culachy WF and noise from the Beauly Denny line at property Ard-Aluin | Agreed the cumulative noise assessment methodology |

## 11.5. Assessment Methodology

### *study area*

11.5.1. The study area for this assessment is shown on **Figure 11.1** has been informed by maps and aerial images of the Proposed Development site and its surroundings, as well as site visits undertaken. A sample of the closest, and therefore potentially worst-affected, NSRs to the Proposed Development have been identified and adopted for the evaluation of noise impacts. These have been selected to represent a geographic spread across the local area. NSRs identified are either single dwellings or representative of a group or cluster of dwellings.

11.5.2. Determination of the study area for a wind farm typically requires that the 35 $dBL_{A90}$ noise contour is predicted.

11.5.3. The 35 $dBL_{A90}$ operational noise contour for the Proposed Development in isolation (i.e. without cumulative developments) at the wind speed at which the proposed turbines generate their maximum sound power level, is shown in **Figure 11.1**.

11.5.4. **Figure 11.1** shows that the area surrounding the Proposed Development is sparsely inhabited; there are no identified properties within the 35 dB contour and 22 NSRs substantially outside the 35 dB noise contour in the wider locality. The representative NSRs considered in the assessment are listed in **Table 11.3**. The representative NSRs were identified as properties at a similar distance from the proposed turbines as Ard-Aluin.

**Table 11.3 - List of Identified NSRs**

| NSR Name | NSR ID | Grid Reference (OSGB) | |
|---|---|---|---|
| | | X | Y |
| Owl Cottage | NSR1 | 234018 | 803135 |
| Calderburn Cottage | NSR2 | 234018 | 803135 |
| Aberchalder Farm | NSR3 | 234073 | 803313 |
| Aberchalder Lodge | NSR4 | 234225 | 803339 |
| Laraigan | NSR5 | 234236 | 803442 |
| Taigh an Lianach | NSR6 | 234146 | 803456 |
| Culachy Steading | NSR7 | 237670 | 806411 |
| Strathoich | NSR8 | 234527 | 803976 |
| Log Cabin, Old Aberchalder Station | NSR9 | 234445 | 804012 |
| Railway Cottage | NSR10 | 234667 | 804012 |
| Lundie View Guest House | NSR11 | 234740 | 804028 |
| Old Aberchalder Station | NSR12 | 234433 | 804042 |
| Scotia Lodge | NSR13 | 234906 | 804557 |
| Forest Lodge | NSR14 | 234995 | 804636 |
| Calbarian | NSR15 | 235260 | 804753 |
| Thrush Cottage | NSR16 | 235288 | 804788 |
| Strongarbh | NSR17 | 235349 | 804875 |
| Netherwood House | NSR18 | 235404 | 804955 |
| Netherwood Cottage | NSR19 | 235385 | 804935 |
| Culachy House | NSR20 | 237672 | 806559 |
| Torrandorrach | NSR21 | 237649 | 806973 |
| Ard Aluinn | NSR22 | 237318 | 807112 |

### *Characterisation of Baseline Noise Environment*

11.5.5. As there are no identified properties within the 35 dB contour no baseline noise survey was required, agreed in consultation with THC.

11.5.6. The baseline noise environment has been characterised by a site visit and desk study. The noise environment close to the site is typical of a rural environment in which anthropogenic noise is a minor contributor, and noise from natural sources, including bird calls, watercourses, the wind and wind-blown vegetation are the primary control on baseline noise levels.

11.5.7. The noise environment in the vicinity of the NSRs is mixed, with anthropogenic noise from road traffic on the A82 and agricultural and forestry activities.

### *Construction Phase Noise – Derivation of Noise Limits*

11.5.8. Prediction and evaluation of construction and decommissioning phase noise has been scoped out of this assessment.

11.5.9. Construction noise limits have been derived from measured baseline noise levels, using criteria derived in accordance with the ABC method set out in BS5228. Following the ABC assessment method, the most stringent assessment criterion (Category A), applies during the daytime (07:00 to 19:00 weekdays and 07:00 to 13:00 Saturdays) where the prevailing ambient noise levels are below 65 $dBL_{Aeq,T}$.

### *Operational Phase Wind Turbine Noise*

#### *General Method of Prediction*

11.5.10. A detailed noise model has been prepared for the site and surrounding area, including the adopted NSRs. This model was prepared using the CadnaA® noise modelling software. The model was set to use the ISO 9613 prediction method, which includes prescribed methods for accounting for the effects of geometric divergence, ground absorption, and atmospheric absorption, in accordance with the requirements of ETSU-R-97 and the IoA GPG.

11.5.11. Whilst the IoA GPG presents methodologies for the determination of additional corrections to account for propagation directivity, which could be used for example to account for the effects of wind direction where a receptor is located between two developments, such corrections have not been included within this assessment. The predicted operational noise levels can therefore be considered worst-case in this regard.

11.5.12. The noise model was configured to ensure noise level predictions in compliance with the IoA GPG, including the following:

- Ground absorption: G=0.5;
- Receptor Height: 4 m;
- Uncertainty correction of +2dB was applied;
- A correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 dB was applied;
- Temperature: 10°C; and
- Humidity: 70%.

11.5.13. The requirement to apply valley corrections and topographic screening corrections was determined with reference to the IoA GPG. Valley corrections have been determined on a turbine-by-turbine basis for all identified NSRs using proprietary software within Geographic Information System (GIS) software. Where topographic screening is determined to be applicable, no valley correction is applied, since it is assumed that if the turbine is fully screened at the NSRs, then any concavity determined to lie between the turbine and the NSR will not result in constructive acoustic reflections.

11.5.14. This assessment has determined that no corrections for concavity will apply at any NSR for the Proposed Development. All turbines of the Proposed Development are entirely screened from line of sight at all receptors. However, in a conservative approach, the -2 dB correction for topographic screening has not been applied to predicted noise levels.

### *Approach to Cumulative Noise Impacts (noise from Beauly Denny transmission line)*

11.5.15. During consultation with THC it was identified that one of the NSRs, Ard-Aluin, currently experiences noise believed to emanate from some element of the Beauly Denny transmission line, which runs north to south through the Great Glen near Fort Augustus and concerns were raised with regard to cumulative noise due from this and the Proposed Development.

11.5.16. A number of assessments of noise from the Beauly Denny line were undertaken for Ard-Aluin during which noise measurements were conducted at the property.

11.5.17. It was agreed with THC in consultation correspondence that, should noise due to the Proposed Development be predicted to be at least 10 dB below the measured noise levels due to the Beauly Denny line at Ard-Aluin, then cumulative noise impacts would not occur.

### *Details of the Proposed Development*

11.5.18. The noise assessment is based on the Vestas V162 7.2 MW as candidate turbine. The source noise terms of the V162 have been provided by Vestas as octave band data, quoted as sound power levels over the operational range hub-height wind speed, standardised to 10 m. This may not be the final turbine chosen for the Proposed Development, but the Applicant will ensure any change in turbine meets the noise levels detailed within this assessment.

11.5.19. An appropriate uncertainty correction of +2 dB has been applied to the sound power levels in accordance with the requirements of the IoA GPG. The resultant A-weighted sound power levels for the V162 are provided in **Table 11.4**.

**Table 11.4 - Vestas V162 Reported Sound Power Levels**

| Wind Speed $ms^{-1}$ | Sound Power Level (including +2 dB uncertainty) Standardised to 10 m Height Wind Speed, dB(A) |
|---|---|
| 4 | 96.0 |
| 5 | 96.0 |
| 6 | 97.0 |
| 7 | 100 |
| 8 | 103.5 |
| 9 | 106.1 |
| 10 | 106.6 |
| 11 | 106.7 |
| 12 | 106.8 |

11.5.20. Octave band spectral data for the turbine is not available currently; however, octave band spectral data for the Vestas V 162 6MW at $7ms^{-1}$ wind speed is provided in **Table 11.5.**

Table 11.5 - Vestas V162 Octave Band Sound Power Levels

| Octave Band Centre Frequency Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| **Sound Power Level, dB** | 63.8 | 74.9 | 82.9 | 87.8 | 89.7 | 88.4 | 84.1 | 76.6 | 66.1 |

11.5.21. The proposed turbine layout is provided in **Figure 11.1**.

## *Assessment of Potential Effect Significance*

11.5.22. The impact magnitude and effect significance have been determined following the criteria described in the assessment of potential effect significance section below.

### *Receptor Sensitivity*

11.5.23. The guidance contained within TAN to PAN 1/2011 has been drawn upon in the generation of an appropriate set of significance criteria. The receptor sensitivity criteria for the construction, operational and decommissioning phases of the Proposed Development are considered to be the same. These are presented within **Table 11.6**.

Table 11.6 - Noise Receptor Sensitivity Criteria

| Receptor Sensitivity | Description | Examples |
|---|---|---|
| High | Receptors where people or operations are particularly susceptible to noise. | Residential, quiet outdoor recreational areas, schools and hospitals. |
| Medium | Receptors moderately sensitive to noise, where it may cause some distraction or disturbance. | Offices and restaurants. |
| Low | Receptors where distraction or disturbance from noise is minimal. | Buildings not occupied, factories and working environments with existing levels of noise. |

### *Impact Magnitude – Operational Wind Turbine Noise*

11.5.24. The impact magnitude of operational wind turbine noise has been determined solely by reference the proposed noise limits, as set out in **Paragraph 11.6.6**.

### *Impact Magnitude - Fixed (Non-turbine) Plant Noise*

11.5.25. For noise from any fixed (non-turbine) plant such as substations and battery energy storage, it is appropriate to determine significance criteria based on the guidance contained within BS 4142, i.e. by consideration of the difference between the rating level from the plant noise and the prevailing background sound level, but also with respect to context and the resulting sound levels in absolute terms.

11.5.26. The impact magnitudes associated with noise generated from fixed plant are presented in **Table 11.7**.

**Table 11.7 - Impact Magnitude for Fixed (non-turbine) Plant Noise**

| Difference between Rating Level ($L_{Ar,Tr}$) and Background Sound Level ($L_{A90}$) | BS4142 Guidance | Impact Magnitude |
|---|---|---|
| ≥+10 | Indication of significant adverse impact | High |
| +5 | Indication of adverse impact | Medium |
| 0 | Indication of low Impact | Low |
| -10 | - | Negligible |

*Where the rating level ($L_{Ar,Tr}$) is below 35 dB the impact magnitude is classified as 'Negligible' regardless of the relationship to the background noise level, in accordance with BS 4142.*

*+ indicates rating level above background noise level*

*- indicates rating level below background noise level*

### *Effect Significance – Operational Wind Turbine Noise*

11.5.27. The significance of operational wind turbine noise has been determined only with reference to the proposed ETSU-R-97 and THC Supplementary Guidance noise limits as follows:

- This assessment considers that compliance with the proposed noise limits at NSRs will demonstrate operational wind turbine noise is "not significant"; and
- This assessment considers that operational wind turbine noise levels above the proposed noise limits at NSRs will be "significant".

### *Effect Significance*

11.5.28. The effect significance for non-wind turbine noise has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in **Table 11.8**.

**Table 11.8 - Effect Significance Matrix**

| Impact Magnitude | Receptor Sensitivity | | |
|---|---|---|---|
| | High | Medium | Low |
| High | Major | Moderate | Minor |
| Medium | Moderate | Minor | Negligible |
| Low | Minor | Negligible | Negligible |
| Negligible | Negligible | Negligible | Negligible |

11.5.29. This assessment considers all identified NSRs to be of "high" sensitivity in accordance with **Table 11.6**, given that they are residential dwellings. This assessment considers that effects with a significance of "**moderate**" and "**major**" are significant and effects with a significance of "**negligible**" and "**minor**" are not significant.

*Requirements for Mitigation*

11.5.30. Consideration has been given to available mitigation measures to reduce adverse effects where relevant. Where mitigation measures are detailed, these are committed to by the Applicant and have been determined through professional judgement and the implementation of best practice.

*Assessment of Residual Effect Significance*

11.5.31. Residual effects have been assessed following the methodologies described above but taking into account the committed mitigation measures.

*Limitations to Assessment*

11.5.32. The assessment of operational impacts associated with the wind turbines has been undertaken adopting source noise levels for the candidate turbine model, which is the Vestas V162-7.2. Following completion of the tendering process, it is possible that the precise turbine make / model adopted and / or the operational mode will change from that adopted within the assessment. It should be noted, however, that the final turbine model chosen will be selected to ensure compliance with the derived noise level limits.

## 11.6. Baseline Conditions

### *Description of Baseline Noise Environment*

11.6.1. The baseline noise environment was dominated by the wind and wind-induced noise from vegetation. Traffic on the A82 was audible in the vicinity of the NSRs. Bird calls were also audible. In a rural environment such as this, background levels are assumed to be relatively low and are likely to be below 30 dB during the night-time period under calm weather conditions.

### *Adopted Noise Limits*

*Construction and Decommissioning Noise Limits*

11.6.2. As the baseline noise environment is rural it is reasonable to assume that the baseline ambient level is below 65 dB during the daytime period. The construction phase noise limit for weekday daytimes and Saturdays, in accordance with the ABC method provided in BS 5228, is therefore Category A; 65 dB $L_{Aeq,T}$.,

*Operational Noise Limits – Fixed Non-Turbine Plant*

11.6.3. Operational noise limits for fixed non-turbine plant, such as transformers, substations, and battery energy storage facility have been derived in accordance with BS 4142, with reference to the likely low background noise levels within the area.

11.6.4. It is assumed fixed non-turbine plant will operate at a constant level, therefore noise limits will be determined by the night-time background level, when noise from road traffic and other anthropogenic sources is at a minimum.

11.6.5. This assessment adopts the rating level noise limit of 35 dB at any identified NSR, given that the context of the site and nearby NSRs is that background levels are low.

*Operational Noise Limits – Wind Turbine Noise*

11.6.6. The assessment adopts the noise limits for wind turbine noise in THC's supplementary guidance for wind energy developments. The supplementary guidance states that:

- the overall fixed minimum daytime noise limit should be 35 $dBL_{A90,10min}$; and
- the overall fixed minimum night-time noise limit should be 38 $dBL_{A90,10min}$.

The operational noise limits in this assessment do not vary with wind speed or background noise levels and are 'flat', in accordance with the simplified ETSU method. This approach has been agreed with THC Environmental Health.

## 11.7. Standard Mitigation

### *Construction Phase*

11.7.1. Good practice measures, as set out in BS 5228, will be followed during construction to limit unnecessary noise. Specific measures to be adopted will be included within the Construction Environmental Management Plan.

### *Operational Phase*

#### *Candidate Turbine Source Noise Levels*

11.7.2. The sound power data provided for the Vestas V162-7.2 contains data for non-serrated and serrated blades. The serrated blade option has a slightly lower sound power level and is typically supplied as standard. The Applicant has confirmed that, if the Vestas turbine is confirmed as the chosen model for the Proposed Development, then the serrated blade turbine will be used. This assessment therefore uses the sound power level (SWL) of the serrated blade turbine.

#### *Fixed (Non-Turbine) Plant Noise*

11.7.3. Noise from non-turbine operational plant will comprise noise from the substation compound and battery energy storage facility. The items of plant and sound power levels are yet to be finalised, however, noise from any non-turbine plant will be attenuated by acoustic enclosure (if required), such that it meets the derived non-turbine noise limits.

## 11.8. Potential Effects

### *Operational Phase*

#### *Fixed (Non-Turbine) Plant Noise*

11.8.1. The Proposed Development will include a substation compound and battery energy storage facility which will generate noise, which may potentially be tonal in nature. No details are currently available on the source noise levels of plant from the compound, and it is therefore considered appropriate that suitable noise control limits be set to which any such ancillary plant items will be required to conform. The noise limits apply to the rating level, which includes any corrections for acoustic characteristics, such as tonality and intermittency, in accordance with the BS 4142 method.

11.8.2. This assessment adopts the rating level noise limit of 35 dB at any identified NSR. Provided that the noise limit is met by all non-turbine plant, including the substation, with reference to **Table 11.8** the impact magnitude will be low. At high sensitivity NSRs, the resultant effect significance will be minor and therefore not significant.

#### *Wind Turbine Noise*

11.8.3. Predicted noise levels due to operation of the Proposed Development turbines are provided in **Table 11.5**. **Table 11.9** across the range 4 m/s – 12 m/s.

**Table 11.9 - Predicted Noise Levels, $dBL_{A90,10min}$**

| NSR ID | Wind Speed, m/s | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | Predicted noise level, $dBL_{A90}$ | | | | | | | | |
| NSR1 | 12.5 | 12.6 | 13.6 | 16.9 | 20.1 | 22.7 | 23.2 | 23.2 | 23.1 |
| NSR2 | 12.5 | 12.6 | 13.6 | 16.9 | 20.1 | 22.7 | 23.2 | 23.2 | 23.1 |
| NSR3 | 12.3 | 12.4 | 13.4 | 16.7 | 19.9 | 22.5 | 23.0 | 23.1 | 23.0 |
| NSR4 | 12.6 | 12.7 | 13.7 | 17.0 | 20.2 | 22.8 | 23.3 | 23.4 | 23.3 |
| NSR5 | 12.5 | 12.6 | 13.6 | 16.9 | 20.1 | 22.7 | 23.2 | 23.2 | 23.1 |
| NSR6 | 12.2 | 12.4 | 13.3 | 16.6 | 19.9 | 22.5 | 23.0 | 23.0 | 22.9 |
| NSR7 | 9.2 | 9.3 | 10.3 | 13.6 | 16.8 | 19.4 | 19.9 | 19.9 | 19.8 |
| NSR8 | 12.1 | 12.2 | 13.2 | 16.5 | 19.7 | 22.3 | 22.8 | 22.8 | 22.7 |
| NSR9 | 11.8 | 12.0 | 12.9 | 16.2 | 19.5 | 22.1 | 22.6 | 22.6 | 22.5 |
| NSR10 | 12.3 | 12.4 | 13.4 | 16.7 | 19.9 | 22.5 | 23.0 | 23.0 | 22.9 |
| NSR11 | 12.4 | 12.5 | 13.5 | 16.8 | 20.0 | 22.6 | 23.1 | 23.1 | 23.0 |
| NSR12 | 11.8 | 11.9 | 12.9 | 16.2 | 19.4 | 22.0 | 22.5 | 22.5 | 22.4 |
| NSR13 | 11.5 | 11.6 | 12.6 | 15.9 | 19.1 | 21.7 | 22.2 | 22.3 | 22.2 |
| NSR14 | 11.5 | 11.6 | 12.6 | 15.9 | 19.1 | 21.7 | 22.2 | 22.3 | 22.1 |
| NSR15 | 11.6 | 11.7 | 12.7 | 16.0 | 19.2 | 21.8 | 22.3 | 22.4 | 22.2 |
| NSR16 | 11.6 | 11.7 | 12.7 | 16.0 | 19.2 | 21.8 | 22.3 | 22.3 | 22.2 |
| NSR17 | 11.4 | 11.6 | 12.6 | 15.9 | 19.1 | 21.7 | 22.2 | 22.2 | 22.1 |
| NSR18 | 11.3 | 11.5 | 12.4 | 15.7 | 18.9 | 21.5 | 22.0 | 22.1 | 22.0 |
| NSR19 | 11.4 | 11.5 | 12.5 | 15.8 | 19.0 | 21.6 | 22.1 | 22.1 | 22.0 |
| NSR20 | 8.8 | 8.9 | 9.9 | 13.2 | 16.4 | 19.0 | 19.5 | 19.6 | 19.4 |
| NSR21 | 7.9 | 8.0 | 9.0 | 12.3 | 15.5 | 18.1 | 18.6 | 18.7 | 18.5 |
| NSR22 | 7.6 | 7.7 | 8.7 | 12.0 | 15.2 | 17.8 | 18.3 | 18.4 | 18.2 |

### *Assessment of Wind Turbine Noise*

11.8.4. The predicted noise levels due to the Proposed Development turbines are evaluated against the applicable noise limits in **Table 11.10.**

Table 11.10 - Evaluation of compliance at NSRs

| NSR ID | Wind Speed, m/s | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | Comparison with noise limit (predicted level minus noise limit), dB | | | | | | | | |
| **Daytime** | | | | | | | | | |
| NSR1 | -22.5 | -22.4 | -21.4 | -18.1 | -14.9 | -12.3 | -11.8 | -11.8 | -11.9 |
| NSR2 | -22.5 | -22.4 | -21.4 | -18.1 | -14.9 | -12.3 | -11.8 | -11.8 | -11.9 |
| NSR3 | -22.7 | -22.6 | -21.6 | -18.3 | -15.1 | -12.5 | -12.0 | -11.9 | -12.0 |
| NSR4 | -22.4 | -22.3 | -21.3 | -18.0 | -14.8 | -12.2 | -11.7 | -11.6 | -11.7 |
| NSR5 | -22.5 | -22.4 | -21.4 | -18.1 | -14.9 | -12.3 | -11.8 | -11.8 | -11.9 |
| NSR6 | -22.8 | -22.6 | -21.7 | -18.4 | -15.1 | -12.5 | -12.0 | -12.0 | -12.1 |
| NSR7 | -25.8 | -25.7 | -24.7 | -21.4 | -18.2 | -15.6 | -15.1 | -15.1 | -15.2 |
| NSR8 | -22.9 | -22.8 | -21.8 | -18.5 | -15.3 | -12.7 | -12.2 | -12.2 | -12.3 |
| NSR9 | -23.2 | -23.0 | -22.1 | -18.8 | -15.5 | -12.9 | -12.4 | -12.4 | -12.5 |
| NSR10 | -22.7 | -22.6 | -21.6 | -18.3 | -15.1 | -12.5 | -12.0 | -12.0 | -12.1 |
| NSR11 | -22.6 | -22.5 | -21.5 | -18.2 | -15.0 | -12.4 | -11.9 | -11.9 | -12.0 |
| NSR12 | -23.2 | -23.1 | -22.1 | -18.8 | -15.6 | -13.0 | -12.5 | -12.5 | -12.6 |
| NSR13 | -23.5 | -23.4 | -22.4 | -19.1 | -15.9 | -13.3 | -12.8 | -12.7 | -12.8 |
| NSR14 | -23.5 | -23.4 | -22.4 | -19.1 | -15.9 | -13.3 | -12.8 | -12.7 | -12.9 |
| NSR15 | -23.4 | -23.3 | -22.3 | -19.0 | -15.8 | -13.2 | -12.7 | -12.6 | -12.8 |
| NSR16 | -23.4 | -23.3 | -22.3 | -19.0 | -15.8 | -13.2 | -12.7 | -12.7 | -12.8 |
| NSR17 | -23.6 | -23.4 | -22.4 | -19.1 | -15.9 | -13.3 | -12.8 | -12.8 | -12.9 |
| NSR18 | -23.7 | -23.5 | -22.6 | -19.3 | -16.1 | -13.5 | -13.0 | -12.9 | -13.0 |
| NSR19 | -23.6 | -23.5 | -22.5 | -19.2 | -16.0 | -13.4 | -12.9 | -12.9 | -13.0 |
| NSR20 | -26.2 | -26.1 | -25.1 | -21.8 | -18.6 | -16.0 | -15.5 | -15.4 | -15.6 |
| NSR21 | -27.1 | -27.0 | -26.0 | -22.7 | -19.5 | -16.9 | -16.4 | -16.3 | -16.5 |
| NSR22 | -27.4 | -27.3 | -26.3 | -23.0 | -19.8 | -17.2 | -16.7 | -16.6 | -16.8 |
| **Night-time** | | | | | | | | | |
| NSR1 | -25.5 | -25.4 | -24.4 | -21.1 | -17.9 | -15.3 | -14.8 | -14.8 | -14.9 |

| NSR ID | Wind Speed, m/s | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | Comparison with noise limit (predicted level minus noise limit), dB | | | | | | | | |
| NSR2 | -25.5 | -25.4 | -24.4 | -21.1 | -17.9 | -15.3 | -14.8 | -14.8 | -14.9 |
| NSR3 | -25.7 | -25.6 | -24.6 | -21.3 | -18.1 | -15.5 | -15.0 | -14.9 | -15.0 |
| NSR4 | -25.4 | -25.3 | -24.3 | -21.0 | -17.8 | -15.2 | -14.7 | -14.6 | -14.7 |
| NSR5 | -25.5 | -25.4 | -24.4 | -21.1 | -17.9 | -15.3 | -14.8 | -14.8 | -14.9 |
| NSR6 | -25.8 | -25.6 | -24.7 | -21.4 | -18.1 | -15.5 | -15.0 | -15.0 | -15.1 |
| NSR7 | -28.8 | -28.7 | -27.7 | -24.4 | -21.2 | -18.6 | -18.1 | -18.1 | -18.2 |
| NSR8 | -25.9 | -25.8 | -24.8 | -21.5 | -18.3 | -15.7 | -15.2 | -15.2 | -15.3 |
| NSR9 | -26.2 | -26.0 | -25.1 | -21.8 | -18.5 | -15.9 | -15.4 | -15.4 | -15.5 |
| NSR10 | -25.7 | -25.6 | -24.6 | -21.3 | -18.1 | -15.5 | -15.0 | -15.0 | -15.1 |
| NSR11 | -25.6 | -25.5 | -24.5 | -21.2 | -18.0 | -15.4 | -14.9 | -14.9 | -15.0 |
| NSR12 | -26.2 | -26.1 | -25.1 | -21.8 | -18.6 | -16.0 | -15.5 | -15.5 | -15.6 |
| NSR13 | -26.5 | -26.4 | -25.4 | -22.1 | -18.9 | -16.3 | -15.8 | -15.7 | -15.8 |
| NSR14 | -26.5 | -26.4 | -25.4 | -22.1 | -18.9 | -16.3 | -15.8 | -15.7 | -15.9 |
| NSR15 | -26.4 | -26.3 | -25.3 | -22.0 | -18.8 | -16.2 | -15.7 | -15.6 | -15.8 |
| NSR16 | -26.4 | -26.3 | -25.3 | -22.0 | -18.8 | -16.2 | -15.7 | -15.7 | -15.8 |
| NSR17 | -26.6 | -26.4 | -25.4 | -22.1 | -18.9 | -16.3 | -15.8 | -15.8 | -15.9 |
| NSR18 | -26.7 | -26.5 | -25.6 | -22.3 | -19.1 | -16.5 | -16.0 | -15.9 | -16.0 |
| NSR19 | -26.6 | -26.5 | -25.5 | -22.2 | -19.0 | -16.4 | -15.9 | -15.9 | -16.0 |
| NSR20 | -29.2 | -29.1 | -28.1 | -24.8 | -21.6 | -19.0 | -18.5 | -18.4 | -18.6 |
| NSR21 | -30.1 | -30.0 | -29.0 | -25.7 | -22.5 | -19.9 | -19.4 | -19.3 | -19.5 |
| NSR22 | -30.4 | -30.3 | -29.3 | -26.0 | -22.8 | -20.2 | -19.7 | -19.6 | -19.8 |

11.8.5. Predicted noise levels are more than 10dB below the derived noise limits at all NSRs, for all wind speeds, both during the daytime and the night time period. The lowest margins of compliance occur at 10 m/s.

### *Summary of Significance*

11.8.6. At all NSRs predicted noise levels meet the derived noise limits at all wind speeds, both during the daytime and the night-time period by a margin of at least 11.6 dB. With reference to

**Paragraph 11.5.27** the impact magnitude is negligible, therefore with reference to **Paragraph 11.5.24** the effect significance is negligible and is therefore **not significant**.

## 11.9. Cumulative Effects with other Wind Developments

11.9.1. Predicted noise levels due to the Proposed Development are, at all wind speeds and at all receptors, more than 10 dB below the noise limits and could not, therefore, contribute to any potential breach of the noise limits (when noise levels from more than one source differ by 10 dB or more, the lower noise level cannot, mathematically, contribute to any increase). The Proposed Development will not have any cumulative noise effects with other developments.

## 11.10. Cumulative Effects with Beauly Denny line at Ard-Aluin

11.10.1. The noise experienced at Ard-Aluin due to the Beauly Denny line is a particularly tonal noise, generally within the 500 and 630 Hz third octave bands. A report and investigation undertaken by Wood Group (ref 6.17.10073.GLA.R.001, 2017), on behalf of Scottish and Southern Electricity Networks (the operators of the Beauly Denny transmission line) gave details of the noise level experienced externally to the Ard Aluin property with a noise level of 35-36 dB at 550 Hz and 512 Hz.

11.10.2. The predicted third octave band noise levels at Ard-Aluin (NSR22) due to the Proposed Development are 11.5 dB and 7.6 dB at 500 Hz and 630 Hz.

11.10.3. Predicted noise due to the Proposed Development is more than 10 dB below the measured noise due to the Beauly Denny transmission line. In accordance with the consultation detailed within **Section 11.5**, THC have agreed that cumulative impacts will not occur.

## 11.11. Summary

11.11.1. This chapter has considered potential noise effects associated with construction and operation of the Proposed Development.

11.11.2. The assessment of noise comprised consultation with THC, qualitative characterisation of the baseline noise environment, assessment of construction traffic noise effects, prediction of noise levels associated with construction activities, operational wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

11.11.3. Baseline noise levels in the study area are typically dominated noise from natural sources, including bird calls, the wind, wind-blown vegetation. Noise from anthropogenic sources, such as road traffic, is a minor contributor to total noise levels.

11.11.4. Noise limits have been derived for non-turbine fixed plant associated with operation of the Proposed Development. Items of fixed plant, including the BESS, will be specified such that they meet the derived noise limits at all representative NSRs. Noise effects from fixed plant are therefore not significant.

11.11.5. Predicted wind turbine noise levels associated with operation of the Proposed Development meet derived day and night-time noise limits at all the identified representative NSRs, for all wind speeds. Noise effects due to operation are therefore not significant.

11.11.6. Predicted wind turbine noise levels are more than 10 dB below the daytime and night-time noise limits at all receptors and, therefore, cumulative impacts with other wind developments will not occur.

11.11.7. Predicted wind turbine noise levels at Ard Aluinn are predicted to be more than 10 dB below noise levels from the Beauly Denny line in the octave bands of interest and, therefore, cumulative impacts will not occur.

**Table 10.11 - Summary of Effects**

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/Adverse | | Significance | Beneficial/Adverse |
| Construction, Operation and Decommissioning | | | | | |
| Noise and Vibration effects | No effect | N/A | None Required | No Effect | N/A |

**Table 10.12: Summary of Cumulative Effects**

| Receptor | Effect | Cumulative Developments | Significance of Cumulative Effect | |
|---|---|---|---|---|
| | | | Significance | Magnitude |
| Noise and Vibration effects | No effect | Other wind farm developments | No Effect | N/A |
| Noise and Vibration effects | No effect | The Beauly Denny Line | No Effect | N/A |

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