CONTENTS

INTRODUCTION

13.1 This Chapter considers the noise effects arising from the Proposed Development during the operational phase of the project.

13.2 The assessment of operational and cumulative noise has been undertaken in accordance with the Energy Technology Support Unit (ETSU) report, 'The Assessment and Rating of Noise from Wind Farms' (The Working Group on Noise from Wind Farms, 1996). The ETSU report (ETSU-R-97) provides guidance on noise limits for wind turbine developments which are considered to *"offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development"*. Current best practice on the application of ETSU-R-97 has been taken from the Institute of Acoustics document 'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise' (IOA GPG).

13.3 Planning policies of relevance to this assessment are provided in **Technical Appendix 4.1: Legislation, Planning Policy and Guidance**.

SCOPE AND CONSULTATION

Consultation

13.4 The formal scoping process is described in **Chapter 6: Scoping and Consultation** of this EIA Report and **Table 13-1** summarises the scoping response received from THC with respect to the noise assessment. Consultation was carried out with the Highland Council (THC) in September 2022 and March 2023.

Table 13-1: Key Issues Raised During Scoping and Consultation

Consultee	Summary of Key Issues	Where Addressed in Chapter
THC (Environmental Health)	The assessment of cumulative noise will need to use either consented limits or predicted levels with a 2 dB margin for neighbouring wind farms.	**Paragraphs 13.38** to **13.42**
	Sufficient baseline noise data is available to define the existing background noise level in the area around the Proposed Development. It is not practicable to obtain clean background data that does not contain wind turbine noise.	**Paragraph 13.54**
	There is no objection to a daytime cumulative noise limit at the greater of 38 dB, or 5 dB above background; provided that supporting information relating to the ETSU-R-97 criteria is detailed.	**Paragraph 13.22**
	The cumulative daytime and night-time noise limit at any financially involved property should be based on the higher of 45 dB L_{A90} and 5 dB above the prevailing background for the corresponding assessment period.	**Paragraph 13.24**
	The night-time noise limit at all noise sensitive receptors, with the exception of any that are financially involved, should be based on the higher of 38 dB L_{A90} or 5 dB above background noise.	**Paragraph 13.23**

Consultee	Summary of Key Issues	Where Addressed in Chapter
	The noise assessment is to include predicted noise levels from the Proposed Development at each relevant noise sensitive receptor at wind speeds up to 12 m/s.	**Table 13-9** and **Table 13-10**
	Background noise levels at the assessment locations are to be provided.	**Table 13-4** and **Table** 13-5
	The noise assessment is to include the consented limits from other existing or consented wind farms at each Noise Sensitive Receptor (NSR). If any reduction is made for controlling property or another reason, this should be made clear. There is no scope to allow for an increase in any consented limits at existing or consented wind farms.	**Technical Appendix 13.2: Noise Limits for Cumulative Wind Farms, paragraphs 13.40** to **13.42**
	A mitigation scheme is to be provided that could be implemented should noise levels from the development be subsequently found to exceed the consented limits.	**Paragraphs 13.70** to **13.73** and **Table 13-11**
	If noisy construction work is planned outside the hours of 8am to 7pm Monday to Friday and 8am to 1pm Saturday, a construction noise assessment is required.	**Paragraph 13.6**
	Regardless of whether a construction noise assessment is required, it is expected that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. Attention should be given to construction traffic and the use of tonal reversing alarms.	**Paragraph 13.62**

Effects Scoped Out

13.5 The following effects were scoped out of the assessment during the scoping stage:

- low frequency and infrasound, as there is no evidence of health effects as a result of these from wind turbines;
- amplitude modulation, including 'excess amplitude modulation' and 'other amplitude modulation', in line with the IOA GPG and THC guidance, is not something that can be adequately assessed at the planning stage;
- noise associated with traffic during the operation of the Proposed Development, as this is likely to be low and not significant in the context of the existing road network; and
- vibration effects as a result of construction and operational activities and associated traffic, considering the distances to the closest NSRs.

13.6 In addition to the above, a detailed construction noise assessment has been scoped out during consultation with THC. This is justified as the majority of construction activity would typically take place at large distances from the closest receptors and would not be outside the hours of 8am to 7pm Monday to Friday and 8am to 1pm Saturdays.

13.7 A brief overview of recently published studies into low frequency noise, infrasound and amplitude modulation is provided as **Technical Appendix 13.1: Amplitude Modulation, Low Frequency Noise and Tonal Noise**.

APPROACH AND METHODS

Study Area

13.8 The study area for the operational noise assessment has been determined in accordance with the methodology in **paragraph 13.29**. The study area comprises the area where noise levels from the Proposed Development are predicted to be within 10 dB of those from other relevant wind energy developments, and the predicted cumulative wind farm noise level is greater than 35 dB L_{A90}. This aligns with current best practice as set out in the IOA GPG. The reason that two noise levels with a difference of 10 dB or greater need not be considered is that when they are added together the total noise level will equal that of the higher value.

13.9 Noise-Sensitive Receptors (NSRs) are properties which are potentially sensitive to noise and, as such, require protection from nearby noise sources.

13.10 The NSRs identified within the study area for this assessment are all residential properties and noise levels are predicted to a location representative of each outdoor amenity area rather than the façade of the property. This is in line with the IOA GPG which states (at **paragraph 4.3.8**) that *"calculations should be made at points representative of the relevant outdoor amenity area (as defined in ETSU-R-97) at locations nearest to the proposed wind farm development"*.

13.11 Note that in the above, and subsequently in this assessment, the term 'noise emission' relates to the sound power level of a wind turbine, whereas the term 'noise immission' relates to the sound pressure level experienced at a receptor location.

13.12 **Table 13-2** details the identified NSRs within the study area for the assessment of operational and cumulative noise, the horizontal straight-line distance to the nearest turbine within the Proposed Development rounded down to the nearest 5m and its general direction. **Figure 13.1** shows the location of each NSR in relation to the proposed and cumulative developments, together with the study area, as formed by the criteria discussed in **paragraph 13.8**.

13.13 It is not always appropriate to assess impacts at all nearby NSRs, as a worst-case can be presented with a selection of NSRs. Where multiple NSRs are in the same general direction from the Proposed Development, it may be appropriate to present results for just one of these which represents the worst-case for all.

Table 13-2: Noise-Sensitive Receptors

NSR ID	NSR Name	Distance to Closest Turbine (m) (Turbine ID)	Direction from Closest Turbine	OS Grid Coordinates	
				OS Easting	OS Northing
NSR1	9 Balmeanach	2190 (T8)	South	133132	843734
NSR2	Allt Ruairidh	2520 (T8)	South	132485	843549
NSR3	23 Upper Edinbane	3205 (T1)	North	135080	850681

Information and Data Sources

13.14 The following documents have been used to inform the operational noise propagation calculations for the Proposed Development:

- Nordex Energy SE & Co, Noise Level Power Curves and Thrust Curve Data F008_272_A13_EN Revision 05, 13 January 2022, N133 / 4.8 MW overall noise level Mode 0 with serrated trailing edge (STE); and
- Nordex Energy SE & Co, Octave Sound Power Level Data F008_272_A14_EN Revision 05, 13 January 2022, N133 / 4.8 MW octave sound power level with STE Mode 0.

13.15 In addition, the following documents have been used to inform the cumulative operational noise impacts:

- TNEI Group, Operational Noise Report Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions 14299-006, dated 30 October 2020. Accompanying planning application reference 20/04369/S42 (Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions);
- The Highland Council, Planning Consent for Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions 20/04369/S42, 15 February 2023, Planning Condition 14;
- The Highland Council, Planning Consent for Ben Sca Wind Farm Extension 21/05767/FUL, 07 April 2023, Planning Condition 25;
- The Highland Council, Planning Consent for Glen Ullinish Wind Farm 20/01129/S42, 21 December 2021, Planning Condition 21;
- Nordex Energy SE & Co, Noise Level Power Curves and Thrust Curve Data F008_272_A13_EN Revision 05, 13 January 2022, N133 / 4.8 MW overall noise level Mode 0 without STE; and
- Nordex Energy SE & Co, Octave Sound Power Level Data F008_272_A14_EN Revision 05, 13 January 2022, N133 / 4.8 MW octave sound power level without STE Mode 0;
- Enercon, Sound Power Level E-70 E4 2.3 MW, 17 February 2006, E-70 Operational Mode II 64m hub height; and
- Enercon, Data Sheet E-115 EP3 E3 / 4000 kW with TES (Trailing Edge Serrations) Operating Mode 0, D0744492-0/DA, 01 September 2018, Mode 0 with TES;

Assessment Methods

Operational Noise Limits

13.16 It is set out in ETSU-R-97 and subsequently in the IOA GPG, that noise limits for wind turbines should be set relative to existing background noise levels at the nearest properties and that these limits should reflect the variation in both turbine source noise and background noise with wind speed. The wind speed range which should be considered is that of the operation of the turbines, typically between the cut-in speed and 12m/s. It should be noted that within this assessment, unless specified otherwise, all references to wind speeds are to a standardised 10m height, derived in accordance with Section 2.6 of the IOA GPG and its Supplementary Guidance Note (SGN) 4: Wind

Shear. Whilst the assessment should cover this range of wind speeds, often modern pitch-regulated wind turbines reach maximum sound power levels at a wind speed less than 12m/s. Therefore, the IOA GPG recommends that the baseline noise survey data is captured during a range of wind speeds from the cut-in speed and the wind speed corresponding to the turbine's maximum sound power level, and for the Proposed Development this is 7m/s.

13.17 Separate noise limits apply for the daytime and night-time, chosen to protect a property's external amenity and to prevent sleep disturbance indoors, respectively. Noise limits comprise two elements:

- a lower fixed value; and
- a derived relative value equal to the prevailing background curve plus 5 dB(A).

13.18 The noise limit will be equal to the greater of these two elements. The assessment needs to consider the combined operational noise of the Proposed Development with the other wind farms in the area to ensure that the combined cumulative noise levels are within the relevant ETSU-R-97 criterion.

13.19 The prevailing background curve is derived from noise data, using the $L_{A90,\ 10min}$ parameter, measured at a representative location of a receptor and wind data measured at a location that is representative of the proposed wind turbines. Data measured during the ETSU-R-97 '*quiet periods of the day*' inform the daytime prevailing background curve. These quiet periods are: weekdays between 18:00 and 23:00, Saturdays between 13:00 and 23:00 and all day on Sundays (07:00 to 23:00). Data measured between 23:00 and 07:00 inform the night-time prevailing background curve.

13.20 The fixed lower value of the daytime noise limit is provided in ETSU-R-97 as a single value in the range between 35 dB L_{A90} and 40 dB L_{A90}. The exception to this is when a property is financially involved with the project and in such cases the appropriate fixed lower limit is 45 dB L_{A90} during the day and night-times. For non-financially involved properties, there are three factors that should be considered when determining an appropriate value for the lower fixed daytime noise limit:

- the number of noise-affected properties;
- the potential impact on the power output of the wind farm; and
- the likely duration and level of exposure.

13.21 As set out in **paragraph 13.18**, the noise limit applies to the combined cumulative noise levels from all wind farms within the study area. Therefore, when considering the above factors that influence the choice of the lower fixed daytime noise limit it must be done in the context of the cumulative case and not just the Proposed Development in isolation.

13.22 For this case, 38 dB L_{A90} is considered appropriate for the fixed lower value element of the daytime noise limit. The reasons for this are primarily based on the low number of properties affected by noise when compared to the power output of the wind turbines in the study area, including those within the Proposed Development. Furthermore, whilst the Proposed Development would introduce additional turbines to the area, they would remain within the cluster of turbines that is formed by Ben Aketil Wind Farm and Extension, Ben Sca Wind Farm and Extension and Edinbane Wind Farm and therefore would not influence the duration of exposure by introducing turbines in an opposing direction for any NSR. The total wind turbine noise currently permissible, when considering worst case calculation methods set out in **paragraph 13.29**, and maximum possible emission levels as set out in **paragraph 13.40** to **paragraph 13.42**, is approximately 38 dB L_{A90}. Therefore, by setting the fixed lower value to this level will ensure that the introduction of the

Proposed Development would not notably alter the total wind turbine noise level at the NSRs within the study area.

13.23 The fixed lower value of the night-time noise limit for non-financially involved properties is given in ETSU-R-97 as 43 dB L_{A90}; however, THC has confirmed that in accordance with The Highland Council Onshore Wind Energy Supplementary Guidance (OWESG) and the Scoping Opinion a value of 38 dB L_{A90} is to be used. Therefore, this assessment uses a value of 38 dB L_{A90} for the lower fixed value of the night-time noise limit.

13.24 ETSU-R-97 and OWESG allows for a higher fixed lower limit of 45 dB L_{A90} where it can be demonstrated that a property has a financial interest in the wind development. No properties that are financially involved with the Proposed Development, or any other neighbouring wind energy development, have been identified within the study area.

13.25 As set out above, the noise limit is also defined by the prevailing background noise level at an NSR as well as the fixed lower limit. ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise. The presence of many wind turbines in the study area that are not under the control of Applicant, make background noise measurements difficult.

13.26 Background noise monitoring was undertaken at two nearby locations in June 2002 as part of the noise assessment for Ben Aketil Wind Farm. In addition, background noise monitoring was also carried out at a further nearby location in May/ June 2013 as part of the noise assessment for the consented Glen Ullinish Wind Farm. These datasets were used in the noise assessment that accompanied the planning application for Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions. As noted in that noise assessment, the dataset collected in 2002 required correction to properly account for wind shear in accordance with Section 2.6 of the IOA GPG and SGN4. The data measured during 2013 directly accounted for wind shear, so no further corrections were necessary.

13.27 At the time when the original 2002 baseline noise survey was undertaken there were no other operational wind farms/ turbines which would have influenced measured background noise levels. During the 2013 survey directional filtering was undertaken to remove potential noise immissions from the Edinbane turbines (as is detailed in Section 8.5.3 of Glen Ullinish Environmental Statement) that were operating at the time of survey.

Operational Noise Model

13.28 The ISO 9613-2 model has been used to calculate the noise immission levels at the NSRs as advised in the IOA GPG. The model accounts for the attenuation due to geometric spreading, atmospheric absorption, and barrier and ground effects. All attenuation calculations have been made on an octave band basis and therefore account for the sound frequency characteristics of the turbines.

13.29 All noise level predictions have been undertaken using a receiver height of four metres above local ground level, mixed ground (G=0.5) and an air absorption based on a temperature of 10°C and 70% relative humidity. A receiver height of four metres will be typical of first floor windows and result in slightly higher predicted noise levels than if a 1.2 to 1.5 metre receiver height were chosen in the ISO 9613 algorithm. The attenuation due to terrain screening accounted for in the calculations has been limited to a maximum of 2 dB(A). In situations of propagation above concave ground, a correction of +3dB was added.

13.30 This method is consistent with the recommendations of the above-referenced IOA GPG which provides recommendations on the appropriate approach when predicting wind turbine noise levels. The IOA GPG also allows for directional effects to be taken into account within the noise modelling: under upwind propagation conditions between a given receiver and the wind farm the noise immission level at that receiver can be as much as 10 dB(A) to 15 dB(A) lower than the level predicted using the ISO 9613-2 model. However, predictions have been made assuming downwind propagation from every turbine to every receptor at the same time as a worst case.

13.31 The exact model of turbine to be used at the site will be the result of a future tendering process. The Nordex N133 4.8 MW turbine with serrated trailing edges has been identified as representative of those models likely to be installed on site and has therefore been selected as the candidate turbine for this assessment. The candidate turbine is a variable speed, pitch regulated machine with a rotor diameter of 133m and a hub height of 83.4m. Due to its variable speed operation the sound power output of the turbine varies considerably with wind speed, being quieter at the lower wind speeds when the blades are rotating more slowly.

13.32 In addition to this general low noise characteristic at lower wind speeds, the candidate turbine also incorporates noise control technology. This allows the sound power output of the turbine to be reduced across a range of operational wind speeds, albeit with some loss of electrical power generation, to enable the best compromise to be achieved in any given situation between emitted noise and electrical power generation. Noise control of the candidate turbine is provided in a number of noise control modes with various noise/power output combinations. Similar noise reduction management systems are also offered by other wind turbine manufacturers. These systems are generally similar in that they rely on the turbine's computer-based controller adjusting either the pitch of the blades or holding back the rotational speed of the blades to reduce emitted noise under selected wind conditions (direction, speed or some combination of the two). In this manner noise management only comes into play, and therefore potential power generation capacity is only lost, for those conditions under which it is required.

13.33 Nordex have supplied noise emission data for the N133 4.8 MW turbine which represent the values that the manufacturer specify will not be exceeded in practice. In the absence of specific information about uncertainty allowances in the data, a further correction factor of +2 dB was added to the specification data in line with advice in the IOA GPG. The sound power data has been made available for standardised wind speeds of 3 m/s to 12 m/s inclusive. In addition to the overall sound power data, typical sound power frequency distribution for the turbine has been specified, based on an energetic average of the available information at each octave band. The overall sound power and spectral data for the N133 4.8 MW turbine are presented in **Technical Appendix 13.3: Wind Turbine Data**.

13.34 Similarly, overall sound power and typical sound power frequency data for the turbines within neighbouring wind energy developments, detailed in **paragraph 13.36**, have been obtained from the respective noise assessments and are summarised in **Technical Appendix 13.3**. Each of these turbines includes an appropriate correction for uncertainty in line with the IOA GPG. In addition, an uplift was applied to the predicted immission levels which was appropriate for the wind farm under consideration, as detailed in **paragraph 13.40** to **paragraph 13.42**. All wind farm noise immission levels in this chapter are presented in terms of the L_{A90} noise indicator in accordance with the recommendations of the ETSU-R-97 report, obtained by subtracting 2 dB(A) from the calculated L_{Aeq} noise levels based on the turbine sound power levels presented in **Technical Appendix 13.3**.

Operational Impact Assessment

13.35 ETSU-R-97 states that the assessment should take account of the effect of noise from all existing consented or, in some cases, proposed wind turbines that may affect a particular NSR. A screening exercise was conducted to identify any wind turbines either operational, consented, or part of a current planning application, located within 5km of the proposed turbines.

13.36 The screening exercise identified the following cumulative developments for assessment, and agreed with the EHO:

- Ben Aketil Wind Farm (02/00275/FULS) and Extension (09/00115/FULS) (life extension 20/04369/S42) (operational);
- Ben Sca Wind Farm (20/00013/FUL) and Extension (21/05767/FUL) (consented);
- Edinbane Wind Farm (02/00089/FULS) (operational); and
- Glen Ullinish Wind Farm (latest variation 20/01129/S42) (consented).

13.37 It is noted that there are more wind energy schemes that are within 5km of the Proposed Development; however, they are not considered relevant to this assessment. The reasons being that they either do not produce a level of noise that is within 10 dB of the Proposed Development and therefore, sit outside the study area, as described in **paragraph 13.8**; or they were at the scoping stage at the time of writing and insufficient detail is available to assess.

13.38 As noted in the IOA GPG and OWESG, when assessing cumulative noise levels, consideration should be given to the noise limits applicable to each development, or an appropriate margin to be applied to predicted noise levels of the neighbouring developments.

13.39 Each cumulative development has been considered in isolation and a comparison was undertaken of their predicted immission levels against their consented noise limits. The apportionment options provided in the IOA GPG were then considered to determine the most appropriate method for each scheme, as discussed below. Site specific noise limits for the Proposed Development operating in isolation have been derived for each of the NSRs considered within **Table 13-2** by logarithmically subtracting the appropriate noise immission level for each cumulative development from the ETSU-R-97 noise limit.

13.40 For Ben Aketil and Ben Sca Wind Farms and their respective Extensions, it is assumed that they will be operating at their consented noise limit. The consented noise limits for these developments are equal to the predicted wind turbine noise immission level + 2 dB.

13.41 It is assumed that the noise assessment undertaken for the latest variation of Glen Ullinish Wind Farm for 11 Nordex N133 turbines was carried out against the simplified method described in ETSU-R-97 which uses a fixed limit of 35 dB L_{A90} at all wind speeds, as this was reflected in the planning consent. The noise assessment was not available to view on the planning portal, so predictions were carried out of the noise from Glen Ullinish Wind Farm as part of this assessment. Predicted noise levels by Bow Acoustics show that Glen Ullinish Wind Farm would be operating up to the consented limit of 35 dB L_{A90} at a controlling property NSR1 (9 Balmeanach) using the Nordex N133 machine. Therefore, as it would not be possible for this wind farm to produce a greater level of noise without exceeding the limit at NSR1, it is assumed that it would be operating at the predicted level without any further uplift.

13.42 Similarly, Edinbane Wind Farm does not have any information publicly available, as its application predates the digital planning portal. A copy of the Environmental Statement has been obtained which included a short section on noise. Noise immission levels were not predicted at the NSRs considered in this assessment for the Proposed Development and as such could not be used. Predictions have been made for this assessment using sound power data for the installed turbine, Enercon E70, plus an additional + 2 dB uplift.

13.43 Further information is provided in **Technical Appendix 13.2** regarding the consented noise limits for the above wind farms.

13.44 The *'Guidelines for Environmental Noise Impact Assessment',* produced by IEMA, addresses the key principles of noise impact assessment and are applicable to all development proposals where noise effects are likely to occur. The guidelines state that *"much noise measurement and quantification is concerned with the effect of noise which varies significantly with time".* The guidelines go on to state:

"Measuring in decibels means that a 3dB change is a doubling of the sound energy and a 10dB change is a tenfold increase. For sounds which are very similar in all but magnitude, a change or difference of 1dB is just perceptible under laboratory conditions, 3dB is perceptible under most normal conditions and a 10dB increase appears to be twice as loud."

13.45 The guidelines also provide specific support on how noise impact assessments fit within the EIA process. They cover:

- how to scope a noise assessment;
- issues to be considered when defining the background noise environment;
- prediction of changes in noise levels as a result of implementing development proposals; and
- definition and evaluation of the significance of the effects of changes in noise levels.

13.46 The key terms within this assessment, which are relevant to the EIA process, are 'sensitivity' and 'significance'. In accordance with the IEMA guidelines, the noise impact, the noise effect and the significance of the effect must be determined.

Sensitivity of Receptor

13.47 The significance of the noise effect would depend on the receptor type and its sensitivity to the noise impact. All identified NSRs within this assessment are residential properties; therefore, the sensitivity of these receptors is considered to be 'High'.

Statement of Significance

13.48 The assessment of the significance of effects from operational and cumulative wind turbine noise is made as follows, with reference to ETSU-R-97 and the IOA GPG:

- where operational and/or cumulative noise levels at receptors do not exceed the relevant ETSU-R-97 noise limits, this is determined to be 'not significant'; and
- where operational and/or cumulative noise levels at receptors are above the relevant ETSU-R-97 noise limits, this is determined to be 'significant'.

Cumulative Effects Assessment

13.49 Operational cumulative effects are considered as an inherent part of the assessment methodology detailed above. No specific additional cumulative assessment is required.

Assumptions, Limitations and Confidence

13.50 A number of good practice environmental measures are usually in-built into the design of a Proposed Development (i.e. embedded mitigation) as set out in **Chapter 2: Site Description and Design Evolution**, and these are assumed to be in place prior to any assessment of effects. In relation to operational noise, adverse operational and cumulative noise effects were intrinsic considerations in the design of the Proposed Development to avoid any long-term effects that could affect the planning consent of the Proposed Development and/or nearby noise-sensitive receptors. The Proposed Development has therefore been designed to ensure that effects from operational noise are not significant, mainly through siting of the turbines.

13.51 The assessment of operational noise has been based on available published data for the associated noise sources. The noise predictions in this assessment have been undertaken using the proprietary software-based noise model iNoise, which implements the full range of UK calculation methods including ISO 9613-2:1996 with the relevant terrain corrections as required by the IOA GPG and set out in **paragraph 13.29**.

13.52 With respect to the latter, the IOA GPG comments on several recent studies on noise propagation and states (at paragraph 4.1.4), *"the outcome of this research has demonstrated that the ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from onshore wind turbines during the worst-case propagation conditions"*. The ISO 9613-2:1996 prediction framework takes into account the distance between the sound sources and the closest receptors and the amount of attenuation due to atmospheric absorption. The methodology also assumes downwind propagation, i.e. a wind direction that assists the propagation of sound from the source to receiver.

BASELINE CONDITIONS

13.53 The proposed turbines would be situated on moorland approximately 3km to the south of Edinbane, and approximately 8km to the east of Dunvegan on the Isle of Skye. The site lies between the operational Ben Aketil and Edinbane Wind Farms. The consented Ben Sca Wind Farm and Extension would be located to the north west and Glen Ullinish Wind Farm located to the south. The baseline noise environment is typically low during night-time hours; however, noise levels may be influenced by the existing and operational wind farms under certain wind conditions.

13.54 The presence of various operational wind turbines in the area makes it difficult to measure prevailing background noise as this must be done in the absence of any wind turbine noise, or adequately accounted for to ensure it does not contribute to the measured total. Data presented in Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions application has been used as it summarises the prevailing background noise level in the area in the absence of wind turbine noise. Furthermore, all datasets were normalised to the common wind reference of standardised 10m using a reference ground roughness of 0.05m, in accordance with the latest requirements set out in the IOA GPG.

13.55 The Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions noise assessment used baseline noise survey data from three measurement locations, detailed in **Table 13-3** and illustrated on **Figure 13.1**. Originally data at Noise Measurement Location (NML) NML1 Black Hill and NML2 Upper Feorlig, measured for the first Ben Aketil Wind Farm application, were correlated against wind data measured directly at a height of 10m, which is no longer accepted as the preferred approach as it does not account for wind shear. To account for this, the Ben Aketil and Ben Aketil Extension Wind Farm Life Extensions assessment included a long-term windshear analysis which was applied to correct the windspeed reference at these two locations. Background noise data at the third location, NML3 Glen Vic Askill, was measured more recently for Glen Ullinish Wind Farm and are in line with Method B of Section 2.6.3 of the IOA GPG, which accounts for windshear. In addition, directional filtering was applied to remove any influence from the Edinbane wind turbines that were operational at the time of monitoring.

Table 13-3: Noise Measurement Locations

NML ID	NSR Name	OS Grid Coordinates		NSR Where Data is Used as a Proxy Location
		OS Easting	OS Northing	
NML1	Black Hill	134523	850415	NSR3 – 23 Upper Edinbane
NML2	Upper Feorlig	129913	844997	NSR1 – 9 Balmeanach & NSR2 – Allt Ruairidh
NML3	Glen Vic Askill	135977	844301	Not used

13.56 It is noted that NSR1 and NSR2 are situated between the two monitoring locations NML2 and NML3 with similar landscapes, such that the background noise climate may be described to be similar to either monitoring location. Therefore, a comparison of the quiet daytime and night-time background noise levels was made and NML2 was typically quieter at higher wind speeds, which provides a worst case for the noise limit.

13.57 A summary of the measured background noise levels used in the assessment for the Proposed Development at each of the NSRs are set out in **Table 13-4** for the quiet daytime and **Table 13-5** for the night-time periods.

Table 13-4: Summary of Prevailing Background Noise Levels during the Quiet Daytime

NSR ID	Prevailing Background Noise Level, dB L_{A90}, Standardised 10m Integer Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
NSR1	27	27	27	28	29	30	32	34	35
NSR2	27	27	27	28	29	30	32	34	35
NSR3	23	26	30	32	35	37	39	40	41

Table 13-5: Summary of Prevailing Background Noise Levels during the Night-time

NSR ID	Prevailing Background Noise Level, dB L_{A90}, Standardised 10m Integer Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
NSR1	29	29	29	29	29	30	31	33	35
NSR2	29	29	29	29	29	30	31	33	35
NSR3	25	27	28	30	32	34	36	38	41

13.58 The noise limits used in the assessment of the Proposed Development at the NSRs are set out in the **Table 13-6** for the quiet daytime and **Table 13-7** for the night-time periods. Note the fixed portion of the limit is set to 38 dB L_{A90} during the day and the night-time period and all windspeeds are standardised 10m values. This is discussed further in **paragraphs 13.22** and **13.23**.

Table 13-6: ETSU-R-97 Noise Limits during the Quiet Daytime

NSR ID	Noise Limit, dB L_{A90}, Standardised 10m Integer Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
NSR1	38	38	38	38	38	38	38	39	40
NSR2	38	38	38	38	38	38	38	39	40
NSR3	38	38	38	38	40	42	44	45	46

Table 13-7: ETSU-R-97 Noise Limits during the Night-time

NSR ID	Noise Limit, dB L_{A90}, Standardised 10m Integer Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
NSR1	38	38	38	38	38	38	38	38	40
NSR2	38	38	38	38	38	38	38	38	40
NSR3	38	38	38	38	38	39	41	43	46

FUTURE BASELINE

13.59 The future baseline noise environment may increase over time due to gradual increases in traffic on the local road network, as well as a result of committed and/or other Proposed Developments.

ASSESSMENT OF EFFECTS

Construction Effects

Potential Effects

13.60 As set out in **paragraph 13.6** an assessment of construction noise and vibration has been scoped out with THC. Notwithstanding this, THC have requested that the developer/contractor will employ the best practicable means to reduce the impact of noise from construction activities. Set out below are a series of best practices that can be applied during the construction phase. These measures are also included in the **Outline CEMP (Technical Appendix 3.1)**.

Mitigation

13.61 Several safeguards exist to control and minimise the effects of construction noise, and these would apply during the construction phase of the Proposed Development. These include:

- European Commission (EC) Directive to control noise emissions from construction plant;
- the guidance within BS5228-1:2009+A1:2014 on the control of noise from construction sites; and
- Section 60 of the Control of Pollution Act 1974, which gives local authorities the power to control noise from construction sites.

13.62 The adoption of Best Practicable Means is usually the most effective method of controlling noise from construction sites. The precise noise mitigation measures to control noise from construction activities, with respect to the Proposed Development, may require agreement with THC prior to the works starting. However, generic measures are provided below to illustrate the range of techniques available:

- all roads would be kept clean and maintained in a good state of repair to avoid unwanted rattle from vehicles;
- materials would be handled in a manner that minimises noise;
- all plant would have noise emission levels that comply with the limiting levels defined in EC Directive 2000/14/EC, and any subsequent amendments;
- consideration would be given to the recommendations set out in Annex B of BS5228-1:2009+A1:2014 with respect to noise sources, remedies and their effectiveness;
- plant would be operated in a proper manner with respect to minimising noise emissions, i.e. minimisation of drop heights, no unnecessary revving of engines, etc.;
- plant would be started up sequentially, rather than all at once;
- plant would be subject to regular maintenance and kept in good working order to meet manufacturers' noise rating levels;
- plant that is used intermittently would be shut down when not in use;
- vehicles would not wait or queue on the public highway with engines idling; and
- reversing alarms would incorporate one of the following features where practicable –

directional sounders, broadband signals, self-adjusting sounders or flashing warning lights. Alternative and comparable systems could be used to minimise noise and nuisance from reversing alarms.

Operational Effects

Potential Effects

13.63 The predicted noise immission levels (L_{A90}) at the identified receptors due to the cumulative operation of the Proposed Development together with the relevant other wind farms in the area, as listed in **paragraph 13.36**, are presented numerically in **Table 13-8**. These predicted immission levels include the additional uplifts detailed in **paragraph 13.40** to **paragraph 13.41**.

Table 13-8: Predicted Cumulative Operational Noise Levels, dB L_{A90}

NSR ID	NSR Name	Cumulative Operational Noise, dB L_{A90} Standardised 10m Integer Wind Speed, m/s								
		4	5	6	7	8	9	10	11	12
NSR1	9 Balmeanach	27	32	36	37	38	38	38	38	38
NSR2	Allt Ruairidh	24	29	34	35	35	36	36	36	36
NSR3	23 Upper Edinbane	25	29	34	36	37	38	38	38	38

13.64 It is shown that, for all receptors, cumulative noise levels due to the operation of the Proposed Development together with operational or consented wind farms within the area are predicted to be on or below the ETSU-R-97 noise limit during the daytime (**Table 13-6**) and night-time (**Table 13-7**) across all wind speeds.

13.65 **Technical Appendix 13.4: ETSU-R-97 Assessment Graphs** graphically show the wind turbine immission levels from the Proposed Development, each of the neighbouring wind farms including the uplift, the cumulative total and the ETSU-R-97 noise limit for each NSR during the daytime and night-time.

13.66 When considering the Proposed Development in isolation of the neighbouring wind farms, the IOA GPG advises that noise limits for the individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.

13.67 Therefore, to determine an appropriate site-specific noise limit for the Proposed Development in isolation, the total permissible noise from the operational and consented wind farms, in the absence of the Proposed Development, has been logarithmically subtracted from the total ETSU-R-97 noise limit. Where the total noise from other wind farms equals the ETSU-R-97 noise limit; a site-specific limit for the Proposed Development equal to 10 dB less than the ETSU-R-97 limit has been set.

13.68 **Table 13-9** and **Table 13-10** show the daytime and night-time site-specific noise limits, noise predictions for the Proposed Development and the exceedance level. A negative exceedance demonstrates compliance with the site-specific noise limits.

13.69 The Tables show that the predicted wind turbine noise immission levels for the Proposed Development meet the site-specific noise limits under all conditions and at all locations for both

daytime and night-time periods. **Technical Appendix 13.4** shows this information graphically.

Table 13-9: Site Specific Assessment Daytime, dB L_{A90}

NSR ID	Detail	Noise Level, dB L_{A90} Standardised 10m Integer Wind Speed, m/s								
		4	5	6	7	8	9	10	11	12
NSR1	Site specific noise limit	28	28	28	28	28	28	28	32	37
	Proposed Development immission	18	24	28	28	28	28	28	28	28
	Margin	-10	-4	0	0	0	0	0	-4	-9
NSR2	Site specific noise limit	35	35	35	35	35	35	35	36	39
	Proposed Development immission	17	22	27	27	27	27	27	27	27
	Margin	-18	-13	-8	-8	-8	-8	-8	-9	-12
NSR3	Site specific noise limit	34	34	34	34	37	40	42	44	45
	Proposed Development immission	16	22	26	27	27	27	27	27	27
	Margin	-18	-12	-8	-7	-10	-13	-15	-17	-18

Table 13-10: Site Specific Assessment Night-time, dB L_{A90}

NSR ID	Detail	Noise Level, dB L_{A90} Standardised 10m Integer Wind Speed, m/s								
		4	5	6	7	8	9	10	11	12
NSR1	Site specific noise limit	28	28	28	28	28	28	28	28	36
	Proposed Development immission	18	24	28	28	28	28	28	28	28
	Margin	-10	-4	0	0	0	0	0	0	-8
NSR2	Site specific noise limit	35	35	35	35	35	35	35	35	38
	Proposed Development immission	17	22	27	27	27	27	27	27	27
	Margin	-18	-13	-8	-8	-8	-8	-8	-8	-11
NSR3	Site specific noise limit	30	30	30	30	30	30	38	42	46
	Proposed Development immission	16	22	26	27	27	27	27	27	27
	Margin	-14	-8	-4	-3	-3	-3	-11	-15	-19

Mitigation

13.70 The scoping response requested that a mitigation scheme is to be provided that could be implemented should noise levels from the Proposed Development be subsequently found to exceed the consented limits. Set out below is an example mitigation scheme based on the candidate turbine. It should be noted that the candidate machine may not be available or the most

appropriate at the time of installation and that multiple noise reduced modes are available which could enable several different permutations to result in the same noise immission. Therefore, the mitigation scheme can only be an example to demonstrate that a reduction in noise is possible. Similar noise control modes are available for other wind turbines, as discussed in **paragraph 13.32**.

13.71 If required in practice, a mitigation scheme would be developed following the identification of the specific receptor, together with the wind speeds and directions at which the consented noise limits are exceeded. The smallest margin between the site-specific noise limit and the immission levels of the Proposed Development, provided in **Table 13-9** and **Table 13-10** is present at NSR1; therefore, the example mitigation scheme has been developed for this location.

13.72 Revised noise immission levels with the example mitigation in place have been calculated using the same parameters as described in **paragraph 13.28** to **paragraph 13.30**, including downwind propagation. In practice, operational constraint would only be required under downwind conditions.

13.73 The example mitigation scheme, set out in **Table 13-11**, has been determined for a wind speed of 6 m/s. The Nordex N133 4.8 MW turbine has a total of 13 noise reduced modes. Unconstrained operation is classified as 'Mode 0', the first noise reduced mode, 1, offers the least attenuation in noise and the final noise reduced mode, 13, provides the greatest attenuation.

Table 13-11: Example Mitigation Scheme

Turbine ID	Operational Mode
T1	Mode 0
T2	Mode 0
T3	Mode 0
T4	Mode 0
T5	Mode 2
T6	Mode 0
T7	Mode 0
T8	Mode 6
T9	Mode 6
T10	Mode 5

Residual Effects

13.74 The example operational mitigation scheme set out in **Table 13-11** reduces the noise immission from the Proposed Development to 26 dB at 6 m/s. This increases the margin set out in **Table 13-9** and **Table 13-10** to -2 dB during both the daytime and night-time periods for this wind speed.

13.75 Greater reductions are available through the use of more stringent noise reduced modes; however,

this would result in an immission level below the typical background noise and approximately 10 dB below the cumulative noise from all other turbines in the area. These factors mean that it would not be possible to accurately determine the Proposed Development immission level in isolation of all other sources of noise if compliance is to be demonstrated through measurement.

13.76 The residual noise immission from the Proposed Development would remain under the noise limit and therefore deemed not significant.

FURTHER SURVEY REQUIREMENTS AND MONITORING

13.77 Based on the conclusions of the assessment of operational noise associated with the Proposed Development, there are no requirements for future noise monitoring.

SUMMARY OF PREDICTED EFFECTS

13.78 This Chapter has assessed the potential noise effects from the operation of the Proposed Development.

13.79 Predicted noise immission levels, due to the operation of the Proposed Development, do not exceed the ETSU-R-97 criterion at any identified receptor, for any period of the day and across all assessed wind speeds. This assessment inherently takes account of other cumulative wind energy developments and separately considers the Proposed Development in isolation against site specific noise limits that would result in no cumulative excess.

13.80 As the wind turbine noise immission levels do not exceed the ESTU-R-97 criterion, the resultant effect would be not significant in accordance with **paragraph 13.48**.

CUMULATIVE EFFECTS ASSESSMENT

13.81 Operational cumulative noise effects have been considered as an inherent part of the assessment methodology detailed in this Chapter and have been found to be not significant.

STATEMENT OF SIGNIFICANCE

13.82 The effect of operational and cumulative noise is predicted to be not significant.

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