9 Noise

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9 Noise

9.1 Executive Summary

9.1.1 This chapter considers potential noise effects associated with construction and operation of the Proposed Development. No potential vibration effects have been identified and consideration of vibration has therefore been scoped out. Planning permission in perpetuity is sought for the Proposed Development, therefore no specific decommissioning phase is proposed. It is anticipated, however, that should decommissioning be required, that associated noise effects would be similar to, but lesser than, construction phase effects.

9.1.2 The assessment of noise comprised consultation with Orkney Islands Council (OIC) Environmental Health Department, characterisation of the baseline noise environment, prediction of noise levels associated with construction activities, construction traffic, operation of wind turbines and operation of other non-turbine fixed plant, and evaluation of predicted levels against derived criteria.

9.1.3 Noise effects from construction, including on-site activities and construction traffic, were found to be not significant. Noise effects from fixed non-turbine plant have been determined to be not significant.

9.1.4 The Applicant has committed to noise levels associated with operation of the Proposed Development meeting the development-specific noise limits to be agreed through the consenting process at all Noise Sensitive Receptors (NSRs). Where necessary, this may require a noise management plan to be put in place. Residual noise effects due to operation are therefore not significant.

9.2 Introduction

9.2.1 This chapter considers the potential noise effects of the Proposed Development on receptors sensitive to noise during the construction phase and the operational phase.

Scope of assessment

9.2.2 The scope of this assessment has comprised the following:

- scoping consultation with OIC Environmental Health Department;
- evaluation of noise effects associated with construction of the Proposed Development;
- evaluation of noise effects associated with operation of the Proposed Development in isolation;
- evaluation of noise effects associated with the operation of the Proposed Development cumulatively with other wind turbines in the study area;
- specification of appropriate mitigation, where necessary; and
- evaluation of residual effects.

9.2.3 Given the separation distances involved between sources and NSRs, vibration associated with construction and operation of the Proposed Development at the closest sensitive receptors will be negligible, therefore vibration has been scoped out of further assessment.

9.2.4 Traffic flows associated with the operational phase of the Proposed Development will be negligible (<1 vehicle movement per day), therefore operational road traffic noise has been scoped out of further assessment.

9.3 Legislation, Policy and Guidelines

9.3.1 Details of relevant legislation, policy and guidelines that have been taken into consideration during the assessment are provided below.

Legislation

9.3.2 The control of noise, such that it does not give rise to nuisance, is required under the Control of Pollution Act, 1974. 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.

9.3.3 In lieu of any specific legislation, assessing the effect of such a development during the construction, operational and decommissioning phases must draw on information from a variety of sources. Therefore, this assessment makes reference to a number of British Standards, official planning policy and advice notes and national guidance.

Planning Policy

Scottish Planning Policy

9.3.4 The latest Scottish Planning Policy (Scottish Government, 2014a) details policies relating to renewable energy. The SPP recognises the need to facilitate the transition to a low carbon economy and supports the development of a diverse range of electricity generation from renewable energy sources, noting:

"*Development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets, giving due regard to relevant environmental, community and cumulative impact considerations.*"

9.3.5 The SPP provides guidance on where wind farms will and will not be acceptable, according to a spatial framework as follows:

- Group 1 – Areas where wind farms will not be acceptable, comprising National Parks and National Scenic Areas;
- Group 2 – Areas of significant protection where wind farms may be appropriate in some circumstances, with consideration required to demonstrate that any significant effects on the qualities of these areas can be substantially overcome by siting, design or other mitigation; and
- Group 3 – Areas with potential for wind farm development, where wind farms are likely to be acceptable, subject to detailed consideration against identified policy criteria, which may include noise.

Planning Advice Note 1/2011 Planning and Noise

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

9.3.7 With regard to 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."

9.3.8 With regard to appropriate assessment methods, the 'web-based planning advice' referred to in PAN 1/2011 is contained in an online document entitled '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 assessment guidance (discussed in paragraphs 9.3.16 to 9.3.29 below).

9.3.9 The accompanying TAN to PAN 1/2011 also refers to ETSU-R-97, including a summary of the associated assessment approach (Scottish Government, 2011b). The TAN points out that the ETSU-R-97 report presents a consensus view of a group of experts, who between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.

9.3.10 With regards to the assessment and control of noise from construction sites the use of BS 5228: 2009 (Parts 1 and 2) is discussed. BS 5228 has been superseded by BS 5228 1:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites. Noise. The standard is summarised in paragraphs 9.3.51 to 9.3.57.

9.3.11 Of relevance to the assessment of development generated road traffic noise, it is stated that a change of 3 dB(A) is the minimum perceptible under normal conditions, and that a change of 10 dB(A) corresponds roughly to a halving or doubling of the perceived loudness of a sound.

9.3.12 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. The standard is summarised in paragraphs 9.3.41 to 9.3.47.

9.3.13 In summary, national planning policy on assessment of operational noise impacts from wind farms stipulates the use of the ETSU-R-97 assessment method and application of the Institute of Acoustics' Good Practice Guide (IoA GPG), whilst construction noise and vibration should be assessed with reference to BS 5228. These guidance documents, and others relevant to the assessment of possible noise and vibration impacts generated by the Proposed Development, are summarised below.

Regional & Local Planning Policy

9.3.14 Local planning policy is discussed in Chapter 5 of this EIA Report.

Guidance

9.3.15 Cognisance has been taken of the following guidance and best practice guidelines.

ETSU-R-97: The Assessment and Rating of Noise from Windfarms

9.3.16 As referenced for use in PAN 1/2011 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).

9.3.17 ETSU 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.

9.3.18 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 to 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.

9.3.19 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, as well as 13:00 to 18:00 hours on Saturdays and Sundays, and 07:00 to 13:00 hours on Sundays.

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

- The number of dwellings in the neighbourhood of the wind farm;
- The effect of noise limits on the kilowatt hours (kWh) generated; and
- The duration and level of exposure (to noise).

9.3.21 No specific criteria are provided in ETSU for the evaluation of the above factors, however, and the Applicant is required to justify the application of the lower noise limit based on these factors.

9.3.22 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.

9.3.23 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}.

9.3.24 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).

9.3.25 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 windfarm*". 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.

9.3.26 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 less than the $L_{Aeq,T}$ measured over the same period.

9.3.27 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.

9.3.28 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 turbine manufacturers.

9.3.29 It is stated within this document 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 windfarm 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 windfarm 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

9.3.30 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.

9.3.31 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.

9.3.32 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.

9.3.33 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:

- 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. Where the data have been filtered by wind direction the guideline values are reduced.
- 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 water courses following rainfall, seasonal effects such as early-morning birdsong ('dawn chorus'), atypical traffic movements and other unusual noise sources affecting measured levels.
- 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).
- 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.

- 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.
- 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.
- 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).
- 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.
- 'Excess amplitude modulation' (i.e. where the wind turbine noise has higher variability with momentary time than the 2 dB(A) – 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.

9.3.34 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*'.

9.3.35 This guidance in relation to cumulative effects is relevant to the assessment of noise from the Proposed Development because it is proposed in the vicinity of a number of other operational wind turbines.

9.3.36 In the section titled '*existing windfarm/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 proposed 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 proposed site can be applied directly*".

9.3.37 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. In most cases this approach will result in a highly restrictive noise limit.

9.3.38 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. Additionally, this can apply 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.

9.3.39 In the section entitled '*concurrent applications*' it is stated that where there are no pre-existing wind farms, this scenario permits the apportionment of the ETSU-R-97 limits between the concurrent developments, i.e. each of the developments could be subject to noise limits below the full ETSU-R-97 guidance, such that even if the individual limits applied to each development were utilised 'in full', the combined effect would be that the ETSU-R 97 guidance would not be exceeded cumulatively.

9.3.40 A method is provided for determining the effect of directivity, such that reductions attributable to individual turbines at specific receptors may be determined for when the receptor is under cross-wind or up-wind orientation with respect to the turbine.

BS4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound

9.3.41 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*".

9.3.42 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 ($L_{Ar,Tr}$) 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.

9.3.43 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.

9.3.44 The following guidance is presented with regard to 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.

9.3.45 It can be seen from the above that 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.

9.3.46 With regard to the absolute level, it is stated, amongst other points, 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".*

9.3.47 The 1997 version of BS4142 stated that rating levels below 35 dB and background noise levels below 30 dB(A) were considered to be "*very low*".

Design Manual for Roads and Bridges (DMRB)

9.3.48 DMRB (Highways Agency, 1989) 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.

9.3.49 DMRB provides screening criteria whereby a change in noise level of 1 $dBL_{A10,18hr}$ is equivalent to a 25% increase or 20% decrease in traffic flow, and a change in noise level of 3 $dBL_{A10,18hr}$ is equivalent to a 100% increase or 50% decrease in traffic flow.

9.3.50 The threshold criteria used for traffic noise assessment during the daytime is a permanent change in magnitude of 1 dB $L_{A10,18hr}$ in the short term (i.e. on opening) or a 3 dB $L_{A10,18hr}$ change in the long term (typically 15 years after project opening). For night time noise impacts, the threshold criterion of a 3 dB $L_{night,outside}$ noise change in the long term should also apply but only where an $L_{night,outside}$ greater than 55 dB is predicted in any scenario.

BS5228:2009+A1:2014 – Code of practice for noise and vibration control on construction and open sites – Part 1 (noise) and Part 2 (vibration)

9.3.51 Part 1 of the standard 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.

9.3.52 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.

9.3.53 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.

9.3.54 With respect to absolute fixed noise limits, those detailed within *Advisory Leaflet 72: 1976: Noise control on building sites* are presented. These limits are presented according to the nature of the surrounding environment, for a 12-hour working day. The presented limits are:

- 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise; and
- 75 dB(A) in urban areas near main roads and heavy industrial areas.

9.3.55 The above noise level limits are applicable at the façade of the receptor in question (not free-field).

9.3.56 The standard goes on to provide 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 operations. Two example assessment methods are presented, these are the 'ABC method' as summarised within Table 9.1 and the '5 dB(A) change' method as described in paragraph 9.3.57.

Table 9.1 – Example 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.* *NOTE 3: Applied to residential receptors only*			
A) Category A: threshold values to use when ambient levels (when rounded to the nearest 5 dB) are less than these values. *B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.* *C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.* *D) 19.00-23.00 weekdays, 13.00-23.00 Saturdays and 07.00-23.00 Sundays*			

9.3.57 With respect to the '5 dB(A) change' method, the guidance states:

"Noise levels generated by construction activities are deemed to be significant if the total noise (pre-construction ambient plus construction noise) exceeds the pre-construction ambient noise by 5 dB or more, subject to lower cut-off values of 65 dB, 55 dB and 45 dB L_{Aeq}, from construction noise alone, for the daytime, evening and night-time periods, respectively; and a duration of one month or more, unless works of a shorter duration are likely to result in significant impact."

9.4 Consultation

9.4.1 Table 9.2 provides details of consultations undertaken with relevant regulatory bodies, together with action undertaken by the Applicant in response to consultation feedback. Copies of relevant consultation correspondence are included in Appendix 9.1.

Table 9.2 – Consultation undertaken

Consultation sent	Consultation response	Applicant action
Orkney Islands Council Scoping Opinion (refer to Appendix 4.2) 08/08/18	Confirmed that assessment to be undertaken in accordance with ETSU-R-97. Potentially cumulative turbines identified. Cumulative developments to be assumed to be operating at their consented noise limits. Noted construction noise can likely be controlled by limiting hours of work.	Comments noted
Orkney Islands Council Email 08/10/2019 Supplementary consultation with Environmental Health – agreement of baseline noise survey monitoring locations	14/10/2019 – phone call. Agreed locations in principle and to meet on site.	Met with Environmental Health on site, micro-siting agreed at each monitoring position.
Orkney Islands Council Email 14/05/2020 Provided records of baseline studies and initial findings of baseline data analysis, proposed allocation of monitoring data to receptor locations, discussion of methods for addressing noise from existing cumulative turbines on measured baseline noise levels, methods for deriving noise limits and consideration of cumulative developments in evaluation of operational noise.	Email 18/05/2020 Confirmed approval that baseline studies undertaken in accordance with guidance. Requested further information regarding treatment of baseline data seeking to minimise noise from existing turbines.	Comments noted and accepted. Further information provided (see below)
Orkney Islands Council Email 18/05/2020 Further information provided regarding data treatment and filtering of noise when up-wind/down-wind of existing cumulative turbines.	Email 22/05/2020 Noted that baseline data showed no significant difference in up-wind/ down-wind conditions, accepted proposed approach to subtract predicted level of existing turbines at monitoring positions from measured background levels to derive 'true' background.	Comments noted and accepted. Proposed method adopted.

Consultation sent	Consultation response	Applicant action
Orkney Islands Council Email 03/06/2020 Further discussion of potential treatment of cumulative noise from existing turbines	Phone call – EHO noted that Binga Fea (consented application using method proposed by Applicant) approach would not work for the Proposed Development, citing difficulty in conditioning cumulative noise limits with multiple turbine operators.	Comments noted and accepted.
Orkney Islands Council Email 15/06/2020 Proposed use of 40 dB fixed minimum daytime limit, given absence of available headroom due to existing wind turbines	Email 23/06/2020 Confirmed Gable End Theatre and Ore Burn Cottage non-residential and therefore do not need to be considered as NSRs. Noted that arguments for proposed use of 40 dBL_{A90} daytime noise limit appears to fit IoA GPG approach and may be valid, but this should be determined through the planning process. Noted concern regarding ability to write enforceable planning conditions to control three developments (assumed to mean Proposed Development and the two existing turbines); this to be determined by Planning Experts and determined at a Planning Hearing (assumed to mean determined through the consenting process).	Comments noted.

9.5 Assessment Methodology and Significance Criteria

Consultation

9.5.1 Details of consultation with OIC are provided in Section 9.4. Additional face-to-face discussions with Environmental Health were undertaken during the site visit to install noise monitoring equipment with regard to the micro-siting of the equipment, and the audibility of existing cumulative turbines.

Study Area

9.5.2 The study area for this assessment has been informed by maps and aerial images of the Proposed Development site and its surroundings, as well as site visits undertaken during the baseline noise survey. A sample of the closest, and therefore potentially worst-affected, noise sensitive receptors (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, including those located between the Proposed Development and the considered cumulative developments. NSRs at which noise limits have been set for cumulative developments have been identified for the evaluation of potential cumulative effects. NSRs identified are either single dwellings or representative of a group or cluster of dwellings.

9.5.3 Determination of the study area for a wind farm typically requires that the 35 dBL_{A90} noise contour is predicted, and NSRs which lie beyond the contour are assumed to meet the most stringent ETSU noise limit, and are therefore scoped out and discounted from further consideration. NSRs which are identified within the 35 dBL_{A90} noise contour are scoped in, and noise impacts are assessed further.

9.5.4 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 9.1. This predicted contour does not include any corrections for concave topography or for the visibility of the turbines from receptor locations, and is intended only as a screening tool. It should be noted that the 35 dB noise contour is based on noise immission levels from the Proposed Development only and does not account for cumulative effects.

9.5.5 Figure 9.1 shows the identified representative properties within the 35 dB noise contour, comprising two potential NSRs. The remaining NSRs considered lie outside the 35 dBL_{A90} noise contour but are considered to account for potential cumulative effects. The representative NSRs considered in the assessment are listed in Table 9.3.

Table 9.3 – Identified representative NSRs

NSR name	NSR ID	Grid reference (OSGB)	
		X	Y
Rysa Mill	NSR1	329970	995448
The Noddle	NSR2	330004	995375
Scews	NSR3	330022	995111
Little Scews	NSR4	330045	994879
Summer Cleary	NSR5	330333	994894
Moorlands	NSR6	330076	994491
Thurvoe	NSR7	330039	994439
Haybrake Farm	NSR8	330482	994495
Treetops bungalow	NSR9	330408	994509
Lyness Hotel	NSR10	330407	994458
Unknown property name	NSR11	330511	994410
2 Chalet	NSR12	330423	994320
1 Chalet	NSR13	330416	994290
Ore Farm	NSR14	330452	993546
Halla	NSR15	330664	992954
Old Kirk	NSR16	330662	992893
Old School House	NSR17	330690	992840
North Walls Schoolhouse	NSR18	330698	992818
Dunfarmin	NSR19	330746	992273
Upper Seatter	NSR20	329810	992062

Baseline Noise Survey

9.5.6 A baseline survey was undertaken at three locations to characterise baseline noise levels at representative NSRs within the study area. The noise monitoring positions (NMPs) used are provided in Table 9.4 and shown on Figure 9.1.

Table 9.4 – Baseline noise monitoring positions

NMP name	NMP ID	Grid reference (OSGB)	
		X	Y
Little Scews	NMP1	330109	994945
North Walls School	NMP2	330680	992703
Upper Seatter	NMP3	329789	992105

9.5.7 The baseline survey was completed over the period 15th October to 14th November 2019.

9.5.8 The sound level meters (SLMs) used were compliant with Class 1 specification, as described in BS EN 61672-1:2003. The calibration of the SLMs was checked in the field before and after each measurement and no significant drift in calibration was noted. The SLMs and the calibrator used were within their accredited laboratory calibration period of two years and one year, respectively. Calibration certificates for the SLMs and calibrator are provided in Appendix 9.2.

9.5.9 The SLMs were installed at the monitoring positions each with a microphone at a height of approximately 1.5 m above ground in a free-field location, i.e. at least 3.5 m from any vertical sound reflective surfaces. The microphones were fitted with double-skin outdoor wind shields with a minimum 200 mm diameter.

9.5.10 The monitoring locations are described as follows:

- NMP1 Little Scews – SLM installed within a field next to the property, to the north-east of the house. The SLM was sited more than 3.5 m from any façades, and as distant from trees and bushes as could be achieved. A rain gauge was installed adjacent to the SLM. Weather conditions during installation were dry, clear, with moderate to high wind speeds. Given the presence of trees throughout the garden surrounding the Little Scews property, the SLM was sited within the adjacent paddock, to minimise the effect of wind-blown vegetation noise.
- NMP2 North Walls School – SLM installed to the south of the School building, positioned such that the SLM is at least 3.5 m away from any facades and as far away from vegetation as could be achieved. Weather conditions during installation were dry, clear, with moderate to high wind speeds. This cluster of properties are exposed to noise from an existing small turbine (the Gable End Theatre turbine). The SLM was therefore installed at a representative location as far from the turbine as possible. At this location the North Walls School precluded line-of-sight between the measurement location and the turbine, thereby providing screening to turbine noise. The turbine was not audible at the monitoring position during the site visit.
- NMP3 Upper Seatter – SLM installed in a field to the north of the property. The SLM was sited more than 3.5 m away from any façades and there was little vegetation in the surrounding area. Weather conditions during installation were dry, clear, with moderate to high wind speeds. The SLM was installed within approximately 20 m of the closest dwelling, comprising an outbuilding converted for residential use.

9.5.11 The EHO was present during the commissioning of monitoring equipment, and the micro-siting of both NMPs was discussed and agreed with the EHO during the installation. Full details of the monitoring locations and photographs of the equipment in-situ are provided in Appendix 9.3.

9.5.12 Wind speed data was gathered using a Lidar device, sited on Wee Fea hill, close to the proposed position of Turbine 1 (refer to Figure 9.1). Wind speeds were measured at multiple heights above the local ground level of 115 m, including at the proposed hub height of 80 m.

Construction Phase Noise

Construction Traffic

9.5.13 Projected construction traffic flows (refer to Chapter 12) have been compared with measured baseline traffic flows on the affected links, and the resultant increase in road traffic noise determined.

On-site Construction Activities; Method of Prediction

9.5.14 A detailed breakdown of the construction schedule and plant for the Proposed Development. Drawing on our experience of previous wind farm development, the following assumptions have been made in the prediction of construction noise:

Working hours

- 07.30-18.00 Monday – Fridays;
- 08.00-13.00 Saturdays; and
- No working Sundays and Bank holidays.

Construction plant:

Access tracks and turbine hardstandings

- 4 x road wagons (BS 5228 Table C11, Item 4)
- 1 x 35T excavator (BS 5228 Table C6, Item 7)
- 2 x 6T dump trucks (BS 5228 Table C4, Item 3)
- 1 x 12T bulldozer (BS 5228 Table C2, Item 13)
- 1 x 12T roller (BS 5228 Table C2, Item 38)

Turbine bases and borrow pits

- 1 x 35T excavator (BS 5228 Table C6, Item 7)
- 1 x concrete pump (BS 5228 Table C4, Item 28)
- 2 x cement trucks (BS 5228 Table C4, Item 27)

Turbine installation

- 1 x 400T crane (BS 5228 Table C4, Item 38)
- 1 x road wagon (BS 5228 Table C11, Item 4)

Other assumptions

- all plant has been assumed to operate continuously (100 % utilisation) throughout the working hours;
- all plant has been placed at the closest approach of construction works to the closest NSR – Turbine 1 and the construction compound;
- noise levels have been predicted in accordance with the BS 5228 prediction method; and
- construction plant has been assumed to have an effective height of 2 m above local ground level.

9.5.15 The closest NSRs to the assumed worst-case construction activities are NSR6 and NSR7. Noise levels, and therefore the magnitude of impacts associated with construction activities, will be lesser at NSRs further from the Proposed Development, therefore noise impacts associated with the construction phase have been evaluated using predicted levels at NSR6 and NSR7 only.

Derivation of Construction Phase Noise Limits

9.5.16 The predicted site preparation / construction noise levels have been assessed based on noise level criteria determined following a worst-case interpretation of the guidance contained within BS5228. As detailed within Section 9.3, BS5228 details three example methods for determining the significance of potential construction noise impacts. With regard to the presented absolute noise level criteria (example method 1), following a worst-case approach, the lowest absolute noise level criterion for the daytime period (07:00 to 19:00) is 70 dB(A) façade, (equivalent to 67 dB(A) free field), which is stated to apply in rural areas.

9.5.17 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 dB $L_{Aeq,T}$. Where Category A applies, the allowable noise levels arising from the combined effect of both the prevailing ambient noise and the construction noise is 65 dB(A). Assuming an average ambient noise level of 49 dB(A), the allowable 'construction only' noise level is 65 dB(A) $L_{Aeq,T}$.

9.5.18 With regards to the 5 dB(A) change method, the allowable construction noise level during the daytime is 65 dB(A), or higher where the resulting ambient noise level change would be less than +5 dB(A). Accordingly, the most stringent allowable 'construction only' noise level following this approach is 65 dB(A). With regard to the above, it can be seen that applying the ABC method or the 5 dB change method gives rise to the most stringent daytime construction noise level criteria of 65 dB$L_{Aeq,T}$.

9.5.19 Criteria have been derived drawing on the above and are provided in Table 9.9 within the Impact Magnitude section.

Operational Phase Noise

General Method of Prediction

9.5.20 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.

9.5.21 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, except when considering potential mitigation strategies to address instances of predicted noise levels above the derived noise limits at NSR14 (refer to para. 9.10.17). The predicted operational noise levels can therefore be considered worst-case in this regard.

9.5.22 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;
- A correction from $L_{Aeq,T}$ to $L_{A90,T}$ of -2 dB was applied;
- No acoustic screening from buildings or topography was included in the calculated noise levels (worst-case);

- Temperature: 10°C; and
- Humidity: 70%.

9.5.23 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 has been determined to be applicable, no valley correction has been applied, since it is assumed that if the turbine is not visible at the NSRs, then any concavity determined to lie between the turbine and the NSR will not result in constructive acoustic reflections.

9.5.24 The applicable valley and topographic screening corrections are presented in Table 9.5.

Table 9.5 – Applicable valley and screening corrections

NSR ID	Corrections applicable	
	Screening correction -2 dB	Valley correction +3 dB
NSR1	T4	-
NSR2	T4	-
NSR3	T4	-
NSR4	T4	-
NSR5	-	-
NSR6	-	-
NSR7	-	-
NSR8	-	-
NSR9	-	-
NSR10	-	-
NSR11	-	-
NSR12	-	-
NSR13	-	-
NSR14	-	T1, T2, T4, T5, T6
NSR15	-	T1, T2, T3, T4, T5, T6
NSR16	-	T1, T2, T3, T4, T5, T6
NSR17	-	T1, T2, T3, T4, T5, T6
NSR18	-	T1, T2, T3, T4, T5, T6
NSR19	-	T2, T3, T5, T6
NSR20	-	T2, T3, T5, T6

9.5.25 In a robust approach, given the small number of topographic screening corrections which apply (maximum 1 turbine per NSR at only 4 NSRs, distant from the Proposed Development), no screening

corrections have been applied to the predicted levels. Full valley corrections have been applied to the relevant predicted levels where relevant.

Proposed Development

9.5.26 The noise assessment is based on the Vestas V136, which has a serrated trailing edge of the turbine blades to reduce noise. The source noise terms of the Vestas V136 have been provided by Vestas as 1/3 octave band data, quoted as sound power levels over a range of operational hub-height wind speeds. 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.

9.5.27 The 1/3 octave band data has been accumulated into octave-band data and standardised to 10 m height wind speeds, and 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 source noise terms for the Vestas V136 are provided in Table 9.6.

Table 9.6 – Sound power levels of the Vestas V136

Wind speed, m/s	Sound power level standardised to 10 m height wind speed, dB(A)
3	93.4
4	96.7
5	101.5
6	105.3
7	105.9
8	105.9
9	105.9
10	105.9
11	105.9
12	105.9

9.5.28 The Vestas V136 operates at its maximum sound power level at wind speeds of 7 m/s and above.

9.5.29 Octave-band data for the turbine at height of 10 m for a wind speed of 9 m/s, at which the maximum sound power level is reached, is provided in Table 9.7.

Table 9.7 –Octave band sound power levels at 9 m/s wind speed

Octave band centre frequency, Hz	31.5	63	125	250	500	1000	2000	4000	8000
Sound power level, dB(A)	76.2	86.8	94.5	99.2	101.0	99.9	95.8	88.9	78.8

9.5.30 The proposed turbine layout is shown in Figure 9.1.

Cumulative Noise

Identification of Cumulative Developments

9.5.31 A review was undertaken of existing and proposed wind energy developments in the vicinity of the site, using information available on the OIC planning portal and in consultation with Environmental Health. This review has been completed to identify those developments which have the potential to give rise to a cumulative noise impact when operating simultaneously with the Proposed Development. The results of this desk-based review have been used to inform the assessment of operational turbine noise. The identified cumulative developments are as follows:

- Ore Brae Wind Turbine
  - Planning reference 08/249/PPF
  - Enercon E-44 900 kW
  - Hub height 48 m
  - Operational
- Gable End Theatre Turbine
  - Planning reference 09/369/PP
  - Scirocco 6 kW
  - Hub height 9 m
  - Maximum reported sound power level 87.8 dBL_{Aeq} at 10 m/s
  - Operational

9.5.32 Where two predicted noise levels differing by 10 dB or more are summed, the total level is the same as the larger of the two levels; i.e. the lower level contributes a negligible amount to the total. This principle has been used to determine the cumulative study area for this assessment, and to identify which turbines contribute cumulatively to the Proposed Development.

9.5.33 The model assumed each turbine operates at its consented noise limit at the closest residential property, as reported in the relevant planning conditions. The spectral values for the installed models of turbine, as provided via the planning portal, were used in the prediction.

9.5.34 Using the modelling predictions, a 'noise contour' was produced which identifies the area in which predicted noise levels exceed 35 dBL_{A90} and where the contribution of the Proposed Development is within 10 dB of the predicted level from cumulative developments. This enabled the identification of NSRs at which cumulative effects may occur. The cumulative noise contour is shown in Figure 9.2. The shaded area identifies NSRs at which noise levels exceed 35 dBL_{A90} and at which predicted noise levels due to the Proposed Development are within 10 dB of noise from cumulative turbines.

9.5.35 With reference to Figure 9.2, the shaded areas include NSR6, NSR7 and NSR14. NSR15, NSR16, NSR117 and NSR18 are in close proximity to the shaded area, therefore cumulative effects have been considered at these receptors also. At all other NSRs either the total predicted noise level, excluding topographic corrections, is below 35 dBL_{A90}, or no cumulative noise effects will occur.

Review of Cumulative Noise Limits

9.5.36 Consented noise limits for the identified cumulative developments were in accordance with the 'simplified ETSU' approach, whereby noise levels due to small individual turbines or clusters of small turbines are conditioned to a simplified noise limit of a 'flat' 35 $dBL_{A90,10min}$ across the range of wind speeds at all properties.

Derivation of Noise Limits at NSRs where Potential Cumulative Effects Identified

9.5.37 The evaluation of operational wind turbine noise is a multi-stage process, which is necessarily highly technical in nature. The process is particularly complex where cumulative noise from existing or proposed/consented turbines requires consideration. The stages are summarised as follows:

- **Identify potentially cumulative developments** – refer to para. 9.5.31 and Appendix 9.4;
- **Determine a cumulative study area** – refer to para. 9.5.2 and Figure 9.2;
- **Identify NSRs at which cumulative effects may occur** – refer to Figure 9.2 and Appendix 9.6;
- **Derive noise limits from measured background noise levels for the daytime and night-time period** – refer to Section 9.6. Note that the derived noise limits have been corrected to account for the predicted contribution of noise from existing wind turbines at the baseline noise monitoring locations to determine 'true' baseline, in the absence of wind turbine noise.
- **Determine the applicable site-specific noise limit, accounting for the consented noise limits of existing and consented cumulative developments –** refer to para. 9.5.42.

9.5.38 Derivation of noise limits where there are potential cumulative effects involves the use of several technical noise terms; to aid the reader, these terms are described below:

- Fixed Minimum Limit (FML) – an absolute level, within the range of 35-40 dB $L_{A90,10min}$, used in low noise environments, which wind farm noise must not exceed;
- Overall Noise Limit (ONL) – the noise limit derived in accordance with ETSU from the measured background +5 dB or the FML, whichever is higher;
- Headroom – derived by logarithmical subtraction of predicted noise levels of existing turbines from noise limits derived from measured background noise levels;
- Residual Noise Limit (RNL) – the noise limit available to the Proposed Development when the influence of existing turbines (i.e. the headroom) has been taken into consideration:
  - Where significant headroom (>5 dB) is identified the RNL is derived by subtraction of a 'cautious prediction' (predicted levels +2 dB) from the ONL;
  - Where significant headroom is not present the RNL is set based on the deduction of the consented limit for other wind farm developments from the ONL at each integer wind speed, or where this is not possible at 10 dB below the ONL.

9.5.39 Given the use of 'simplified ETSU' flat noise limits for identified cumulative small turbine developments within the study area, NSRs at which cumulative effects may occur have assumed noise limits which do not vary with wind speed. Given the use of 'flat' limits, there is no existing baseline data for these turbines.

9.5.40 This assessment relies on measured (2019) baseline noise levels; where the background +5 dB does not exceed 35 dB, the resultant noise limit has been set at 10 dB below the assumed noise limit of 35 dB.

9.5.41 At higher wind speeds, where the background +5 dB exceeds 35 dB, the available headroom has been determined by logarithmic subtraction of the predicted contribution of cumulative turbines from the 'background +5 dB' noise limit. In accordance with the IoA GPG, in the derivation of site-specific noise limits, the Ore Brae and Gable End turbines have been assumed to not exceed their consented noise limit.

9.5.42 The approach to setting noise limits at NSRs at which potential cumulative effects may occur considers available 'headroom'; the overall noise level due to existing turbines has been subtracted from the noise limits derived from measured background noise levels.

9.5.43 Where significant presented headroom (>5 dB) has been identified, the Residual Noise Limit (RNL) available to the Proposed Development has been derived by subtraction of a 'cautious prediction' (predicted levels +2 dB) from the overall ETSU limit.

9.5.44 Where significant headroom is not present, the RNL applicable to the Proposed Development should be set at 10 dB below the Overall Noise Limit (ONL), such that the Proposed Development has a negligible contribution to cumulative noise levels. The derivation of RNLs is shown in detail in Appendix 9.6 of this chapter (Table 8 through to Table 11).

9.5.45 The ONL are set based on the ETSU 'background + 5dB' or ETSU Fixed Minimum Limit (FML) whichever is the higher'. ETSU allows a FML in the range 35-40dB, depending on circumstance (refer to para 9.3.16 to 9.3.22). OIC has indicated a preference for a lower daytime ETSU FML of 35 dB, however acknowledge that planning policy allows for a higher daytime ETSU FML of up to 40 dB.

9.5.46 The determination of the most appropriate daytime FML to derive the ONL and RNL is considered in detail in Section 9.10 of this Chapter.

Impact Magnitude and Effect Significance Criteria

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

Receptor Sensitivity

9.5.48 The guidance contained within Technical Advice Note 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 9.8 and are applicable to both noise and vibration effects.

Table 9.8 – Noise and vibration receptor sensitivity criteria

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

Impact Magnitude - Construction Noise

9.5.49 The construction noise impact magnitude has been determined according to the threshold levels provided in Table 9.9.

Table 9.9 – Evaluation criteria for noise from construction activities (predicted façade level), weekday daytimes (08:00 – 18:00) and Saturdays 08:00 – 12:30

Difference (d) between predicted construction noise level and applicable limit, dB	Impact magnitude
d ≥+5	High
0 ≤ d < +5	Medium
-10 ≤ d < 0	Low
d <-10	Negligible

Impact Magnitude – Construction Traffic Noise

9.5.50 The Design Manual for Roads and Bridges states that "*In the period following a change in traffic flow, people may find benefits or disadvantages when the noise changes are as small as 1 dB(A) – equivalent to an increase in traffic flow of 25% or a decrease in flow of 20%. These effects last for a number of years*", whilst PAN 1/2011 advises that a change of 3 dB(A) is the minimum perceptible under normal conditions. Criteria for the evaluation of road traffic noise effects based on these changes are provided in Table 9.10.

Table 9.10 – Evaluation criteria for noise from construction traffic

Increase (i) over existing road traffic noise level due to construction traffic flows, dB	Impact magnitude
i ≥+5	High
3 ≤ i < +5	Medium
1 ≤ i < +3	Low
0 ≤ i < +1	Negligible

Impact Magnitude - Operational Wind Turbine Noise

9.5.51 For noise from the proposed wind turbines once operational, the impact magnitude scale has been derived based on the guidance contained with ETSU-R-97. It is considered that where cumulative wind turbine noise meets the applicable noise limits (and is up to 10 dB below the limits), an impact magnitude of low would arise. Where cumulative wind turbine noise falls ≥10 dB below the applicable limits, the impact magnitude is considered to be negligible. Where cumulative wind turbine noise exceeds the applicable limits by up to 5 dB, an impact magnitude of medium is considered to arise. Where the there is an exceedance of a limit by >5 dB, an impact magnitude of high is considered to arise. These criteria are summarised in Table 9.11.

Table 9.11 – Impact magnitude scale – wind turbine noise

Difference (d) between predicted turbine noise level and applicable limit, dB	Impact magnitude
d ≥+5	High
0 ≤ d < +5	Medium
-10 ≤ d < 0	Low
d <-10	Negligible

Impact Magnitude - Fixed (Non-turbine) Plant Noise

9.5.52 For noise from any fixed (non-turbine) plant such as any transformers, control buildings or substations, it is appropriate to determine significance criteria based on the guidance contained within BS4142, i.e. by consideration of the difference between the rating level from the plant noise and the prevailing background sound levels, but also with respect to context and the resulting sound levels in absolute terms.

9.5.53 The impact magnitudes associated with noise generated from fixed plant are presented in Table 9.12.

Table 9.12 – 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 35dB the impact magnitude is classified as 'Negligible' regardless of the relationship to the background noise level. *+ indicates rating level above background noise level* *- indicates rating level below background noise level*		

Effect Significance

9.5.54 The effect significance has been determined by consideration to both the receptor sensitivity and the impact magnitude according to the matrix detailed in Table 9.13.

Table 9.13 – Effect significance matrix

Impact Magnitude	**Receptor Sensitivity**		
	High	**Medium**	**Low**
High	Major	Moderate	Minor
Medium	Moderate	Minor	Neutral
Low	Minor	Neutral	Neutral
Negligible	Neutral	Neutral	Neutral

9.5.55 This assessment considers all identified NSRs to be of "high" sensitivity in accordance with Table 9.8, 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 "neutral" and "minor" are not significant.

Requirements for Mitigation

9.5.56 Consideration has been given to available mitigation measures to reduce adverse effects and enhance beneficial effects. 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

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

Limitations to Assessment

9.5.58 Detailed information on techniques and equipment for the construction phase of the Proposed Development is not currently available. Consequently, appropriate and robust assumptions have been made regarding the nature of likely construction activities and plant, and noise predictions made accordingly. It is therefore anticipated that predicted noise levels represent the "worst case" potential construction noise levels.

9.5.59 It was not possible to determine the contribution of existing cumulative turbines to baseline noise levels at the NMPs by analysis of baseline data. The contribution of these turbines has instead been determined by prediction, in accordance with the recommendation of the IoA GPG, using appropriately robust methods and assumptions, where appropriate. It is considered that this approach is highly conservative.

9.5.60 The assessment of operational impacts associated with the wind turbines has been undertaken adopting source noise levels for the Vestas V136. 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.

9.6 Baseline Conditions

Wind Conditions

9.6.1 Wind speed data was checked for quality on receipt and it was identified that when the Lidar device was displaying an error (e.g. temporary shut-down arising from battery outage), then a wind speed of 0 m/s was displayed. All wind speeds <1 m/s were therefore excluded from further analysis.

9.6.2 A wind rose of measured wind speeds and directions derived to 10 m above ground level over the period of the baseline survey is provided in Chart 9.1 in Appendix 9.5. With reference to Chart 9.1, the most commonly occurring wind speeds were in the range 5 m/s – 10 m/s and the most prominent wind directions were north-easterly and south-westerly. Wind from the north-west and south-east occurred for less than 5 percent of the time.

Description of Baseline Noise Environment

9.6.3 Time-history charts of the measured ambient[1] (L_{Aeq}) and background[2] (L_{A90}) noise levels for each monitoring location are provided in Appendix 9.5. Periods of rainfall-affected data, which have been screened out of subsequent analysis, are shown in dark blue.

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[1] Ambient level – the equivalent continuous sound pressure level of the totally encompassing sound in a given situation at a given time, usually from multiple sources, at the assessment location over a given time interval, T.

[2] Background level - the A-weighted sound pressure level that is exceeded for 90 percent of a given time interval, T. The background level is unaffected by short-duration, noisy events, and is therefore representative of the lowest-occurring noise levels in a given noise environment. This noise index is used in the evaluation of the baseline noise environment and predicted noise levels from wind turbines in wind farm noise assessments.

9.6.4 Charts showing the measured background noise levels correlated with wind speed, and divided into Quiet Daytime and Night-time periods, in accordance with ETSU, are provided in Appendix 9.5 for all three NMPs. The proposed hub height of 80 m was used to derive the 10 m wind speed for correlation with background noise levels. The charts show the wind-dependent background noise level, the 'background +5 dB' criterion and the derived noise limits. Rainfall-affected data has been screened out, in accordance with the IoA GPG (i.e. with the periods preceding and after the recorded rainfall also excluded). A wind rose for the location is provided in Appendix 9.5.

NMP1 – Little Scews

9.6.5 The dominant noise source observed during the installation was the wind, with lesser contributions from distant waves on the shore, fairly constant bird calls, and distant and very infrequent road traffic movements.

9.6.6 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events is provided as Chart 9.2 in Appendix 9.5. With reference to Chart 9.2, the following observations are noted with regard to measured baseline noise levels:

- the ambient and background levels show a close correlation throughout the majority of the measurement period; this is indicative of a fairly constant noise source such as wind-induced noise, rather than intermittent anthropogenic activities;
- there is no clear diurnal variation and the primary control on noise levels is attributed to weather and sea conditions, rather than time of day; and
- there are several short-duration spikes in the ambient level, attributed to anthropogenic noise, however these are infrequent and typically do not exceed 10 minutes in duration.

9.6.7 The measured daytime and night-time background noise levels for NMP1 correlated to wind speed are provided in Appendix 9.5, Chart 9.3 shows the daytime period and Chart 9.4 the night-time period including all wind directions. Rainfall affected data which has been excluded is shown as a separate dataset. The following observations are noted regarding the correlation of noise and wind speed data, and the derivation of noise limits:

- There are a substantial number of datapoints across the full range of operational wind speeds, both during the daytime and night-time period, meeting the minimum requirement provided in the IoA GPG at all wind speeds, however, there is more data at higher wind speeds (>7 m/s);
- With reference to Chart 9.3, there is a general correlation between wind speed and measured background noise level during the daytime period, however, there is a degree of data scatter, with a relatively low R^2 value (value closer to 1.0 indicate a stronger correlation);
- The range in measured noise levels is attributed to the contribution of noise from the sea. Further data treatment has been undertaken to determine noise levels when the monitoring location was up-wind and down-wind of the sea; this is shown in Chart 9.11;
- With reference to Chart 9.4, there is a fair correlation between wind speed and measured background noise level during the night-time period;
- As with the daytime period, there is a wider distribution of noise levels at higher wind speeds, attributed to noise from the sea. Further data treatment has been undertaken to determine noise levels when the monitoring location was up-wind and down-wind of the sea; this is shown in Chart 9.12;
- With reference to Chart 9.11 and Chart 9.12, noise levels at NMP1 during the daytime period and the night-time period are lower when the NMP was up-wind of the sea. As the NSRs which this NMP represents will not be simultaneously down-wind of the sea and the Proposed Development, noise limits for the Proposed Development have been derived from the

background noise level when the NMP was up-wind of the sea, i.e. when the background levels were lowest; and

- The derived daytime and night-time background noise levels, excluding noise from the sea, are shown in Chart 9.11 and Chart 9.12.

NMP2 – School

9.6.8 The dominant noise source was the wind, with distant, infrequent traffic and birdsong both lesser contributors to overall noise levels. A small (6 kW) wind turbine is located approximately 250 m to the east-north-east of the monitoring location, however, this was inaudible at the NMP during installation[3].

9.6.9 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels, and rainfall events is provided as Chart 9.5 in Appendix 9.5. With reference to Chart 9.5, the following observations are noted with regard to measured baseline noise levels:

- the ambient and background levels show a fair correlation throughout the majority of the measurement period, however, there is less consistency at this location than at NMP1;
- as with NMP1 there is no consistent pattern of diurnal variation; there is no evidence of dawn chorus or traffic noise effects and the primary control on noise levels can be attributed to wind conditions, rather than time of day; and
- a spike in measured ambient and background noise levels occurs from approximately 16:30 to 18:10 on 17th October. Such an 'event' is consistent with nearby anthropogenic activity, such as grass cutting/landscape maintenance works. The event falls outside the 'quiet daytime' period and is therefore excluded from analysis of baseline data and has not affected the derivation of noise limits.

9.6.10 The measured daytime and night-time background noise levels for NMP2, correlated to wind speed, and with rain-affected data removed, are provided in Appendix 9.5, Chart 9.6 shows the daytime period and Chart 9.7 the night-time period including all wind directions. Rainfall affected data which has been excluded is shown as a separate dataset. The following observations are noted regarding the correlation of noise and wind speed data, and the derivation of noise limits:

- There are a substantial number of datapoints across the full range of operational wind speeds, both during the daytime and night-time period, meeting the minimum requirement provided in the IoA GPG at all wind speeds;
- With reference to Chart 9.6, there is a close correlation between wind speed and measured background noise levels during the daytime period, with no outliers and no banding of datapoints;
- During the daytime period the measured background level exceeds the fixed minimum daytime noise limit (35 dB) at winds speeds of 9 m/s and above, and exceeds the 40 dB daytime minimum limit[4] at wind speeds of 11 m/s and above;
- With reference to Chart 9.7, there is a strong correlation between wind speed and measured background noise level during the night-time period; and
- During the night-time period the measured background level exceeds the fixed minimum night-time noise limit (43 dB) at winds speeds of 11 m/s and above.

[3] Note that any noise associated with the operational hours of the school will have been excluded from baseline data in accordance with screening for 'quiet daytime' period as per ETSU-R-97 guidance.

[4] Refer to paragraph 9.6.26

NMP3 – Upper Seatter

9.6.11 The dominant noise source was wind noise, with bird calls and distant and infrequent road traffic lesser contributors. The property is a working farm, with livestock in nearby fields and farm machinery in occasional use.

9.6.12 A time-history graph of measured L_{Aeq} (ambient) and L_{A90} (background) levels and rainfall events is provided as Chart 9.8 in Appendix 9.5. With reference to Chart 9.8, the following observations are noted with regard to measured baseline noise levels:

- The ambient and background levels typically show a fair correlation throughout the majority of the measurement period; this is indicative of a fairly constant noise source such as wind-induced noise, rather than intermittent anthropogenic activities;
- The ambient and background levels diverge during the daytime period on 17th October, assumed to be due to noise from farming activities. Noise from the morning of Thursday 17th October falls outside the 'quiet daytime' period and is therefore excluded from baseline analysis. There is no indication within the data that any anthropogenic activity in the afternoon of 17th October has influenced the background noise levels;
- A short (10 minute) duration spike in the ambient and background noise levels on 19th October is attributed to a noisy event close to the NMP. This event falls outside the quiet daytime period and therefore does not influence noise limit derivation; and
- As with the other NMPs there is no clear diurnal variation throughout the measurement and the primary influence on noise levels was the weather, with spikes in ambient and background levels attributed to high wind speeds and rainfall events.

9.6.13 The measured daytime and night-time background noise levels for NMP3, correlated to wind speed, and with rain-affected data removed, are provided in Appendix 9.5, Chart 9.9 shows the daytime period and Chart 9.10 the night-time period including all wind directions. Rainfall affected data which has been excluded is shown as a separate dataset. The following observations are noted regarding the correlation of noise and wind speed data, and the derivation of noise limits:

- There are a substantial number of datapoints across the full range of operational wind speeds, both during the daytime and night-time period, meeting the minimum requirement provided in the IoA GPG at all wind speeds;
- With reference to Chart 9.9, there is a close correlation between wind speed and measured background noise levels during the daytime period, with no outliers and no banding of datapoints;
- During the daytime period the measured background level exceeds the fixed minimum daytime noise level (35 dB) at winds speeds of 9.5 m/s and above;
- With reference to Chart 9.10, there is a strong correlation between wind speed and measured background noise level during the night-time period; and
- During the night-time period the measured background level does not exceed the fixed minimum night-time noise limit (43 dB) at wind speeds below 12 m/s.

Correction for Noise from the Sea

9.6.14 With reference to Chart 9.11 and Chart 9.12 the background noise levels at NMP1 were found to be affected by noise from the sea. When NMP1 was downwind of the sea noise levels were higher than when the NMP was upwind of the sea. NMP1 is representative of the noise environment at NSRs which will never be simultaneously down-wind of the Proposed Development and the sea, therefore noise from the sea will not 'mask' wind turbine noise. The noise limits derived for NMP1 therefore

exclude datapoints when the NMP was down-wind of the sea, resulting in lower noise limits than if the entire dataset were used.

Correction for Noise from Existing Turbines

9.6.15 With reference to the cumulative study area in Figure 9.2, it can be seen that noise from existing turbines forms part of the baseline noise environment at some NSRs and, although monitoring locations were selected to minimise any such effects, turbine noise may have contributed to the measured background noise levels at NMPs (it should be noted that no turbine noise was audible during commissioning and decommissioning of equipment). The effect of noise from existing wind turbines on measured baseline noise levels has therefore been investigated at the monitoring locations.

9.6.16 Measured noise levels at all monitoring locations have been filtered to determine whether noise levels are significantly different under different wind directions. At NMP2 and NMP3 this considered conditions when the NMPs are up-wind of the turbines compared to when the turbines are down-wind. If the turbines contributed significantly to measured baseline noise levels, it would be expected that noise levels would be higher when the NMPs are down-wind of the turbine. The results of the filtering during the daytime period are shown in Chart 9.13 and Chart 9.14 in Appendix 9.5.

9.6.17 The results of the filtering show that noise levels at NMP2 and NMP3 are marginally higher under southerly wind conditions, when the NMPs are up-wind of the turbines, than under northerly conditions when the NMPs are down-wind. This is an indication that noise from the existing turbines has a limited effect on the baseline noise environment at NMPs, and that other factors, such as the exposure of the monitoring location to the wind from different directions, and wave noise from the sea, have a greater effect on measured levels. A similar pattern is evident in the data for the night-time period, and graphs of the night-time data are therefore not provided. In a robust approach and in agreement with the EHO, the measured background noise levels under both up-wind and down-wind conditions have therefore been corrected for existing turbine noise by subtraction of the predicted noise level due to the existing turbines from the measured background noise levels.

9.6.18 In a robust approach, the correction for the predicted noise from existing turbines has been applied at all NMPs, even though NMP1 is remote from any existing turbines. At NMP2 the Gable End Theatre turbine was completely screened from line of sight by the school building. The IoA GPG allows that predicted turbine noise levels may be corrected when screened entirely by topography by application of a -2 dB correction. Given the inaudibility of the Gable End Theatre turbine at the NMP during commissioning/decommissioning, and the absence of any evident difference in noise levels under up-wind and down-wind conditions, predicted levels have been corrected for the screening provided by the school building by application of a -2 dB correction. This correction has only been applied during correction of the background noise levels, and not at subsequent stages of the assessment, where a correction would not be appropriate.

9.6.19 The process of correction of background noise levels by subtraction of predicted noise levels from the existing turbines is shown in Appendix 9.6 (Table 2 and Table 3).

Adopted Noise Limits

Construction and decommissioning noise limits

9.6.20 With reference to noise levels presented in Appendix 9.5, specifically in Chart 9.2, Chart 9.5 and Chart 9.8, the baseline ambient level was below 65 dB throughout the survey. The construction phase noise limit for weekday daytimes and Saturdays, in accordance with the ABC method provided in BS5228, is therefore Category A - 65 $dBL_{Aeq,T}$.

Operational noise limits – fixed non-turbine plant

9.6.21 Operational noise limits for fixed non-turbine plant, such as transformers and substations, have been derived in accordance with BS4142, with reference to measured background noise levels at

NMP1, which is representative of the closest NSRs to proposed items of plant. It is assumed that such 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. At wind speeds lower than 5 m/s and in the absence of rainfall (as required by BS4142), as shown in Appendix 9.5 Chart 9.7, the measured background level during the night-time period at NMP2 was <25 $dBL_{A90,T}$. In accordance with BS4142, a rating level of up to 5 dB above the representative background level is indicative of a 'low' impact, therefore the adopted noise limit for the rating level of fixed non-turbine plant at the closest receptor is 30 dB.

Operational noise limits –wind turbine noise

9.6.22 Noise limits for the Proposed Development have been derived using measured background noise levels. The noise levels have been used to determine an Overall Noise Limit (ONL). In the absence of noise from cumulative turbines, the ONL would apply directly to the Proposed Development.

9.6.23 Where cumulative noise from other developments requires to be considered, the ONL may be used to derive a Residual Noise Limit (RNL) which applies specifically to turbine noise from the Proposed Development, taking account of noise generated by existing turbines and the amount of 'headroom' remaining in the ONL for the Proposed Development to use.

9.6.24 Where cumulative turbines are consented to the full ONL, the Proposed Development cannot contribute any noise without causing the ONL to be exceeded, therefore the RNL must be set 10 dB below the ONL (refer to para. 9.5.32 and para. 9.5.37).

9.6.25 The ONLs derived from baseline data collected at NMP1, NMP2 and NMP3 are provided in Table 9.14 for the range of operational wind speeds. ETSU allows that the daytime FML may be set within the range 35 dB – 40 dB. In consultation, OIC Environmental Health requested that the daytime FML for the Proposed Development should be 35 dB, at the lower end of the ETSU range[5].

9.6.26 The presented ONLs have been derived for FMLs of 35 dB, 38 dB and 40 dB. Multiple ONLs are provided because, with reference to para. 9.5.37 and Appendix 9.6 (Table 8 and Table 9), it has been determined that both the existing Ore Brae and Gable End Theatre turbines are consented to an individual limit of 35 dB, leaving no available residual limit within the ONL for the Proposed Development at NSRs at some wind speeds.

9.6.27 Operation of the Proposed Development to an RNL 10 dB below the ONL would be highly restrictive, and this assessment considers that this runs counter to the principles of ETSU, whereby developments which generate more power should be considered more favourably than those which generate relatively small amounts of power (i.e. small turbines should not result in the prevention from development of substantially-sized wind farms).

9.6.28 The noise limits derived from measurements at NMPs have been allocated to NSRs on the basis of observations of the noise environment while setting up the SLMs, the proximity of NSRs to the NMPs and the predicted contribution of existing turbines. The allocation of noise limits by proxy to NSRs has been agreed with OIC Environmental Health (refer to Appendix 9.1).

[5] *OIC Environmental Health subsequently noted that the supporting evidence for the proposed use of a 40dB L_{A90} daytime noise limit was in accordance with the IoA GPG approach and may be valid but that this should be determined through the planning process (see Appendix 9.1)*

Table 9.14 – Derived ONLs, $dBL_{A90,10min}$

Wind speed, m/s	Derived noise limit, $dBL_{A90,10min}$								
	4	5	6	7	8	9	10	11	12
NMP1 – Little Scews – ONL derived from 'background +5 dB', minus predicted contribution from cumulative turbines									
Daytime, 35 dB FML	35.0	35.0	35.0	35.0	35.0	35.7	39.0	41.3	42.4
Daytime, 38 dB FML	38.0	38.0	38.0	38.0	38.0	38.0	39.0	41.3	42.4
Daytime, 40 dB FML	40.0	40.0	40.0	40.0	40.0	40.0	40.0	41.3	42.4
Night-time 43 dB FML	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Overall limit applicable at: NSR1, NSR2, NSR3, NSR4, NSR5, NSR6, NSR7, NSR8, NSR9, NSR10, NSR11, NSR12, NSR13									
NMP2 – North Walls School – ONL derived from 'background +5 dB', minus predicted contribution from cumulative turbines									
Daytime, 35 dB FML	35.0	35.0	35.0	35.0	35.0	38.0	41.8	45.1	48.1
Daytime, 38 dB FML	38.0	38.0	38.0	38.0	38.0	38.0	41.8	45.1	48.1
Daytime, 40 dB FML	40.0	40.0	40.0	40.0	40.0	40.0	41.8	45.1	48.1
Night-time 43 dB FML	43.0	43.0	43.0	43.0	43.0	43.0	43.1	46.3	49.1
Overall limit applicable at: NSR14, NSR15, NSR16, NSR17, NSR18									
NMP3 – Upper Seatter – ONL derived from 'background +5 dB', minus predicted contribution from cumulative turbines									
Daytime, 35 dB FML	35.0	35.0	35.0	35.0	35.0	37.7	40.8	43.7	46.6
Daytime, 38 dB FML	38.0	38.0	38.0	38.0	38.0	38.0	40.8	43.7	46.6
Daytime, 40 dB FML	40.0	40.0	40.0	40.0	40.0	40.0	40.8	43.7	46.6
Night-time	43.0	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.2
Overall limit applicable at: NSR19, NSR20									

9.6.29 None of the identified NSRs will be Financially Involved (FI) with the project, therefore the higher FI noise limit does not apply.

9.6.30 The ONLs have been used to derive RNLs for each NSR, accounting for the predicted cumulative noise levels from the Ore Brae and Gable End Theatre turbines. The derivation of the RNLs where significant headroom (>5 dB) has been determined takes into account a 'cautious prediction' of the noise level due to the existing turbines, whereby a +2 dB correction has been applied to the predicted levels, in accordance with the IoA GPG. In this process, where the noise level from cumulative turbines exceeds their consented noise limit, it has been assumed that these turbines are operating at their consented limits. Where significant headroom has been determined not to be present the RNL has been set 10 dB below the ONL.

9.6.31 The RNLs for each NSR are provided in Table 8, Table 9 and Table 10 in Appendix 9.6, for the 35 dB, 38 dB and 40 dB ONLs.

9.7 Receptors Brought Forward for Assessment

9.7.1 The NSRs considered in this assessment are provided in Table 9.3 and shown in Figure 9.1.

9.8 Standard Mitigation

Construction phase

9.8.1 The following good practice measures will be implemented during construction to limit unnecessary noise:

- avoid unnecessary revving of engines and switching off plant when not required (i.e. no idling);
- haul routes to be kept well maintained;
- minimising the drop height of materials during delivery to, and movement around, site;
- starting up plant and vehicles sequentially, rather than all together;
- specification of plant with white-noise or directional reversing alarms, rather than beeper type alarms;
- where possible, selection of quiet / noise reduced plant;
- vehicles accessing the site will have regard to the normal operating hours of the site and the location of nearby NSRs; and
- use and siting of equipment will be considered such that noise is minimised. For example, any generators or powered cabins within the construction compound will be sited such that noise from the generator exhaust is directed away from the closest NSRs, and cabins and other infrastructure are used to screen noise from such plant wherever possible.

Operational phase

Fixed (non-turbine) plant noise

9.8.2 Noise from non-turbine operational plant will comprise noise from substations only. The sound power level and final location of the substation(s) are yet to be finalised, however, noise from the final type and location of the substation will be attenuated by acoustic enclosure (if required), such that it meets the derived non-turbine noise limits (see Section 9.9.7). A total sound power level of 97 dB(A), equivalent to a sound pressure level of 68 dB(A) at 10 m, would enable the noise limit to be met. The installed plant will meet these criteria.

9.9 Likely Effects

Construction

Construction traffic

9.9.1 Observations noted during the baseline noise survey confirmed that road traffic forms a very minor component of the noise environment within the study area. Vehicle movements at all NMPs were noted to be infrequent and distant.

9.9.2 With reference to Chapter 12 (Traffic and Transport), projected construction traffic flows on the B9048 and the site access track during the peak construction month total 36 and 46 daily vehicle movements respectively, equivalent to increases over the projected future baseline flows of 16 % and 153 %, respectively. While the percentage increases are large, the total number of vehicle movements per day on both of these roads remains below the 50 vehicles per hour minimum threshold for calculation of noise for low -traffic flow roads provided in CRTN. Traffic flows can therefore be considered very low. This assessment therefore assumes that the total noise level due to roads affected by construction traffic, at the closest NSRs, will see an increase of up to 3 dB, equivalent to a doubling of the road traffic noise, in any given hour. Despite the change in noise levels, the equivalent $L_{Aeq\ 18hr}$ traffic noise level is expected to remain low and the increase is considered unlikely to be at a level which would cause disturbance.

9.9.3 With reference to Table 9.10, an increase of up to 3 dB corresponds to a **low** impact magnitude. With reference to Table 9.13, the resultant effect significance is **minor,** and is therefore not significant.

On-site Construction

9.9.4 The predicted noise levels at NSR6 and NSR7, the closest properties to the Proposed Development site are provided and evaluated against the adopted noise limits in Table 9.15 for each of the three stages of construction considered.

Table 9.15 – Evaluation of worst-case construction phase noise levels at closest NSRs (NSR6 & NSR7)

Scenario	Predicted level, $dBL_{Aeq,T}$	Exceedance of noise limit, dB
Construction of access tracks	48	-17
Construction of turbine bases	41	-24
Installation of turbines	41	-24

9.9.5 At NSR6 and NSR7, predicted worst-case noise levels due to construction activities would be experienced and these meet the derived noise limits by a margin of 17 dB or more. With reference to Table 9.9 the impact magnitude is **negligible**, therefore with reference to Table 9.13 the effect significance is **neutral**, and is therefore not significant.

Operation

Fixed (non-turbine) plant noise

9.9.6 The Proposed Development will include a substation which will generate noise, which will potentially be tonal in nature. No details are currently available on the source noise levels of the substation, and it is therefore considered appropriate that suitable noise control limits will 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 BS4142 method.

9.9.7 This assessment adopts the rating level noise limit of 30 dB at any identified NSR, equivalent to the baseline background noise levels at NMP1. Provided that the noise limit is met by all non-turbine

plant, including the substation, with reference to Table 9.12 the impact magnitude will be **low**. At high sensitivity NSRs, the resultant effect significance will be **minor** and therefore not significant.

Wind turbine noise

9.9.8 Predicted noise levels due to operation of the Proposed Development with all turbines operating in power-optimised mode, including appropriate corrections for concave topography (refer to Table 9.5), are provided in Table 9.16 across the range 4 m/s – 12 m/s.

Table 9.16 – Predicted wind turbine noise levels due to Proposed Development

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level, dBL_{A90}								
NSR1	22.9	27.7	31.5	32.1	32.1	32.1	32.1	32.1	32.1
NSR2	23.1	27.9	31.7	32.3	32.3	32.3	32.3	32.3	32.3
NSR3	24.2	29.0	32.8	33.4	33.4	33.4	33.4	33.4	33.4
NSR4	25.0	29.8	33.6	34.2	34.2	34.2	34.2	34.2	34.2
NSR5	23.0	27.8	31.6	32.3	32.2	32.2	32.2	32.2	32.2
NSR6	25.8	30.7	34.5	35.1	35.1	35.0	35.1	35.1	35.1
NSR7	26.2	31.1	34.9	35.5	35.5	35.4	35.4	35.4	35.5
NSR8	22.8	27.6	31.4	32.0	32.0	32.0	32.0	32.0	32.0
NSR9	23.3	28.1	31.9	32.5	32.5	32.5	32.5	32.5	32.5
NSR10	23.3	28.2	32.0	32.6	32.6	32.6	32.6	32.6	32.6
NSR11	22.7	27.5	31.3	31.9	31.9	31.9	31.9	31.9	31.9
NSR12	23.3	28.2	32.0	32.6	32.6	32.5	32.6	32.6	32.6
NSR13	23.4	28.2	32.0	32.6	32.6	32.6	32.6	32.6	32.6
NSR14	25.2	30.0	33.8	34.5	34.4	34.4	34.4	34.4	34.4
NSR15	23.0	27.8	31.6	32.3	32.3	32.2	32.2	32.3	32.3
NSR16	22.9	27.7	31.5	32.1	32.1	32.1	32.1	32.1	32.1
NSR17	22.8	27.6	31.4	32.0	32.0	32.0	32.0	32.0	32.0
NSR18	22.5	27.4	31.2	31.8	31.8	31.8	31.8	31.8	31.8
NSR19	21.0	25.8	29.6	30.2	30.2	30.2	30.2	30.2	30.2
NSR20	23.2	28.0	31.8	32.4	32.4	32.4	32.4	32.4	32.4

9.9.9 The predicted levels are evaluated against the 35 dB daytime ONL and 43 dB night-time ONL (i.e. excluding consideration of cumulative turbines) in Table 9.17.

Table 9.17 – Evaluation of predicted noise levels from Proposed Development against derived daytime and night-time ONLs

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level minus ONL, dBL_{A90}								
Daytime period (07:00 – 23:00), derived ONL									
NSR1	-12.1	-7.3	-3.5	-2.9	-2.9	-3.6	-6.9	-9.2	-10.3
NSR2	-11.9	-7.1	-3.3	-2.7	-2.7	-3.4	-6.7	-9.0	-10.1
NSR3	-10.8	-6.0	-2.2	-1.6	-1.6	-2.3	-5.6	-7.9	-9.0
NSR4	-10.0	-5.2	-1.4	-0.8	-0.8	-1.5	-4.8	-7.1	-8.2
NSR5	-12.0	-7.2	-3.4	-2.7	-2.8	-3.5	-6.8	-9.1	-10.2
NSR6	-9.2	-4.3	-0.5	0.1	0.1	-0.7	-3.9	-6.2	-7.3
NSR7	-8.8	-3.9	-0.1	0.5	0.5	-0.3	-3.6	-5.9	-6.9
NSR8	-12.2	-7.4	-3.6	-3.0	-3.0	-3.7	-7.0	-9.3	-10.4
NSR9	-11.7	-6.9	-3.1	-2.5	-2.5	-3.2	-6.5	-8.8	-9.9
NSR10	-11.7	-6.8	-3.0	-2.4	-2.4	-3.1	-6.4	-8.7	-9.8
NSR11	-12.3	-7.5	-3.7	-3.1	-3.1	-3.8	-7.1	-9.4	-10.5
NSR12	-11.7	-6.8	-3.0	-2.4	-2.4	-3.2	-6.4	-8.7	-9.8
NSR13	-11.6	-6.8	-3.0	-2.4	-2.4	-3.1	-6.4	-8.7	-9.8
NSR14	-9.8	-5.0	-1.2	-0.5	-0.6	-4.0	-7.6	-10.8	-13.7
NSR15	-12.0	-7.2	-3.4	-2.7	-2.7	-6.2	-9.8	-12.9	-15.8
NSR16	-12.1	-7.3	-3.5	-2.9	-2.9	-6.3	-9.9	-13.1	-16.0
NSR17	-12.2	-7.4	-3.6	-3.0	-3.0	-6.4	-10.0	-13.2	-16.1
NSR18	-12.5	-7.6	-3.8	-3.2	-3.2	-6.6	-10.2	-13.4	-16.3
NSR19	-14.0	-9.2	-5.4	-4.8	-4.8	-7.5	-10.6	-13.5	-16.4
NSR20	-11.8	-7.0	-3.2	-2.6	-2.6	-5.3	-8.4	-11.3	-14.2
Night-time period (23:00 – 07:00), derived ONL									
NSR1	-20.1	-15.3	-11.5	-10.9	-10.9	-10.9	-10.9	-10.9	-10.9
NSR2	-19.9	-15.1	-11.3	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7
NSR3	-18.8	-14.0	-10.2	-9.6	-9.6	-9.6	-9.6	-9.6	-9.6
NSR4	-18.0	-13.2	-9.4	-8.8	-8.8	-8.8	-8.8	-8.8	-8.8
NSR5	-20.0	-15.2	-11.4	-10.7	-10.8	-10.8	-10.8	-10.8	-10.8
NSR6	-17.2	-12.3	-8.5	-7.9	-7.9	-8.0	-7.9	-7.9	-7.9
NSR7	-16.8	-11.9	-8.1	-7.5	-7.5	-7.6	-7.6	-7.6	-7.5

NSR ID	Wind Speed, m/s								
	4	5	6	7	8	9	10	11	12
	Predicted noise level minus ONL, dBL_{A90}								
NSR8	-20.2	-15.4	-11.6	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0
NSR9	-19.7	-14.9	-11.1	-10.5	-10.5	-10.5	-10.5	-10.5	-10.5
NSR10	-19.7	-14.8	-11.0	-10.4	-10.4	-10.4	-10.4	-10.4	-10.4
NSR11	-20.3	-15.5	-11.7	-11.1	-11.1	-11.1	-11.1	-11.1	-11.1
NSR12	-19.7	-14.8	-11.0	-10.4	-10.4	-10.5	-10.4	-10.4	-10.4
NSR13	-19.6	-14.8	-11.0	-10.4	-10.4	-10.4	-10.4	-10.4	-10.4
NSR14	-17.8	-13.0	-9.2	-8.5	-8.6	-8.6	-8.8	-12.0	-14.8
NSR15	-20.0	-15.2	-11.4	-10.7	-10.7	-10.8	-11.0	-14.1	-16.9
NSR16	-20.1	-15.3	-11.5	-10.9	-10.9	-10.9	-11.1	-14.3	-17.1
NSR17	-20.2	-15.4	-11.6	-11.0	-11.0	-11.0	-11.2	-14.4	-17.2
NSR18	-20.5	-15.6	-11.8	-11.2	-11.2	-11.2	-11.4	-14.6	-17.4
NSR19	-22.0	-17.2	-13.4	-12.8	-12.8	-12.8	-12.8	-14.6	-17.0
NSR20	-19.8	-15.0	-11.2	-10.6	-10.6	-10.6	-10.6	-12.4	-14.8

Note – red text indicates predicted noise level above ONL

9.9.10 The results of the evaluation are as follows:

- The predicted levels are above the daytime ONL at NSR6 and NSR7 only, at 7 m/s and 8 m/s wind speed by 0.1 dB at NSR6 and 0.5 dB at NSR7.
- At all other NSRs the predicted levels are below the daytime ONL by a margin of typically less than 10 dB across the range of wind speeds.
- At NSR3, NSR4, NSR6, NSR7 and NSR14 the predicted noise levels are below the night-time ONL by a margin of typically less than 10 dB across the range of wind speeds.
- At all other NSRs the predicted levels are below the night-time ONL by a margin of more than 10 dB across the entire range of wind speeds.
- With reference to Table 9.11 the impact magnitude during the daytime period at NSR6 and NSR7 at 7 m/s and 8 m/s is **medium**, and the resultant effect significance as per Table 9.13 is **moderate adverse** and significant. At NSR6 and NSR7 at all other wind speeds the impact magnitude is **low** and the effect significance is **minor adverse** and not significant.
- At all other NSRs during the daytime period the impact magnitude is **low** and the effect significance is **minor adverse** and not significant.
- With reference to Table 9.11 the impact magnitude during the night-time period at NSR3, NSR4, NSR6, NSR7 and NSR14 is **low**, and the resultant effect significance as per Table 9.13 is **minor adverse** and not significant.
- At all other NSRs during the night-time period the impact magnitude is **negligible** and the effect significance is **neutral** and not significant.

- At all other NSRs during the daytime period the impact magnitude is **low** and the effect significance is **minor adverse** and not significant.

9.9.11 Given the robust nature of the prediction method, it is likely that actual noise levels would be lower than the predicted levels, and that no mitigation would be required for the Proposed Development to meet the derived daytime ONL. The Applicant commits to compliance with appropriate noise limits, therefore should actual noise levels at NSR6 and NSR7 be above the noise limit, then appropriate mitigation would be put in place such that noise limits are met. Accordingly, the effect would be impact magnitude is **low** and the effect significance is **minor adverse** and not significant.

9.9.12 The effect of operation of the Proposed Development in isolation, i.e. without cumulative turbines, has therefore been determined to be not significant.

9.10 Cumulative Assessment

Construction

9.10.1 No cumulative effects are anticipated during the construction phase, and cumulative noise effects are therefore considered to be not significant.

Operational noise

9.10.2 Given the presence of existing cumulative wind turbines, the Proposed Development will not operate in isolation, and the apportionment of the daytime and night-time ONL to derive appropriate RNLs and the ability of the Proposed Development to comply with these RNLs is considered within this section. The predicted noise levels and compliance with limits are presented in Appendix 9.6.

35 dB daytime ONL

9.10.3 As shown in Appendix 9.6 Table 12, if a 35 dB FML ONL is used to derive the RNL, predicted noise levels from the Proposed Development are above the RNL (by 0.2 dB up to 9.5 dB) at NSR13, NSR14, NSR15, NSR16, NSR17 and NSR18 across the wind speed range 4 m/s to 9 m/s.

9.10.4 The predicted levels are above the RNL by a smaller margin at NSR6 and NSR7 (1.0 dB up to 2.9 dB) at wind speeds of 6 m/s – 9 m/s. Additionally, predicted levels are above the RNL at NSR12 by 0.3 dB at 8 m/s only.

38 dB daytime ONL

9.10.5 As shown in Appendix 9.6 Table 14, if a 38 dB FML ONL is used to derive the RNL, predicted noise levels from the Proposed Development are above the RNL at NSR14 across the wind speed range 5 m/s to 9 m/s by up to 6.5 dB, and above the RNL at NSR15, NSR16, NSR17 and NSR18 at 9 m/s only, by a margin of up to 4.2 dB.

40 dB daytime ONL

9.10.6 As shown in Appendix 9.6 Table 16, if a 40 dB FML ONL is used to derive the RNL, predicted noise levels from the Proposed Development meet the RNL at all NSRs across the full range of wind speeds.

43 dB night-time ONL

9.10.7 As shown in Appendix 9.6 Table 17, predicted operational noise levels meet the RNL derived using the 43 dB night-time ONL at all NSRs across the full range of wind speeds.

9.10.8 On the basis of the results presented in Appendix 9.6 Table 13 and Table 15, substantial mitigation will be required for the Proposed Development to meet daytime RNLs derived using the 35 dB FML ONL and the 38 dB FML ONL. With reference to Appendix 9.6 Table 16 predicted noise levels due to the Proposed Development are below the RNLs derived using the 40 dB FML ONL at all NSRs, therefore no mitigation will be required.

Justification for Daytime FML

9.10.9 Consideration is provided below with regard to the context of the three factors set out in ETSU when determining an appropriate FML for the ONL.

The number of dwellings in the neighbourhood of the wind farm

9.10.10 The island of Hoy is generally sparsely populated, and there are no dwellings to the north or west of the Proposed Development; dwellings are present only to the east and south, within and around the settlement of Lyness.

9.10.11 Of the dwellings considered to be in the 'neighbourhood' of the Proposed Development, this assessment notes, with reference to Appendix 9.6 Table 12, that there are 9 NSRs affected by predicted noise levels above the most stringent RNL. At all other NSRs the predicted levels meet the 35 dB ONL and the 35 dB ONL-derived RNL.

9.10.12 The number of dwellings in the neighbourhood is therefore small, and the number of dwellings at which predicted noise levels are above the most stringent noise limits is considered to be very small. This assessment therefore considers that the Proposed Development meets the first criteria provided in ETSU for justification of a higher FML.

The effect of noise limits on the number of kilowatt hours (kWh) generated

9.10.13 Wind turbines are directional noise sources, and the predicted noise levels consider worst case (highest) noise levels at NSRs under down-wind propagation (i.e. when the NSRs are downwind of the wind farm). Noise levels when the NSRs are under crosswind or upwind conditions will be lower. This assessment has considered the potential curtailment required under the prevailing wind conditions to enable the different RNLs to be met.

9.10.14 In addition to typical 'Power Optimised' mode, details have been provided by Vestas for the V136 turbine in five different low-noise ('Sound Optimised') operation modes; SO1, SO2, SO11, SO12 and SO13. These modes result in lower sound power levels at mid-to high wind speeds, with a concurrent reduction in electrical power generation of up to 30% (depending on wind speed). Curtailment options considered have included the use of the sound optimised modes of operation, and also switching off individual turbines where use of these modes does not provide sufficient reduction in noise for the noise limits to be met.

9.10.15 An outline schedule of curtailment required to meet the RNLs derived using a 35 dB FML ONL and a 38 dB FML ONL is provided in Appendix 9.6 Table 13 and Table 15 respectively. No curtailment is required to meet the RNLs derived using a 40 dB ONL.

9.10.16 With regard to meeting the 35 dB and 38 dB daytime ONLs, the receptor at which the predicted noise levels are above the noise limits by the greatest margin and across the widest range of wind speeds is NSR14 Ore Farm. This is a result of the contribution of the existing Ore Brae turbine to cumulative noise levels at NSR14, and its consented simplified ETSU noise limit of 35 dB. Noise levels at NSR14 will therefore be the primary constraint to operation of the Proposed Development and it will be the controlling receptor.

9.10.17 The IoA GPG provides a method for determining corrections for directivity. Analysis has been undertaken in accordance with the IoA GPG method, using the corrections for the angle between individual turbines of the Proposed Development and NSR14, to determine the noise level for 10^{o} wind sectors across the range of wind speeds. This analysis is presented in Appendix 9.7 and the results are as follows:

- Noise levels due to the Ore Brae turbine are greatest at NSR14 under southerly to north-westerly wind conditions (ca. 180 – 330^{o}).
- Noise levels due to the Proposed Development are greatest at NSR14 under south-westerly to northerly wind conditions (ca. 200 – 20^{o}).
- The greatest contributor to overall noise levels at NSR14 is the Ore Brae turbine, with predicted noise levels ranging from approx. 10 dB above the Proposed Development at 4 m/s – 5 m/s,

down to approx. 3 dB above the Proposed Development under down-wind conditions at 6 m/s - 9 m/s.

- The predicted levels due to the Proposed Development and cumulative turbines are above the 35 dB ONL at 4 m/s – 9 m/s.
- The predicted level of the Proposed Development is above the 35 dB RNL from 6 m/s to 9 m/s wind speed in all wind directions, and above the 35 dB RNL at 4 m/s and 5 m/s for a partial range of wind speeds.
- The predicted level due to the Proposed Development and cumulative turbines are above the 38 dB ONL at 4 m/s – 9 m/s.
- The predicted level of the Proposed Development is above the 38 dB RNL from 6 m/s to 9 m/s wind speed in the majority of wind directions, and above the 38 dB RNL at 5 m/s for a partial range of wind speeds.

9.10.18 With reference to the wind rose provided in Appendix 9.8, the wind in the vicinity of the Proposed Development during recent wind monitoring (Figure 9.3) is broadly split between south-easterly, westerly and northerly directions, with higher wind speeds typically occurring from the west. Wind speeds are split broadly equally between <10 m/s and > 10m/s. Considering the 20 year estimation (Figure 9.4), the wind is shown to be predominantly from the south-east and the west, with wind speeds mostly falling within the range 5 - 10 m/s (approx. 60% of the time). Wind speeds of <5 m/s and >10 m/s typically occur for less than 40% combined.

9.10.19 Since the predicted noise levels are above the RNL at wind speeds of 4 m/s – 9 m/s, and the highest noise levels from the Proposed Development at the most-affected NSRs occur under south-westerly to northerly wind conditions, using a RNL derived from a 35 dB or 38 dB ONL would result in the requirement for a degree of curtailment to be put in place for approximately 60% of the time.

9.10.20 Example curtailment strategies to enable the RNL to be met at NSR14 are provided in Appendix 9.6. The curtailment strategies consider 'worst case' down-wind conditions. The results of the curtailment strategies in conjunction with the directivity analysis are discussed below:

35 dB RNL

- Turbine T2 would require to be switched off at 4 m/s wind speed for a range of wind directions.
- At 5 m/s wind speed turbines T2, T3 and T5 would require to be switched off for wind directions of approx. 180º – 360º, with slightly lesser curtailment required across the remaining range of wind directions.
- At 6 m/s – 9 m/s wind speeds turbines T1, T2, T3, T5 and T6 would be required to switch off for wind directions 160º – 70º, with lesser curtailment required across the range 80º – 150º.

38 dB RNL

- At 5 m/s wind speed turbine T2 would be required to switch off for wind directions of approx. 230º – 0º and T3 and T5 would operate in SO11 mode, with no curtailment in wind directions 30º - 180º, and intermediate levels of curtailment in the remaining wind sectors.
- At 6 m/s wind speed turbine T2 would be required to switch off for wind directions of approx. 160º – 50º and T3 and T5 would operate in SO11 mode, with lesser curtailment required across wind directions 230º - 350º and no curtailment in wind directions 40º - 170º with intermediate levels of curtailment in the remaining sectors.
- At 7 m/s wind speed turbine T2 would be required to switch off for wind directions of approx. 160º – 50º and T1, T3, T4, T5 and T6 would operate in SO11 mode, with lesser curtailment

required across wind directions 230 ° - 350 ° and no curtailment in wind directions 20° - 100° with intermediate levels of curtailment in the remaining sectors.

- At 8 m/s wind speed turbine T2 would be required to be switch off for the majority of wind direction sectors. Turbines T1, T4 and T6 would operate in SO2 mode and turbines T3 and T5 in SO11 mode. Lesser curtailment would be required across the range 80° – 140°.
- At 9 m/s wind speeds turbines T2 would be required to be switch off for the majority of wind direction sectors and turbines T1, T3, T4, T5 and T6 would operate in SO11 mode. Lesser curtailment would be required across the range 80° – 140°.
- No curtailment is required at wind speeds of 10 m/s and above for RNLs derived using the 35 dB or 38 dB ONLs, and no curtailment is required using for the RNL derived using the 40 dB RNL.
- No curtailment is required during the night-time period.

9.10.21 Adopting the 35 dB FML to derive the ONL has been demonstrated to result in the Proposed Development having to implement highly restrictive levels of curtailment to operate for the majority of wind direction sectors at wind speeds of 5 m/s – 8 m/s during the daytime period. Such a restriction would result in a substantial reduction (up to 83% when switching off 5 of the 6 turbines) in generating capacity of the Proposed Development for approximately 60% of the 16-hour daytime period.

9.10.22 Adopting the 38 dB FML to derive the ONL has been demonstrated to result in the Proposed Development having to implement moderately restrictive levels of curtailment to operate under a substantial range of wind directions under wind speeds of 5 m/s – 8 m/s during the daytime period. Such a restriction would result in a moderate reduction (approximately 20% – 40%) in generating capacity for up to approximately 60% of the 16-hour daytime period.

9.10.23 The requirement to curtail operation of the ca. 28.8 MW Proposed Development arises predominantly as a result of the use of the ONL by the existing 900 kW Ore Brae turbine and, to a lesser extent, by the 6 kW Gable End Theatre turbine.

9.10.24 The curtailment required and the potential loss of generating capacity outlined above is an approximation. Detailed wind resource analysis would be required to confirm the exact number of kWh of potential electricity generating capacity lost due to curtailment and is beyond the scope of this assessment.

9.10.25 The IoA GPG notes the following with regard to the setting of the FML:

"This (the potential impact on the power output of the wind farm) *is in practice mainly based on the relative generating capacity of the development, as larger schemes have relatively more planning merit (for noise) according to the description in ETSU-R-97. In cases when the amenity fixed limit has little or no impact on the generating capacity (i.e. noise is not a significant design constraint) then a reduced limit may be applied."*

9.10.26 This assessment considers that the above is an indication that larger wind farms warrant higher noise limits; particularly where lower noise limits may restrict the generating capacity of the development.

The duration and level of exposure

9.10.27 Introduction of additional wind turbines into the study area will increase the level of exposure of most NSRs in the vicinity of the Proposed Development to wind turbine noise.

9.10.28 NSRs in the north of the study area (NSR1 – NSR11) and in the far south of the study area (NSR19 & NSR20) currently receive low levels of wind turbine noise (predicted levels <30 dB), indeed, the existing turbines are likely to be inaudible at these NSRs under a wide range of wind speeds and directions.

9.10.29 At these NSRs the predicted worst-case wind turbine noise levels will increase as a result of the Proposed Development, however, given that the level of curtailment required will be determined

by NSRs at which cumulative effects are greater, and the commitment of the Applicant to meet the consented noise limits, noise levels at these NSRs will meet the noise limits by a reasonable margin.

9.10.30 Given the limited level of existing exposure of these NSRs to wind turbine noise, the duration of exposure at these NSRs will increase concurrently with the level of exposure as a result of the Proposed Development.

9.10.31 At NSRs which are already exposed to wind turbine noise from the existing Ore Brae and Gable End Theatre turbines (NSR12 – NSR18) the duration and level of exposure will also increase, however, given the similarity of the orientation of the Proposed Development to the Ore Brae turbine at the majority of these NSRs, the range of wind directions under which maximum exposure to wind turbine noise will not increase substantially. This will limit the increase in the duration of exposure.

9.10.32 With reference to Appendix 9.7, the Ore Brae turbine is the dominant contributor to overall noise levels (Proposed Development plus cumulative turbines) at NSR14 at wind speeds from 4 m/s – 12 m/s. Interrogation of the noise model indicates that noise from existing cumulative turbines is also dominant at NSR12, NSR13, NSR15, NSR16, NSR17 and NSR18 over the majority of the wind speed range.

9.10.33 The situation is less consistent at NSRs further from the Ore Brae turbine and close to the Gable End Theatre turbine, with the dominant contributor dependent on wind speed. It may be assumed that the level of exposure to wind turbine noise at these NSRs will increase.

Proposed cumulative noise limit

9.10.34 On the basis of the above, this assessment considers that a 35 dB ONL is overly restrictive to the Proposed Development, and that the 'three factors' provided in ETSU for justification of a higher limit are fulfilled.

9.10.35 Should a 35 dB ONL be applied, the existing contribution to overall noise levels by small turbines would result in a significant reduction to the generating capacity of the Proposed Development, despite the Proposed Development resulting in a generally minor to moderate increase in the level and duration of noise exposure at comparatively small number of dwellings, and being able to meet the 35 dB ONL when operating in isolation with minimal need for mitigation.

9.10.36 Although the mitigation requirements are reduced, a similar significant reduction in generating capacity would be experienced should the 38 dB ONL be adopted.

9.10.37 The ONL should therefore be set at a value of 40 dB; this would minimise the loss of potential generating capacity of the Proposed Development by allowing higher levels of cumulative noise at a small number of NSRs. The generating capacity of the Proposed Development would be substantially compromised by setting the ONL at 35 dB or 38 dB. This approach is in accordance with policy outlined through ETSU-R-97 in setting the minimum ONL. Many wind farms in similar situations have been consented with an ONL of 40 dB.

9.10.38 With reference to Table 9.17, given that the Proposed Development meets derived noise limits during operation in isolation, and noise issues only become significant when cumulative turbines are considered, the Proposed Development may request a larger share, or sole use of the entire ONL (if either 35 dB or 38 dB were selected), if the cumulative turbines were decommissioned. It is assumed that this could be incorporated into the planning condition.

Decommissioning

9.10.39 The Applicant is seeking in-perpetuity consent for the Proposed Development. However, should the planning authority decide to limit the consent, at the eventual time of decommissioning the Applicant will decommission the Proposed Development following the operational lifespan. It is anticipated that the mitigation required and the significance of the residual effects of decommissioning the Proposed Development will be similar to, or lesser than, those identified within this chapter for the construction phase.

9.11 Additional Mitigation and Enhancement

9.11.1 The Applicant has committed to meeting noise limits for the Proposed Development agreed through the consenting process.

9.11.2 Final turbine selection will be undertaken with a view to achieving compliance and minimising the amount of curtailment (subject to the eventual ONL applied). This assessment has been undertaken using the Vestas V136. Should a different turbine model be chosen then a supplementary noise assessment will be undertaken to confirm compliance with the derived noise limits. A warranty covering the noise emissions of the selected turbine will be obtained from the turbine supplier/manufacturer.

9.11.3 In the event of a noise complaint, a noise assessment will be commissioned by the Applicant to determine compliance with the consented noise limits. Should any exceedances of noise limits attributable to the Proposed Development be identified, the Applicant will either implement an operational noise management plan, or amend its existing plan, such that noise limits are met.

9.12 Residual Effects

Construction

9.12.1 No requirement for specific additional mitigation (beyond good practice measures) has been determined for the construction phase, therefore no additional mitigation is proposed, and residual effects remain unchanged, and are therefore not significant.

Operation

Fixed non-turbine plant

9.12.2 No additional mitigation is required for fixed non-turbine plant, therefore residual effects remain unchanged, and are therefore not significant.

9.12.3 **Noise from wind turbines**

9.12.4 As noted above, the Applicant has committed to meeting the consented noise limits of the Proposed Development. Following selection and procurement of the final turbine model, and implementation of an appropriate turbine noise management plan, if required, it is anticipated that operational wind turbine noise levels will meet the derived noise limits at all NSRs across the full range of wind speeds, both during the daytime and the night-time periods.

9.12.5 With reference to Table 9.11 and Table 9.13 and Appendix 9.6 Table 13 and Table 15, the residual impact magnitude and effect significance at NSR14, assuming example curtailment strategies (where required) are put in place, is **low** and the effect significance is **minor adverse** and not significant. At all other NSRs the impact magnitude and effect significance will be lesser than at NSR14. Residual noise effects associated with operation of the Proposed Development are therefore not significant.

9.13 Summary

9.13.1 This chapter has considered potential noise effects associated with construction and operation of the Proposed Development. No potential vibration effects have been identified and consideration of vibration has therefore been scoped out.

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

9.13.3 Baseline noise levels in the study area are typically dominated by the wind and the sea, and show a strong correlation with wind speed. Noise from anthropogenic sources, such as road traffic, is a minor contributor to total noise levels.

9.13.4 Predicted noise levels associated with construction activities meet threshold noise levels set out in the relevant guidance at all identified representative NSRs, during weekday daytimes and Saturday mornings. Noise effects from construction activities are therefore not significant.

9.13.5 The predicted increase in road traffic noise levels associated with construction traffic will be in the region of 3 dB, however, given very low absolute traffic flows, and the negligible contribution of existing road traffic to ambient noise levels, this has therefore been assessed as being of minor significance. Noise effects from construction activities are therefore not significant.

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

9.13.7 The Applicant has committed to meeting the consented noise limits for the Proposed Development. Predicted wind turbine noise levels associated with operation of the Proposed Development in isolation meet derived noise limits during the daytime period at all identified representative NSRs, with minimal requirement for mitigation. Predicted noise levels for operation in isolation meet the night-time noise limits at all NSRs. Noise effects due to operation in isolation are therefore not significant.

9.13.8 In cumulative operation with existing wind turbines, additional mitigation may be required, depending on the consented daytime period ONL. This assessment considers that the ONL during the daytime period should be set with a FML of 40 dB, to account for the noise contribution of existing small turbines. No mitigation is required to meet the night-time ONL in cumulative operation. Taking into account committed mitigation, noise effects during the daytime and night-time periods are not significant.

Table 9.18 – Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure (committed and additional)	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction					
Noise from construction activities	Minor	Adverse	Implementation of appropriate noise controls regarding hours of work, timing of site deliveries, and use of best practice to minimise unnecessary noise	Minor	Adverse
Noise from construction traffic	Minor	Adverse	Implementation of appropriate noise controls regarding hours of work, timing of site deliveries, and use of best practice to minimise unnecessary noise	Minor	Adverse
Operation					
Noise from non-turbine fixed plant	Minor	Adverse	Selection of plant which complies with specified maximum sound power level such that the derived noise limits are met.	Minor	Adverse
Noise from wind turbines	Minor	Adverse	Subject to the selection of the daytime period Overall Noise Limit, a noise management plan may be required such that Residual Noise Limits are met at all NSRs.	Minor	Adverse

Table 9.19 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
All NSRs	Cumulative wind turbine noise	Ore Brae and Gable End Theatre wind turbines.	Minor	Adverse

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