7. Noise

7.1 Introduction

7.1.1 This chapter assesses the potential effects on noise sensitive receptors ('NSRs') surrounding the Development Site, as a result of the Proposed Development. This chapter should be read in conjunction with **Chapter 3 – Description of the Proposed Development** of the EIA Report**.**

7.1.2 Noise can have an influence on the environment and on the quality of life enjoyed by individuals and communities. Noise is often therefore an important consideration in the determination of planning applications. This assessment considered the likely noise effects predicted to arise during the construction, operation and decommissioning of the Proposed Development.

7.1.3 Construction noise effects are normally of a temporary nature and result from both moving and static sources. Assessment allows the temporary impact of construction noise to be understood and for suitable mitigation measures to be identified to minimise any potential significant adverse effects.

7.1.4 When operational, wind turbines emit two types of noise – mechanical noise and aerodynamic noise. The main sources of mechanical noise are from internal components housed within the nacelle, such as the gearbox and generator. Mechanical noise from a modern wind turbine is negligible, as the nacelles are insulated to reduce noise emissions and the various mechanical components housed within the nacelle are acoustically isolated to prevent structure-borne noise. Aerodynamic noise occurs from the movement of the blades passing through the air. At higher wind speeds, aerodynamic noise is usually masked by the increasing sound of wind blowing through trees and around buildings. The level of masking determines the perceived audibility of the wind farm. This noise impact assessment established the relationship between wind turbine noise and the natural masking noise and assesses levels against established standards.

7.1.5 This chapter includes an assessment of construction and operational noise from the Proposed Development, and also considers the cumulative effects from existing, consented and proposed wind farms. Decommissioning noise is generally considered less or, at worst, similar to that experienced during the construction period; hence, a specific assessment of the decommissioning noise has not been undertaken, on the basis that the same conclusions and mitigations of the construction assessment would apply.

7.1.6 The assessment methodology adopted, including proposed monitoring locations, has been agreed with the relevant Environmental Health Officer ('EHO') at East Ayrshire Council ('EAC').

7.1.7 Following a summary of relevant policy and legislation, this chapter describes the adopted assessment methodology, the overall baseline conditions and how the design of the project evolved (incorporating embedded mitigation measures) from a noise specific viewpoint. The scope of the assessment and a detailed assessment of the likely significant effects are presented, along with details of any environmental measures required to avoid, minimise, mitigate or compensate for any remaining adverse noise effects.

7.1.8 While the final choice of turbine for the Development Site will follow a competitive tendering process, the candidate turbine considered for the purposes of this noise

assessment is the Vestas V136,with a maximum height to blade tip of 149.9m and hub height of approximately 82m.

7.2 Limitations of this Assessment

7.2.1 No limitations relating to noise have been identified that affect the robustness of the assessment of potentially significant effects as a result of the Proposed Development.

7.3 Relevant Legislation, Planning Policy, Technical Guidance

Policy and Legislative context

7.3.1 The key national guidance document, which provides guidelines on the assessment of noise in Scotland, is Planning Advice Note 1/2011 (PAN 1/2011). PAN 1/2011 does not aim to provide a definitive source of guidance on noise issues; however, it does set out the range of noise issues that determining authorities need to be aware of in formulating development plans and making decisions on planning applications. With regards to the noise effects of wind farms it states:

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

7.3.2 The web-based renewables advice referred to within PAN 1/2011 gives specific advice in relation to noise emanating from on-shore wind turbines, stating:

'The Report, 'The Assessment and Rating of Noise from Wind Farms' (ETSU-R-97) describes a framework for the measurement of wind farm noise, which should be followed by applicants and consultees, and used by planning authorities to assess and rate noise from wind energy developments, until such time as an update is available. This gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable burdens on wind farm developers, and suggest appropriate noise conditions.'

7.3.3 The Onshore Wind: Policy Statement 2022 refers to ETSU-R-97, stating, '[t]*he Assessment and Rating of Noise from Wind Farms' (Final Report, Sept 1996, DTI), (ETSU-R-97) provides the framework for the measurement of wind turbine noise, and all applicants are required to follow the framework and use it to assess and rate noise from wind energy developments… Until such time as new guidance is produced, ETSU-R-97 should continue to be followed by applicants and used to assess and rate noise from wind energy developments.*'

7.3.4 Consequently, the assessment methodology adopted was that found in the ETSU-R-97 Guidance. The advice presented in the ETSU-R-97 Guidance was produced by the Working Group on Noise from Wind Turbines, a body comprising a number of interested parties including, amongst others, wind farm operators, Environmental Health Officers, acoustic consultants, and legal experts. The assessment approach was developed to address the shortcomings of other standards in addressing wind farm noise.

7.3.5 **Table 7.1** details the planning policy and guidance relevant to this noise assessment.

Table 7.1 Relevant planning policy and guidance

Policy / Guidance Reference	Policy / Guidance Issue	Considered in Section
National Planning Advice		
Planning Advice Note 1/2011	PAN 1/2011 provides general guidance and advice on the role of the planning system in helping to prevent and limit the adverse effects of noise.	Whole chapter
Onshore Wind: Policy Statement 2022	Chapter 3: Environmental Considerations: Achieving Balance and Maximising Benefits, in particular Section 3.7, advocates the use of ETSU-R-97 as the framework for the measurement and assessment of noise from wind energy developments.	Whole chapter
National Planning Framework 4 (NPF4) (2023)	The NPF4 Energy Policy Intent is: *'To encourage, promote and facilitate all forms of renewable energy development onshore and offshore. This includes energy generation, storage, new and replacement transmission and distribution infrastructure and emerging low-carbon and zero emissions technologies including hydrogen and carbon capture utilisation and storage ('CCUS').'* The NPF4 Health and Safety Policy Intent is: *'To protect people and places from environmental harm, mitigate risks arising from safety hazards and encourage, promote and facilitate development that improves health and wellbeing.'* The following policies relate to noise and wind farms: **Policy 11** *'a) Development proposals for all forms of renewable, low-carbon and zero emissions technologies would be supported. These include:* *i. wind farms including repowering, extending, expanding and extending the life of existing wind farms;…* *e) In addition, project design and mitigation would demonstrate how the following impacts are addressed:* *i. impacts on communities and individual dwellings, including, residential amenity, visual impact, noise and shadow flicker;….'* **Policy 23** *'e) Development proposals that are likely to raise unacceptable noise issues would not be supported. The agent of change principle applies to noise sensitive development. A Noise Impact Assessment may be required where the nature of the proposal or its location suggests that significant effects are likely.'*	Whole chapter

Policy / Guidance Reference	Policy / Guidance Issue	Considered in Section
Local Policies		
East Ayrshire Council Local Development Plan (2017)	The Local Development Plan policies relevant to the EIA Report Chapter are: • Policy RE3: Wind energy proposals over 50 metres in height; • Schedule 1: Renewable Energy Assessment Criteria; and Policy ENV12: Water, air and light and noise pollution.	Whole chapter
East Ayrshire Local Development Plan Supplementary Guidance: Planning for Wind Energy (2017)	This document states: *'All proposals for turbines of over 50 metres to blade tip should be accompanied by a full detailed assessment of the noise impacts of the proposal, in line with ETSU-R-97 standards, which outlines a framework for measuring noise. Applicants should refer to the Institute of Acoustics* 'A Good Practice Guide to the Application of ETSU-R-97 For the Assessment and Rating of Wind Turbine Noise'. *The Council would only support proposals where it can be clearly evidenced that the noise levels would not significantly impact on residential amenity.'*	Whole chapter
East Ayrshire Council Local Development Plan 2 – Proposed Plan (2022)	The proposed Local Development Plan policies relevant to the EIA Report Chapter are: • Policy SS2: Overarching Policy; and • Policy NE12: Water, air, light and noise pollution. Policy RE1: Renewable Energy	Whole chapter
Guidance Relating to Construction Noise		
BS5228:2009+A1:2014 Noise control on construction and open sites' Part 1: Noise	Detailed guidance on assessing noise from construction sites.	Section 7.4 and 7.10
Calculation of Road Traffic Noise (CRTN)	CRTN provides methodology for predicting noise levels due to road traffic.	Section 7.4 and 7.10
Design Manual for Roads and Bridges LA111: Noise and Vibration (DMRB)	Provides guidance on the assessment of impacts from noise and vibration that may result from road projects.	Section 7.4 and 7.10
Guidance on the Assessment of Noise from Wind Farms		
ETSU-R-97, 'The Assessment and Rating of Noise from Wind Farms', The Working Group on Noise from Wind Turbines	Information and advice to developers and planners on the environmental assessment of noise from wind turbines. The guidance offers a framework for the measurement of wind farm noise and gives indicative noise levels that offer a reasonable degree of protection to wind farm neighbours.	Section 7.5 and 7.10
Institute of Acoustics 'A Good Practice Guide to the Application of ETSU-R-97 for	A good practice guide ('GPG') produced by a noise working group setup by the Institute of Acoustics (IoA) presenting current good practice in the application of	Section 7.5 and 7.10

Policy / Guidance Reference	Policy / Guidance Issue	Considered in Section
the Assessment and Rating of Wind Turbine Noise'	ETSU-R-97 assessment methodology for wind turbine developments above 50kW.	

7.4 Construction Noise Modelling

Direct Effects

7.4.1 During the construction period, a range of different activities could take place within the Development Site. Due to the minimum distance of approximately 4.2km between the proposed turbines and the nearest NSRs, construction noise is unlikely to result in significant effects.

7.4.2 However, as a worst case, a construction noise assessment has been undertaken, based on impact piling. The results will be assessed against criteria provided in BS 5228-1:2009+A1:2014. Annex E, The ABC Method. **Table 7.2** is Table E.1 from BS 5228-1:2009+A1:2014.

Table 7.2 Example of threshold of potential significant effect at dwellings

Assessment category and threshold value period	Threshold value, in decibels (dB) ($L_{Aeq, T}$)		
	Category A [A)]	Category B [B)]	Category C [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 noise 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.

7.4.3 The precise construction methodology for the Proposed Development will not be finalised until such time as a construction contractor is commissioned, and, as such, the actual plant to be used is unknown. The plant given in **Table 7.3** was therefore based upon a worst-case scenario of impact piling, using data located in Appendix C of BS 5228-1:2009+A1:2014.

Table 7.3 Construction Plant Source Data

Plant	BS 5228-1:2009+A1:2014 Reference	dB $L_{Aeq,T,T}$ at 10m	Number of Plant	Total Sound Power Level L_{WA} dB(A)
Hydraulic hammer rig	Table C.3 Item 1	89	1	117

7.4.4 Predictions of noise immissions have been carried out for impact piling using the plant in **Table 7.3**, assuming that the plant would operate at the point of closest approach to each receptor. It has been assumed within the calculations that all plant would operate 100% of the time, therefore a 'worst-case' scenario.

7.4.5 Whilst other plant would also be on site during the impact piling works, it is anticipated that all other plant would be at least 10 dB quieter than the hydraulic hammer rig and would therefore not change the overall results.

7.4.6 A hydraulic hammer rig has been chosen as a worst-case scenario as this plant has the highest $L_{Aeq,T}$ at 10m in Annex C of BS 5228-1:2009+A1:2014.

Decommissioning

7.4.7 For impact assessment purposes, the EIA Report assumes that the project will be decommissioned at the end of its operational life. It is typically assumed that decommissioning noise should be generally less or, at worst, similar to that experienced during the construction period. It is therefore assumed that noise effects relating to the decommissioning of the Proposed Development would be no more significant than those experienced during construction; provided similar restrictions on working hours and transport routes are applied. Therefore, a specific assessment of the decommissioning noise has not been undertaken, on the basis that the same conclusions and mitigation of the construction assessment would apply to decommissioning.

Indirect Effects

Site traffic

7.4.8 Traffic noise due to construction has the ability to give rise to significant effects for NSRs lining the construction traffic route. **Chapter 14 – Traffic and Transport** of the EIA Report identifies the following construction traffic movements during the peak construction time and is therefore, considered to be a worst-case scenario:

- a maximum total average daily flow of 71 HGVs (including arrivals and departures from site), which is equivalent to a flow rate of 6 vehicles per hour, assuming a 12-hour working day.

7.4.9 In order for the construction traffic to result in potential significant noise impacts, an increase of more than 100% in the traffic flow would be required as this is equivalent to a 3dB increase in noise. As there would not be a 100% increase in traffic flow along the B741, NSRs lining this road are scoped out of the construction noise assessment.

7.4.10 It is anticipated that Afton Road, which has residential receptors lying within 300m of the edge of the road, would experience an increase in traffic flow greater than 100%. However, the existing baseline flow is likely to be less than 250 vehicles an hour - based on a review of aerial imagery. Therefore, the calculation and assessment methods presented within CRTN and DMRB are not suitable, and it would be appropriate to assess

the significance of noise based on the criteria outlined in **Table 7.2,** in line with BS 5228-1:2009 + A1:2014. Whilst the construction traffic movements are likely to increase the ambient noise levels along Afton Road, it is unlikely that the addition of a maximum of 71 HGV movements a day would exceed the threshold criteria outlined in **Table 7.2**, and therefore NSRs lining this road are scoped out of the construction noise assessment.

7.5 Operational Noise Modelling

Research Background

7.5.1 In May 2013, the Institute of Acoustics (IoA) published '*A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IoA GPG). The IoA GPG is as a result of a comprehensive public consultation process and was produced and peer reviewed by a number of noise consultants who act on behalf of both developers and opponents of wind farms, some of whom sat on the ETSU-R-97 Noise Working Group.

7.5.2 The use of the IoA GPG in the assessment of wind turbine noise has been endorsed by Scottish Government. John Swinney MSP, Cabinet Secretary for Finance, Employment and Sustainable Growth, stated in a letter to the IoA on 29th May 2013:

'In view of the careful, expert work and consultation that has informed the Good Practice Guide, I am happy to accept that it represents current industry good practice.'

7.5.3 Whilst the IoA GPG does not examine the noise limits set out within the ETSU-R-97 Guidance, it does present good practice in its application for wind developments greater than 50kW. The assumptions listed in the section below are all confirmed within the IoA GPG as the correct approach to modelling wind turbine noise emissions.

7.5.4 In line with the IoA GPG, the model used in this assessment was based upon that found in ISO 9613-2 *'Acoustics - Attenuation of sound during propagation outdoors'*. The model considered:

- geometric divergence (attenuation with distance);
- air absorption;
- barriers (including buildings or topography);
- screening (including vegetation); and
- ground absorption and reflection.

7.5.5 The ISO 9613-2 algorithm has been chosen as being the most robust prediction method; based on the findings of a joint European Commission research project into wind farm noise propagation over large distances. According to this research, this model (like all the others considered in the research) tends to over-estimate noise levels at nearby dwellings, rather than under-estimate them. The conclusion of the study was that the ISO 9613-2 algorithm tended to predict noise levels that would generally occur under downwind propagation conditions.

7.5.6 Another important outcome of the research demonstrated that under upwind propagation conditions, between a given receiver and the wind farm, the wind farm noise level at that receiver would be as much as 10dB(A) to 15dB(A) lower than the level predicted based on ISO 9613-2.

Operational Noise Modelling for the Proposed Development

7.5.7 For the purposes of the assessment, noise level predictions have been based upon the following assumed model parameters, all of which are advocated within the IoA GPG:

- a receiver height of 4.0 metres above local ground level – to represent the height of a typical bedroom window;
- mixed ground (G = 0.5) – this represents a ground cover that has equal amounts of fully reflective and fully absorptive character. For the purposes of this assessment, mixed ground represents a ground cover that is as equally absorptive of noise as it is reflective;
- air absorption based on a temperature of 10°C and 70% relative humidity;
- $L_{A90,\ 10min}$ is 2dB less than $L_{Aeq,\ 10min}$ for wind farm noise; and
- predicted turbine noise levels inclusive of any 'Canyon Effect' penalty (discussed below).

7.5.8 These assumptions are considered conservative in terms of the existing site. An example of this is, that in reality, ground cover is likely to be more absorptive than reflective due to a large amount of soft ground in the area.

7.5.9 An assessment of cumulative noise impacts at sensitive receptors has included wind developments that are likely to produce noise levels within 10dB of those from the Proposed Development. Conversely, where it has been demonstrated that the Proposed Development is likely to produce noise levels at least 10dB lower than those of an existing or proposed development, then the impact of the Proposed Development upon cumulative noise immissions (i.e., the noise levels at the receiver position) at that receptor is considered negligible. This approach is advocated within the IoA GPG. The developments considered are discussed in **Section 7.10**.

Concave Ground Effect

7.5.10 The IoA GPG recommends that a noise correction should be applied in circumstances where the intervening terrain height between a proposed wind development and sensitive receptors drops away significantly. The correction is to account for the effective decrease in ground absorption at higher propagation paths. Where a 'concave ground effect' is shown to occur, a penalty of 3dB (or 1.5dB if a ground absorption factor of 0 is being used) is applied to the overall predicted noise level at receptors.

Significance Evaluation Methodology

Overview of Construction and Decommissioning Noise Assessment Procedure

7.5.11 For construction phase emissions, it is standard industry practice to refer to the guidance relating to acceptability presented within BS 5228-1:2009+A1:2014. The appropriate noise limit for a project in an area such as the Development Site would be 65 dB $L_{Aeq,\ 12h}$ (or $L_{Aeq,\ T}$) during the daytime (07:00-19:00 weekdays, 07:00-13:00 Saturday). This aligns with Category A threshold values shown in **Table 7.2** (i.e., baseline ambient noise levels during 07:00 – 19:00 weekdays and 07:00 – 13:00 Saturdays are assumed to be below 65 dB. when rounded to the nearest 5 dB).

7.5.12 The limit is applicable to all construction activities taking place on site, including all fixed and mobile plant operations associated with the Proposed Development, and including the movement of HGVs on site.

Overview of Operational Noise Assessment Procedure

7.5.13 ETSU-R-97 Guidance advises (Paragraph 3, page 4) within the context of wind energy:

'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'

7.5.14 The EIA Regulations require that all likely 'significant' effects are identified. Most of the noise related guidance and standards (including the ETSU-R-97 Guidance**Error! Bookmark not defined.**) are not directly related to the concepts of 'significant' and 'not significant' that underpin the EIA process. However, for the purposes of this assessment, the determination of effect significance for each phase of the development is based upon compliance with the applicable noise limit; i.e., breach of the noise limits indicates a 'significant' effect, whereas compliance with noise limits indicates a 'not significant' effect. As noise levels exceeding the ETSU-R-97 Guidance noise limits are deemed to be 'significant', they would require further consideration with a view to appropriate mitigation being identified.

7.5.15 ETSU-R-97 Guidance provides a simplified approach, if predicted operational noise at receptors is limited to an $L_{A90,10min}$ of 35 dB in wind speeds up to 10ms^{-1} at 10m height. Preliminary modelling for the Proposed Development indicated that operational noise was likely to exceed this threshold at a number of surrounding properties. The ETSU-R-97 Guidance therefore recommends that wind farm noise limits should be set relative to existing background noise levels, subject to a fixed minimum limit, and that these limits should reflect the variation in background noise with wind speed. The wind speeds that should be considered range from the wind turbine 'cut-in' speed (i.e., the wind speed at which the turbine begins to operate, typically 4 ms^{-1}) up to 12 ms^{-1}, the point at which wind turbines are usually at or above 95% of their rated power and thus no significant increases in noise emission from the turbines are expected beyond this speed. Wind speeds are referenced to a 10 m measurement height (V_{10}) on the wind farm site.

7.5.16 The daytime noise limit is derived from background noise data measured at residential properties during the 'quiet daytime', as defined in the ETSU-R-97 Guidance, which comprises:

- weekday evenings from 18:00 - 23:00;
- Saturday from 13:00 - 23:00; and
- all day Sunday 07:00 - 23:00.

7.5.17 The noise measurements are plotted against the concurrent wind speed data measured at the Development Site and a 'best fit' correlation is established.

7.5.18 In low noise environments (i.e. where background noise levels are less than 30-35 dB, the ETSU-R-97 Guidance recommends that wind farm noise for daytime periods (07:00 – 23:00) should be limited to a lower fixed level within the range 35-40 dB $L_{A90,10min}$ or 5 dB above the prevailing background noise level, whichever is the greater. The choice of which lower fixed level to use within the range is based upon a number of factors as outlined in Paragraph 22 of the ETSU-R-97 Guidance. These include:

- the number of dwellings in the neighbourhood of the wind farm;
- the effect of noise limits on the amount of electricity generated; and
- the duration and level of exposure.

7.5.19 Given that there are no dwellings in close proximity to the Proposed Development, with the closest residential receptor to a proposed turbine locations being approximately 4.2 km away, and the generating capacity of the Proposed Development, a lower fixed daytime noise limit of 35 dB $L_{A90, 10min}$ (or 5 dB(A) above background, whichever is greater) has been applied to this assessment.

7.5.20 The night-time noise limit is derived from the background noise data measured during the night-time period of 23:00 to 07:00 every day. As with the daytime data, this is plotted against the concurrent wind speed data and a 'best fit' correlation established. A noise limit of 43 dB L_{A90} or 5dB above background (whichever is greater) has been used for the night-time noise assessment, in line with the ETSU-R-97 guidance. For an assessment of cumulative impacts, the lower fixed level of 40 dB L_{A90} has been used to assess daytime noise levels and 43 dB L_{A90} for night-time noise levels. This is in accordance with the guidance provided in the ETSU-R-97 that 43 dB L_{A90} is appropriate when background noise levels are low, as in this instance.

7.5.21 The ETSU-R-97 Guidance noise criteria assume that the wind turbine noise contains no audible tones. Where tones are present, a correction is added to the measured or predicted noise level before comparison with the recommended limits. The level of correction would depend on how audible the tone is. A warranty would be sought from the turbine manufacturers selected for the Proposed Development, such that the noise output would either not require a tonal correction (under the ETSU-R-97 Guidance) or, where tonal corrections are required, the noise criteria would be met having made the appropriate correction for any tonal component.

7.5.22 Wind farm noise assessment is part of an iterative design process, the aim of which is to achieve a design from which noise emissions meet limits derived following the approach given in ETSU-R-97 and/or relevant local guidelines. Where this can be achieved, the design of the scheme is such that necessary operational noise limits are met, and no additional mitigation measures are required.

7.6 Baseline Conditions

Current baseline

7.6.1 The Development Site is located in a semi-rural area with the most notable noise source being occasional traffic on the B741. Afton Road lies approximately 4.5km east of the turbine locations and is expected to have a low traffic flow.

7.6.2 The closest operational wind farm to the Proposed Development is the 22MW Brockloch Rig extension (planning reference 16/1852/S36) approximately 1.3km south of the Development Site. This wind farm was not audible during the site visits and computer noise modelling does not indicate that this would currently have a significant contributory effect on the noise environment at assessed NSRs.

Wind Shear

7.6.3 The level of wind shear at a particular location defines the relationship between wind speeds at different heights. A low level of wind shear means that the wind speed at the hub height of the turbines is not much greater than that near the ground, whereas a high level of wind shear means that the wind speed at hub height is significantly greater than that near the ground.

7.6.4 Wind turbine manufacturers reference their turbine noise emissions to a 10m height wind speed, assuming a standard level of wind shear in their calculations, the implication being

that should the site experience a high level of wind shear, for a particular 10m height wind speed, the wind speed at hub height might be greater than assumed within the noise modelling, and thus wind turbine noise levels would be greater for the same background noise level.

7.6.5 The moderately complex terrain of the Development Site is such that the potential for a high level of wind shear is relatively low compared to sites which are located in lowland areas with less variable topography (i.e., 'flat' landscapes). Nevertheless, to ensure that the assessment fully addressed the issue and complied with the IoA GPG, simultaneous 10-minute averaged wind speed and direction data was recorded on the Development Site at a height equivalent to the proposed 82m hub-height as part of the 2015 Enoch Hill ES. Details of the meteorological measurements taken can be found in Appendix 7.C of that report.

7.6.6 The wind speeds at 10m height, against which the noise limits are derived, were calculated as follows:

- the wind speeds at the 80m hub-height have been measured using the anemometry mast for each 10-minute period; and
- the 80m hub-height wind speed was then converted to a 10m height using a standard roughness length of 0.05m, as assumed by turbine manufacturers in certifying turbine noise emissions, to maintain the requirement of the ETSU-R-97 Guidance of deriving noise limits referenced to a 10m height.

7.6.7 Thus, the noise assessment effectively compared measured background noise levels with potential worst case wind speeds at hub-height.

Enoch Hill Planning Application (2015) survey

7.6.8 A total of 5 No. locations were originally selected for background noise monitoring. However, as access to the property at Maneight could not be secured, EAC agreed that the noise monitoring results at Meikle Hill could be used as a proxy.

7.6.9 Monitoring positions are shown in **Figure 7.1** and are listed in **Table 7.4**.

Table 7.4 Monitoring positions

Ref	Location	Easting	Northing	Monitoring Position
M1	Meikle Hill	253464	608875	The sound level meter ('SLM') was located to the south-west of the main house. The SLM was deployed in a free-field position, more than 10m from the façade of the main house. The main contributor to the noise environment at this location was from occasional road traffic movements along the B741. Additional noise contributions were from wind in the trees to the west of the monitoring location, and from sheep in an adjacent field. The SLM was deployed to the south-west of the main house as this area was considered to be the property's main amenity area. The SLM location was also on the side of the property away from the B741.
M2	Knockburnie	256177	610457	The SLM was located to the west of the main property, in a 'free-field' position, more than 10m from the closest reflecting façade. The main contributors to the noise environment during kit deployment were noted as occasional road traffic

Ref	Location	Easting	Northing	Monitoring Position
				movements along the B741 and from occasional HGV accessing the 'House of Water' quarry to the northwest. The SLM was located away from the main property in order to avoid noise impacts from the working farm.
M3	Dalleagles Terrace	257635	610587	The SLM was located in the rear garden, to the south of the property. The SLM was deployed in a free-field position more than 10m from the main house, and 4m from a garden out-house. The noise environment at the SLM location was dominated by occasional road traffic movements along the B741 to the north of the property. Additional contributions to the noise environment from bird song were noted. The SLM location was chosen as it was on the opposite side of the property to the B741, which was the dominant noise source.
M4	Brochloch	259458	610538	The SLM was located in a 'free-field' position, to the north-east of the property, more than 4m from the closest acoustically reflective façade. The SLM was located in a 'court-yard' area, so that it was sheltered from the wind in trees, to the west of the property. Contributions to the noise environment included bird song and distant road traffic noise.

7.6.10 Unattended, long-term monitoring of background noise levels was undertaken at these four locations between 23rd June 2014 and 21st July 2014, ensuring there were at least three weeks of continuous noise measurements at each location. The length of the noise survey ensured a good distribution of wind speeds and directions to correspond with the noise level results at each monitoring location.

Baseline Assumptions

7.6.11 It has been assumed that the prevailing baseline noise conditions have not changed significantly from those presented within the 2015 Enoch Hill Wind Farm ES (this is supported by anecdotal evidence from site visits by other technical specialists during the intervening period). The results of background noise monitoring, and the associated noise limits derived using methodology advocated within the ETSU-R-97 Guidance, therefore remain applicable for the EIA report. Furthermore, as the baseline noise level normally increases over time, the use of the previous background noise level to represent residential receptors is considered a conservative approach.

7.7 Data Gathering Methodology

Study Area

7.7.1 The study area for this assessment covers the closest residential receptors in each direction from the Development Site.

Desk Study

7.7.2 The baseline information within this chapter is largely based upon data used within the 2015 EIA report and 2017 FEI for Enoch Hill Wind Farm. Sources of information used for the noise assessment are listed in **Table 7.5**.

Table 7.5 Sources of turbine information

Site	Turbine Type	Source
Afton	Gamsea G80	Sanquhar II Environmental Statement
Benbrack	Vestas V136*	Benbrack Finalises Turbine Contract with Vestas
Enoch Hill	Assessment 'Envelope'	Enoch Hill Wind Farm Variation Application
Enoch Hill 2	Vestas V136	Vestas V136-4.0/4.2 MW Third octave noise emission
Euchanhead	Vestas V150	Euchanhead Renewable Energy Development. Technical Appendix 13.1 - Environmental Noise Assessment
Greenburn	Vestas V136	Greenburn Wind Park EIA Report
Hare Hill	Vestas V47	Sandy Knowe Environmental Statement Technical Appendix
Hare Hill Extension	Gamesa G52	Sandy Knowe Environmental Statement Technical Appendix
High Park Farm	Vestas V52	Performance Specification V52-850kW 50/60Hz
Lorg	Vestas V162	Lorg Wind Farm Environmental Statement
North Kyle	Vestas V136	North Kyle T49 Energy Project Revised Operational Noise Assessment
Pencloe	Siemens SWT-3.2-101	Pencloe Wind Farm Variation EIA Report
Over Hill	Senvion 3.4M 114	Over Hill Wind Farm, East Ayrshire Environmental Assessment
Sanquhar II	Enercon E-138 EP3	Sanquhar II Community Windfarm Volume 1a – EIA Report
Sanquhar Six	Senvion MM92	Sandy Knowe Environmental Statement Technical Appendix
South Kyle	Vestas V90	South Kyle Environmental Statement
Windy Rig	Vestas V112	Performance Specification V112-3.45MW 50/60 HzV112-3.45-Mk-50/60 Hz Third Octaves according to General Specification (DMS0049-1551 V01)
Brockloch Rig	Nordtank NTK600	Sanquhar II Community Windfarm Volume 1a – EIA Report
Brockloch Rig Extension	Senvion MM82	Sanquhar II Community Windfarm Volume 1a – EIA Report
Brockloch Rig Phase III	Siemens SWT-3.2-113	Brockloch Rig III Environmental Statement

Site	Turbine Type	Source
	Siemens SWT-3.2-82	

*Benbrack Wind Farm has placed an order with Vestas for 13 V136 turbines and 2 V117 turbines. As the placement of the different turbines is unknown, all turbines have been assumed to be V136 as a worst-case scenario.

7.7.3 Further non-turbine related information sources that informed the assessment are listed in **Table 7.6**.

Table 7.6 Other Data Sources

Organisation	Data Source	Data Provided
Google	Google Earth Pro 7.3.4.8248	Aerial Imagery
Ordnance Survey	OS Terrain 50	Terrain data

Survey Work

7.7.4 The data sources most relevant to the assessment of noise from the Proposed Development are those detailed within the 2017 Enoch Hill Wind Farm FEI and the comprehensive background noise survey undertaken in 2014 to inform the impact assessment for that (now consented) project.

Turbine data

7.7.5 A range of turbine models would be appropriate for the Proposed Development. The final turbine selection would follow a competitive tendering process and thus the actual model of turbine installed at the Development Site may differ from that upon which the assessment has been based. However, the final choice of turbine would be required to comply with the noise criterion levels which have been established within the noise assessment for the Proposed Development.

7.7.6 While the final choice of turbine is not confirmed, a candidate turbine suitable for use at the Development Site has been selected. The candidate turbine used for the purposes of this assessment is the Vestas V136, modelled on full power. **Table 7.7** below provides the candidate turbine sound power level referenced to 10m height with a +2dB uncertainty correction included, whilst **Table 7.8** shows the octave band sound power levels.

Table 7.7 Sound power levels used for Enoch Hill 2 turbines (+2dB uncertainty correction)

Candidate turbine	Sound power levels (dB L_{WA}) at standardised 10m height wind speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Vestas V136	97	102	106	106	106	106	106	106	106

Table 7.8 Octave band sound power levels used for Enoch Hill 2 turbines at different wind speeds (+2dB uncertainty correction)

Wind speed (m/s)	Sound power levels (dB L_{WA}) by octave band (Hz)							
	63	125	250	500	1000	2000	4000	8000
4	78	85	90	92	91	87	80	70
5	82	90	95	97	96	91	85	74
6	87	94	99	101	98	96	89	79
7	87	95	99	101	100	96	89	79
8	87	95	99	101	100	96	89	79
9	87	95	99	101	100	96	89	79
10	87	95	99	101	100	96	89	79
11	87	95	99	101	100	96	89	79
12	87	95	99	101	100	96	89	79

7.7.7 In addition to considering the noise effects from the Proposed Development in isolation, cumulative noise effects taking the closest existing, consented and in planning wind turbines within 10km of the Development Site have also been considered.

7.7.8 **Table 7.9** below outlines the identified wind farms for the cumulative assessment with sound power levels for associated turbine types presented in **Table 7.10**. Where turbine sound power data is unavailable, the closest match has been used.

Table 7.9 Cumulative wind developments

Wind Development Name	Status	Number of Turbines	Assumed Turbine Type
Afton	Operational	25	Gamesa G80
Benbrack	Consented	15	Vestas V136
Enoch Hill	Consented	16	Vestas V136
Euchanhead	In Planning	21	Vestas V150
Greenburn	In Planning	16	Vestas V136
Hare Hill	Operational	20	Vestas V47/660
Hare Hill Extension	Operational	35	Gamesa G52 850kW
High Park Farm	Operational	1	Vestas V52
Lorg Variation	In Planning	15	Vestas V162
North Kyle	Consented	49	Vestas V136

Wind Development Name	Status	Number of Turbines	Assumed Turbine Type
Overhill	Consented	10	Senvion 3.4M 114
Pencloe	Consented	19	Siemens SWT-DD-130
Sanquhar II	In Planning	50	Enercon E-138 EP3 4MW
Sanquhar Six	Consented	6	Senvion MM92 3.0 MW
South Kyle	Under Construction	50	Vestas V90 3MW
Windy Rig	Operational	12	Vestas V112/3450
Brockloch Rig	Operational	36	Nordtank NTK600/43
Brockloch Rig Extension	Operational	30	Senivon MM82 2.05
Brockloch Rig Phase III	Consented	20	Brockloch Rig Envelope

Table 7.10 Broadband sound power levels for cumulative wind farm assessment

Wind turbine development	Sound power levels (dB L_{WA}) at standardised 10m height wind speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Afton	98	103	105	105	105	105	105	105	105
Benbrack	97	102	106	106	106	106	106	106	106
Enoch Hill	97	102	106	106	106	106	106	106	106
Euchanhead	101	106	109	109	109	109	109	109	109
Greenburn	97	102	106	106	106	106	106	106	106
Hare Hill	101	102	102	102	103	103	104	104	105
Hare Hill Extension	98	102	106	107	108	108	108	108	108
High Park Farm	95	98	102	106	106	107	107	107	107
Lorg	101	105	108	109	109	109	109	109	109
North Kyle	97	102	106	106	106	106	106	106	106
Overhill	100	104	107	107	107	107	107	107	107
Pencloe	99	104	107	108	108	108	108	108	108
Sanquhar II	102	103	104	105	105	106	106	106	106
Sanquhar Six	94	99	102	105	105	105	105	105	105
South Kyle	100	104	107	108	109	109	107	107	107
Windy Rig	96	97	100	103	106	108	109	109	109

Wind turbine development	Sound power levels (dB L_{WA}) at standardised 10m height wind speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Brockloch Rig	100	101	102	103	104	105	106	107	108
Brockloch Rig Extension	97	102	106	106	106	106	106	106	106
Brockloch Rig Phase III	101	106	108	108	108	108	108	108	108

7.8 Consultation

7.8.1 EAC provided the EIA Scoping Opinion on 2nd April 2020. EAC stated that the appropriateness of the proposed methodologies and procedure to assess noise associated with the Proposed Development would need to be agreed with its noise consultant, ACCON, before reaching a view as to whether they are acceptable and agreeable.

7.8.2 EAC also gave comment to a number of other to details related to the noise assessment, which included:

- as a result of the final turbine models unlikely to be finalised prior to the submission of the EIA report, noise limits of the candidate turbine would need to comply with any noise limits set.
- a worst-case construction noise assessment should be included.
- the cumulative noise assessment should consider all existing, consented and application stage wind farms, including the recent Enoch Hill 1 variation application.

7.8.3 EAC noise consultants ACCON responded to the EIA scoping report on 17th June 2020. ACCON confirmed that the proposed methodologies in chapter 6 of the EIA scoping report were acceptable, however a number of comments and queries were raised:

- raised the need to re-analyse the noise data measured during the 2015 planning application, in order to account for the wind shear from proposed hub height of the development.
- indicated that the daytime noise limits should be derived from the baseline noise levels measured during the quiet daytime periods. ACCON also noted the preference noise limit during night-time of 38dB L_{A90} for the development in isolation for non-financially involved receptors.
- would expect that all of the receptors utilised in the Enoch Hill 1 planning application, also be considered for this assessment.

7.8.4 The majority of the points raised by both EAC and ACCON have been incorporated into the noise assessment. The ETSU limits however have been used for the night-time noise assessment of the development in isolation. The noise data measured in 2015 has not been re-analysed as for the purpose of this assessment a candidate turbine with a hub height of 82m has been assumed and therefore the wind data measured at 80m is acceptable.

7.9 Scope of the Assessment

7.9.1 The spatial scope considered for the noise assessment of the Proposed Development is the same as the one considered for the consented Enoch Hill Wind Farm variation (consented in 2020) and the same receptors are considered in the EIA Report chapter.

Potential Receptors

7.9.2 The eight assessed receptors are: R1 - Meikle Hill; R2 - Nith Lodge; R3 - Maneight; R4 - Knockburnie; R5 - Dalleagles; R6 - Dalleagles Terrace; R7 - Brockloch and R8 - Laglaff. These NSRs are shown on **Figure 7.1**.

7.9.3 It is noted that Craigdarroch Farmhouse is a NSR that lies approximately 4.7km to the east of the proposed turbine location. Given this is surrounded by other wind farms not related to the Proposed Development however, the focus of the operational noise assessment is on the receptors lining the B741.

7.10 Assessment of Noise Effects

Predicted Effects and their Significance (Development Only) – Construction

Direct Effects

7.10.1 Construction noise is transient in nature and can generally be controlled by following standard industry practices, applying best practicable means and using modern, well-maintained and serviced items of plant.

7.10.2 Predictions have been undertaken using the plant list and noise source levels given in **Table 7.3** for the nearest properties to the proposed turbine locations. The predicted noise levels during construction are given in **Table 7.11.**

Table 7.11 Construction noise assessment

Receptor	Distance from Closest Turbine (m)	Predicted dB $L_{Aeq, 1hr}$
R1 - Meikle Hill	5250	26
R2 - Nith Lodge	5450	26
R3 - Maneight	5100	26
R4 - Knockburnie	4500	28
R5 - Dalleagles	4200	28
R6 - Dalleagles Terrace	4150	29
R7 - Brockloch	4200	28
R8 - Laglaff	4300	28

7.10.3 The noise predictions confirm that the minimum noise guideline value of 65 dB(A) quoted in BS 5228-1:2009+A1:2014 and seen in **Table 7.2** would not be exceeded at any of the identified receptors should impact piling (the worst-case construction activities in terms of noise emission) be used. On this basis, construction noise is unlikely to have a 'significant' effect upon the closest assessed receptors.

Predicted Effects and their Significance (Development Only) - Operation

7.10.4 **Table 7.12** and **Table 7.13** present the following information for each wind speed for each of the eight assessed properties for daytime and night-time respectively:

- values of the quiet day-time amenity and night-time background noise curve at the integer wind speeds, measured and adjusted for wind shear;
- the quiet day-time amenity and night-time noise limits derived from the background noise curve, in accordance with the ETSU-R-97 Guidance;
- the predicted turbine noise levels from the Proposed Development based on worst-case downwind noise propagation at receptors, assuming turbines are operating simultaneously; and
- the margin by which the predicted turbine noise meets the noise limits at each wind speed using the worst-case downwind noise predictions (negative values (blue) indicate the predicted noise levels are lower than the noise limits, whilst red denotes an exceedance).

7.10.5 It should be noted that the predicted turbine noise is equal for both the day and night-time periods and the assessments are presented separately to take account of the different noise limits which are applicable during these two periods.

Table 7.12 Daytime noise assessment

Noise parameters, $L_{A90,\ 10\ min}$, dB	**Standardised 10m Height Wind Speed (V_{10}) ms^{-1}**								
	4	5	6	7	8	9	10	11	12
R1 - Meikle Hill									
Background Noise Curve	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	35	35	35	35	35	38	42	42	42
Wind Farm Turbine Noise	3	8	12	12	11	12	12	12	12
Margin Under / Over Noise Limit	-32	-27	-23	-23	-24	-26	-30	-30	-30
R2 - Nith Lodge									
Background Noise Curve	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	35	35	35	35	35	38	42	42	42
Wind Farm Turbine Noise	3	8	12	12	11	12	12	12	12
Margin Under / Over Noise Limit	-32	-27	-23	-23	-24	-26	-30	-30	-30
R3 - Maneight									

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Background Noise Curve	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	35	35	35	35	35	38	42	42	42
Wind Farm Turbine Noise	3	8	12	13	12	13	13	13	13
Margin Under / Over Noise Limit	-32	-27	-23	-22	-23	-25	-29	-29	-29
R4 - Knockburnie									
Background Noise Curve	26	27	27	28	29	31	33	33	33
ETSU-R-97 Derived Noise Limit	35	35	35	35	35	36	38	38	38
Wind Farm Turbine Noise	5	10	14	14	13	14	14	14	14
Margin Under / Over Noise Limit	-30	-25	-21	-21	-22	-22	-24	-24	-24
R5 - Dalleagles									
Background Noise Curve	30	30	31	32	33	33	34	34	34
ETSU-R-97 Derived Noise Limit	35	35	36	37	38	38	39	39	39
Wind Farm Turbine Noise	5	10	15	15	14	15	15	15	15
Margin Under / Over Noise Limit	-30	-25	-21	-22	-24	-23	-24	-24	-24
R6 - Dalleagles Terrace									
Background Noise Curve	30	30	31	32	33	33	34	34	34
ETSU-R-97 Derived Noise Limit	35	35	36	37	38	38	39	39	39
Wind Farm Turbine Noise	6	10	15	15	14	15	15	15	15
Margin Under / Over Noise Limit	-29	-25	-21	-22	-24	-23	-24	-24	-24
R7 - Brockloch									
Background Noise Curve	28	29	30	31	33	34	36	36	36
ETSU-R-97 Derived Noise Limit	35	35	35	36	38	39	41	41	41
Wind Farm Turbine Noise	7	12	17	17	16	17	17	17	17
Margin Under / Over Noise Limit	-28	-23	-18	-19	-22	-22	-24	-24	-24
R8 - Laglaff									
Background Noise Curve	28	29	30	31	33	34	36	36	36
ETSU-R-97 Derived Noise Limit	35	35	35	36	38	39	41	41	41
Wind Farm Turbine Noise	9	14	19	19	19	19	19	19	19

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-26	-21	-16	-17	-19	-20	-22	-22	-22

Table 7.13 Night-time noise assessment

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
R1 - Meikle Hill									
Background Noise Curve	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	3	8	12	12	11	12	12	12	12
Margin Under / Over Noise Limit	-40	-35	-31	-31	-32	-31	-31	-31	-31
R2 - Nith Lodge									
Background Noise Curve	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	3	8	12	12	11	12	12	12	12
Margin Under / Over Noise Limit	-40	-35	-31	-31	-32	-31	-31	-31	-31
R3 - Maneight									
Background Noise Curve	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	3	8	12	13	12	13	13	13	13
Margin Under / Over Noise Limit	-40	-35	-31	-30	-31	-30	-30	-30	-30
R4 - Knockburnie									
Background Noise Curve	25	25	25	25	26	26	26	27	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	5	10	14	14	13	14	14	14	14
Margin Under / Over Noise Limit	-38	-33	-29	-29	-30	-29	-29	-29	-29
R5 - Dalleagles									
Background Noise Curve	23	23	23	23	24	24	25	26	27
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Wind Farm Turbine Noise	5	10	15	15	14	15	15	15	15
Margin Under / Over Noise Limit	-38	-32	-28	-28	-29	-28	-28	-28	-28
R6 - Dalleagles Terrace									
Background Noise Curve	23	23	23	23	24	24	25	26	27
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	6	10	15	15	14	15	15	15	15
Margin Under / Over Noise Limit	-37	-33	-28	-28	-29	-28	-28	-28	-28
R7 - Brockloch									
Background Noise Curve	25	26	26	26	27	28	29	29	29
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	7	12	17	17	16	17	17	17	17
Margin Under / Over Noise Limit	-36	-31	-26	-26	-27	-26	-26	-26	-26
R8 - Laglaff									
Background Noise Curve	25	26	26	26	27	28	29	29	29
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Wind Farm Turbine Noise	9	14	19	19	19	19	19	19	19
Margin Under / Over Noise Limit	-34	-29	-24	-24	-24	-24	-24	-24	-24

7.10.6 The results of the noise predictions show that there are no exceedances of the ETSU-R-97 guidance. On the basis that ETSU-R-97 criteria are not exceeded, effects resulting from the operation of the Proposed Development would be **not significant**.

Predicted Cumulative Effects and their Significance

7.10.7 In addition to considering the noise effects from the Proposed Development in isolation, cumulative noise effects taking the closest existing, consented and application wind farm developments within 10 km of the Development Site (calculated as the distance between the closest turbines of each development) have also been assessed.

7.10.8 **Table 7.9** outlines the identified wind farms for the cumulative assessment with sound power levels for associated turbine types presented in **Table 7.10**.

7.10.9 **Table 7.14** and **Table 7.15** present the results of the cumulative noise predictions. The predicted turbine noise levels shown at each receptor assumed that all turbines are operating simultaneously and that receptors are all in a downwind position. In reality, this scenario (all receptors downwind) cannot occur due to the positioning of the turbines of

the wind farm sites considered relative to the residential properties assessed and, as such, this is an unrealistic worst-case scenario.

Table 7.14 Daytime cumulative noise assessment

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
R1 – Meikle Hill									
Background Noise Level	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	42	42	42
Predicted Noise Level	29	33	36	37	37	37	37	37	37
Margin Under/Over Noise Limit	-11	-7	-4	-3	-3	-3	-5	-5	-5
R2 – Nith Lodge									
Background Noise Level	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	42	42	42
Predicted Noise Level	28	32	36	37	37	37	37	36	37
Margin Under/Over Noise Limit	-12	-8	-4	-3	-3	-3	-5	-5	-5
R3 - Maneight									
Background Noise Level	24	25	26	28	30	33	37	37	37
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	42	42	42
Predicted Noise Level	29	34	37	38	38	38	38	38	38
Margin Under/Over Noise Limit	-11	-6	-3	-2	-2	-2	-4	-4	-4
R4 - Knockburnie									
Background Noise Level	26	27	27	28	29	31	33	33	33
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	40	40	40
Predicted Noise Level	28	32	36	37	37	37	37	37	37
Margin Under/Over Noise Limit	-12	-8	-4	-3	-3	-3	-3	-3	-3
R5 - Dalleagles									
Background Noise Level	30	30	31	32	33	33	34	34	34
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	40	40	40
Predicted Noise Level	28	32	35	36	36	36	36	36	36
Margin Under/Over Noise Limit	-12	-8	-5	-4	-4	-4	-4	-4	-4

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
R6 – Dalleagles Terrace									
Background Noise Level	30	30	31	32	33	33	34	34	34
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	40	40	40
Predicted Noise Level	28	32	35	36	36	36	36	36	36
Margin Under/Over Noise Limit	-12	-8	-5	-4	-4	-4	-4	-4	-4
R7 - Brockloch									
Background Noise Level	28	29	30	31	33	34	36	36	36
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	41	41	41
Predicted Noise Level	27	31	35	35	36	36	36	36	36
Margin Under/Over Noise Limit	-13	-9	-5	-5	-4	-4	-5	-5	-5
R8 - Laglaff									
Background Noise Level	28	29	30	31	33	34	36	36	36
ETSU-R-97 Derived Noise Limit	40	40	40	40	40	40	41	41	41
Predicted Noise Level	28	32	35	35	36	36	36	36	36
Margin Under/Over Noise Limit	-12	-8	-5	-5	-4	-4	-5	-5	-5

Table 7.15 Night-time cumulative noise assessment

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
R1 – Meikle Hill									
Background Noise Level	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	29	33	36	37	37	37	37	37	37
Margin Under/Over Noise Limit	-14	-10	-7	-6	-6	-6	-6	-6	-6
R2 – Nith Lodge									
Background Noise Level	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	28	32	36	37	37	37	37	36	37

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
Margin Under/Over Noise Limit	-15	-11	-7	-6	-6	-6	-6	-7	-6
R3 - Maneight									
Background Noise Level	21	21	21	22	23	24	25	26	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	29	34	37	38	38	38	38	38	38
Margin Under/Over Noise Limit	-14	-9	-6	-5	-5	-5	-5	-5	-5
R4 - Knockburnie									
Background Noise Level	25	25	25	25	26	26	26	27	28
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	28	32	36	37	37	37	37	37	37
Margin Under/Over Noise Limit	-15	-11	-7	-6	-6	-6	-6	-6	-6
R5 - Dalleagles									
Background Noise Level	23	23	23	23	24	24	25	26	27
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	28	32	35	36	36	36	36	36	36
Margin Under/Over Noise Limit	-15	-11	-8	-7	-7	-7	-7	-7	-7
R6 – Dalleagles Terrace									
Background Noise Level	23	23	23	23	24	24	25	26	27
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	28	32	35	36	36	36	36	36	36
Margin Under/Over Noise Limit	-15	-11	-8	-7	-7	-7	-7	-7	-7
R7 - Brockloch									
Background Noise Level	25	26	26	26	27	28	29	29	29
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	27	31	35	35	36	36	36	36	36
Margin Under/Over Noise Limit	-16	-12	-8	-8	-7	-7	-7	-7	-7
R8 - Laglaff									
Background Noise Level	25	26	26	26	27	28	29	29	29

Noise parameters, $L_{A90,\ 10\ min}$, dB	Standardised 10m Height Wind Speed (V_{10}) ms^{-1}								
	4	5	6	7	8	9	10	11	12
ETSU-R-97 Derived Noise Limit	43	43	43	43	43	43	43	43	43
Predicted Noise Level	28	32	35	35	36	36	36	36	36
Margin Under/Over Noise Limit	-15	-11	-8	-8	-7	-7	-7	-7	-7

7.10.10 The results show that there are no exceedances of the ETSU-R-97 criteria noted and cumulative effects resulting from the operation of the Proposed Development in combination with others is **not significant**.

7.10.11 It is also important to note that the sound levels presented are worst case scenario, taking into account the following conservatisms in the noise assessment:

- the predictions assume that receptors are downwind of all turbines simultaneously;
- a maximum 2dB limit on all topographical screening has been applied, as per ETSU-R-97 methodology. However, the sound pathway from some turbines to receptors are significantly obstructed by large hill masses, likely to result in reductions of noise by more than 2dB;
- the assessment criterion is based on historic background noise levels, which may have increased in the intervening time, potentially resulting in less stringent assessment criteria.

Battery Storage and Substation Facility

7.10.12 A new substation and battery storage facility are included as part of the Proposed Development. The proposed location is approximately 800m east of the eastern turbine (T1).

The nearest receptor (R8 – Laglaff) is approximately 3.5 km north of the proposed substation/battery storage and significant noise related effects are, therefore, unlikely as a result of the separation distance between these.

7.11 Conclusions of Significance Evaluation

7.11.1 No exceedances of the ETSU-R-97 criteria are predicted. As such the operational noise effects of the Proposed Development, either alone or in combination with other developments, would be **not significant**.

7.12 Implementation of Environmental Measures

Construction and Decommissioning Noise

7.12.1 Construction noise is transient in nature and can generally be controlled by following standard industry practices, applying best practicable means and using modern, well-maintained and serviced items of plant.

7.12.2 No significant noise effects are expected during the construction and decommissioning phases, and no specific mitigation is required with regard to construction noise. However, general guidance for controlling construction noise is given in British Standard 5228-

1:2009+A1:2014. As good practice, the following embedded mitigation measures concerning construction noise would be implemented:

- restricted hours of working for most HGV movements (07:00 to 19:00 Monday to Friday, 07:00 - 12:00 Saturdays) to avoid sensitive periods. Any requirement to work outside these periods would only occur through prior agreement with EAC (for example turbine erection requires low wind speed conditions and may require longer working hours if conditions are poor at the time);
- all construction activities would be undertaken in accordance with good practice as set out in BS 5228-1:2009+A1:2014;
- all employees on the construction site would be advised of quieter methods of operating plant and tools, and to report any damage to noise control measures as soon as they are identified;
- where practicable, for any particular activity, suitable plant, machinery and working practices would be adopted. All equipment would be maintained in good working order and would be fitted with appropriate noise controls at all times (e.g., silencers, mufflers and/or acoustic hoods); and
- construction plant capable of generating significant noise and vibration levels would be operated in a manner to minimise the duration of the higher magnitude levels.

Operational Noise

7.12.3 As shown in **Section 7.10**, the candidate turbines utilised for this assessment did not exceed the ETSU-R-97 noise limits. When it comes to choosing the final turbine model, the environmental measures outlined in **Table 7.16** should be considered.

Table 7.16 Summary of environmental measures to be implemented – relating to noise

Environmental Measure	Responsibility for Implementation	Compliance Mechanism	EIA Report section reference
Turbine sound power levels to not exceed noise limits presented in Table 7.12 and Table 7.13	Developer/Contractor	Compliance with the noise limits when choosing final wind turbine type	Section 7.10