12. Noise

12.1 Introduction

- 12.1.1 This chapter considers the likely significant effects of noise of the Proposed Development on noise sensitive receptors arising during construction, operation and decommissioning.
- 12.1.2 The chapter:
 - Describes the current baseline established from site-specific surveys;
 - Describes the assessment methodology and significance criteria used in completing the impact assessment;
 - Describes the potential effects, including direct, indirect and cumulative effects;
 - Reaches a conclusion on the likely significant effects based on the information gathered and the analysis and assessments undertaken; and
 - Highlights any necessary monitoring and/or mitigation measures recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects.
- 12.1.3 The assessment has been carried out by Rob Shepherd MEng, MIOA, of Hayes McKenzie Partnership Ltd (HMPL). Rob has a master's degree (MEng) in Acoustical Engineering from the Institute of Sound and Vibration Research (ISVR) at the University of Southampton and has been carrying out wind farm noise assessments for over 20 years. Rob is a member of the Institute of Acoustics (MIOA), and Hayes McKenzie are members of the Association of Noise Consultants (ANC).

12.2 Legislation, Policy & Guidance

12.3 The assessment detailed within this chapter has been informed by the following guidelines/policies:

Planning Policy

- Scottish Government 2023, National Planning Framework 4;
- Scottish Government 2022, Onshore Wind Policy Statement 2022;
- Scottish Government 2014, Web Based Planning Advice, Onshore Wind Turbines; and
- Scottish Government 2011, Assessment of noise: technical advice note.

Local Development Plan

• East Ayrshire Local Development Plan Supplementary Guidance, Planning for Wind Energy December 2017.



Guidance

- British Standard (BS) 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise;
- BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites Vibration;
- BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound;
- ETSU-R-97 The Assessment and Rating of Noise from Wind Farms; and
- Institute of Acoustics (IOA), A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise (the IOA GPG).

12.4 Consultation

12.4.1 A summary of the consultation related to the noise assessment is presented in **Table 12.1** below. The proposed methodology was set out in the Scoping Report, and the Local Authority's appointed independent consultants were consulted on the choice of baseline noise measurement locations prior to the installation of the equipment.

Table 12.1 Consultation Responses

Consultee	Consultation Response	Applicant Action
Statutory consultees. East Ayrshire Council response to the Scoping Report. (22 May 2024)	EAC considered that construction noise, if likely to be carried out close to residential properties, should be assessed, and that detailed construction predictions should not be scoped out.	Confirmed via email (28 May 2024) that the EIA would present a construction noise assessment that compares predicted construction noise levels against the relevant noise limits described in BS 5228-1:2009+A1:2014, Code of practice for noise and vibration control on construction and open sites. Noise.
		However, the final design of the Proposed Development confirmed that no construction activities would be carried out within 1 km of a noise sensitive receptor, and therefore detailed construction predictions were scoped out and a fixed construction noise limit has been proposed.
Statutory consultees. East Ayrshire Council response to the Scoping Report. (22 May 2024)	EAC stated that the noise assessment should set out anticipated noise emissions from the proposed BESS, and that the cumulative effects of the BESS and the wind turbines should be discussed, noting that they are both assessed under different methodologies.	Confirmed via email (28 May 2024) that the EIA would consider operational noise from the BESS, which will be assessed in line with BS 4142:2014+A1:2019, Methods for rating and assessing industrial and commercial sound.
	EAC noted that a cumulative noise assessment may be required if other noise generating developments such as other BESS developments are likely to be audible at noise sensitive receptors.	However, the final design of the Proposed Development confirms that the proposed BESS is to be located at least 2.5 km from the nearest noise sensitive receptor, and that at such distances operational noise from the BESS would not be audible. Therefore, detailed BESS and cumulative BESS effects have not been considered further.
	EAC noted that if any noise mitigation for the BESS such as noise barriers is required that it should be included in the proposed plans, otherwise a separate planning consent would be required for mitigation such as noise barriers.	
Statutory consultees. East Ayrshire Council response to the Scoping Report. (22 May 2024)	EAC noted that Council's Environmental Health Service will be useful and could assist with agreeing the noise methodology, but that the Council currently uses the services of an independent noise consultant to deal with wind farm noise matters. They recommended that discussion is undertaken with the Council's noise	HMPL consulted with EAC's appointed independent noise consultants directly over the noise assessment methodology and selected baseline measurement locations.

Consultee	Consultation Response	Applicant Action
	consultant to agree the methodology for noise assessment to inform the EIA Report. EAC noted that they would encourage the use of the lower end of the ETSU limits.	
East Ayrshire independent noise consultant responses to the Scoping Report	EAC's appointed independent consultants ACCON, responded to the questions included at the end of the noise section of the Scoping Report.	The operational noise assessment has scoped in receptors where predicted operational noise levels from the Proposed Development acting alone are above 30 dB LA90.
(24 June 2024)	It was confirmed that operational noise can be scoped out where the predicted noise levels from the Proposed Development acting alone are below 30 dB LA90.	The assessment has been carried out by applying the ETSU-R-97 lower daytime noise limit, but with reference to the limit range where relevant.
	It was confirmed that cumulative operational noise levels would be considered to be acceptable where they are below the greater of plus 5 dB above background or 35-40 dB LA90 during the daytime, and 43 dB LA90 at night, but is was noted that the noise assessment report should justify the fixed part of the daytime noise limit in the range 35-40 dB LA90.	
East Ayrshire independent noise consultant responses to the baseline measurement locations (24 June 2024)	EAC's appointed independent consultants ACCON, agreed to the baseline measurement locations proposed, and noted that they would not need to attend the installation of the equipment.	Agreement of measurement locations noted, and baseline measurements carried out at the agreed locations.



12.5 Assessment Methods & Significance Criteria

Study Area

- 12.5.1 The study area for noise impacts incorporates the nearest noise sensitive receptors to the Proposed Development. In this case, noise sensitive receptors are inhabitable residential properties. If the relevant noise limits are met at the nearest noise sensitive receptors, and therefore no significant impact expected, it can be concluded that noise effects at more distant locations would be lower still and also not significant.
- 12.5.2 For the purposes of the noise assessment, all residential property locations are treated as noise sensitive receptors with a high receptor sensitivity for noise effects. Properties which are derelict or require planning permission to return to habitable use are not classed as noise sensitive and have been scoped out of the assessment.
- 12.5.3 The study area for construction and decommissioning noise comprises an evaluation of the likely noise levels arising at the nearest noise sensitive receptors to construction (and decommissioning) activities. It is not necessary to individually assess all receptors where construction noise could be audible if the relevant noise limits are met at the nearest receptors.
- 12.5.4 The noise sensitive receptors for operational noise are set out in **Table 12.2** below. The noise sensitive receptors are also shown on **Figure 12.1**. Noise sensitive receptors were scoped into the assessment where predicted operational noise levels from the Proposed Development acting alone are greater than 30 dB L_{A90}. The assessment has been carried out for the nearest residential properties (on the basis that if the limits are met at the nearest noise sensitive receptors, operational noise levels will be acceptable at more distance receptors).

Property Name	Easting	Northing
Rankinston Farm*	246182	613115
Ravenscroft*	245960	614206
Drumbowie	246580	615338
Seaview	245208	613319
Rankinston Village (nearest)	245143	613954
Muirston	246843	616192
Polquhairn	247442	616240
The Castle	245752	614516

Table 12.2 Summary of Sensitive Receptors Scoped In



- 12.5.5 The residents of Rankinston Farm and Ravenscroft are financially involved with the Proposed Development (identified with an '*' in **Table 12.2** above), and therefore the financially involved operational noise limits apply at these locations.
- 12.5.6 The potentially noise sensitive receptors shown at **Table 12.3** below were scoped out of the assessment as they are derelict, and therefore not considered to be noise sensitive.

Property Name	Easting	Northing			
Old Polquhairn (derelict)	247909	615793			
Muirston (derelict)	246970	615992			

Table 12.3 Summary of Receptors Scoped Out

Site Visit

12.5.7 Baseline noise measurements were carried out at four locations representative of the nearest residential receptors to the Proposed Development. The details of the measurements are set out in **Technical Appendix 12.1**, and the measurement locations are shown in **Table 12.4**.

Table 12.4 Baseline Measurement Locations

Property Name	Easting	Northing
Rankinston Farm	246182	613115
Ravenscroft	245960	614206
Drumbowie	246580	615338
Seaview	245208	613319

Assessment of Significance

Construction Noise

- 12.5.8 A detailed assessment of construction noise has been deemed unnecessary due to the large separation distances between the Proposed Development construction activities and nearby noise sensitive receptors. Nevertheless, construction impacts are discussed.
- 12.5.9 The elements of construction of the Proposed Development that could give rise to the greatest levels of noise are track construction, as it has the potential to pass closest to residential properties, and blasting at the borrow pits, which if required will generate the highest levels of noise at the source.
- 12.5.10 The nearest noise sensitive receptor to the track construction activities is Rankinston Farm which is over 1 km from the nearest access track. Rankinston Farm is also the nearest noise sensitive receptor to the proposed borrow pit locations which are all over 1.5 km away. Construction noise is therefore considered at this location, and if noise impacts are acceptable then it can be concluded that construction noise will be not significant at all other noise sensitive receptors. It is noted that as the residents of Rankinston Farm are financially involved with the



Proposed Development their sensitivity to construction noise is lower than at noninvolved noise sensitive receptors. Nevertheless, as a worst case, the same construction noise limits have been applied at all receptors.

- 12.5.11 BS 5228:2009+A1:2014 provides example criteria for the assessment of significance of construction noise effects and a method for the prediction of noise levels from construction activities. The noise limits applied here are based on the minimum criteria of 45, 55 and 65 dB L_{Aeq} for night-time (23:00-07:00), evening and weekends (19:00-23:00 weekdays, 13:00-23:00 Saturdays and 07:00-23:00 Sundays), and daytime (07:00-19:00) including Saturdays (07:00-13:00) respectively. These limits are applicable irrespective of existing baseline noise levels, and where construction activities have a duration of one month or more. It should be noted that the time period to which each limit applies also defines the time averaging period for the calculated L_{Aeq}.
- 12.5.12 The specific daytime criterion to be applied to the Proposed Development for construction noise is 65 dB L_{Aeq, 8-hour}. This along with the evening and night limits are detailed in **Table 12.5**. If the criterion is met at a specific receptor location, then the noise effect at that location is considered to be not significant.

Time Period	Limit (dB L _{Aeq,t})
Weekday day-time (07:00-19:00) and Saturday morning (07:00-13:00)	65
Evenings (19:00-23:00) and weekends (Saturday 13:00-19:00 and Sunday 07:00-19:00)	55
Night time (23:00-07:00)	45

Table 12.5: Construction Noise Limits

Operational Noise

- 12.5.13 The assessment follows guidance set out in ETSU-R-97, as required by national policy, and as described in East Ayrshire Local Development Plan; *Supplementary Guidance, Planning for Wind Energy*. The assessment of noise from wind turbines includes the following stages:
 - a) Baseline noise survey conducted at noise sensitive receptors around the Proposed Development and correlated with wind speeds measured concurrently within the Proposed Development;
 - Plots of baseline L_{A90} noise levels against standardised 10 m height wind speeds are used to derive prevailing quiet daytime and night-time background noise curves for a range of wind speeds up to 12 m/s;
 - c) Derived prevailing background noise curves are used to define daytime and night-time noise limits calculated in accordance with ETSU-R-97;
 - d) Predicted noise levels are calculated/modelled using ISO 9613-2 methodology implemented using noise modelling software;



- Noise contour plots are produced showing predicted L_{A90} at a height of 4 m above ground level assuming downwind conditions in all directions (not possible in practice but represents worst-case for all receptor locations); and
- f) Predicted noise levels are compared to the relevant noise limits.
- 12.5.14 ETSU-R-97 requires that the overall turbine levels do not exceed derived noise limits, which take into account the balance of the need for renewable energy and the protection of the noise environment at neighbouring properties. Accordingly, no scale of magnitude is applied to the assessment and whether or not an effect is significant depends solely on whether the derived noise limits are predicted to be met.
- 12.5.15 The ETSU-R-97 noise limits apply to cumulative operational noise levels and therefore cumulative operational noise impact assessment is intrinsic to the assessment of the Proposed Development. The specific night and daytime noise limits to be applied to cumulative operational noise from all wind turbine developments in the vicinity as agreed with East Ayrshire Council (EAC) are set out in **Table 12.6**. If the relevant noise limits are met at a specific receptor location, then the noise effect at that location is considered to be not significant.

Time Period	Limit
Day-time	The greater of 35 dB L_{A90} or plus 5 dB above background
Night-time	The greater of 43 dB L_{A90} or plus 5 dB above background
Night and daytime (financially involved)	The greater of 45 dB L_{A90} or plus 5 dB above background

Table 12.6: Overarching Cumulative Operational Noise Limits

12.5.16 It should be noted that the ETSU-R-97 daytime lower limiting value is in the range of 35-40 dB L_{A90} depending on a number of factors. EAC have advised that their preference is for the daytime lower limiting value to be set at the lower end of the range, and in this case the lowest value of 35 dB has been applied, although that is not to say that a higher limit within the range would not be appropriate.

Limitations, Difficulties and Uncertainties

12.5.17 The operational noise impact assessment is based on a candidate wind turbine which may not be the turbine that is installed in practice. However, operational noise limits will be set for the Proposed Development via planning conditions which will stipulate operational noise levels that cannot be exceeded at noise sensitive

properties. Therefore, regardless of the model of turbine installed, these limits must be met throughout the operational lifetime of the wind farm.

12.6 Baseline

Current Baseline

12.6.1 The results of the baseline noise measurements (presented in Technical Appendix 12.1) have been used to derive noise limits as required by ETSU-R-97. The baseline noise levels are shown at Table 12.7 below.

Location	Time Period	Stand	dardise	ed 10 m	n heigh	t wind	speed	(m/s)			
		3	4	5	6	7	8	9	10	11	12
Rankinston	Night-time	29.1	31.0	32.9	35.0	37.3	39.9	42.8	46.1	49.8	54.0
Farm	Quiet Daytime	28.5	30.4	32.6	35.0	37.7	40.5	43.5	46.7	50.0	53.4
Ravenscroft	Night-time	25.4	27.0	28.9	31.2	33.7	36.4	39.2	42.1	44.9	47.7
	Quiet Daytime	28.2	29.5	31.1	33.0	35.1	37.6	40.4	43.4	46.8	50.5
Drumbowie	Night-time	22.5	24.7	27.4	30.5	33.6	36.6	39.1	41.0	41.9	41.6
	Quiet Daytime	23.9	25.9	28.4	31.1	34.1	37.1	40.0	42.7	45.2	47.2
Seaview	Night-time	22.8	24.9	27.5	30.5	33.6	36.8	39.8	42.3	44.4	45.6
	Quiet Daytime	24.3	26.2	28.5	31.2	34.1	37.1	40.0	42.8	45.1	47.1

Table 12.7: Measured Baseline Noise Levels (dB LA90)

12.6.2 The resultant noise limits, which apply to the cumulative operational noise from all wind farm developments in the vicinity are set out in **Table 12.8**. At baseline measurement locations that are financially involved with the Proposed Development, both the financially involved and non-involved ETSU-R-97 noise limits are shown for completeness.

Table 12.8: Derived Cumulative Noise Limits from Baseline Measurements	(dB L _{A90}))
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Location	Time	Stand	Standardised 10 m height wind speed (m/s)									
	Period	3	4	5	6	7	8	9	10	11	12	
Rankinston Farm	Night-time	45.0	45.0	45.0	45.0	45.0	45.0	47.8	51.1	54.8	59.0	
(financially involved limits)	Daytime	45.0	45.0	45.0	45.0	45.0	45.5	48.5	51.7	55.0	58.4	
Rankinston Farm	Night-time	43.0	43.0	43.0	43.0	43.0	44.9	47.8	51.1	54.8	59.0	
	Lower Daytime	35.0	35.4	37.6	40.0	42.7	45.5	48.5	51.7	55.0	58.4	
Ravenscroft	Night-time	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.1	49.9	52.7	
(financially involved limits)	Lower Daytime	35.0	35.0	36.1	38.0	40.1	42.6	45.4	48.4	51.8	55.5	
Ravenscroft	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.1	49.9	52.7	
	Lower Daytime	35.0	35.0	36.1	38.0	40.1	42.6	45.4	48.4	51.8	55.5	



Location	Time	Standardised 10 m height wind speed (m/s)										
	Period	3	4	5	6	7	8	9	10	11	12	
Drumbowie	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.1	46.0	46.9	46.6	
	Lower Daytime	35.0	35.0	35.0	36.1	39.1	42.1	45.0	47.7	50.2	52.2	
Seaview	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.3	49.4	50.6	
	Lower Daytime	35.0	35.0	35.0	36.2	39.1	42.1	45.0	47.8	50.1	52.1	

12.6.3 The ETSU-R-97 noise limits apply to cumulative noise from all wind farm developments in the vicinity of the Proposed Development, and therefore a cumulative operational noise impact assessment is presented in addition to assessing the noise effects of the Proposed Development acting alone.

Future Baseline

- 12.6.4 Baseline noise levels in the absence of the Proposed Development are likely to remain broadly similar to that derived from background noise measurements, where the potential contribution from existing wind farm developments has been excluded.
- 12.6.5 Although the baseline noise levels for the purposes of the derivation of appropriate cumulative noise limits must not include the contribution from existing wind farm developments, currently operational wind farm noise is a feature of the existing noise environment by virtue of the existing residential receptors being in the vicinity of consented wind farm developments. There are a number of proposed wind farm developments in the vicinity and therefore the future baseline could include an increase in audible wind turbine noise at residential receptors locations, although the maximum cumulative operational noise level should be restricted to ensure that they do not exceed the ETSU-R-97 noise limits.

12.7 Scope of the Assessment

Spatial Scope

12.7.1 The study area is defined by the predicted operational noise levels rather than by a set distance or area, and covers all identified noise sensitive receptors as defined in **Section 12.5**.

Temporal Scope

12.7.2 The construction limits apply to all construction activities with a duration of over 1 month during the construction phase. Construction noise will be present to varying degrees during the full construction programme. 12.7.3 The operational limits apply to the lifetime of the Proposed Development, and operational effects will be present for this duration also.

Receptors Requiring Assessment

12.7.4 The receptors requiring assessment are those identified as being within the study area as defined in **Section 12.5**, and laid out in **Table 12.2**.

Environmental Measures Embedded into the Development Proposals

Construction Noise

- 12.7.5 Standard best practice measures to minimise noise during construction will be implemented in accordance with a detailed Construction Environmental Management Plan (CEMP), which can be secured by means of an appropriately worded planning condition. A simplified daytime construction noise limit of 65 dB L_{Aeq} during normal working hours will be applied in accordance with the second method from BS5228 discussed above. Further information on noise mitigation during construction is provided in **Section 12.9** of this chapter.
- 12.7.6 Any potential noise issues associated with the movement of construction vehicles to and from the Proposed Development Site would be sufficiently dealt with within the Construction Traffic Management Plan (CTMP) where considered necessary.

Scoped Out of Assessment

12.7.7 The following potential effects have been scoped out of the assessment.

Operational Substation and Battery Storage Noise

- 12.7.8 Operational noise from substations and battery energy storage systems (BESS) can be assessed according to BS 4142:2014+A1:2019, where rating noise levels (noise levels at receptor locations corrected for any distinguishing character) associated with the operation of the plant are compared with background sound levels to determine the significant of the noise impact. The main noise source for substation and BESS is typically associated with fans that are required for ventilation/cooling of the plant, as such the operational noise output is related to ambient temperature and electrical demand.
- 12.7.9 In this case the proposed substation and BESS locations are more than 2.5 km from the nearest noise sensitive receptor, Rankinston Farm, and all other receptors are significantly more distant. It is considered that at such distances, given the proposed scale of the Proposed Development substation and BESS, operational noise is unlikely to be audible at noise sensitive receptors. As such operational noise from both the Proposed Development substation and BESS has been scoped out of the assessment. In addition, as operational noise from the BESS and substation will not



be audible at noise sensitive receptors, no cumulative operational noise assessment including these elements of the Proposed Development is necessary.

Tonal Noise

12.7.10 ETSU-R-97 (DTI, 1996) specifies that, in line with other noise guidance, a penalty should be added to measured or predicted wind turbine noise levels if there is a tonal noise above a certain level which is audible at residential properties. In this assessment, it has been assumed that there would be no tonal noise associated with the operation of the Proposed Development which would give rise to such a penalty as most modern turbines operate without significant tonal noise. It is anticipated that a penalty scheme would be included in an appropriately worded planning condition such that a tonal penalty would need to be added to measured operational noise levels, where required, before comparing them with the noise limits. Warranty agreements with turbine suppliers seek to ensure that any such penalties will not occur in practice. Tonal noise during the operational phase of the development has therefore been scoped out of the assessment.

Low Frequency and Infrasound

- 12.7.11 Low frequency sound is typically defined as sound in the audible hearing frequency range of 20 Hz up to about 200 Hz. Noise from wind turbines is not inherently low frequency and it is typically broadband in nature, and close to a wind turbine the dominant frequencies are usually in the 250 Hz to 2000 Hz range. As the distance from a wind farm increases, the noise level decreases as a result of the spreading out of the sound energy and also due to air absorption which increases with increasing frequency. This means that, although the energy across the whole frequency range is reduced, higher frequencies are reduced more than lower frequencies with the effect that as distance from the Proposed Development increases the ratio of low to high frequencies also increases. This effect may be observed with road traffic noise or natural sources, such as the sea, where higher frequency components are diminished relative to lower frequency components at long distance. At such distances however, the overall noise level is so low, such that any bias in the frequency spectrum can usually be considered to be insignificant.
- 12.7.12 Work carried out in 2006 by Hayes McKenzie for the UK Department of Trade and Industry (DTI, 2006) to investigate the extent of low frequency and infrasonic noise from three UK wind farms concluded that *"the common cause of complaints associated with noise at all three wind farms is not associated with low frequency noise, but is the audible modulation of the aerodynamic noise, especially at night"*. It is therefore considered that specific assessment of low frequency noise can be scoped out of the assessment.
- 12.7.13 Infrasound is noise occurring at frequencies below that at which sound is normally audible, i.e. less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range for sound to be perceptible it has to be at a very high amplitude, which is not the case for wind turbine noise. In November 2016, a study into low frequency and infrasound was published by the State Office for the Environment, Measurement and Nature Conservation of the



Federal State of Baden-Wuerttemberg (LUBW, 2016) that contained a comprehensive review of low frequency and infrasound from wind turbines and evaluated such noise in relation to other sources. The results state that "the infrasound level in the vicinity of wind turbines is – at distances between 120 m and 300 m – well below the threshold of what humans perceive" and that "at a distance of 700 m from the wind turbines, it was observed by means of measurements that when the turbine is switched on, the measured infrasound level did not increase or only increased to a limited extent. The infrasound was generated mainly by the wind and not by the turbines."

12.7.14 The report concludes that *"infrasound is caused by a large number of different natural and technical sources. It is an everyday part of our environment that can be found everywhere. Wind turbines make no considerable contribution to it. The infrasound level generated by them lie clearly below the limits of human perception. There is no scientifically proven evidence of adverse effects in this level range".* It is therefore considered that infrasound can be scoped out of the assessment.

Amplitude Modulation

- 12.7.15 The variation in noise level associated with wind turbine operation, at the rate at which turbine blades pass any fixed point of their rotation (the blade passing frequency), is often referred to as blade swish or amplitude/aerodynamic modulation (AM). This effect is identified within ETSU-R-97 where it is envisaged that "... modulation of blade noise may result in variation of the overall A-Weighted noise level by as much as 3 dB(A) (peak to trough) when measured close to a wind turbine..." and that at distances further from a wind turbine where there are "... more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6 dB(A) (peak to trough)". There have been instances where the level of AM rates are higher than this, which results in the noise being perceived as more intrusive (in the same way as tonal content makes the noise more intrusive).
- 12.7.16 The Department of Energy & Climate Change (DECC) commissioned a Wind Turbine AM Review report that was published in two phases: Phase 1 in September 2015 and Phase 2 in October 2016 (although the Phase 2 report is dated August 2016) (DECC, 2016). Phase 1 of the report sets out the approach and methodology to the review and research, and the Phase 2 report includes a literature review, research into human response to AM, and recommends how excessive AM might be controlled through the use of a planning condition. The reports include recommendations on how AM should be addressed when quantified according to the recommendations of a separate Institute of Acoustics (IOA) working group document, A Method for Rating Amplitude Modulation in Wind Turbine Noise (IOA, 2016).
- 12.7.17 The AM Review reports recommend a two-tier approach whereby the first tier seeks a reduction in the depth and/or occurrence of AM with a rating level (according to the IOA Amplitude Modulation Working Group method) ≥3 dB. Whether remedial action is required depends on the prevalence of any complaints, and how often AM rating levels ≥3 dB occur. The second tier is that if AM is deemed to be a significant issue, and if nothing can be done to reduce the level of AM, then a penalty scheme is proposed whereby a penalty ranging from 3 dB (for a rating level of 3 dB) up to a



maximum of 5 dB (for a rating level of 10 dB and above) could be added to the measured level before measured levels are compared with the relevant noise limits.

12.7.18 It should be noted that most wind farms operate without significant AM, and that it is not possible to predict the likely occurrence of AM. At the time of writing there has been no official response to those recommendations from the IOA Noise Working group or endorsement from any Scottish Government Minister or Department. The IOA GPG (IOA, 2013), states *that "the evidence in relation to "Excess" or "other" Amplitude Modulation (AM) is still developing. At the time of writing, current practice is not to assign a planning condition to deal with AM", although it is possible to control such noise with an appropriately worded planning condition if necessary. It is therefore considered that AM can be scoped out of the assessment.*

Vibration

- 12.7.19 The nature of wind farm construction works, and the distances involved, are such that the risk of significant effects relating to ground-borne vibration are very low. Potentially significant construction vibration effects are not anticipated beyond 100 m for standard on-site construction activates. The exception to this is blasting, if required at borrow pits, where an increased scoping distance is applied. In this case, if blasting is utilised in borrow pits at a distance of more than 1 km from noise sensitive receptors, no significant vibration effects are anticipated. As all borrow pit search areas are more than 1 km, and all other on-site construction activities are more than 100 m, from noise sensitive receptors, construction vibration effects are scoped out and considered to be not significant.
- 12.7.20 The overall vibration impacts during decommissioning are usually equal to or lower than during the construction phase and will be assessed and mitigated as required at the time of decommissioning. As such, decommissioning vibration is also scoped out and considered to be not significant.
- 12.7.21 The levels of ground-borne vibration generated by operational wind turbines is very low. The closest receptor to the proposed turbine locations is over 1 km, and at such distances vibration from the operation of the wind farm will not be perceptible. Therefore, due to large distances between turbines and receptors, operational vibration effects are scoped out and considered to be not significant.

Decommissioning Noise

12.7.22 Noise arising from decommissioning activities will meet the relevant noise limits that apply to noise from construction, and decommissioning activities will be undertaken in line with the relevant standards and limits that apply at the time. Noise effects



during decommissioning would be no greater than those during construction and are thereby considered not significant and therefore are not considered further.

12.8 Assessment of Potential Effects

Construction Effects

- 12.8.1 As mentioned previously, a detailed assessment of construction noise is not included because it is deemed unnecessary due to the distances between construction activities and noise sensitive receptors. The two main construction activities that have been considered are that of blasting at the borrow pits and track construction. All other construction activities are likely to result in significantly lower levels of noise at noise sensitive properties.
- 12.8.2 Due to the large distances (>1.5 km) between the borrow pits and sensitive receptors, general excavation activities can be deemed to have no significant effect and therefore do not require detailed assessment. However, blasting may be required for the extraction of aggregate. This type of noise does not typically fall within the assessment of normal construction noise because of the extremely high amplitude and impulsive nature of the waveform. It is very likely that blasting noise could be heard at nearby residential locations, but a construction noise assessment would average noise levels across the day and is therefore not applicable for use for the assessment of blasting noise impacts. Mitigation to reduce the noise impact from blasting activities is set out in Section 12.9.
- 12.8.3 The closest sensitive receptor to the proposed track route is Rankinston Farm at a distance of approximately 1 km. At a distance of 1 km between a sensitive receptor and track construction the worst case predicted noise levels are very likely to be below 65 dB L_{Aeq} (i.e. the daytime construction noise limit). Therefore, the noise levels predicted for Rankinston Farm, and all other noise sensitive properties, will meet the applicable noise limit.
- 12.8.4 Overall, noise from construction activities is considered to be *not significant*, but it should be noted that noise from construction activities will be assessed and mitigated through the CEMP that will be submitted prior to the commencement of construction. An outline construction programme is presented in **Chapter 2: Proposed Development**.

Operational Effects

12.8.5 Operational noise impacts have been assessed by comparing predicted operational noise levels with noise limits derived from the baseline noise measurements. The noise limits at properties where measurements were not undertaken have been assigned from baseline noise measurement results at an appropriate measurement location based on geographic proximity. As Rankinston Farm and Ravenscroft are financially involved with the scheme, the lower limiting value for both night and

daytime has been set to 45 dB L_{A90} . The limits applied to each location in the assessment are presented at **Table 12.9**.

Location	Time	Standardised 10 m height wind speed (m/s)										
	Period	3	4	5	6	7	8	9	10	11	12	
Rankinston Farm	Night-time	45.0	45.0	45.0	45.0	45.0	45.0	47.8	51.1	54.8	59.0	
	Daytime	45.0	45.0	45.0	45.0	45.0	45.5	48.5	51.7	55.0	58.4	
Ravenscroft	Night-time	45.0	45.0	45.0	45.0	45.0	45.0	45.0	47.1	49.9	52.7	
	Daytime	45.0	45.0	45.0	45.0	45.0	45.0	45.4	48.4	51.8	55.5	
Drumbowie	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.1	46.0	46.9	46.6	
	Daytime	35.0	35.0	35.0	36.1	39.1	42.1	45.0	47.7	50.2	52.2	
Seaview	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.3	49.4	50.6	
	Daytime	35.0	35.0	35.0	36.2	39.1	42.1	45.0	47.8	50.1	52.1	
Rankinston Village	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.8	47.3	49.4	50.6	
(nearest)	Daytime	35.0	35.0	35.0	36.2	39.1	42.1	45.0	47.8	50.1	52.1	
Muirston	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.1	46.0	46.9	46.6	
	Daytime	35.0	35.0	35.0	36.1	39.1	42.1	45.0	47.7	50.2	52.2	
Polquhairn	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.1	46.0	46.9	46.6	
	Daytime	35.0	35.0	35.0	36.1	39.1	42.1	45.0	47.7	50.2	52.2	
The Castle	Night-time	43.0	43.0	43.0	43.0	43.0	43.0	44.2	47.1	49.9	52.7	
	Daytime	35.0	35.0	36.1	38.0	40.1	42.6	45.4	48.4	51.8	55.5	

Table 12.9: Applied Limits at Each Sensitive Receptor (dB LA90)

- 12.8.6 Operational noise predictions have been carried out for the candidate wind turbine under consideration for the Proposed Development in line with the methodology set out in the IOA GPG (IOA, 2013). Full details of the prediction methodology are set out in **Technical Appendix 12.2**, but the main assumptions are described below:
 - Receiver height of 4 m;
 - Ground effect ground coefficient G=0.5;
 - Atmospheric attenuation corresponding to a temperature of 10°C and a relative humidity of 70%;
 - Topographical barrier and concave ground profile corrections have been applied (and are included in **Technical Appendix 12.3**); and
 - A margin of plus 2 dB has been added to manufacturer's sound power level data to account for uncertainty.
- 12.8.7 The source noise levels for the Vestas V136 4.5 MW candidate turbine on an 82 m hub height assumed for the Proposed Development are set out in **Table 12.10**. The octave band noise data taken from the manufacturer's technical specification

document are also set out at **Table 12.10**. The sound power levels include the plus 2 dB uncertainty discussed above.

Standardised 10 m			Broadband						
(m/s)	63	125	250	500	1000	2000	4000	8000	
3	72.5	80.7	86.0	88.4	87.9	84.4	78.0	68.7	93.4
4	75.7	83.9	89.2	91.6	91.1	87.6	81.2	71.9	96.6
5	80.5	88.7	94.0	96.4	95.9	92.4	86.0	76.7	101.4
6	84.3	92.5	97.8	100.2	99.7	96.2	89.8	80.5	105.2
7	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9
8	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9
9	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9
10	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9
11	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9
12	85.0	93.2	98.5	100.9	100.4	96.9	90.5	81.2	105.9

Table 12.10: Vestas V136 4.5 MW STE Octave Band Sound Power Level (dB L_{WA})

12.8.8 Operational noise prediction results are presented in **Table 12.11** for all receptors scoped into the assessment. It should be noted that the predictions assume that each receptor location is downwind of the Proposed Development to provide a worst-case scenario. Under non-downwind conditions, operational noise levels will be lower. In addition, worst-case downwind noise contours for the maximum operational noise level (i.e. corresponding to wind speeds of 7-12 m/s) as well as the noise sensitive receptor locations are shown at **Figure 12.2**.

Location	Stand	dardise	ed 10 m	n heigh	t wind	speed	(m/s)			
	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	26.6	29.8	34.6	38.4	39.1	39.1	39.1	39.1	39.1	39.1
Ravenscroft	23.5	26.7	31.5	35.3	36.0	36.0	36.0	36.0	36.0	36.0
Drumbowie	22.6	25.8	30.6	34.3	35.0	35.0	35.0	35.0	35.0	35.0
Seaview	21.0	24.2	29.0	32.8	33.5	33.5	33.5	33.5	33.5	33.5
Rankinston Village (nearest)	19.9	23.1	27.9	31.7	32.4	32.4	32.4	32.4	32.4	32.4
Muirston	18.7	21.9	26.7	30.5	31.1	31.1	31.1	31.1	31.1	31.1
Polquhairn	18.9	22.1	26.9	30.7	31.4	31.4	31.4	31.4	31.4	31.4
The Castle	21.7	24.9	29.7	33.5	34.2	34.2	34.2	34.2	34.2	34.2

Table 12.11: Predicted Operational Noise	Levels; Proposed Development (dB L _{A90})
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12.8.9 **Table 12.12** and **Table 12.13** show the margin between predicted noise levels and the night and daytime derived noise limits respectively.

	Stand	dardise	ed 10 m	n heigh	t wind	speed	(m/s)			
Location	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	18.4	15.2	10.4	6.6	5.9	5.9	8.7	12.0	15.7	19.9
Ravenscroft	21.5	18.3	13.5	9.7	9.0	9.0	9.0	11.1	13.9	16.7
Drumbowie	20.4	17.2	12.4	8.7	8.0	8.0	9.1	11.0	11.9	11.6
Seaview	22.0	18.8	14.0	10.2	9.5	9.5	11.3	13.8	15.9	17.1
Rankinston Village (nearest)	23.1	19.9	15.1	11.3	10.6	10.6	12.4	14.9	17.0	18.2
Muirston	24.3	21.1	16.3	12.5	11.9	11.9	13.0	14.9	15.8	15.5
Polquhairn	24.1	20.9	16.1	12.3	11.6	11.6	12.7	14.6	15.5	15.2
The Castle	21.3	18.1	13.3	9.5	8.8	8.8	10.0	12.9	15.7	18.5

Table 12.12: Margin to Night-time Noise Limits; Proposed Development (dB LA90)

	Stand	dardise	ed 10 m	n heigh	t wind	speed	(m/s)			
Location	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	18.4	15.2	10.4	6.6	5.9	6.4	9.4	12.6	15.9	19.3
Ravenscroft	21.5	18.3	13.5	9.7	9.0	9.0	9.4	12.4	15.8	19.5
Drumbowie	12.4	9.2	4.4	1.8	4.1	7.1	10.0	12.7	15.2	17.2
Seaview	14.0	10.8	6.0	3.4	5.6	8.6	11.5	14.3	16.6	18.6
Rankinston Village (nearest)	15.1	11.9	7.1	4.5	6.7	9.7	12.6	15.4	17.7	19.7
Muirston	16.3	13.1	8.3	5.6	8.0	11.0	13.9	16.6	19.1	21.1
Polquhairn	16.1	12.9	8.1	5.4	7.7	10.7	13.6	16.3	18.8	20.8
The Castle	13.3	10.1	6.4	4.5	5.9	8.4	11.2	14.2	17.6	21.3

12.8.10 It can be seen from **Table 12.12** and **Table 12.13** that the derived noise limits are met by the Proposed Development acting in isolation, and therefore, operational noise from the Proposed Development acting alone can be considered to be *not significant.*

12.9 Mitigation

Mitigation during Construction

12.9.1 Construction noise will be minimised through the use of standard 'best practicable means' to reduce the potential level of noise generated as part of the construction

activities. This will include the restriction of certain activities to certain times, use of quiet working methods, and ensuring construction plant is in good working order.

- 12.9.2 Any specific mitigation measures that may be required for certain activities will be detailed within the CEMP, to be secured by means of a planning condition.
- 12.9.3 Noise during construction works will be controlled by generally restricting works to standard working hours (07:00 to 19:00 Monday to Friday, and 07:00 to 13:00 on Saturdays), unless specifically agreed otherwise. Outside these hours, construction activities on the Proposed Development site will be limited to turbine erection, maintenance, emergency works, dust suppression, and the testing of plant and equipment, unless otherwise approved in advance in writing by EAC.
- 12.9.4 It is possible that blasting at the Proposed Development site borrow pits will be required to extract aggregate for construction. The most appropriate way to address blasting noise is for a pre-blasting management programme to be prepared which would identify the most sensitive receptors that could be potentially affected by blasting noise. The programme would contain details of the proposed frequency of blasting, and proposed monitoring procedures. The operator would inform the nearest residents of the proposed times of blasting and of any deviation from this programme in advance of the operations. The programme would also contain contact details which would be provided to local residents should concerns arise regarding construction and blasting activities. In addition, each blast will be designed carefully to maximise its efficiency and to reduce the transmission of noise.

12.10 Assessment of Residual Effects

12.10.1 Noise associated with the operation of the Proposed Development is considered *not significant* and no specific mitigation measures are considered necessary.

12.11 Assessment of Cumulative Effects

- 12.11.1 The ETSU-R-97 derived noise limits apply to cumulative noise from all wind farms in the vicinity of the Proposed Development. Predicted cumulative operational noise levels have therefore been compared with the noise limits shown at **Table 12.8** above. It should be note that the lower daytime (35 dB L_{A90}) noise limit has been applied, although the daytime lower limiting value can be set within the range 35-40 dB as discussed previously.
- 12.11.2 Wind farms within 20 km of the Proposed Development shown at **Figure 5.24** were considered for inclusion in the noise impact assessment, and the wind farms shown at **Table 12.14** have been included in the cumulative operational noise impact assessment based on distance from the Proposed Development. It should be noted that wind farms where the individual predicted operational noise levels are below



25 dB L_{A90} at any noise sensitive receptor considered in this assessment can be scoped out of the assessment as their contribution is considered to be negligible.

Wind Farm	Status	Number of Turbines	Assumed Wind Turbine
Knockkippen	Application	12	Vestas V136 4.0 MW, 83.5 m hub Vestas V150 6.0 MW 113.5 m hub
Knockshinnoch	Consented	2	Vestas V90, 2 MW, 80 m hub
North Kyle	Under construction	49	Vestas V136 4.5 MW, 82 m hub

Table 12.14: Wind Farms Included in the Cumulative Assessment

12.11.3 The wind farms that were considered for inclusion in the cumulative operational noise impact assessment but subsequently scoped out of the cumulative operational assessment are shown in **Table 12.15** below. They were scoped out as their predicted individual contribution was less than 25 dB L_{A90} at any of the scoped in noise sensitive receptors.

Table 12.15: Nearby Wind Farms Scoped out of the Cumulative Assessment

Wind Farm	Status	Number of Turbines	Assumed Wind Turbine
Greenburn	Under construction	16	Vestas V136 4.2 MW, 82 m hub
Overhill	Consented	10	Nordex N133 4.8 MW, 120 m hub
Sclenteuch	Application	9	Vestas V150 6.0 MW, 125 m hub

- 12.11.4 The details of the turbine locations and sound power levels used for the cumulative prediction can be found in **Technical Appendix 12.4**. To ensure a conservative cumulative operational noise assessment as none of the wind farms included in the cumulative assessment are operational, an additional 2 dB has been added to the standard 2 dB uncertainty included in the noise modelling. Therefore, a total of 4 dB uncertainty has been added to the sound power level data assumed for each of the wind turbines included in the cumulative operational noise modelling.
- 12.11.5 The results of the cumulative predictions for all receptors scoped into the assessment are presented in **Table 12.16**, and shown graphically on a noise contour plot at **Figure 12.3**.

Location	Stand	dardise	ed 10 m	n heigh	t wind	speed	(m/s)			
	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	27.9	31.1	35.9	39.6	40.2	40.3	40.3	40.3	40.3	40.3
Ravenscroft	25.4	28.4	33.2	36.8	37.5	37.6	37.6	37.6	37.6	37.6
Drumbowie	23.9	27.0	31.8	35.5	36.2	36.2	36.2	36.2	36.2	36.2
Seaview	25.6	28.3	33.0	36.5	37.2	37.4	37.4	37.4	37.4	37.4
Rankinston Village (nearest)	24.6	27.1	31.9	35.4	36.1	36.3	36.3	36.3	36.3	36.2
Muirston	21.2	24.3	29.1	32.8	33.5	33.6	33.6	33.6	33.5	33.5

Table 12.16: Predicted Noise Levels; Cumulative (dB LA90)



Location	Standardised 10 m height wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Polquhairn	21.6	24.7	29.5	33.2	33.9	33.9	33.9	33.9	33.9	33.9
The Castle	24.1	27.0	31.8	35.4	36.1	36.2	36.2	36.2	36.2	36.2

12.11.6 The margin between the cumulative predicted levels and the night and daytime derived noise limits are presented in **Table 12.17** and **Table 12.18** respectively.

Location	Stand	dardise	ed 10 m	ı heigh	t wind	speed	(m/s)			
	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	17.1	13.9	9.1	5.4	4.8	4.7	7.5	10.8	14.5	18.8
Ravenscroft	19.6	16.6	11.8	8.2	7.5	7.4	7.4	9.5	12.4	15.2
Drumbowie	19.1	16.0	11.2	7.5	6.8	6.8	7.9	9.7	10.7	10.4
Seaview	17.4	14.7	10.0	6.5	5.8	5.6	7.3	9.9	12.0	13.3
Rankinston Village (nearest)	18.4	15.9	11.1	7.6	6.9	6.7	8.4	11.0	13.1	14.4
Muirston	21.8	18.7	13.9	10.2	9.5	9.4	10.6	12.4	13.3	13.1
Polquhairn	21.4	18.3	13.5	9.8	9.1	9.1	10.2	12.0	13.0	12.7
The Castle	18.9	16.0	11.2	7.6	6.9	6.8	8.0	10.8	13.7	16.5

Table 12.17: Margin to Night-time Noise Limits; Cumulative (dB LA90)

Table 12.18:	: Margin to	Daytime	Noise Limits;	Cumulative	(dB	L _{A90})
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Location	Standardised 10 m height wind speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Rankinston Farm	17.1	13.9	9.1	5.4	4.8	5.2	8.2	11.4	14.8	18.2
Ravenscroft	19.6	16.6	11.8	8.2	7.5	7.4	7.8	10.8	14.2	17.9
Drumbowie	11.1	8.0	3.2	0.6	2.9	5.8	8.8	11.5	14.0	16.0
Seaview	9.4	6.7	2.0	-0.3	1.9	4.7	7.6	10.3	12.8	14.7
Rainkinston Village (nearest)	10.4	7.9	3.1	0.8	3.0	5.8	8.7	11.5	13.9	15.8
Muirston	13.8	10.7	5.9	3.3	5.5	8.5	11.4	14.2	16.6	18.7
Polquhairn	13.4	10.3	5.5	2.9	5.2	8.1	11.1	13.8	16.3	18.3
The Castle	10.9	8.0	4.3	2.5	4.0	6.4	9.1	12.2	15.6	19.3

- 12.11.7 It can be seen from **Table 12.17** and **Table 12.18** that the predicted cumulative noise levels are below the derived noise limits except at Seaview, where the predicted cumulative operational noise levels above the lower daytime noise limit by 0.3 dB at one wind speed (and still 3.5 dB below the ETSU-R-97 upper daytime noise limit), which can be considered to be an insignificant exceedance.
- 12.11.8 The cumulative operational noise modelling assumes downwind propagation in all directions, and an additional 2 dB was added to the 2 dB uncertainly already incorporated into the sound power levels used for the modelling of other wind farms in the vicinity. In addition, the lower daytime noise limit is met once wind direction is



taken into account. Therefore, as the lower daytime noise limit would be met in practice, no significant cumulative effects are predicted.

12.12 Summary

- 12.12.1 Noise levels likely to arise at residential receptors in the vicinity of the Proposed Development have been assessed against the relevant noise limits.
- 12.12.2 Construction noise levels will remain within the relevant noise limits, and therefore construction noise effects are predicted to be not significant. Noise during the construction phase will be controlled via the CEMP which will be prepared and submitted to the Local Authority prior to commencement of construction.
- 12.12.3 The results of the operational noise impact assessment indicates that the derived noise limits, which apply to the Proposed Development, are met at all noise sensitive receptors for the Proposed Development acting alone.
- 12.12.4 The results of the cumulative operational noise impact assessment indicates that the derived noise limits, which apply to the Proposed Development, are met at all noise sensitive receptors for the cumulative scenario when taking into account wind direction effects.
- 12.12.5 Noise effects during the construction, operation, and decommissioning of the Proposed Development have been assessed against noise limits derived in accordance with the requirement of national policy. Where the relevant noise limits are met, the noise effects are considered to be *not significant*.
- 12.12.6 The relevant noise limits during the construction, operation, and decommissioning of the Proposed Development have been shown to meet the relevant noise limits, with the implementation of the necessary mitigation, and therefore the effects during each phase of the development have been determined to be *not significant*.

Table 12.19: Summary

Description of Effect	Significance of	Potential Effect	Mitigation Measures	Significance of Residual Effect								
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse							
During Construction & Decommissioning												
Noise during construction phase	Negligible	Adverse	Noise will be managed and controlled via a CEMP.	Negligible	Adverse							
During Operation												
Operational noise effects	Negligible	Adverse	No specific mitigation measures required	Negligible	Adverse							
Cumulative Effects												
Cumulative operational noise effects	Negligible	Adverse	No specific mitigation measures required	Negligible	Adverse							

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