Appendix 11.1: Noise

An Càrr Dubh Wind Farm.
Appendix 11.1 Noise

REVISION 01 – 06 OCTOBER 2022
AUTHOR: RYLAN NORCROSS

Audit sheet.

Rev.	Date	Description	Prepared	Verified
01	06/10fap/2022	First version	RN	MMC

Annex A – Glossary

Terminology	Description
A-weighting	A filter that down-weights low frequency and high frequency sound to better represent the frequency response of the human ear when assessing the likely effects of noise on humans
Acoustic character	One or more distinctive features of a sound (e.g. Tones, whines, whistles, impulses) that set it apart from the background noise against which it is being judged, possibly leading to a greater subjective effect than the level of the sound alone might suggest
Acoustic screening	The presence of a solid barrier (natural landform or manmade) between a source of sound and a receiver that interrupts the direct line of sight between the two, thus reducing the sound level at the receiver compared to that in the absence of the barrier
Ambient noise	All-encompassing noise associated with a given environment, usually a composite of sounds from many sources both far and near, often with no particular sound being dominant
Annoyance	A feeling of displeasure in this case evoked by noise
Attenuation	The reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.
Audio frequency	Any frequency of a sound wave that lies within the frequency limits of audibility of a healthy human ear, generally accepted as being from 20 Hz To 20,000 Hz
Background noise	The noise level rarely fallen below in any given location over any given time period, often classed according to day time, evening or night time periods (for the majority of the population of the UK the lower limiting noise level is usually controlled by noise emanating from distant road, rail or air traffic)
dB	Abbreviation for 'decibel'
dB(A)	Abbreviation for the decibel level of a sound that has been a-weighted
Decibel	The unit normally employed to measure the magnitude of sound
Directivity	The property of a sound source that causes more sound to be radiated in one direction than another
Equivalent continuous sound pressure level	The steady sound level which has the same energy as a time varying sound signal when averaged over the same time interval, t, denoted by $L_{Aeq,t}$
External noise level	The noise level, in decibels, measured outside a building
Filter	A device for separating components of an acoustic signal on the basis of their frequencies
Frequency	The number of acoustic pressure fluctuations per second occurring about the atmospheric mean pressure (also known as the 'pitch' of a sound)
Frequency analysis	The analysis of a sound into its frequency components
Ground effects	The modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver
Hertz	The unit normally employed to measure the frequency of a sound, equal to cycles per second of acoustic pressure fluctuations about the atmospheric mean pressure
Impulsive sound	A sound having all its energy concentrated in a very short time period
Instantaneous sound pressure	At a given point in space and at a given instant in time, the difference between the instantaneous pressure and the mean atmospheric pressure
Internal noise level	The noise level, in decibels, measured inside a building
L_{Aeq}	The abbreviation of the a-weighted equivalent continuous sound pressure level
L_{A10}	The abbreviation of the 10 percentile noise indicator, often used for the measurement of road traffic noise
L_{A90}	The abbreviation of the 90 percentile noise indicator, often used for the measurement of background noise
Level	The general term used to describe a sound once it has been converted into decibels
Loudness	The attribute of human auditory response in which sound may be ordered on a subjective scale that typically extends from barely audible to painfully loud
Noise	Physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure.

Terminology	Description
	Subjectively: sound that evokes a feeling of displeasure in the environment in which it is heard, and is therefore unwelcomed by the receiver
Noise emission	The noise emitted by a source of sound
Noise immission	The noise to which a receiver is exposed
Noise nuisance	An unlawful interference with a person's use or enjoyment of land, or of some right over, or in connection with it
Octave band frequency analysis	A frequency analysis using a filter that is an octave wide (the upper limit of the filter's frequency band is exactly twice that of its lower frequency limit)
Percentile exceeded sound level	The noise level exceeded for n% of the time over a given time period, t, denoted by $L_{An,t}$
Receiver	A person or property exposed to the noise being considered
Residual noise	The ambient noise that remains in the absence of the specific noise whose effects are being assessed
Sound	Physically: a regular and ordered oscillation of air molecules that travels away from the source of vibration and creates fluctuating positive and negative acoustic pressure above and below atmospheric pressure
	Subjectively: the sensation of hearing excited by the acoustic oscillations described above (see also 'noise')
Sound level meter	An instrument for measuring sound pressure level
Sound pressure amplitude	The root mean square of the amplitude of the acoustic pressure fluctuations in a sound wave around the atmospheric mean pressure, usually measured in pascals (Pa)
Sound pressure level	A measure of the sound pressure at a point, in decibels
Sound power level	The total sound power radiated by a source, in decibels
Spectrum	A description of the amplitude of a sound as a function of frequency
Standardised wind speed	Values of wind speed at hub height corrected to a standardised height of ten metres using the same procedure as used in wind turbine emission testing
Threshold of hearing	The lowest amplitude sound capable of evoking the sensation of hearing in the average healthy human ear (0.00002 Pa)
Tone	The concentration of acoustic energy into a very narrow frequency range

Annex B – Location maps and turbine coordinates

Figure B1 Map showing the layout of the turbines (green markers) and the noise assessment locations (black markers).

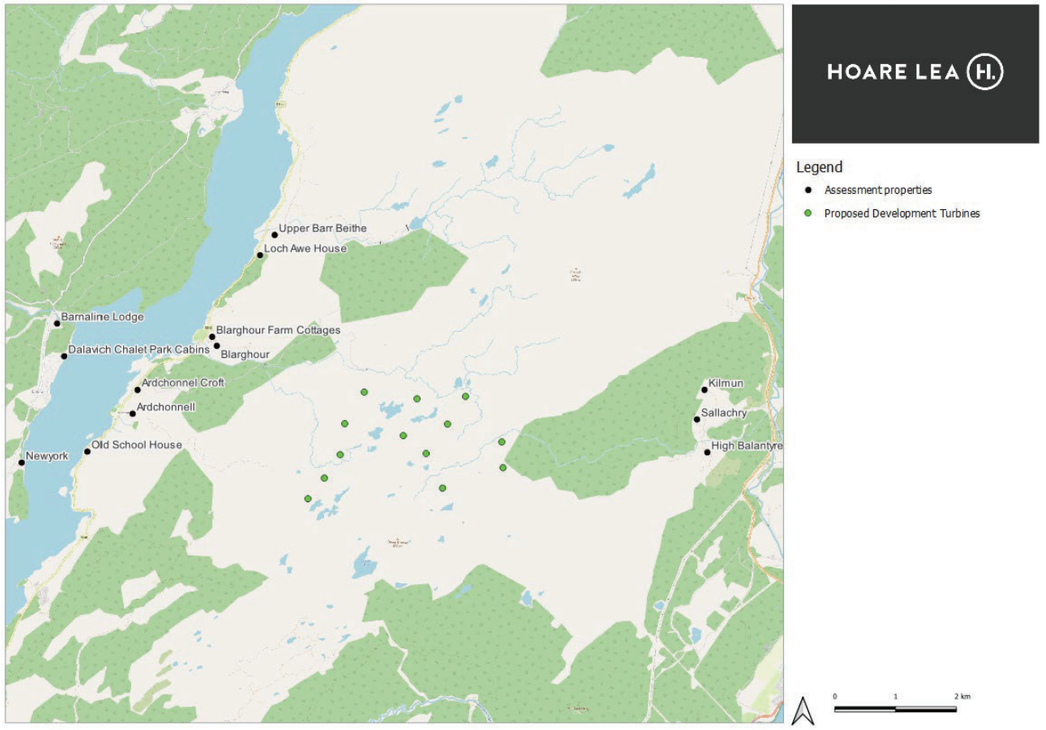

Table B1 – Turbine coordinates and hub heights for the proposed development

Turbine	Easting	Northing	Hub height (m)
1	204480	711431	105
2	204460	711855	105
3	203485	711094	105
4	203215	711665	105
5	202838	711959	105
6	203065	712565	105
7	203863	712604	105
8	203567	712148	105
9	201875	712156	105
10	202196	712675	105
11	201800	711645	105
12	201540	711260	105
13	201270	710920	105

Table B2 – Turbine coordinates and modelled hub heights for Blarghour Wind Farm

Turbine	Easting	Northing	Hub height (m)
B1	203346	715537	78
B2	203838	715467	78
B3	204304	715255	78
B4	202753	715068	78
B5	203429	715110	78
B6	203973	714991	78
B7	202864	714693	78
B8	203557	714678	78
B9	204006	714583	78
B10	203338	714353	78
B11	203826	714180	78
B12	203139	713969	78
B13	203612	713792	78
B14	203296	713466	78
B15	202580	713317	78
B16	202947	713093	78
B17	202890	713681	78

Annex C – Noise prediction model assumptions

Turbine Details: the Proposed Development

The exact model of turbine to be used at the site will be the result of a future tendering process and therefore a representative turbine model has been assumed for this noise assessment. This operational noise assessment is based upon the noise specification of the Vestas V150 6.0 MW wind turbine. 13 turbines have been modelled using the layout as indicated on the map in Annex B. The candidate turbine is a variable speed, pitch regulated machine with a rotor diameter of 150 metres and hub height of 105 metres. Due to its variable speed operation the sound power output of the Vestas V150 6.0 MW turbine varies considerably with wind speed, being quieter at the lower wind speeds when the blades are rotating more slowly.

Vestas have supplied specified noise emission data for the V150 6.0 MW turbine. In the absence of specific information about uncertainty allowances in the data, a further correction factor of +2 dB was added to the specification data in line with advice in the IOA GPG. The sound power data has been made available for standardised 10 m reference wind speeds of 3 m/s to 12 m/s inclusive. In addition to the overall sound power data, reference has been made to the Vestas V150 6.0 MW turbine test report for the turbine sound spectrum levels. The overall sound power and spectral data are presented in Table C1 and Table C2 respectively.

Table C1 - Wind turbine sound power levels (dB L_{Aeq}) used in the noise assessment - the Proposed Development

Turbine make / model	Standardised 10 m Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Vestas V150-6.0 MW (Mode PO6000) 105m hub height	94.8	98.2	102.5	106.0	106.8	106.9	106.9	106.9	106.9	106.9
Derived from: Performance Specification V150-6.0 MW, 0098-0749.V01										

Table C2 - Octave band sound power spectrum (dB L_{Aeq}) for reference wind speed conditions (v_{10} = 8 m/s) - the Proposed Development

Turbine make / model	Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	A
Vestas V150-6.0 MW 105m hub height	81.1	88.7	93.4	95.1	94.0	89.9	82.9	72.9	99.9
Derived from: V150-6.0MW Third Octaves, 0095-3747.V01 Table 1: V150-PO6000									

Table C3 - Propagation attenuation effects due to terrain (dB) for the Proposed Development – positive numbers are due to terrain shielding barrier effects (e.g. 2), representing a decrease in noise levels, and negative numbers (e.g. -3) represent an increase in predicted noise levels due to concave ground effects. Where there is a zero shown, neither terrain shielding nor concave ground were found.

Property name	Turbine number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Blarghour	2	2	2	2	2	2	2	2	0	2	2	2	2
Ardchonnel Croft	2	2	2	2	2	2	2	2	0	0	0	0	0
Ardchonnell	2	2	2	0	0	2	2	2	0	0	0	0	0
Blarghour Farm Cottages	2	2	2	2	2	2	2	2	2	2	2	2	2
Old School House	2	2	2	2	2	2	2	2	2	2	2	2	2
Sallachry	0	0	0	2	2	2	2	2	2	2	2	2	2
Kilmun	0	0	0	2	2	2	2	2	2	2	2	2	2
High Balantyre	0	0	0	0	2	2	0	0	2	2	2	2	2
Loch Awe House	2	2	2	2	2	2	2	2	2	2	2	2	2
Upper Barr Beithe	2	2	2	2	2	2	2	2	2	2	2	2	2
Dalavich Chalet Park Cabins	2	0	0	0	0	0	0	0	-3	-3	0	-3	-3
Newyork	2	2	0	0	0	0	0	0	0	0	0	0	0
Barnaline Lodge	0	0	-3	-3	-3	-3	0	-3	-3	-3	-3	-3	-3

Cumulative Site Details: Blarghour Wind Farm

Assessment of the cumulative noise from operating the consented Blarghour Wind Farm together with the Proposed Development also requires source information for the coordinates and turbine type. The data assumed for Blarghour Wind Farm, as outlined in Tables C4 and C5, is based on the Vestas V117 3.45 MW turbine model, which is consistent with the candidate turbine specified in the noise assessment[1] for Blarghour Wind Farm. Specified noise emission data for these turbines running unconstrained are referenced in Table C4. In the absence of specific information about uncertainty allowances in the data, a further correction factor of +2 dB was added to the specification data in line with advice in the IOA GPG.

A further + 2.8 dB uplift was applied to the predicted Blarghour Wind Farm noise emission levels, such that the consented 35 dB noise limit[2] at the controlling property (Upper Barr Beith) for this wind farm is just met assuming the wind farm operator was to fully utilise the consented noise limits. The total sound power levels in Table C4 account for this uplift in the values shown and in the prediction model.

Table C4 - Wind turbine sound power levels (dB L_{Aeq}) used in the noise assessment – Blarghour Wind Farm

Turbine make / model	Standardised 10 m Wind Speed (m/s)									
	3	4	5	6	7	8	9	10	11	12
Vestas V117 3.45 MW (Mode 0) Including +2.8 dB uplift 80 m hub height	97.2	100.5	105.2	109.1	111.4	111.6	111.6	111.6	111.6	111.6
Derived from: Performance Specification 'DMS 0055-1397 V02, 'V117 3.45 MW Third octave noise emission', 30/11/2016										

Table C5 - Octave band sound power spectrum (dB L_{Aeq}) for reference wind speed conditions (v_{10} = 8 m/s) – Blarghour Wind Farm

Turbine make / model	Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	A
Vestas V117 3.45 MW	90.8	98.0	100.9	102.5	103.1	100.8	96.8	85.7	108.7
Derived from: Vestas Document 'DMS 0055-1397 V02, 'V117 3.45 MW Third octave noise emission', 30/11/2016									

[1] Blarghour Wind Farm Environmental Statement: Volume 2, Technical Appendix 2.6 (Noise impact assessment), Blarghour Wind Farm Ltd, May 2018
[2] Blarghour Wind Farm Decision Notice, Energy Consents Division, ECU ref. EC00005267, Noise section 28, page 35, dated 29/10/2021

Table C6 - Propagation attenuation effects due to terrain (dB) for Blarghour Wind Farm– positive numbers are due to terrain shielding barrier effects (e.g. 2), representing a decrease in noise levels, and negative numbers (e.g. -3) represent an increase in predicted noise levels due to concave ground effects. Where there is a zero shown, neither terrain shielding nor concave ground were found.

Property name	Turbine number															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Blarghour	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Ardchonnel Croft	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2
Ardchonnell	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	2	0
Blarghour Farm Cottages	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Old School House	0	0	2	0	0	2	0	2	2	2	2	2	2	2	2	2	2
Sallachry	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Kilmun	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
High Balantyre	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Loch Awe House	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Upper Barr Beithe	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Dalavich Chalet Park Cabins	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Newyork	0	0	-3	-3	-3	0	-3	-3	-3	-3	-3	-3	-3	0	-3	0	-3
Barnaline Lodge	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3

HOARE LEA

RYLAN NORCROSS
ACOUSTICS ENGINEER

+44 1454 806 668
rylannorcross@hoarelea.com

HOARELEA.COM

155 Aztec West
Almondsbury
Bristol
BS32 4UB
England