Contents

13. Noise

13.1 Introduction

13.1.1 This chapter presents an assessment of the likely significant effects of the Proposed Development with respect to noise. The assessment is based on information obtained to date. It should be read in conjunction with the Project description provided in **Chapter 4: Description of the Proposed Development.** This chapter also considers any potential impacts of construction of the grid connection in the area shown in **Figures 1.2** and **4.1.**

13.1.2 This chapter describes:

- the legislation, policy and technical guidance that has informed the assessment (**Section 13.2**);
- consultation and engagement that has been undertaken and how comments from consultees relating to noise have been addressed (**Section 13.3**);
- the methods to be used for baseline data gathering (**Section 13.4**);
- overall baseline (**Section 13.5**);
- embedded measures relevant to noise (**Section 13.6**);
- the scope of the assessment for noise (**Section 13.7**);
- the methods used for the assessment (**Section 13.8**);
- the assessment of noise effects (**Section 13.9**);
- assessment of cumulative (inter-project) effects (**Section 13.10**);
- a summary of the significance conclusions (**Section 13.11**); and
- an outline of further work to be undertaken for the Environmental Statement (ES) (**Section 13.13**).

Limitations and assumptions

13.1.3 The Draft ES has been produced to fulfil the Applicant's consultation duties and enable consultees to develop an informed view of the likely significant effects of the Proposed Development.

13.1.4 An initial baseline noise survey has been undertaken using a 10 metre met mast, to provide baseline noise data cross referenced at a variety of wind speeds. A second baseline noise survey will be undertaken prior to the submission of the final ES when the full height met mast is installed on site in accordance with IOA guidance (see **Table 13.3** for details), with the results considered as part of the assessment. However, at this stage, the survey data gathered in conjunction with the 10 metre wind speeds provides a suitable understanding of the baseline noise environment and is likely to result in a conservative assessment using the Institute of Acoustics (IOA) correction factor (see **paragraph 13.9.3**).

13.2 Relevant legislation, planning policy and technical guidance

13.2.1 This section identifies the legislation, planning policy and technical guidance that has informed the assessment of effects with respect to noise. Further information on policies relevant to the Project is provided in **Chapter 5: Legislation and policy overview**.

Legislation

13.2.2 A summary of the relevant legislation is given in **Table 13.1**.

Table 13.1 Legislation relevant to the noise assessment

Legislation	Legislative context
Environmental Protection Act 1990, Part III – as amended by the Noise and Statutory Nuisance Act 1993[1]	An Act to make provision for the improved control of pollution arising from certain industrial and other processes, including noise pollution.
Control of Pollution Act 1974[2]	An Act to make further provision with respect to waste disposal, water pollution, noise, atmospheric pollution, and public health; and for the purposes connected with the matters aforesaid.

Planning policy

13.2.3 A summary of the relevant national and local planning policy is given in **Table 13.2**.

Table 13.2 Planning policy relevant to the noise assessment

Policy	Policy context
National planning policy	
National Policy Statements	NPS EN-1[3] advises that applicants include a noise assessment to consider both construction and operation effects where appropriate. EN-3[4] at 2.7.56 states that the applicant's assessment of noise from the operation of the wind turbines should use ETSU-R-97[5], taking account of the latest industry good practice. ETSU-R-97 is

[1] UK Government (1990), Environmental Protection Act 1990. (Online) Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 13 January 2022).
[2] UK Government (1974). Control of Pollution Act 1974. (Online) Available at: https://www.legislation.gov.uk/ukpga/1974/40 (Accessed 13 January 2022).
[3] Department of Energy & Climate Change (2011). Overarching National Policy Statement for Energy (EN-1). (Online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf (Accessed 13 January 2022).
[4] Department of Energy & Climate Change (2011). National Policy Statement for Renewable Energy Infrastructure (EN-3). (Online) Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf (Accessed 13 January 2022).
[5] The Working Group on Noise from Wind Turbines (1996). ETSU-R-97 The assessment and rating of noise from wind farms. (Online) Available at: https://regmedia.co.uk/2011/08/02/etsu_r_97.pdf (Accessed 13 January 2022).

Policy	Policy context
	also referred to alongside associated good practice guides (see Table 1.3) in Planning Policy Wales[6].
Future Wales – The National Plan 2040[7]	Provides the national development framework up to 2040 and refers to the protection from noise through planning throughout, including renewables.
Welsh Assembly Government: Technical Advice Note (TAN) 11: Noise (1997)[8]	TAN 11 provides general advice on noise and refers to TAN 8[9] for guidance regarding noise from wind turbines and wind farms. TAN 8 has now been superseded by national development framework embedded within 'Future Wales'.
Local planning policy	
Blaenau Gwent County Borough Council Local Development Plan up to 2021 (Adopted November 2012)[10]	**Policy DM1** New Development states: *"Development proposals will be permitted provided:* *… There would be no unacceptable risk of harm to health and/or local amenity from unacceptably high levels of noise, vibration, odour or light pollution…"* **Policy DM4** Low and Zero Carbon Energy states: *"The Council will encourage major development proposals to incorporate schemes which generate energy from renewable and low/zero carbon technologies. These technologies include onshore wind…* *…These technologies will be permitted provided that:* *…They will not have an unacceptable adverse impact on local amenity by reason of noise emission…"*

Technical guidance

13.2.4 A summary of the technical guidance for noise is given in **Table 13.3**.

Table 13.3 Technical guidance relevant to the noise assessment

Technical guidance document	Context
ETSU-R-97 The Assessment and Rating of Noise from Wind Farms, The Working Group on Noise from Wind Turbines (1996)[5]	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 thought to offer a reasonable degree of protection to wind farm neighbours.

[6] Welsh Government, Planning Policy Wales. Edition 11: February 2021. (Online) Available at: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf (Accessed 26 January 2021).
[7] Welsh Assembly Government (2021). Future Wales. The National Plan 2020. (Online) Available at: https://gov.wales/sites/default/files/publications/2021-02/future-wales-the-national-plan-2040.pdf (Accessed on 28 January 2022).
[8] Welsh Assembly Government (1997). Technical Advice Note 11: Noise. (Online) Available at: https://gov.wales/sites/default/files/publications/2018-09/tan11-noise.pdf (Accessed 13 January 2022).
[9] Welsh Assembly Government (2005). Technical Advice Note 8: Planning for Renewable Energy. (Online) Available at: https://gov.wales/sites/default/files/publications/2018-09/tan8-renewable-energy_0.pdf (Accessed 4 April 2022).
[10] Blaenau Gwent County Borough Council (2012). Local Development Plan up to 2021. (Online) Available at: https://www.blaenau-gwent.gov.uk/en/resident/planning/local-development-plan/adopted-ldp-allocations/adopted-local-development-plan-2006-2021/ (Accessed 13 January 2022).

Technical guidance document	Context
A Good Practice Guide ('IOA GPG') to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, Institute of Acoustics (2013)[11]	Presents current good practice in the application of ETSU-R-97[5] for all wind turbine developments above 50kW. The good practice guide gives information to assist consultants, developers and local planning authorities in using the correct technical and procedural methods for the assessment and determination of wind farm applications, reflecting the original principles within ETSU-R-97 and the results of research carried out and experience gained since its publication.
BS 5228-1:2009 + A1:2014 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise, BSI (2014)[12]	Detailed guidance on assessing noise from construction sites.

13.3 Consultation and engagement

Overview

13.3.1 The assessment has been informed by consultation responses and ongoing stakeholder engagement. An overview of the approach to consultation is provided in **Section 2.4** of **Chapter 2: Approach to Environmental Impact Assessment.**

Scoping Direction

13.3.2 A Scoping Direction was issued by PEDW, on behalf of the Welsh Ministers, on 15 June 2021. A summary of the relevant responses received in the Scoping Direction in relation to noise and confirmation of how these have been addressed within the assessment to date is presented in **Table 13.4**.

Table 13.4 Summary of EIA Scoping Direction responses for noise

Consultee	Consideration	How addressed in this Draft ES
PEDW	In line with comments received from the Specialist Environmental Health Officer at BGCBC, current background readings should be provided as part of the baseline data for the identified sensitive noise receptors. The applicant is encouraged to seek an agreed approach to this aspect of the environment and to include an explanation of the approach in the final ES.	Noise measurements have been undertaken in conjunction with wind speed measurements to characterise the baseline noise environment at the identified noise sensitive residential locations. Additional measurements will be taken when the full height met mast is installed on site in accordance with the latest IOA guidance.

[11] Institute of Acoustics (2013). A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise. (Online) Available at: https://www.ioa.org.uk/sites/default/files/IOA%20Good%20Practice%20Guide%20on%20Wind%20Turbine%20Noise%20-%20May%202013.pdf (Accessed 13 January 2022).

[12] British Standards Institution (2014). British Standard BS 5228-1:2009 + A1:2014 Code of practice for noise and vibration control on construction and open sites, Part 1: Noise. BSI, London.

Technical engagement

13.3.3 Technical engagement with consultees in relation to noise is ongoing. A summary of the technical engagement undertaken to date is outlined in **Table 13.5**.

Table 13.5 Technical engagement on the noise assessment

Consultee	Consideration	How addressed in this Draft ES
Blaenau Gwent County Borough Council	The Environmental Health Officer at BGC was contacted to check whether a 10 metre met mast was sufficient for the capturing of meteorological data during the noise survey, due to the full height met mast not being available until after submission. It was agreed that it would be more appropriate to wait until a noise survey could be undertaken in full accordance with the IOA GPG.	Baseline noise surveys will be conducted for the final ES.

13.3.4 The EHO at Blaenau Gwent County Borough Council (BGCBC) will be consulted on the locations of the baseline noise survey once a full met mast has been established on the site.

13.4 Data gathering methodology

Study area

Wind Farm development

13.4.1 The study area is based on a radius of 10km from the Proposed Development.

13.4.2 Within the 10km study area, other wind farm developments, including those that are consented but not built or at planning stage, have been considered as part of the assessment of cumulative effects.

Grid Connection

13.4.3 The study area is based on the Noise Sensitive Receptors (NSRs) within the proposed grid connection corridor.

Desk study

13.4.4 A summary of the source of data, together with the nature of that data is outlined in **Table 13.6**.

Table 13.6 Data sources used to inform the noise assessment

Organisation	Data source	Data provided
Google	Google Earth Pro 7.3.4.8248[13]	Aerial imagery
British Standard Institute	BS 5228-1: 2009+A1:2014	Noise data for construction noise and vibration predictions.
Vestas	DMS 0067-4732 V03 V136-4.0/4.2 MW Third octave noise emission[14]	Turbine noise data
Nordex	F008_272_A14_EN Nordex N133/4,8 Octave sound power levels[15]	Turbine noise data
Scottish Power Renewables	Euchanhead Renewable Energy Development Technical Appendix 13.1: Environmental Noise Assessment[16]	Turbine noise data
SSE Renewables	Drumnahough Wind Farm EIAR Appendix J-1 Technical Noise Report[17]	Turbine noise data
Community Windfarm	Sanquhar II Community Wind Farm – EIA Report[18]	Turbine noise data
EnergieKontor	Craiginmoddie Wind Farm Environmental Impact Assessment Report[19]	Turbine noise data
Coom Green Energy Park Limited	Environmental Impact Assessment Report (EIAR) for the Proposed Coom Green Energy Park, County Cork[20]	Turbine noise data
IEP Ltd	R4694-1 Rev 1 Proposed Enercon E-53 800kW wind turbine at Top Farm, Foston Noise Impact Assessment[21]	Turbine noise data

[13] Google (2021). Google Earth Pro, version 7.3.4.8248. (Online) Available at: https://www.google.com/earth/download/gep/agree.html?hl=en-GB (Accessed 13 January 2021).
[14] Vestas Wind Systems (2018). DMS 0067-4732 V03 V136-4.0/4.2 MW Third octave noise emission. Vestas, Denmark.
[15] Nordex (2018). F008_272_A14_EN Nordex N133/4.8 Octave sound power levels. Nordex, Germany.
[16] Scottish Power Renewables (2020). Euchanhead Renewable Energy Development Technical Appendix 13.1: Environmental Noise Assessment. (Online) Available at: EUC_TA_13.1_Environmental_Noise_Assessment.pdf (scottishpowerrenewables.com) (Accessed 13 January 2022).
[17] SSE Renewables (2020). Drumnahough Wind Farm EIAR Appendix J-1 Technical Noise Report. (Online) Available at: Technical Noise Appendix (pleanala.ie) (Accessed 13 January 2022).
[18] Community Windfarm (2019). Sanquhar II Community Wind Farm – EIA Report, Section 11 – Noise. (Online) Available at: Section%2011%20-%20Noise_1YlnPR4SyOV17PPJMBkp.pdf (website-editor.net) (Accessed 13 January 2022).
[19] EnergieKontor (2020). Craiginmoddie Wind Farm Environmental Impact Assessment Report, Chapter 10 – Noise. (Online) Available at: preview (energiekontor.co.uk) (Accessed 13 January 2022).
[20] Coom Green Energy Park Limited (2020). Environmental Impact Assessment Report (EIAR) for the Proposed Coom Green Energy Park, County Cork, Volume 2 – Main EIAR – Chapter 7 – Noise and Vibration. (Online) Available at: P20-099_Volume 2 Chapter 7 - Noise & Vibration.pdf (pleanala.ie) (Accessed 13 January 2022).
[21] IEP Ltd (2013). R4694-1 Rev 1 Proposed Enercon E-53 800kW Wind Turbine at Top Farm, Foston Noise Impact Assessment. (Online) Available at: Microsoft Word - R4694-1 rev 1 Top Farm Wind Turbine Assessment.doc (southkesteven.gov.uk) (Accessed 13 January 2022).

Organisation	Data source	Data provided
Ecocel Renewables	Single Wind Turbine Application – Roundshaw Farm Environmental Statement: Volume III – Technical Assessment[22]	Turbine noise data
Senvion	GI-2.21-WT.PO.04-A-A-EN Octave & Third Octave Band Data (MM100/50Hz/60Hz)[23]	Turbine noise data
University of Gothenburg	Project WINDFARM perception Visual and acoustic impact of wind turbine farms on residents[24]	Turbine noise data
Ordnance Survey	OS Terrain 50[25]	Terrain data

Survey work

Wind Farm development

13.4.5 Baseline sound surveys took place between Thursday 10 March 2022 and Wednesday 31 March 2022. A planning application for a permanent full height met mast is awaiting determination and therefore simultaneous wind speed measurements were taken using a temporary mast with an anemometer at a height of 10m. It is acknowledged that this is not the preferred method for wind speed data acquisition in the IOA GPG. However, it does allow for an indication of baseline noise levels at residential receptors.

13.4.6 A repeat survey will be undertaken in accordance with ETSU-R-97[5] and the IOA GPG following the installation of a permanent met mast, in that they will be undertaken over a sufficient period of time to allow a reliable assessment of the prevailing background noise levels to be performed, and for no less than two weeks.

13.4.7 Background noise monitoring was undertaken at four locations surrounding the Proposed Development. The positions of the monitoring locations are shown in **Figure 13.1** and listed in **Table 13.7**.

Table 13.7 Noise monitoring locations

Monitoring location	Location	Approximate distance from site boundary (m)	Easting	Northing
M1	17 Rhiw Park Road, Abertillery	800	321903	204160
M3	The Gables	340	319066	204188

[22] Ecocel Renewables (2014). Single Wind Turbine Application – Roundshaw Farm Environmental Statement: Volume III – Technical Assessment. (Online) Available at: roundshaw farm - environmental statement volume 3.pdf (east-ayrshire.gov.uk) (Accessed 13 January 2022).
[23] Senvion (2014). GI-2.21-WT.PO.04-A-A-EN Octave & Third Octave Band Data (MM100/50Hz/60Hz). Senvion, Germany.
[24] University of Gothenburg (2008). WINDFARM perception Visual and acoustic impact of wind turbine farms on residents. (Online) Available at: Microsoft Word - WFp-final.doc (wind-watch.org) (Accessed 13 January 2022).
[25] Ordnance Survey (2022). OS Terrain 50 (Free OS Open Data). (Online) Available at: https://osdatahub.os.uk/downloads/open/Terrain50 (Accessed 14 January 2022).

Monitoring location	Location	Approximate distance from site boundary (m)	Easting	Northing
M4	Tonyrefail Farm	850	318502	203178
M5	Arail Farm	110	321177	203125
10m Met Mast	-	-	319966	203610

13.4.8 The background levels identified from the measured levels at each location using a polynomial curve as per ETSU-R-97 requirements are presented in **Table 13.8** and ***Data** insufficient at these wind speeds so using the closest preceding baseline.

13.4.9 Table 13.9. Where insufficient data was captured during the survey at higher wind speeds it is assumed that the sound levels would not be below the lower wind speeds as marked in the tables.

Table 13.8 Background sound levels $L_{A90,10min}$ – quiet daytime

Monitoring location	Wind speed at 10m (m/s)									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
M1	37.4	37.3	37.8	39.0	39.0*	39.0*	39.0*	39.0*	39.0*	39.0*
M3	38.7	38.5	38.3	38.3	38.3	38.4	38.5	38.6	38.7	38.8
M4	30.1	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
M5	31.6	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6

*Data insufficient at these wind speeds so using the closest preceding baseline.

Table 13.9 Background sound levels $L_{A90,10min}$ – night-time

Monitoring location	Wind speed at 10m (m/s)									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
M1	32.4	31.8	31.5	32.0	32.0*	32.0*	32.0*	32.0*	32.0*	32.0*
M3	36.7	37.1	37.3	37.4	37.4*	37.4*	37.4*	37.4*	37.4*	37.4*
M4	26.3	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
M5	27.7	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1

*Data insufficient at these wind speeds so using the closest preceding baseline.

Turbine data

13.4.10 A range of turbine models would be appropriate for the Proposed Development. The final selection of turbine will follow a competitive tendering process and thus the actual model of turbine may differ from those on which this assessment has been based. However, the

final choice of turbine will be required to comply with the noise criterion levels which have been established for the development within this noise assessment.

13.4.11 It is understood that the proposed candidate turbine is a Vestas V150 4.2MW turbine, with a hub height of 105m and rotor diameter of 150m. The candidate turbine considered in this envelope is shown in **Table 13.10**, with octave band data in **Table 13.11**. The numbers listed in the tables are for Mode 0 of operation, corrected to a standardised 10m height and include 2dB uncertainty, in line with best practice.

Table 13.10 Broadband wind turbine sound power data for the Proposed Development

Turbine	Sound power levels (dB L_{WA}) by wind speed (m/s)								
	4	5	6	7	8	9	10	11	12
Vestas V150-4.2MW	93.3	95.2	98.4	101.9	105.3	106.9	106.9	106.9	106.9

Table 13.11 Octave band wind turbine sound power data for the Proposed Development at 9m/s

Turbine	Sound power levels (dB L_{WA}) by octave band (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Vestas V150-4.2MW	77.9	88.2	95.6	100.2	102.0	100.9	97.0	90.2	80.6

13.4.12 Data has also been collected for turbines to be considered within the cumulative assessment. Whilst the study area is 10km from the Proposed Development, all sites between 5 – 10km consist of 1 – 3 turbines. Given the distances, the sites further than 5km will not contribute to the sound level at the closest Noise Sensitive Receptors (NSRs) to the Proposed Development and have therefore not been included within the cumulative assessment. **Table 13.12** presents the sites included within 5km of the Proposed Development and therefore included in the cumulative assessment, along with the turbine type and sound power levels by wind speed. Octave sound power levels for each turbine type are presented in **Table 13.13**. Where details are not available about the turbine type, a reasonable worst case turbine has been assumed, such as Abertillery Wind Farm and Manmoel Wind Farm where an envelope of turbines (Vestas V136-4.2MW, Vestas V150-4.2MW, Nordex N133/4.8, Vestas V150-5.6MW, SG SG-5.0-145, SG SG-6.0-155, Enercon E-115 EP3 4MW, Enercon E-126 4.2MW and Enercon E-136 TES) has been considered. The numbers listed in the tables are corrected to a standardised 10m height and include 2dB uncertainty, in line with best practice.

Table 13.12 Broadband wind turbine sound power data for cumulative assessment

Wind Farm Site	Turbine	Sound power levels (dB L_{WA}) by wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
Abertillery Wind Farm /	Envelope	103.5	107.4	110.9	112.0	112.3	112.4	112.4	112.4	112.4

Wind Farm Site	Turbine	Sound power levels (dB L_{WA}) by wind speed (m/s)								
		4	5	6	7	8	9	10	11	12
Manmoel Wind Farm										
Bedlwyn Farm	Enercon E53 800kW	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Blaentillery Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Coed y Gilfach	Vestas V27 225kW	94.0	97.6	98.1	98.5	98.9	99.3	99.7	99.7	99.7
Cruglwyn	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Gelli-wen Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Oakdale Business Park	Senvion MM100 2MW	98.8	103.9	105.2	105.8	105.8	105.8	105.8	105.8	105.8
Pen y Fan Ganol Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Penrhiwhgwaith Farm	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5
Pen-y-Fan Industrial Estate	Vestas V66 1.5MW	102.6	102.6	102.6	102.6	103.6	103.6	103.6	103.6	103.6
Pen-yr-heol	Enercon E53 800kW*	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5

*Assumed turbine due to lack of information

Table 13.13 Octave wind turbine sound power data for cumulative assessment

Turbine	Sound power levels (dB L_{WA}) by octave band								
	31.5	63	125	250	500	1000	2000	4000	8000
Envelope	89.6	97.4	102.2	104.1	104.1	105.7	105.3	102.6	99.5
Enercon E53 800kW	94.0	94.0	95.7	99.2	101.7	103.3	104.5	104.5	104.5

Turbine	Sound power levels (dB L_{WA}) by octave band								
	31.5	63	125	250	500	1000	2000	4000	8000
Vestas V27 225kW	94.0	97.6	98.1	98.5	98.9	99.3	99.7	99.7	99.7
Senvion MM100 2MW	98.8	103.9	105.2	105.8	105.8	105.8	105.8	105.8	105.8
Vestas V66 1.5MW	102.6	102.6	102.6	102.6	103.6	103.6	103.6	103.6	103.6

13.5 Overall baseline

Current baseline

Wind Farm development and grid connection

13.5.1 The Proposed Development is located in a semi-rural area with the villages Abertillery and Six Bells to the east and Aberbeeg to the south. The most notable likely existing noise sources are traffic on the A467 (approximately 300m east of the Proposed Development boundary) and A4046 (approximately 250m west from the Proposed Development boundary).

Future baseline

13.5.2 It is reasonable to assume that, over time, background noise levels in the vicinity of the Proposed Development would generally remain the same, with possible slight increases in road traffic noise in line with forecast traffic growth.

13.6 Embedded measures

13.6.1 A range of environmental measures have been embedded into the Proposed Development as outlined in **Section 4.9**. **Table 13.14** outlines how these embedded measures will influence the noise assessment.

Table 13.14 Summary of the embedded environmental measures

Receptor	Potential changes and effects	Embedded measures	Compliance mechanism
Construction			
All	Construction noise and vibration effects from site works	All construction activities undertaken in accordance with good practice as set out in BS5228-1:2009+A1:2014	Construction Environmental Management Plan (CEMP)

Receptor	Potential changes and effects	Embedded measures	Compliance mechanism
All	Construction noise and vibration effects from site works	All employees on the construction site will 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	CEMP
All	Construction noise and vibration effects from site works	Where practicable, for any particular activity, suitable plant, machinery and working practices will be adopted. All equipment will be maintained in good working order and will be fitted with appropriate noise controls at all times (e.g. silencers, mufflers and/or acoustic hoods)	CEMP
All	Construction noise and vibration effects from site works	Construction plant capable of generating significant noise and vibration levels will be operated in a manner to minimise the duration of the higher magnitude levels	CEMP

13.7 Scope of the assessment

The Proposed Development

13.7.1 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[5]. Consequently, the design of the scheme is such that relevant operational noise limits are met and no environmental mitigation measures are necessary. By way of separation between receptors and turbines resulting from this process, construction noise is also limited, thus only general good-practice noise control measures are required, and no specific mitigation is necessary.

13.7.2 The EIA Regulations 2017 require that all 'significant' effects be identified. The majority of noise related guidance and standards (including ETSU-R-97[5]) 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 is based upon compliance with the applicable noise limits; i.e. breach of the noise limits indicates a 'significant' effect, whereas compliance with noise limits indicates a 'not significant' effect.

13.7.3 The agreed approach and scope for this chapter (in accordance with the noise and vibration chapter within the Scoping Report) is the construction (piling only, if required) and operational noise assessment of predicted turbine noise against measured background noise levels. The noise assessment addresses the operational noise from existing wind turbines within 5km of the Proposed Development. Construction traffic was initially scoped into the assessment, but due to the chosen route taken being a substantial distance from residences and a very minor increase in traffic on A-roads this aspect of the assessment has been scoped out (see **Table 13.16** for more details).

13.7.4 Due to the magnitude of separation distances involved, the potential for vibration impacts during construction and operation of the Proposed Development have been scoped out and no assessment has been undertaken. In addition, it was agreed at scoping stage that

noise emissions from construction activities other than piling (if required) and construction traffic could be scoped out of the assessment.

13.7.5 It is assumed that decommissioning noise would be generally less than or, at most, similar to that experienced during the construction period. It is therefore considered that noise impacts relating to the decommissioning of wind turbines would be no worse than those experienced during construction, provided similar restrictions on working hours and transport routes are applied. Noise from decommissioning has therefore been scoped out of further assessment.

Spatial scope

13.7.6 The spatial scope of the assessment of noise covers the area of the Proposed Development contained within the red line boundary, together with the Zones of Influence (ZoIs) that have formed the basis of the study area described in **Section 13.4**.

13.7.7 The assessment study area has been defined using the screening approach outlined within ETSU-R-97[5]. The screening approach can be adopted where noise at receptors from proposed or existing wind turbines does not exceed 35dB $L_{A90,10min}$ in wind speeds up to 10 ms^{-1} at a 10 metre height. Receptors that are predicted to experience wind turbine noise levels higher than 35dB $L_{A90,10min}$ have been considered to fall within the assessment study area.

13.7.8 Initial noise modelling of the Proposed Development indicated that properties to the east, south and west would likely fall within the 35dB $L_{A90,10min}$ contour and thus are considered further within this chapter.

Temporal scope

13.7.9 The temporal scope of the assessment of noise is consistent with the period over which the Project would be carried out and therefore covers the 25 years of operation.

Potential receptors

13.7.10 The principal noise receptors that have been identified as being potentially subject to effects are summarised in **Table 13.15**.

Table 13.15 Noise receptors subject to potential effects

Receptor	Reason for consideration
Residential receptors	Considered of high sensitivity in respect to noise.
Ecological receptors	Have the potential to be affected by changes in the ambient noise level. These receptors are considered further in **Chapter 8: Biodiversity** and **Chapter 9: Ornithology.**

13.7.11 The residential receptors considered further in this assessment are detailed in **Table 13.16**.

Table 13.16 Potential residential receptors

Reference	Receptor Name	Easting	Northing	Representative monitoring location
R1	King Street, Cwm	318751	204800	M3
R2	The Gables	319061	204168	M3
R3	Tir-bâch	318073	203810	M4
R4	Pen-rhiw-gyngi	318439	203788	M4
R5	Property south of Pen-rhiw-gyngi	318402	203522	M4
R6	Manmoel	317946	203407	M4
R7	Tir y Pentre Farm	318245	203235	M4
R8	Pen-y-fan-ganol	319512	202241	M4
R9	2 Brondeg Cottages	320637	202010	M5
R10	88 – 97 Aberbeeg Road	321101	202321	M5
R11	St Illtyd	321800	201930	M5
R12	Properties to the west of 34 Aberbeeg Road	321422	202777	M5
R13	Arail Farm	321191	203103	M5
R14	1/2 Arail Farm Road	321783	203097	M5
R15	Pantypwdyn Road	322072	203917	M1
R16	Heolgerrig	321931	204086	M1
R17	Old Blaina Road	321150	204333	M1
R18	Ty-Dan-Y-Wal Road	321401	205038	M1
R19	Cyril Place	320673	204777	M1
R20	Glo-byllau	320476	205278	M1

Likely significant effects

13.7.12 The effects on noise receptors which have the potential to be significant and have been taken forward for detailed assessment are summarised in **Table 13.17**.

Table 13.17 Summary of effects scoped in for further assessment

Activity	Likely significant effects
Impact piling (if required as part of the construction of the Proposed Development)	Noise disturbance to receptors in the area of activities
Construction traffic movements	Disturbance to receptors on the construction traffic route
Operational turbine noise	Noise disturbance from wind turbines

13.7.13 In addition to the above, when further details are available regarding the grid connection consideration will be given to operational noise from the overhead lines (currently assumed as a worst case). If necessary (dependent on proximity to residences and line type), the assessment would be based on predicted line noise under dry and wet conditions and the baseline of those conditions as measured at locations representative of the closest residence.

13.7.14 The receptors/effects detailed in **Table 13.18** have been scoped out from being subject to further assessment because the potential effects are not considered likely to be significant.

Table 13.18 Summary of effects scoped out of the noise assessment

Receptors/potential effects	Justification
Blasting	Blasting would be very unlikely to be undertaken as part of the construction of the Proposed Development, however if any blasting is to occur it would be controlled via a blasting management plan as part of a planning condition requirement.
Construction activities other than piling	Noise emissions from construction activities other than piling (including vehicles on haul routes, but not on existing roads) are unlikely to be high enough, given the distance of the Proposed Development to NSRs, to warrant a noise assessment. However, planning conditions regarding standard times of work should apply.
Construction traffic	The HGV route onto site is via the forest road from the A4046, junction at Grid Ref: 319555 (Easting), 203198 (Northing). The forest road route does not pass any residential receptors. HGV flows are estimated at 62 vehicles per day on the A4046. This is an increase of under 1% on top of the total flows on the A4046 of 6,857, the lowest baseline traffic flow on affected roads. As a guide it takes an increase of 25% in traffic flows to have an increase in noise levels of 1 dB. Whilst the increase in HGV numbers would require less of an increase to have a corresponding increase of noise levels of 1 dB, the small percentage flow would still result in a negligible change in noise levels at residences along the A4046. Further details on construction traffic movements are provided in **Chapter 12: Traffic and Transport.**
Operational traffic	Operation traffic noise during the operation of the Proposed Development is scoped out as the amount of traffic associated during the operational phase would be minimal. See **Chapter 12: Traffic and Transport** for further details.
Decommissioning	The effects of decommissioning on any NSRs are likely to be similar in nature but of a lower magnitude than those during the construction phase. As a result, it is not proposed to assess the decommissioning phase of the development in addition to that of the construction phase.

Receptors/potential effects	Justification
Construction of the grid connection	Whilst there will be some construction noise associated with the grid connection at nearby residences, this will be temporary in nature. It is unlikely that the construction works associated with these connections will last for more than 10 days within any consecutive 15 or for a total number of days exceeding 40 in any 6 consecutive months, and therefore noise effects due to the construction at the grid connection has been scoped out from further assessment.

13.8 Assessment methodology

13.8.1 The generic project-wide approach to the assessment methodology is set out in **Chapter 2: Approach to Environmental Impact Assessment** and specifically in **Sections 2.5** to **2.8**. However, whilst this has informed the approach that has been used in this noise assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this noise assessment.

Proposed Development construction assessment methodology

13.8.2 As established at the scoping stage and explained in **Table 13.18**, noise emissions from construction activities other than piling are unlikely to be high enough to result in significant effects given the distance of the Proposed Development to NSRs. Therefore, only noise effects due to piling have been considered in this Draft ES.

13.8.3 BS 5228-1:2009 + A1:2014[12] includes guidelines relating to the acceptability of noise from construction sites. The appropriate noise limit for a project in an area such as the Proposed Development would be 65dB $L_{Aeq,T}$ during the daytime (07:00 – 19:00 weekdays, 07:00 – 13:00 Saturdays).

13.8.4 The precise construction methodology for the Site will not be finalised until such a time as a contractor is commissioned to build the development and as such the actual plant to be used is not yet known. The plant list given in **Table 13.19** is based upon experience of other wind farm construction projects. The noise emission data quoted is taken from BS 5228-1:2009 + A1:2014[12].

Table 13.19 Construction plant source data (piling only)

Plant	$L_{Aeq,T}$ dB at 10m	Number of plant	% on time	Typical sound power level dB(A)	Data source
Large rotary bored piling rig	83	1	100	111	BS 5228-1:2009 + A1:2014[12] Table C.3 Reference 14

13.8.5 A spreadsheet calculation in accordance with Annex F of BS 5228-1:2009 + A1:2014[12] will be undertaken to assess potential significant effects.

Proposed Development operation assessment methodology

13.8.6 Planning Policy Wales (PPW) refers to ETSU-R-97 for guidance on the assessment of noise from wind farms[26].

13.8.7 Consequently, the assessment methodology adopted is that found in ETSU-R-97[5]. The advice presented in the document 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.

Noise limits

13.8.8 Acceptable limits for wind turbine operational noise are defined in ETSU-R-97[5]. The test for operational noise is therefore whether or not the calculated wind turbine noise levels at receptor properties lie at or below the noise limits derived in accordance with ETSU-R-97[5].

13.8.9 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[5] 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 cut-in speed up to 12 ms^{-1}, the point at which turbines are usually at or above 95% of their rated power and thus no significant increases in noise emissions are expected. Wind speeds are referenced to a 10 metre measurement height (V_{10}) on the wind farm site.

13.8.10 The daytime noise limit is derived from background noise data measured at residential properties during the 'quiet daytime', as defined in ETSU-R-97[5], which comprises:

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

13.8.11 The noise measurements are plotted against the concurrent wind speed data measured at the application site and a 'best fit' correlation is established.

13.8.12 In low noise environments (i.e. where background noise levels are less than 30 – 35dB(A)), the ETSU-R-97[5] Guidance recommends that wind farm noise for quiet daytime periods should be limited to a lower fixed level within the range 35 – 40dB $L_{A90,10min}$ or 5 dB(A) above the prevailing background, 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[5] Guidance. These include:

[26] Welsh Assembly Government, Planning Policy Wales. Edition 11: February 2021. (Online) Available at: https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf (Accessed 26 January 2021).

- 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.

13.8.13 The Scoping Report states that the cumulative assessment will be based on a daytime lower fixed noise limit of 40dB $L_{A90,10min}$, based on the level of power provided by all the wind farms together, a factor advocated within ETSU-R-97[5].

13.8.14 The night-time noise limit is derived from the background noise data measured during the night-time period (23:00 – 07:00) every day. As with the daytime data, this is plotted against the concurrent wind speed data and a 'best fit' correlation established. For night-time periods, the ETSU-R-97[5] recommended limits are 43dB $L_{A90,10min}$ or 5dB(A) above prevailing background, whichever is the greater.

13.8.15 The only exception to the daytime and night-time limits outlined above is for properties with a financial involvement in the development where ETSU-R-97[5] limits can be increased to 45dB $L_{A90,10min}$ (or 5dB above the prevailing background, whichever is greater). Receptor 13 – Arail Farm is considered as having a financial benefit from the Proposed Development, therefore the higher noise limits have been adopted for this location.

13.8.16 The ETSU-R-97[5] 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 will depend on how audible the tone is. A warranty will be sought from the manufacturers of the turbine selected for the Proposed Development such that the noise output will either not require a tonal correction (under the ETSU-R-97[5] Guidance) or, where tonal corrections are required, the noise criteria will be met having made the appropriate correction for any tonal component.

13.8.17 The ETSU-R-97[5] Guidance states the $L_{A90,10min}$ descriptor should be used for both the background noise and wind farm noise when setting limits.

Research background

13.8.18 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'[11]. The use of the IoA GPG in the assessment of wind turbine noise has been endorsed by Welsh Government. Carl Sargeant, Minister for Housing and Regeneration, Welsh Government, stated in a letter to the IoA on 22 May 2013:

"The assumptions listed in the section below are all confirmed within the IoA GPG as the correct approach to modelling wind turbine noise emissions."

13.8.19 In line with the IoA GPG[11], the model used in this assessment is based upon that found in ISO 9613-2 *Acoustics – Attenuation of sound during propagation outdoors*[27]. The model takes account of:

[27] International Standards Organization (1996). ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation. ISO, Geneva.

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

13.8.20 The ISO 9613-2[27] 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 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[27] algorithm tended to predict noise levels that would generally occur under downwind propagation conditions.

13.8.21 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 will be as much as 10dB(A) to 15dB(A) lower than the level predicted using the ISO 9613-2[27] algorithm.

Operational noise modelling

13.8.22 For the purposes of the present assessment, noise level predictions have been based upon the following assumed model parameters:

- 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 are inclusive of any 'valley effect' penalty (discussed below).

Valley effect

13.8.23 The IoA GPG[11] recommends that a noise correction is applied in circumstances where the intervening terrain height between a proposed wind development and sensitive receptors drops away significantly. Where a 'valley 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

13.8.24 The assessment of significant operational noise effects is based upon compliance with the ETSU-R-97[5] i.e. a breach of the noise limits indicates a 'significant' effect, whereas compliance with noise limits indicates a 'not significant' effect. It is acknowledged that the ETSU-R-97[5] approach does not directly aim to determine significance in an EIA context, rather it represents a balance between the need for wind energy and the need to protect residential amenities. Since the purpose of identifying significant effect during EIA is to ensure they are taken into account in the 'planning balance', for the purposes of this assessment it is assumed that noise effects up to the ETSU-R-97[5] noise limits have already been taken into account and thus only noise levels exceeding the ETSU-R-97[5] noise limits are deemed to be 'significant' and require further consideration.

13.9 Preliminary assessment of noise effects

Construction of Proposed Development (piling only)

13.9.1 Predictions of the noise levels from piling have been undertaken to find the distance at which 65dB $L_{Aeq,T}$ would no longer be experienced, as summarised in **Table 13.20**.

Table 13.20 Predicted noise levels during construction phase (piling only)

Plant item	$L_{Aeq,T}$ @ 10m (dB)	Distance at which resultant $L_{Aeq,T}$ is below 65dB (m)
Large rotary bored piling rig	83	110

13.9.2 As no NSRs fall within 110m of the construction area where piling could take place, it is considered highly unlikely that an exceedance of 65dB $L_{Aeq,T}$ would be experienced at the NSRs due to piling. Therefore, the noise effects as a result of construction are considered to be **not significant**.

Operation of Proposed Development

13.9.3 Noise levels have been predicted for the closest residential properties to the wind farm, as shown in **Figure 13.1** and listed in **Table 13.16**. As per the IOA GPG, to account for the use of 10 m wind speeds in the formation of the baseline criteria, the turbine noise results at residential receptors have been shifted to the left along the wind speeds (e.g. the prediction results for 10 m/s are compared against the baseline and criteria for 7 m/s). This is to account for the potentially much higher wind shear gradient on the site than would normally be specified with turbine noise corrections at 10 m height. This correction is already embedded in the results tables below.

13.9.4

13.9.5 **Table** 13.21 and

13.9.7 Table 13.22 present the following information for each wind speed for each of the properties for daytime and night-time respectively:

- the noise limits derived from the ETSU-R-97[5] Guidance and IoA GPG[11] in the absence of background noise levels;
- the predicted turbine noise levels (as corrected) from the Proposed Development, based on worst-case downwind noise propagation and inclusive of any 'valley effect' penalty at receptors and assuming turbines are operating simultaneously; and
- the margin by which the predicted turbine noise, inclusive of any 'valley effect' penalty, meets the noise limits at each wind speed using the worst-case downwind noise predictions (negative values indicate the predicted noise levels are lower than the noise limits).

Table 13.21 Noise assessment – daytime

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	38.5	38.3	38.3	38.3	38.4	38.5	38.6	38.7	38.8
ETSU-R-97 Derived Noise Limit	43.5	43.3	43.3	43.3	43.4	43.5	43.6	43.7	43.8
Wind Farm Turbine Noise	28.8	32.2	33.9	33.8	33.8	33.8	33.8	33.8	33.8
Margin Under / Over Noise Limit	-14.7	-11.1	-9.4	-9.5	-9.6	-9.7	-9.8	-9.9	-10.0
R2									
Background Noise Curve	38.5	38.3	38.3	38.3	38.4	38.5	38.6	38.7	38.8
ETSU-R-97 Derived Noise Limit	43.5	43.3	43.3	43.3	43.4	43.5	43.6	43.7	43.8
Wind Farm Turbine Noise	31.9	35.3	36.9	36.9	36.9	36.9	36.9	36.9	36.9
Margin Under / Over Noise Limit	-11.6	-8.0	-6.4	-6.4	-6.5	-6.6	-6.7	-6.8	-6.9
R3									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	30.3	33.7	35.3	35.3	35.3	35.3	35.3	35.3	35.3
Margin Under / Over Noise Limit	-6.2	-4.1	-3.9	-5.5	-7.3	-9.5	-12.1	-15.3	-19.0
R4									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	32.3	35.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3
Margin Under / Over Noise Limit	-4.2	-2.1	-1.9	-3.5	-5.3	-7.5	-10.1	-13.3	-17.0
R5									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	32.0	35.4	37.0	37.0	37.0	37.0	37.0	37.0	37.0
Margin Under / Over Noise Limit	-4.5	-2.4	-2.2	-3.8	-5.6	-7.8	-10.4	-13.6	-17.3
R6									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	29.4	32.8	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Margin Under / Over Noise Limit	-7.1	-5.0	-4.8	-6.4	-8.2	-10.4	-13.0	-16.2	-19.9
R7									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	30.8	34.2	35.8	35.8	35.8	35.8	35.8	35.8	35.8

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-5.7	-3.6	-3.4	-5.0	-6.8	-9.0	-11.6	-14.8	-18.5
R8									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	36.5	37.8	39.2	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	34.7	38.1	39.7	39.7	39.7	39.7	39.7	39.7	39.7
Margin Under / Over Noise Limit	-1.8	0.3	0.5	-1.1	-2.9	-5.1	-7.7	-10.9	-14.6
R9									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	38.5	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	31.7	35.1	36.7	36.7	36.7	36.7	36.7	36.7	36.7
Margin Under / Over Noise Limit	-6.8	-5.5	-6.0	-8.4	-10.9	-13.4	-16.2	-19.0	-21.9
R10									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	38.5	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	30.1	33.5	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Margin Under / Over Noise Limit	-8.4	-7.1	-7.6	-10.0	-12.5	-15.0	-17.8	-20.6	-23.5
R11									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	38.5	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	30.3	33.7	35.4	35.3	35.3	35.3	35.3	35.3	35.3
Margin Under / Over Noise Limit	-8.2	-6.9	-7.3	-9.8	-12.3	-14.8	-17.6	-20.4	-23.3
R12									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	38.5	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	31.1	34.5	36.1	36.1	36.1	36.1	36.1	36.1	36.1
Margin Under / Over Noise Limit	-7.4	-6.1	-6.6	-9.0	-11.5	-14.0	-16.8	-19.6	-22.5
R13									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	38.2	41.6	43.2	43.2	43.2	43.2	43.2	43.2	43.2
Margin Under / Over Noise Limit	-6.8	-3.4	-1.8	-1.9	-4.4	-6.9	-9.7	-12.5	-15.4
R14									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	38.5	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	30.4	33.8	35.4	35.4	35.4	35.4	35.4	35.4	35.4

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-8.1	-6.8	-7.3	-9.7	-12.2	-14.7	-17.5	-20.3	-23.2
R15									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	33.6	37.0	38.6	38.6	38.6	38.6	38.6	38.6	38.6
Margin Under / Over Noise Limit	-8.7	-5.8	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4
R16									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	34.0	37.4	39.1	39.0	39.0	39.0	39.0	39.0	39.0
Margin Under / Over Noise Limit	-8.3	-5.4	-4.9	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
R17									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	36.5	39.9	41.5	41.5	41.5	41.5	41.5	41.5	41.5
Margin Under / Over Noise Limit	-5.8	-2.9	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
R18									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	34.3	37.7	39.3	39.3	39.3	39.3	39.3	39.3	39.3
Margin Under / Over Noise Limit	-8.0	-5.1	-4.7	-4.7	-4.7	-4.7	-4.7	-4.7	-4.7
R19									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	37.2	40.6	42.2	42.2	42.2	42.2	42.2	42.2	42.2
Margin Under / Over Noise Limit	-5.1	-2.2	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8	-1.8
R20									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	33.7	37.1	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Margin Under / Over Noise Limit	-8.6	-5.7	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3

Table 13.22 Noise assessment – night-time

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	37.1	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	28.8	32.2	33.9	33.8	33.8	33.8	33.8	33.8	33.8
Margin Under / Over Noise Limit	-14.2	-10.8	-9.1	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2
R2									
Background Noise Curve	37.1	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	31.9	35.3	36.9	36.9	36.9	36.9	36.9	36.9	36.9
Margin Under / Over Noise Limit	-11.1	-7.7	-6.1	-6.1	-6.1	-6.1	-6.1	-6.1	-6.1
R3									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	30.3	33.7	35.3	35.3	35.3	35.3	35.3	35.3	35.3
Margin Under / Over Noise Limit	-12.7	-9.3	-7.7	-7.7	-7.7	-7.7	-9.2	-10.9	-12.3
R4									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	32.3	35.7	37.3	37.3	37.3	37.3	37.3	37.3	37.3
Margin Under / Over Noise Limit	-10.7	-7.3	-5.7	-5.7	-5.7	-5.7	-7.2	-8.9	-10.3
R5									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	32.0	35.4	37.0	37.0	37.0	37.0	37.0	37.0	37.0
Margin Under / Over Noise Limit	-11.0	-7.6	-6.0	-6.0	-6.0	-6.0	-7.5	-9.2	-10.6
R6									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	29.4	32.8	34.4	34.4	34.4	34.4	34.4	34.4	34.4
Margin Under / Over Noise Limit	-13.6	-10.2	-8.6	-8.6	-8.6	-8.6	-10.1	-11.8	-13.2
R7									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	30.8	34.2	35.8	35.8	35.8	35.8	35.8	35.8	35.8

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-12.2	-8.8	-7.2	-7.2	-7.2	-7.2	-8.7	-10.4	-11.8
R8									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	34.7	38.1	39.7	39.7	39.7	39.7	39.7	39.7	39.7
Margin Under / Over Noise Limit	-8.3	-4.9	-3.3	-3.3	-3.3	-3.3	-4.8	-6.5	-7.9
R9									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	31.7	35.1	36.7	36.7	36.7	36.7	36.7	36.7	36.7
Margin Under / Over Noise Limit	-11.3	-7.9	-6.3	-8.5	-12.4	-16.2	-19.8	-22.9	-25.4
R10									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	30.1	33.5	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Margin Under / Over Noise Limit	-12.9	-9.5	-7.9	-10.1	-14.0	-17.8	-21.4	-24.5	-27.0
R11									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	30.3	33.7	35.4	35.3	35.3	35.3	35.3	35.3	35.3
Margin Under / Over Noise Limit	-12.7	-9.3	-7.6	-9.9	-13.8	-17.6	-21.2	-24.3	-26.8
R12									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	31.1	34.5	36.1	36.1	36.1	36.1	36.1	36.1	36.1
Margin Under / Over Noise Limit	-11.9	-8.5	-6.9	-9.1	-13.0	-16.8	-20.4	-23.5	-26.0
R13									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	38.2	41.6	43.2	43.2	43.2	43.2	43.2	43.2	43.2
Margin Under / Over Noise Limit	-6.8	-3.4	-1.8	-2.0	-5.9	-9.7	-13.3	-16.4	-18.9
R14									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	30.4	33.8	35.4	35.4	35.4	35.4	35.4	35.4	35.4

Noise Parameter, $L_{A90, 10 mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-12.6	-9.2	-7.6	-9.8	-13.7	-17.5	-21.1	-24.2	-26.7
R15									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	33.6	37.0	38.6	38.6	38.6	38.6	38.6	38.6	38.6
Margin Under / Over Noise Limit	-9.4	-6.0	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4	-4.4
R16									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	34.0	37.4	39.1	39.0	39.0	39.0	39.0	39.0	39.0
Margin Under / Over Noise Limit	-9.0	-5.6	-3.9	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0
R17									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	36.5	39.9	41.5	41.5	41.5	41.5	41.5	41.5	41.5
Margin Under / Over Noise Limit	-6.5	-3.1	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5
R18									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	34.3	37.7	39.3	39.3	39.3	39.3	39.3	39.3	39.3
Margin Under / Over Noise Limit	-8.7	-5.3	-3.7	-3.7	-3.7	-3.7	-3.7	-3.7	-3.7
R19									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	37.2	40.6	42.2	42.2	42.2	42.2	42.2	42.2	42.2
Margin Under / Over Noise Limit	-5.8	-2.4	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
R20									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	33.7	37.1	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Margin Under / Over Noise Limit	-9.3	-5.9	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3

13.9.8 The results show compliance at all receptors during the daytime, which would constitute a **not significant** effect, with the exception of R8, where minor exceedances of 0.3dB and 0.5dB are experienced at 5 and 6 m/s respectively, which would constitute a potential

significant effect. The results show compliance at all receptors during the night-time period, resulting in a **not significant** effect.

13.9.9 It is important to note that the exceedances are due to the shifting of the turbine predicted noise by 3m/s. With the appropriate survey data using the full height permanent met mast this exceedance may not exist. This result will be reviewed for the final ES once more noise survey data is collected.

Other operational noise issues

Infrasound and low frequency noise

13.9.10 Infrasound is generally defined as pressure waves with a frequency below 20Hz. The human hearing threshold is much reduced below 20Hz compared to higher frequencies. The exact definition of low frequency noise varies, but generally spans the infrasonic and audible ranges from around 10Hz to 200Hz.

13.9.11 Information published by the British Wind Energy Association (BWEA, now RenewableUK) '*Low Frequency Noise and Wind Turbines*'[28] presents a review of a number of sources of information on low frequency noise. Based upon these sources, it is concluded that levels for wind turbines lie below the threshold of perception even for those who are particularly sensitive to such noise.

13.9.12 The report *'The Measurement of Low Frequency Noise at three UK Wind Farms'*[29] presents the results of a number of measurements taken at wind farm sites throughout the UK. The study concluded that modern wind turbines are not sources of infrasound at levels which could be injurious to the health of a wind farm neighbour. At all of the measurement sites, low frequency noise associated with traffic movement along local roads was greater than that associated with the wind farm.

13.9.13 Furthermore, in its discussions of wind farm noise, TAN 8 states in paragraph 2.17:

"There is no evidence that ground transmitted low frequency from wind turbines is at a sufficient level to be harmful to human health."

Other Amplitude Modulation (OAM)

13.9.14 Amplitude Modulation (AM) is a normal characteristic of noise from a rotating turbine when stood close to it. AM is a variation in noise level over time, often described by observers as a repeating 'blade swish' noise. The AM of the aerodynamic noise observed close to the turbine is principally caused by trailing-edge noise from the rotating blades and is termed 'Normal' Amplitude Modulation (NAM).

13.9.15 The noise limits derived following the procedure recommended by the ETSU-R-97[5] Guidance takes into account the phenomenon of NAM and thus afford receptors some protection. However in unusual and rare occurrences where AM occurs outside the

[28] The British Wind Energy Association (2005). Low Frequency Noise and Wind Turbines. (Online) Available at: http://www.windmeasurementinternational.com/Info/bwea_low_frequency_noise_report.pdf (Accessed 25 January 2022).
[29] Hayes McKenzie Partnership (2006). The Measurement of Low Frequency Noise at Three UK Wind Farms. Department of Trade and Industry, London.

definition and mechanisms of NAM, this is known as 'Other' Amplitude Modulation (OAM). Examples of OAM include circumstances where AM is detected in the far-field downwind from the wind turbines or resulting in greater than expected variations in magnitude. Observers of OAM often describe the noise as a 'thump' in character rather than a 'swish'.

13.9.16 The DTI (Department of Trade and Industry) (later Department for Business, Enterprise and Regulatory Reform (BERR), now Department of Energy and Climate Change (DECC)) study undertaken by Hayes McKenzie into low frequency noise[29] referred to above also investigated the phenomenon of OAM. It was found that internal noise levels associated with aerodynamic modulation were above the threshold of audibility at some properties. While measurements within the report indicated these were not high enough to wake occupiers of a room, they could result in difficulties returning to sleep once awoken.

13.9.17 Following publication of the report[29] in 2005, the DTI published a guidance note in 2006 to advise planning authorities on the issue[30]. It states that concerns apparently relating to the phenomenon have been expressed at five out of the (then) 126 operational wind farms throughout the UK. It is categorically stated that the ETSU-R-97[5] Guidance should continue to be used for the assessment of noise from wind farms and it was not considered necessary to further consider the issue of OAM for the Proposed Development.

13.9.18 The DTI Noise Working Group commissioned Salford University to investigate the occurrence of the phenomenon in more detail[31]. A survey was conducted of local authorities to investigate the extent of OAM, and compliant histories were analysed to determine the number of complainants. The phenomenon was considered to be a factor in four of the sites at which there had been complaints and a possible factor at eight further sites. It was found that meteorological conditions were such that the effect would prevail for between 7 – 15% of the time and could persist for several days. The report concluded that given the low incidence of OAM and the low numbers of people involved it is difficult to justify further research; however they do state it may be prudent to attempt to improve our understanding as the phenomenon cannot be predicted at present.

13.9.19 Following publication of the report in 2007, BERR released a statement as follows:

"Based on these findings, Government does not consider there to be a compelling case for further work into AM and will not carry out any further research at this time; however it will continue to keep the issue under review."

13.9.20 It is noted that the Institute of Acoustics Nosie Working Group (IoA NWG) tasked with putting together the IoA GPG[11] at the time of publication were unwilling to propose a method for predicting OAM. In relation to OAM, the IoA GPG states:

"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."

[30] Department of Trade and Industry (2006). Advice on findings of the Hayes McKenzie report on noise arising from wind farms. DTI, London.
[31] University of Salford (2007). Research into aerodynamic modulation of wind turbine noise. Department of Business Enterprise and Regulatory Reform, Salford.

13.9.21 In December 2013, RenewableUK published *Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects*[32]. The RenewableUK report comprises detailed scientific research into the identification of occurrence and mitigation of OAM. The mechanisms for the occurrence of OAM were found to be generally site specific therefore any proposed mitigation would likely have to be tailored on a site by site basis. As part of the research, members of the Institute of Acoustics developed a proposed planning condition that could be used by Local Authorities and tools for confirming its detection.

13.9.22 More recently, BS 8233:2014 *Guide on sound insulation and noise reduction for buildings*[33] states:

"Excess AM can sometimes occur. However it cannot be predicted at the planning stage with the current state of the art."

13.9.23 Given that the current understanding of the mechanisms of OAM are still in development and that an exact choice of turbine is yet to be determined for the Proposed Development, accurate predictions of the likelihood of its occurrence are not possible. It has therefore been determined that it is not necessary to apply a penalty for OAM at the planning stage.

13.9.24 Should an occurrence of OAM occur that gives rise to a Statutory Nuisance, then remedies remain available to the Local Authority under the Environmental Protection Act 1990[34].

13.10 Preliminary assessment of cumulative (inter-project) effects

13.10.1 A preliminary cumulative effects assessment (CEA) has been undertaken for the Proposed Development which considers the combined impacts with other developments on the same single receptor or resource (inter-project effects).

13.10.2

[32] RenewableUK (2013). Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects. (Online) Available at: https://cdn.ymaws.com/www.renewableuk.com/resource/collection/4E7CC744-FEF2-473B-AF2B-135FF2AA3A43/ruk_wind_turbine_amplitude_modulation_dec_2013_v2_(1).pdf (Accessed 25 January 2022).
[33] British Standards Institution (2014). BS 8233:2014 Guide on sound insulation and noise reduction for buildings. BSI, London.
[34] UK Government (1990), Environmental Protection Act 1990. (Online) Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 13 January 2022).

13.10.3 **Table** 13.23 and **Table 13.24** present the information summarised in the modelling approach for all wind farms contributing to the noise levels at the identified receptors as listed in **Table 13.12**.

13.10.4 The modelling results assume all wind turbines are acting directly downwind of all receptors at the same time, showing an absolute worst-case scenario.

Table 13.23 Noise assessment – cumulative daytime

Noise Parameter, $L_{A90,\ 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	38.5	38.3	38.3	38.3	38.4	38.5	38.6	38.7	38.8
ETSU-R-97 Derived Noise Limit	43.5	43.3	43.3	43.3	43.4	43.5	43.6	43.7	43.8
Wind Farm Turbine Noise	36.2	37.1	37.8	37.8	37.8	37.8	37.8	37.8	37.8
Margin Under / Over Noise Limit	-7.3	-6.2	-5.5	-5.5	-5.6	-5.7	-5.8	-5.9	-6
R2									
Background Noise Curve	38.5	38.3	38.3	38.3	38.4	38.5	38.6	38.7	38.8
ETSU-R-97 Derived Noise Limit	43.5	43.3	43.3	43.3	43.4	43.5	43.6	43.7	43.8
Wind Farm Turbine Noise	35.8	37.6	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Margin Under / Over Noise Limit	-7.7	-5.7	-4.6	-4.6	-4.7	-4.8	-4.9	-5.0	-5.1
R3									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	34.7	36.5	37.6	37.7	37.7	37.7	37.7	37.7	37.7
Margin Under / Over Noise Limit	-5.3	-3.5	-2.4	-3.1	-4.9	-7.1	-9.7	-12.9	-16.6
R4									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	35.9	37.8	39.0	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	-4.1	-2.2	-1.0	-1.7	-3.5	-5.7	-8.3	-11.5	-15.2
R5									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	35.3	37.4	38.7	38.8	38.8	38.8	38.8	38.8	38.8
Margin Under / Over Noise Limit	-4.7	-2.6	-1.3	-2.0	-3.8	-6.0	-8.6	-11.8	-15.5
R6									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	34.3	35.9	37.0	37.2	37.1	37.1	37.2	37.1	37.1
Margin Under / Over Noise Limit	-5.7	-4.1	-3.0	-3.6	-5.5	-7.7	-10.2	-13.5	-17.2
R7									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	35.1	36.9	38.1	38.3	38.2	38.2	38.3	38.2	38.2
Margin Under / Over Noise Limit	-4.9	-3.1	-1.9	-2.5	-4.4	-6.6	-9.1	-12.4	-16.1
R8									
Background Noise Curve	31.5	32.8	34.2	35.8	37.6	39.8	42.4	45.6	49.3
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.8	42.6	44.8	47.4	50.6	54.3
Wind Farm Turbine Noise	38.1	40.5	41.9	42.3	42.2	42.2	42.3	42.2	42.2
Margin Under / Over Noise Limit	-1.9	0.5	1.9	1.5	-0.4	-2.6	-5.1	-8.4	-12.1
R9									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	40.0	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	33.8	36.3	37.6	37.7	37.6	37.6	37.7	37.6	37.6

Noise Parameter, $L_{A90,\ 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-6.2	-4.3	-5.1	-7.4	-10.0	-12.5	-15.2	-18.1	-21.0
R10									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	40.0	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	33.3	35.3	36.5	36.6	36.5	36.5	36.6	36.5	36.5
Margin Under / Over Noise Limit	-6.7	-5.3	-6.2	-8.5	-11.1	-13.6	-16.3	-19.2	-22.1
R11									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	40.0	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	35.4	36.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
Margin Under / Over Noise Limit	-4.6	-3.8	-4.9	-7.3	-9.8	-12.3	-15.1	-17.9	-20.8
R12									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	40.0	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	34.0	36.1	37.3	37.4	37.3	37.3	37.4	37.3	37.3
Margin Under / Over Noise Limit	-6.0	-4.5	-5.4	-7.7	-10.3	-12.8	-15.5	-18.4	-21.3
R13									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	40.0	42.5	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Margin Under / Over Noise Limit	-5.0	-2.5	-1.1	-1.2	-3.7	-6.2	-9.0	-11.8	-14.7
R14									
Background Noise Curve	33.5	35.6	37.7	40.1	42.6	45.1	47.9	50.7	53.6
ETSU-R-97 Derived Noise Limit	40.0	40.6	42.7	45.1	47.6	50.1	52.9	55.7	58.6
Wind Farm Turbine Noise	35.1	36.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	-4.9	-4.0	-5.1	-7.5	-10.0	-12.5	-15.3	-18.1	-21.0
R15									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	37.3	39.1	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Margin Under / Over Noise Limit	-5.0	-3.7	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8
R16									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	37.5	39.4	40.5	40.5	40.5	40.5	40.5	40.5	40.5
Margin Under / Over Noise Limit	-4.8	-3.4	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5	-3.5
R17									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	38.8	41.1	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Margin Under / Over Noise Limit	-3.5	-1.7	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
R18									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	39.2	40.6	41.5	41.5	41.5	41.5	41.5	41.5	41.5
Margin Under / Over Noise Limit	-3.1	-2.2	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5

Noise Parameter, $L_{A90,\ 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R19									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	39.1	41.6	42.9	42.9	42.9	42.9	42.9	42.9	42.9
Margin Under / Over Noise Limit	-3.2	-1.2	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
R20									
Background Noise Curve	37.3	37.8	39.0	39.0	39.0	39.0	39.0	39.0	39.0
ETSU-R-97 Derived Noise Limit	42.3	42.8	44.0	44.0	44.0	44.0	44.0	44.0	44.0
Wind Farm Turbine Noise	36.1	38.4	39.7	39.7	39.7	39.7	39.7	39.7	39.7
Margin Under / Over Noise Limit	-6.2	-4.4	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3

Table 13.24 Noise assessment – cumulative night-time

Noise Parameter, $L_{A90,\ 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	37.1	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	36.2	37.1	37.8	37.8	37.8	37.8	37.8	37.8	37.8
Margin Under / Over Noise Limit	-6.8	-5.9	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2	-5.2
R2									
Background Noise Curve	37.1	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	35.8	37.6	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Margin Under / Over Noise Limit	-7.2	-5.4	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3	-4.3
R3									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	34.7	36.5	37.6	37.7	37.7	37.7	37.7	37.7	37.7
Margin Under / Over Noise Limit	-8.3	-6.5	-5.4	-5.3	-5.3	-5.3	-6.8	-8.5	-9.9
R4									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	35.9	37.8	39.0	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	-7.1	-5.2	-4.0	-3.9	-3.9	-3.9	-5.4	-7.1	-8.5
R5									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	35.3	37.4	38.7	38.8	38.8	38.8	38.8	38.8	38.8
Margin Under / Over Noise Limit	-7.7	-5.6	-4.3	-4.2	-4.2	-4.2	-5.7	-7.4	-8.8
R6									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	34.3	35.9	37.0	37.2	37.1	37.1	37.2	37.1	37.1
Margin Under / Over Noise Limit	-8.7	-7.1	-6.0	-5.8	-5.9	-5.9	-7.3	-9.1	-10.5
R7									

Noise Parameter, $L_{A90,\ 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	35.1	36.9	38.1	38.3	38.2	38.2	38.3	38.2	38.2
Margin Under / Over Noise Limit	-7.9	-6.1	-4.9	-4.7	-4.8	-4.8	-6.2	-8.0	-9.4
R8									
Background Noise Curve	27.7	29.4	31.4	33.4	35.5	37.6	39.5	41.2	42.6
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	44.5	46.2	47.6
Wind Farm Turbine Noise	38.1	40.5	41.9	42.3	42.2	42.2	42.3	42.2	42.2
Margin Under / Over Noise Limit	-4.9	-2.5	-1.1	-0.7	-0.8	-0.8	-2.2	-4.0	-5.4
R9									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	33.8	36.3	37.6	37.7	37.6	37.6	37.7	37.6	37.6
Margin Under / Over Noise Limit	-9.2	-6.7	-5.4	-7.5	-11.5	-15.3	-18.8	-22.0	-24.5
R10									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	33.3	35.3	36.5	36.6	36.5	36.5	36.6	36.5	36.5
Margin Under / Over Noise Limit	-9.7	-7.7	-6.5	-8.6	-12.6	-16.4	-19.9	-23.1	-25.6
R11									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	35.4	36.8	37.8	37.8	37.8	37.8	37.8	37.8	37.8
Margin Under / Over Noise Limit	-7.6	-6.2	-5.2	-7.4	-11.3	-15.1	-18.7	-21.8	-24.3
R12									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	34.0	36.1	37.3	37.4	37.3	37.3	37.4	37.3	37.3
Margin Under / Over Noise Limit	-9.0	-6.9	-5.7	-7.8	-11.8	-15.6	-19.1	-22.3	-24.8
R13									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	40.0	42.5	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Margin Under / Over Noise Limit	-5.0	-2.5	-1.1	-1.3	-5.2	-9.0	-12.6	-15.7	-18.2
R14									
Background Noise Curve	30.0	33.0	36.5	40.2	44.1	47.9	51.5	54.6	57.1
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	45.2	49.1	52.9	56.5	59.6	62.1
Wind Farm Turbine Noise	35.1	36.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	-7.9	-6.4	-5.4	-7.6	-11.5	-15.3	-18.9	-22.0	-24.5
R15									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	37.3	39.1	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Margin Under / Over Noise Limit	-5.7	-3.9	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
R16									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0

Noise Parameter, $L_{A90, 10\ mins}$, dB	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	37.5	39.4	40.5	40.5	40.5	40.5	40.5	40.5	40.5
Margin Under / Over Noise Limit	-5.5	-3.6	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
R17									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	38.8	41.1	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Margin Under / Over Noise Limit	-4.2	-1.9	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6	-0.6
R18									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	39.2	40.6	41.5	41.5	41.5	41.5	41.5	41.5	41.5
Margin Under / Over Noise Limit	-3.8	-2.4	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5	-1.5
R19									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	39.1	41.6	42.9	42.9	42.9	42.9	42.9	42.9	42.9
Margin Under / Over Noise Limit	-3.9	-1.4	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
R20									
Background Noise Curve	31.8	31.5	32.0	32.0	32.0	32.0	32.0	32.0	32.0
ETSU-R-97 Derived Noise Limit	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
Wind Farm Turbine Noise	36.1	38.4	39.7	39.7	39.7	39.7	39.7	39.7	39.7
Margin Under / Over Noise Limit	-6.9	-4.6	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3	-3.3

13.10.5 The results of the cumulative noise assessment show compliance at all receptors during the daytime period, resulting in a not significant effect, with the exception of R8, where exceedances of 1.9dB are predicted, resulting in a potential significant effect. During the night-time, compliance is predicted at all receptors, resulting in a not significant effect.

13.10.6 In addition to the commentary on the exceedance on the site noise alone with regards to conservatisms in the turbine prediction, it should also be noted that there is likely to be an element of directivity in the turbine operation. Often the receptor R8 is not going to be downwind of the dominating wind farm sites at the same time and so the noise levels are likely to be lower than predicted in this assessment.

13.11 Preliminary significance conclusions

13.11.1 Compliance of noise limits has been identified modelling the operation of the Proposed Development assuming a worst-case scenario of all receptors downwind of all turbines, with the exception of R8 where slight exceedances are predicted.

13.11.2 With the further monitoring to be undertaken in compliance with the IOA GPG and taking into account directivity as part of the cumulative assessment, the turbine noise levels at R8 could be reduced to under the noise limits.

13.11.3 Should there be a remaining exceedance at R8 after taking these considerations into account, the noise levels will be able to be further reduced using low noise modes of the candidate turbine. Turbine operation can normally be curtailed at specific wind speeds and directions by at least the 2-5dB that would likely be required to meet the cumulative noise limits. It is therefore considered at this stage that the Proposed Development, such mitigated, would not result in a significant noise effect.

13.11.4 A summary of the results of the preliminary noise assessment is provided in **Table 13.25**.

Table 13.25 Preliminary summary of significance of effects

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Construction daytime: All NSRs	High	Negligible	Not Significant	BS 5228-1:2009 + A1:2014 limits are not exceeded during the daytime period due to piling noise.
Operational daytime: All NSRs	High	Negligible	Not Significant	ETSU-R-97 cumulative noise limits are not exceeded during the daytime period.
Operational night-time: All NSRs	High	Negligible	Not Significant	ETSU-R-97 cumulative noise limits are not exceeded during the night-time period.

1. The sensitivity/importance/value of a receptor is defined using the criteria set out in **Section 13.8** and is defined as low, medium, or high.
2. The magnitude of change on a receptor resulting from activities relating to the development is defined using the criteria set out in **Section 13.8** and is defined as negligible or high.
3. The significance of the environmental effects is based on the combination of the sensitivity/importance/value of a receptor and the magnitude of change and is expressed as major (significant), moderate (potentially significant) or minor/negligible (not significant), subject to the evaluation methodology outlined in **Section 13.8**. The significance is based on the residual effects post mitigation assumed to be included into the design.

13.12 Implementation of environmental measures

13.12.1 Whilst the candidate turbine may change, the residential amenity of surrounding areas would be protected by an appropriately worded planning condition based on ETSU-R-97[5] limits as stipulated within **Section 13.10**. Compliance of these limits can be proven with measurements taken at residential receptor locations once the wind farm is operational.

13.13 Further work to be undertaken

13.13.1 The information provided in this Draft ES is preliminary, the final assessment of likely significant effects will be reported in the ES. This section describes the further work to be undertaken to support the noise assessment presented in the ES.

Baseline

13.13.2 Baseline surveys will be repeated once a permanent met mast is installed on the site. This has the potential to influence the background levels experienced at each wind speed and potentially influence the assessment results, however those presented within this Draft ES are still considered robust.

Assessment

13.13.3 The assessment presented in **Section 13.10** will be reviewed and updated based on the results of the baseline background survey and any changes in candidate turbines. Consideration will be given to the assessment of overhead line noise from the grid connection if the distance to residences would likely result in significant noise effects.

Environmental measures

13.13.4 To date, no additional measures have been identified due to the uncertainty around noise limits in the absence of baseline background noise levels. If (following an updated assessment in the full ES) it is identified that additional measures, such as the use of lower modes on certain turbines, are required, these will be detailed as part of the final ES.