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 **Figure 1.2** and **Figure 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 13.12**).

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 Project.

13.1.4 An initial baseline noise survey for the Draft ES was undertaken using a 10-metre meteorological mast. It is proposed that this will be updated using a full height met mast in accordance with Institute of Acoustics (IOA) guidance (see **Table 13.3** for details), with results being submitted at Final ES submission.

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 provided 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 provided 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[5] is 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.

[1] UK Government (1990), Environmental Protection Act 1990. (Online) Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents (Accessed 5 October 2022).
[2] UK Government (1974). Control of Pollution Act 1974. (Online) Available at: https://www.legislation.gov.uk/ukpga/1974/40/contents(Accessed 5 October 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 5 October 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 5 October 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 5 October 2022).
[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 5 October 2022).
[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 5 October 2022).

Policy	Policy context
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	
Rhondda Cynon Taf County Borough Council Local Development Plan up to 2021 (Adopted March 2011)[10]	Policy AW 10 Environmental Protection and Public Health states: *"Development proposals will not be permitted where they would cause or result in a risk of unacceptable harm to health and / or local amenity because of:- … 2. Noise pollution … unless it can be demonstrated that measures can be taken to overcome any significant adverse risk to public health, the environment and / or impact upon local amenity."* Policy AW 13 relates specifically to wind farm developments generating over 25 MW but contains no specific requirements in relation to noise.

Technical guidance

13.2.4 A summary of the technical guidance for noise is provided 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.
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[5] 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	Detailed guidance on assessing noise from construction sites. Approved code of practice for construction noise under the Control of Pollution Act 1974.

[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 5 October 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 5 October 2022).
[10] Rhondda Cynon Taf County Borough Council, 2012. Local Development Plan 2006 – 2021. (Online) Available at: https://www.rctcbc.gov.uk/EN/Resident/PlanningandBuildingControl/LocalDevelopmentPlans/RelateddocumentsLDP20062021/AdoptedLocalDevelopmentPlan.pdf (Accessed 19 October 2022)
[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 5 October 2022).

Technical guidance document	Context
construction and open sites – Part 1: Noise, BSI (2014)[12]	

13.3 Consultation and engagement

Overview

13.3.1 The assessment has been informed by consultation responses and 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 01 December 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	Recommendation to consult Public Health Wales.	Consultation with Public Health Wales will be undertaken based on the information contained in this Draft ES.
PEDW	Screening: it is unclear how a robust screening exercise can be undertaken without baseline data. Should the ES be presented without baseline data, then this approach should be robustly justified.	Noise measurements have been undertaken in conjunction with wind speed measurements to characterise the baseline noise environment at noise sensitive residential locations identified through a modelling screening exercise to identify those receptors potentially falling within the predicted 35 dBA contour. Additional measurements are proposed with a full height met mast in accordance with the latest IOA guidance.
PEDW	Construction and decommissioning: construction noise and vibration should not be scoped out. Agreed that effects due to decommissioning can be assumed to be no greater than construction effects.	A preliminary assessment of construction noise and vibration is presented in **Section 13.9**.
PEDW	Significance of effects: the noise limits set out in ETSU-R-97 are not a definition of significance. In accordance with the IOA GPG,	Efforts to contact an appropriate person at RCTCBC to discuss the survey and assessment methodology have, so far, been unsuccessful. It is proposed that

[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.

Consultee	Consideration	How addressed in this Draft ES
	lower fixed limits can be used for day and night where baseline data indicates that there is a small difference between daytime and night-time baseline sound levels. Such an approach should be agreed in liaison with RCTCBC. The ES should demonstrate compliance with ETSU-R-97 and explain how significant impacts are identified.	consultation with RCTCBC will be undertaken prior to submission of the final ES. The baseline data presented in **Section 13.4** indicate that differences between daytime and night-time background sound levels are limited, and a combined approach (i.e. analysis of daytime and night-time sound levels together) may therefore be appropriate. The determination of significance relies upon the cumulative assessment and compliance with the ETSU-R-97 limits, as discussed in **Section 13.8**.
PEDW	Operational traffic: it is agreed that operational traffic can be scoped out.	This is discussed further in **Section 13.7**.

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
Rhondda Cynon Taf County Borough Council	Efforts have been made to contact an appropriate person at RCTCBC to discuss the survey and assessment methodology but have been, so far, unsuccessful. It is proposed that consultation with RCTCBC will be undertaken based on the information contained in this Draft ES.
Public Health Wales	Consultation with Public Health Wales will be undertaken based on the information contained in this Draft ES.

13.4 Data gathering methodology

Study area

Wind Farm development

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

13.4.2 Within the 10 km 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, or in close proximity to, the proposed grid connection corridor, which comprises an overhead line,

within the Site boundary, and an underground cable to the connection point at Upper Boat.

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
Google	Google Earth Pro 7.3.4.8248[13]	Aerial imagery
British Standards Institute	BS 5228-1:2009+A1:2014[12]	Noise data for construction noise and vibration predictions.
Vestas	DMS 0069-3309_00 V136-3.6 MW (Can) Third octave noise emission[14]	Turbine noise data (Vestas V136)
Nordex	F008_272_A14_EN Nordex N133/4,8 Octave sound power levels[15]	Turbine noise data (Nordex N133)
Nordex	Nordex N90 – Noise level[16]	Turbine noise data (Nordex N90)
PDA Acoustic Consultants	Proposed wind turbine, Bryn Tail, PontyPridd[17]	Turbine noise data (Vergnet GEV MPR 250kW)
Enercon	Sound Power Level of the Enercon E-48 Operational Mode I (Data Sheet)[18]	Turbine noise data (Enercon E48/400)
Ion Acoustics	Aber Valley Community Wind Turbine. Noise Assessment. Acoustics Report A447 R02E[19]	Turbine noise data (Vensys 100)
SLR	Llwyncelyn Wind Turbines. Noise Assessment[20]	Turbine noise data (Vensys V115)

[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 05 October 2022).
[14] Vestas Wind Systems (2017). DMS 0069-3309_00 V136-3.6 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] Nordex (2003). Nordex N90 – Noise level. Nordex, Germany.
[17] PDA Acoustic Consultants (2013). Proposed wind turbine, Bryn Tail, Pontypridd. Noise impact assessment. Ref. 8024/0540/02. Philip Dunbavin Acoustics Ltd.
[18] Enercon (2012). Sound Power Level of the Enercon E-48 Operational Mode I (Data Sheet). Enercon GmbH, Gernmany.
[19] Ion Acoustics (2016). Aber Valley Community Wind Turbine. Noise Assessment appendices. Appendices to Acoustics Report A447 R02. Ion Acoustics Ltd.
[20] SLR. Llwyncelyn Wind Turbines. Noise Assessment. Ref 422.03541.00018. SLR.

Organisation	Data source	Data
Seren Energy	Mynachdy Wind Turbine Scheme. Desktop Noise Assessment[21]	Turbine noise data (Endurance X35)
KR Associates	Malthouse Development. Heol Las, Llantrisant, Wales.[22]	Turbine noise data (Vensys 82)

Survey work

Wind Farm development

13.4.5 A baseline sound level survey was carried out between Friday 16 September 2022 and Monday 17 October 2022 alongside a 10 m meteorological mast. It is acknowledged that this is not the preferred method for wind speed data acquisition in the IOA GPG[11]. For the Final ES, a repeat survey is proposed following the installation of a permanent (full height) met mast.

13.4.6 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 to nearest proposed turbine, m	Easting	Northing
M2	Glyn, northeast of Tonyrefail	700	302429	188905
M3	4 Bedw Farm Estate, Porth	900	302637	190598
M4	Langton Court Farm	500	304434	203178
10m Met Mast	Approx. 950m east of Glyn, northeast of Tonyrefail	-	303321	188916

[21] Seren Energy (2016). Mynachdy Wind Turbine Scheme. Desktop Noise Assessment. Ref. DNA-MF-2016-05. Seren Energy.
[22] KR Associates, 2015. Malthouse Development. Heol Las, Llantrisant, Wales. CF72 8EG. Environmental Noise Impact Assessment, ETSU-R-97, Institute of Acoustics Good Practice Guide. Ref KR04855. KRA UK Ltd.

13.4.7 Based on the survey results, the background levels identified from the measured levels at each location using a polynomial curve as per ETSU-R-97[5] requirements are presented in **Table 13.8** and **Table 13.9**.

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

Monitoring location	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
M2	29.6	30.1	30.6	31.3	32.1	32.9	33.8	33.8*	33.8*	33.8*
M3	32.5	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7*	35.7*
M4	24.8	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9*	31.9*

* Preceding value used.

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

Monitoring location	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
M2	24.2	24.8	25.9	27.5	29.4	31.4	33.4	33.4*	33.4*	33.4*
M3	25.3	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
M4	23.1	23.7	24.8	26.4	28.4	30.6	32.9	32.9*	32.9*	32.9*

* Preceding value used.

Turbine data

13.4.8 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 that 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 and which will be confirmed in the Final ES.

13.4.9 The candidate turbine used in the assessment is a Vestas V136 STE 3.45 MW turbine, with a hub height of 97.5 m and rotor diameter of 136 m. 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 10 m height and include 2 dB uncertainty, in line with best practice.

Table 13.10 Broadband sound power data, dB L_{wA} of turbine type used in the Proposed Development

Turbine	Wind speed at 10 m, ms^{-1}									
	3	4	5	6	7	8	9	10	11	12
Vestas V136 STE	95.1	98.6	102.9	106.6	107.5	107.5	107.5	107.5	107.5	107.5

Table 13.11 Octave band sound power data dB L_{WA} of turbine type used in the Proposed Development at 14m/s at hub height

Turbine	Sound power level, dB L_{WA}, per Octave band centre frequency, Hz							
	63	125	250	500	1k	2k	4k	8k
Vestas V136 STE	88.2	93.7	98.1	98.7	99.7	98.7	91.6	73.4

13.4.10 Data has also been collected for turbines to be considered within the cumulative assessment. Whilst the study area is 10 km from the Proposed Development, there are a number of single turbines between 5 – 10 km. Given the distances, and the relatively negligible contribution from the single turbines as compared to the multi-turbine sites, the single turbine sites between 5-10 km have not been included in the cumulative assessment. The turbines at the Taff Ely wind farm have not been included, as these are to be decommissioned once Headwind Taff Ely is operational (Condition 33 of the planning permission[23] for the Headwind Taff Ely wind farm requires that the wind farm cannot be erected until the existing turbines within the Taff Ely wind farm are decommissioned and removed from the site).

13.4.11 **Table 13.12** presents the sites which are 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 at Headwind Taff Ely and Twynhywel where Nordex N90 have been assumed. The numbers listed in the tables are corrected to a standardised 10m height and include corrections for uncertainty, in line with best practice.

Table 13.12 Broadband sound power data for turbines used in cumulative assessment

Wind farm site	Turbine	Wind speed at 10 m, ms^{-1}									
		3	4	5	6	7	8	9	10	11	12
Bryntail Farm	Vergnet GEV MPR 250kW	95.1	98.6	102.9	106.6	107.5	107.5	107.5	107.5	107.5	107.5
Ferndale	Enercon E48/400	90.0	90.0	94.3	98.5	101.5	102.5	103.5	103.5	103.5	103.5
Fforch Nest	Nordex N90	99.0	101.0	102.5	103.8	104.8	105.4	106.0	106.3	106.5	106.5
Graig Fatha Farm	Vensys 100	102.0	102.0	104.0	105.6	106.7	107.0	107.1	107.1	107.1	107.1
Headwind Taff Ely	Nordex N90	99.0	101.0	102.5	103.8	104.8	105.4	106.0	106.3	106.5	106.5
Llwyncelyn Farm	Vensys V115 (Mode 5)	94.9	96.4	99.9	102.0	102.0	102.0	102.0	102.0	102.0	102.0

[23] Rhondda Cynon Taf County Borough Council (2015). Town and Country Planning Act 1990, Full Planning Permission. Ref. 11/1468/10. RCTCBC. (Online) Available at: https://documents0122.rctcbc.gov.uk/PublicAccess_Live/Document/ViewDocument?id=3EE67EBA9CD111E482D50021971D20CC [Accessed 19 October 2022]

Wind farm site	Turbine	Wind speed at 10 m, ms^{-1}									
		3	4	5	6	7	8	9	10	11	12
Llwyncelyn Farm	Vensys V115 (Mode 7)	94.9	96.4	99.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mynachdy Farm	Endurance X35	96.1	96.1	97.3	98.8	100.3	101.9	102.9	104.1	104.7	105.1
Mynydd Portref	Vestas V80	91.8	94.0	98.9	102.4	104.0	104.8	104.8	104.0	104.1	104.4
Mynydd Portref Extension	Vestas V80	91.8	94.0	98.9	102.4	104.0	104.8	104.8	104.0	104.1	104.4
Pant-y-Wal	Nordex N90	99.0	101.0	102.5	103.8	104.8	105.4	106.0	106.3	106.5	106.5
Pant-y-Wal extension	Nordex N90	99.0	101.0	102.5	103.8	104.8	105.4	106.0	106.3	106.5	106.5
Twynhywel	Nordex 133	97.0	98.5	104.0	108.2	109.5	109.5	109.5	109.5	109.5	109.5
West of Rhiwfelin Farm	Vensys 82	97.8	97.8	98.8	99.8	100.8	101.8	102.8	103.8	104.8	105.8

Table 13.13 Octave band sound power data for turbines used in cumulative assessment

Turbine	Sound power level, dB L_{WA}, per octave band centre frequency, Hz, at 5 m/s wind speed at 10 m.							
	63	125	250	500	1k	2k	4k	8k
Vergnet GEV MPR 250kW	74.7	81.6	92.4	92.5	88.0	82.7	75.8	45.6
Enercon E48/400	76.1	81.8	88.8	89.5	87.2	83.3	79.5	75.8
Nordex N90	80.9	93.6	94.3	94.0	94.8	96.3	93.5	88.1
Vensys 100	87.4	90.9	96.6	98.7	98.9	94.5	87.4	75.4
Vensys V115 (Mode 5)	81.8	87.3	92.0	93.2	94.0	93.9	86.1	68.3
Vensys V115 (Mode 7)	81.5	87.0	91.7	92.9	93.7	93.6	85.8	68.0
Endurance X35	78.0	87.1	91.8	92.3	90.6	85.9	78.7	68.8
Vestas V80	82.8	89.5	93.7	92.6	90.7	90.1	84.8	72.2
Nordex 133	83.0	90.1	94.9	97.3	97.9	95.4	87.9	75.6
Vensys 82	55.8	67.9	83.8	91.8	94.8	93.1	88.1	76.5

13.5 Overall baseline

Current baseline

Wind Farm development and grid connection

13.5.1 The Proposed Development is located in a rural area, with a number of villages in the vicinity. The most notable existing noise sources are road traffic on the A4058—approximately 1 km to the north of the Proposed Development boundary, and the A4233 west of the Proposed Development.

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 normal growth of flows of road traffic.

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[12].	Construction Environmental Management Plan (CEMP)
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. Noise control measures (silencers, mufflers, any noise barriers, etc.) are to be subject to regular inspection and maintenance.	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.	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 noise emissions.	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 and subsequent Scoping Direction) is that construction noise and vibration (piling only, if required), operational noise, and construction traffic will be assessed.

13.7.4 On the basis of the information provided in **Chapter 4: Project Description Section 4.5: Construction Activities**, the only construction activity that may be required with the potential to generate significant levels of vibration is piling for the wind turbine foundations. It is noted that the nearest dwelling to any potential piling activities is R1, located approximately 430 m west of turbine 1 (and at approximately 70 m lower elevation), with the next nearest dwelling to any potential piling being R21 located approximately 500 m south east of turbine 5. Due to the separation distances involved, it is considered that the potential for significant effects due to vibration during construction and operation of the Proposed Development is negligible. Therefore, based on the above, quantitative assessment of construction vibration has not been carried out, and potential vibration effects have been assessed qualitatively.

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 35 dB $L_{A90,10min}$ 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 35 dB $L_{A90,10min}$ 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 southeast, southwest, west and north would likely fall within the 35 dB $L_{A90,10min}$ 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 30 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	Rhiw-garn-fach Farm	302520	189595	M2
R2	Home Farm, east of Trebanog	302372	189517	M2
R3	Glyn, northeast of Tonyrefail	302398	188889	M2
R4	Lan, north of Castellau Uchaf	304014	187978	M4
R5	Cefn-coed Farm	304443	188629	M4
R6	Tyla-winder Farm	304709	188821	M4
R7	Brookland Bungalow, south of Trefahod	304199	190627	M3
R8	Henllys, Trebanog	302095	189732	M3
R9	Craig Crescent, Trebanog	301629	190460	M3
R10	Concorde Drive, Tonyrefail	302053	188627	M2
R11	Llys Tylcha Fawr, Tonyrefail	301229	188030	M3

Reference	Receptor Name	Easting	Northing	Representative monitoring location
R12	Plas-Rhiwinder, adjacent to Bryngwion House	302387	187942	M2
R13	Tre-boeth Farm	302505	188327	M2
R14	Mountain View, east of Ynys Crug Stud Farm	303115	187345	M2
R15	Rackett Cottages, west of Castallau Uchaf	303667	187549	M2
R16	Twin Pines, Maesycoed	306219	189397	M4
R17	Rheolau Terrace, Trehafod	304171	190805	M3
R18	Glynfach, Porth	302769	190642	M3
R19	Kensington Drive, Porth	303428	190845	M3
R20	Gwaun Bedw, Cymmer	302302	190386	M3
R21	Langton Court Farm	304429	188947	M4
R22	Ty-draw Farm	305112	188697	M4

Likely significant effects

13.7.12 The effects on noise receptors which have the potential to be significant and are being 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
Construction noise and vibration	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, noise and vibration effects from the construction and operation of the grid connection are considered qualitatively, as described in **Chapter 4: Project Description**.

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

Activity	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.
Operational traffic	Operational 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.
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 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 will be considered in the 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 provided 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	dB $L_{Aeq,T}$ at 10m	Number of plant	% on time	Typical sound power level dBA	Data source
Large rotary bored piling rig	83	1	100	111	BS 5228-1:2009+A1:2014[12][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, which will be reported in the ES.

Proposed Development operation assessment methodology

13.8.6 Planning Policy Wales (PPW) refers to ETSU-R-97[5] for guidance on the assessment of noise from wind farms.

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]. The key assessment is the cumulative assessment as ETSU-R-97[5] requires all wind farm noise to be assessed against a baseline free of wind farm noise. However, an assessment of the Proposed Development on its own has also been included for information, but does not affect the significance of effect from the Proposed Development.

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 (V10) 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 to 35 dBA, 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 to 40 dB $L_{A90,10min}$ or 5 dB 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:

- 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 40 dB $L_{A90,10min}$, based on the level of power provided by all the wind farms together, a factor advocated within ETSU-R-97[5]. Consideration of noise from the Proposed Development on its own is based upon a 35 dB $L_{A90,10min}$ for the daytime, to provide an indicative worst-case assessment.

13.8.14 The night-time noise limit is derived from the background noise data measured during the night-time period (23:00 to 07:00) every day. As with the daytime data, this is plotted against the concurrent wind speed data and a 'best fit' correlation established. For night-time periods, the ETSU-R-97[5] recommended limits are 43 dB $L_{A90,10min}$ or 5 dB 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 45 dB $L_{A90,10min}$ (or 5 dB above the prevailing background, whichever is greater). Receptor 1 – Rhiw-garnfach Farm, Receptor 5 – Cefn-coed Farm, Receptor 21 – Langton Court Farm and Receptor 22 – Ty-draw Farm are considered as having a financial benefit from the Proposed Development, therefore the higher noise limits have been adopted for these locations.

13.8.16 The ETSU-R-97[5] noise criteria assumes 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[5] for the Assessment and Rating of Wind Turbine Noise'11. The use of the IOA GPG[11] 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[24]. The model takes account of:

- 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[24] 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[24] 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 10 to 15 dB lower than the level predicted using the ISO 9613-2[24] 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 2 dB 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 3 dB (or 1.5 dB if a ground absorption factor of 0 is being used) is applied to the overall predicted noise level at receptors.

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

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)

Vibration

13.9.1 As outlined in **paragraph 13.7.4**, due to the separation distances involved (the nearest receptor to any potential piling activities is approximately 430 m away), it is considered that the potential for significant effects due to vibration arising from construction and operation is negligible. The vibration effects as a result of construction and operation are therefore considered to be **not significant**.

13.9.2 Notwithstanding the above, should piling be required, vibration emissions would be subject to detailed assessment and vibration emissions controlled, as appropriate, via the CEMP.

Noise

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

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

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

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

Consideration of grid connection noise

13.9.5 Whilst the exact installation method of the grid connection is not known, the construction noise from installing underground cabling and overhead lines would not be significant. This conclusion can be reached based on the construction noise being temporary with any

works in close proximity to residences being less than one month and the threshold for construction noise impacts where noise levels exceed 65 dBA.

13.9.6 The operation of the overhead line may result in audible noise in close proximity to the line during wet weather or after a period of time with detritus build up on the wire. However, given the extent of the area for the grid connection it is considered unlikely that this would be sufficiently close to the existing residential receptors to result in significant effects and there would be options to relocate the line away from receptors if needed. Once the detailed design for the grid connection is known, further analysis may be undertaken to check the assumption within this ES.

Operation of Proposed Development

13.9.7 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[11], to account for the use of 10 m wind speeds, 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.

13.9.8 **Table 13.21** and **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] based on background noise levels measured;
- 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).

13.9.9 It should be noted, as outlined in **paragraph 13.8.8**, that the assessments presented in **Table 13.21** and **Table 13.22** are for information only. In accordance with ETSU-R-97[5] Guidance and IOA GPG[11] it is the cumulative assessment which determines the significance of wind turbine noise at each receptor. The lowest range of daytime fixed noise level limits (i.e. 35 dBA) have been applied for the assessments in **Table 13.21** and **Table 13.22** to provide an indicative worst case assessment. However, the upper range of daytime fixed limits (i.e. 40 dBA) would be more appropriate for the majority of receptors which consist of isolated single dwellings, where the extent of any impacts would be limited to individual dwellings. The upper limit of 40 dBA is used in the cumulative assessment.

Table 13.21 Noise assessment – daytime

Noise parameter,	Standardised 10m Wind Speed (ms^{-1})								
dB $L_{A90,10\,m}$	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
R2									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4
Margin Under / Over Noise Limit	+6.3	+5.8	+5.1	+4.3	+3.5	+2.6	+2.6	+2.6	+2.6
R3									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Margin Under / Over Noise Limit	+5.1	+4.6	+3.9	+3.1	+2.3	+1.4	+1.4	+1.4	+1.4
R4									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	35.0	35.0	35.0	35.0	35.0	35.5	36.9	36.9	36.9
Wind Farm Turbine Noise	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Margin Under / Over Noise Limit	+1.3	+1.3	+1.3	+1.3	+1.3	+0.8	-0.6	-0.6	-0.6
R5									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9
R6									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	35.0	35.0	35.0	35.0	35.0	35.5	36.9	36.9	36.9
Wind Farm Turbine Noise	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
Margin Under / Over Noise Limit	+3.4	+3.4	+3.4	+3.4	+3.4	+2.9	+1.5	+1.5	+1.5
R7									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Margin Under / Over Noise Limit	-2.3	-2.8	-3.3	-3.7	-4.0	-4.4	-4.9	-4.9	-4.9
R8									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	+1.0	+0.5	+0.0	-0.4	-0.7	-1.1	-1.6	-1.6	-1.6
R9									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8
Margin Under / Over Noise Limit	-3.3	-3.8	-4.3	-4.7	-5.0	-5.4	-5.9	-5.9	-5.9
R10									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	+2.4	+1.9	+1.2	+0.4	-0.4	-1.3	-1.3	-1.3	-1.3
R11									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Wind Farm Turbine Noise	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
Margin Under / Over Noise Limit	-6.1	-6.6	-7.1	-7.5	-7.8	-8.2	-8.7	-8.7	-8.7
R12									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5
Margin Under / Over Noise Limit	+1.4	+0.9	+0.2	-0.6	-1.4	-2.3	-2.3	-2.3	-2.3
R13									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	+2.5	+2.0	+1.3	+0.5	-0.3	-1.2	-1.2	-1.2	-1.2
R14									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8
Margin Under / Over Noise Limit	-0.3	-0.8	-1.5	-2.3	-3.1	-4.0	-4.0	-4.0	-4.0
R15									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	35.1	35.6	36.3	37.1	37.9	38.8	38.8	38.8	38.8
Wind Farm Turbine Noise	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Margin Under / Over Noise Limit	-1.3	-1.8	-2.5	-3.3	-4.1	-5.0	-5.0	-5.0	-5.0
R16									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	35.0	35.0	35.0	35.0	35.0	35.5	36.9	36.9	36.9
Wind Farm Turbine Noise	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3
Margin Under / Over Noise Limit	-7.7	-7.7	-7.7	-7.7	-7.7	-8.2	-9.6	-9.6	-9.6
R17									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	35.2	35.2	35.2	35.2	35.2	35.2	35.2	35.2	35.2
Margin Under / Over Noise Limit	-2.9	-3.4	-3.9	-4.3	-4.6	-5.0	-5.5	-5.5	-5.5
R18									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	-0.6	-1.1	-1.6	-2.0	-2.3	-2.7	-3.2	-3.2	-3.2
R19									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8
Margin Under / Over Noise Limit	-1.3	-1.8	-2.3	-2.7	-3.0	-3.4	-3.9	-3.9	-3.9
R20									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	38.1	38.6	39.1	39.5	39.8	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Margin Under / Over Noise Limit	-1.0	-1.5	-2.0	-2.4	-2.7	-3.1	-3.6	-3.6	-3.6
R21									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
Margin Under / Over Noise Limit	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
R22									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9
Margin Under / Over Noise Limit	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1

Table 13.22 Noise assessment – night-time

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4	43.4
Margin Under / Over Noise Limit	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
R2									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4	41.4
Margin Under / Over Noise Limit	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6
R3									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2	40.2
Margin Under / Over Noise Limit	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
R4									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
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	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Margin Under / Over Noise Limit	-6.7	-6.7	-6.7	-6.7	-6.7	-6.7	-6.7	-6.7	-6.7
R5									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9
R6									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
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	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
Margin Under / Over Noise Limit	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6
R7									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Margin Under / Over Noise Limit	-7.2	-7.2	-7.2	-7.2	-7.2	-7.2	-7.2	-7.2	-7.2
R8									

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	39.1	39.1	39.1	39.1	39.1	39.1	39.1	39.1
Margin Under / Over Noise Limit	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9	-3.9
R9									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8
Margin Under / Over Noise Limit	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2
R10									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
R11									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
Margin Under / Over Noise Limit	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0
R12									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.5
Margin Under / Over Noise Limit	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5
R13									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4
R14									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8	34.8
Margin Under / Over Noise Limit	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2	-8.2
R15									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8	33.8
Margin Under / Over Noise Limit	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2	-9.2
R16									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
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	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3	27.3
Margin Under / Over Noise Limit	-15.7	-15.7	-15.7	-15.7	-15.7	-15.7	-15.7	-15.7	-15.7
R17									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	35.2	35.2	35.2	35.2	35.2	35.2	35.2	35.2	35.2
Margin Under / Over Noise Limit	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
R18									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	37.5	37.5	37.5	37.5	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5	-5.5
R19									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8	36.8
Margin Under / Over Noise Limit	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2	-6.2
R20									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1	37.1
Margin Under / Over Noise Limit	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9	-5.9
R21									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2	42.2
Margin Under / Over Noise Limit	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
R22									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9	34.9
Margin Under / Over Noise Limit	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1	-10.1

13.9.10 The results show that predicted turbine noise levels are below the lowest daytime fixed noise limits at the majority of receptors during the daytime. Predicted turbine noise levels at R2, R3, R4, R6, R8, R10, R12 and R13 are predicted to exceed the lowest daytime fixed limit and could be audible. The majority of daytime exceedances are at single dwellings (except R8 and R10, where exceedances are up to 1.0 to 2.4 dB, respectively) and are generally below +3 dB, except at R2, R3 and R6 where exceedances are up to +6.3 dB, +5.1 dB and +3.4 dB, respectively.

13.9.11 The results show that predicted turbine noise levels are below the night-time limits at all receptors during the night-time period.

13.9.12 The daytime exceedances outlined above do not confirm a significant effect, but indicate that significant effects could occur at receptors where exceedances of the lower daytime limits are greatest. Potentially significant effects are considered further in the cumulative assessment in **Section 13.10**.

Other operational noise issues

Infrasound and low frequency noise

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

13.9.14 Information published by the British Wind Energy Association (BWEA, now RenewableUK) 'Low Frequency Noise and Wind Turbines'[25] 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.

13.9.15 The report 'The Measurement of Low Frequency Noise at three UK Wind Farms'[26] 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.

13.9.16 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)

13.9.17 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).

13.9.18 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 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'.

13.9.19 The DTI (Department of Trade and Industry), now Department for Business, Energy and Industrial Strategy (BEIS)) study undertaken by Hayes McKenzie into low frequency noise[27] 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.

13.9.20 Following publication of the report[28] in 2005, the DTI published a guidance note in 2006 to advise planning authorities on the issue[29]. 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

[25] 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].
[26] Hayes McKenzie Partnership (2006). *The Measurement of Low Frequency Noise at Three UK Wind Farms.* Department of Trade and Industry, London.
[27] Department of Trade and Industry (2006). *Advice on findings of the Hayes McKenzie report on noise arising from wind farms*. DTI, London.
[28] University of Salford (2007). *Research into aerodynamic modulation of wind turbine noise.* Department of Business Enterprise and Regulatory Reform, Salford.
[29] 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].

considered necessary to further consider the issue of OAM for the Proposed Development.

13.9.21 The DTI Noise Working Group commissioned Salford University to investigate the occurrence of the phenomenon in more detail. A survey was conducted of local authorities to investigate the extent of OAM, and complaint 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.

13.9.22 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."

13.9.23 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."

13.9.24 In December 2013, RenewableUK published Wind Turbine Amplitude Modulation: Research to Improve Understanding as to its Cause and Effects. 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.

13.9.25 More recently, BS 8233:2014 Guide on sound insulation and noise reduction for buildings[30] states:

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

13.9.26 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.

13.9.27 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.

[30] British Standards Institution (2014). *BS 8233:2014 Guide on sound insulation and noise reduction for buildings*. BSI, London.

13.10 Assessment of cumulative (inter-project) effects

13.10.1 A 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) and constitutes the significance of effect from the development.

13.10.2 **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 receptors listed in **Table 13.16**.

13.10.3 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, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1})								
	4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	43.5	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6
Margin Under / Over Noise Limit	-1.5	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
R2									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	41.6	41.7	41.7	41.7	41.7	41.8	41.8	41.8	41.8
Margin Under / Over Noise Limit	+1.6	+1.7	+1.7	+1.7	+1.7	+1.8	+1.8	+1.8	+1.8
R3									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	40.6	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7
Margin Under / Over Noise Limit	+0.6	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7	+0.7
R4									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	36.9	37.1	37.1	37.1	37.2	37.2	37.2	37.2	37.2
Margin Under / Over Noise Limit	-3.1	-2.9	-2.9	-2.9	-2.8	-2.8	-2.8	-2.8	-2.8
R5									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	39.5	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Margin Under / Over Noise Limit	-5.5	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4
R6									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	38.7	38.8	38.8	38.8	38.8	38.9	38.9	38.9	38.9
Margin Under / Over Noise Limit	-1.3	-1.2	-1.2	-1.2	-1.2	-1.1	-1.1	-1.1	-1.1
R7									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	36.5	36.5	36.5	36.5	36.5	36.5	36.6	36.6	36.6

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Margin Under / Over Noise Limit	-3.5	-3.5	-3.5	-3.5	-3.5	-3.7	-4.1	-4.1	-4.1
R8									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	39.5	39.7	39.7	39.7	39.7	39.8	39.8	39.8	39.8
Margin Under / Over Noise Limit	-0.5	-0.3	-0.3	-0.3	-0.3	-0.4	-0.9	-0.9	-0.9
R9									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	35.5	35.7	35.7	35.7	35.8	35.8	35.8	35.8	35.8
Margin Under / Over Noise Limit	-4.5	-4.3	-4.3	-4.3	-4.2	-4.4	-4.9	-4.9	-4.9
R10									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	38.1	38.4	38.4	38.4	38.4	38.5	38.5	38.5	38.5
Margin Under / Over Noise Limit	-1.9	-1.6	-1.6	-1.6	-1.6	-1.5	-1.5	-1.5	-1.5
R11									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	34.7	35.6	35.7	35.5	35.6	35.7	35.7	35.7	35.7
Margin Under / Over Noise Limit	-5.3	-4.4	-4.3	-4.5	-4.4	-4.5	-5.0	-5.0	-5.0
R12									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	37.2	37.4	37.4	37.4	37.4	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	-2.8	-2.6	-2.6	-2.6	-2.6	-2.5	-2.5	-2.5	-2.5
R13									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	38.2	38.4	38.5	38.4	38.4	38.5	38.5	38.5	38.5
Margin Under / Over Noise Limit	-1.8	-1.6	-1.5	-1.6	-1.6	-1.5	-1.5	-1.5	-1.5
R14									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	35.7	36.0	36.1	36.1	36.1	36.2	36.2	36.2	36.2
Margin Under / Over Noise Limit	-4.3	-4.0	-3.9	-3.9	-3.9	-3.8	-3.8	-3.8	-3.8
R15									
Background Noise Curve	30.1	30.6	31.3	32.1	32.9	33.8	33.8	33.8	33.8
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	35.0	35.4	35.4	35.4	35.4	35.5	35.5	35.5	35.5
Margin Under / Over Noise Limit	-5.0	-4.6	-4.6	-4.6	-4.6	-4.5	-4.5	-4.5	-4.5
R16									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Wind Farm Turbine Noise	31.8	32.0	32.1	32.0	32.0	32.0	32.0	32.0	32.0
Margin Under / Over Noise Limit	-8.2	-8.0	-7.9	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0
R17									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Wind Farm Turbine Noise	35.9	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Margin Under / Over Noise Limit	-4.1	-4.0	-4.0	-4.0	-4.0	-4.2	-4.7	-4.7	-4.7
R18									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	37.8	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
Margin Under / Over Noise Limit	-2.2	-2.1	-2.1	-2.1	-2.1	-2.3	-2.8	-2.8	-2.8
R19									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	37.3	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
Margin Under / Over Noise Limit	-2.7	-2.7	-2.6	-2.6	-2.6	-2.8	-3.3	-3.3	-3.3
R20									
Background Noise Curve	33.1	33.6	34.1	34.5	34.8	35.2	35.7	35.7	35.7
ETSU-R-97 Derived Noise Limit	40.0	40.0	40.0	40.0	40.0	40.2	40.7	40.7	40.7
Wind Farm Turbine Noise	37.5	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	-2.5	-2.4	-2.4	-2.4	-2.4	-2.6	-3.1	-3.1	-3.1
R21									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Margin Under / Over Noise Limit	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6
R22									
Background Noise Curve	25.5	26.4	27.3	28.3	29.4	30.5	31.9	31.9	31.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	35.8	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Margin Under / Over Noise Limit	-9.2	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0

Table 13.24 Noise assessment – cumulative night-time

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
R1									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	43.5	43.6	43.6	43.6	43.6	43.6	43.6	43.6	43.6
Margin Under / Over Noise Limit	-1.5	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4
R2									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	41.6	41.7	41.7	41.7	41.7	41.8	41.8	41.8	41.8
Margin Under / Over Noise Limit	-1.4	-1.3	-1.3	-1.3	-1.3	-1.2	-1.2	-1.2	-1.2
R3									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	40.6	40.7	40.7	40.7	40.7	40.7	40.7	40.7	40.7
Margin Under / Over Noise Limit	-2.4	-2.3	-2.3	-2.3	-2.3	-2.3	-2.3	-2.3	-2.3
R4									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9

Noise parameter, dB $L_{A90,10\,m}$	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	36.9	37.1	37.1	37.1	37.2	37.2	37.2	37.2	37.2
Margin Under / Over Noise Limit	-6.1	-5.9	-5.9	-5.9	-5.8	-5.8	-5.8	-5.8	-5.8
R5									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	39.5	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Margin Under / Over Noise Limit	-5.5	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4
R6									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
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	38.7	38.8	38.8	38.8	38.8	38.9	38.9	38.9	38.9
Margin Under / Over Noise Limit	-4.3	-4.2	-4.2	-4.2	-4.2	-4.1	-4.1	-4.1	-4.1
R7									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	36.5	36.5	36.5	36.5	36.5	36.6	36.6	36.6
Margin Under / Over Noise Limit	-6.5	-6.5	-6.5	-6.5	-6.5	-6.5	-6.4	-6.4	-6.4
R8									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	39.5	39.7	39.7	39.7	39.7	39.8	39.8	39.8	39.8
Margin Under / Over Noise Limit	-3.5	-3.3	-3.3	-3.3	-3.3	-3.2	-3.2	-3.2	-3.2
R9									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	35.5	35.7	35.7	35.7	35.8	35.8	35.8	35.8	35.8
Margin Under / Over Noise Limit	-7.5	-7.3	-7.3	-7.3	-7.2	-7.2	-7.2	-7.2	-7.2
R10									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	38.1	38.4	38.4	38.4	38.4	38.5	38.5	38.5	38.5
Margin Under / Over Noise Limit	-4.9	-4.6	-4.6	-4.6	-4.6	-4.5	-4.5	-4.5	-4.5
R11									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	34.7	35.6	35.7	35.5	35.6	35.7	35.7	35.7	35.7
Margin Under / Over Noise Limit	-8.3	-7.4	-7.3	-7.5	-7.4	-7.3	-7.3	-7.3	-7.3
R12									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	37.2	37.4	37.4	37.4	37.4	37.5	37.5	37.5	37.5
Margin Under / Over Noise Limit	-5.8	-5.6	-5.6	-5.6	-5.6	-5.5	-5.5	-5.5	-5.5
R13									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	38.2	38.4	38.5	38.4	38.4	38.5	38.5	38.5	38.5
Margin Under / Over Noise Limit	-4.8	-4.6	-4.5	-4.6	-4.6	-4.5	-4.5	-4.5	-4.5
R14									

Noise parameter, dB $L_{A90,10\,m}$	Standardised 10m Wind Speed (ms^{-1}) 4	5	6	7	8	9	10	11	12
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	35.7	36.0	36.1	36.1	36.1	36.2	36.2	36.2	36.2
Margin Under / Over Noise Limit	-7.3	-7.0	-6.9	-6.9	-6.9	-6.8	-6.8	-6.8	-6.8
R15									
Background Noise Curve	24.8	25.9	27.5	29.4	31.4	33.4	33.4	33.4	33.4
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	35.0	35.4	35.4	35.4	35.4	35.5	35.5	35.5	35.5
Margin Under / Over Noise Limit	-8.0	-7.6	-7.6	-7.6	-7.6	-7.5	-7.5	-7.5	-7.5
R16									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
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	31.8	32.0	32.1	32.0	32.0	32.0	32.0	32.0	32.0
Margin Under / Over Noise Limit	-11.2	-11.0	-10.9	-11.0	-11.0	-11.0	-11.0	-11.0	-11.0
R17									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	35.9	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Margin Under / Over Noise Limit	-7.1	-7.0	-7.0	-7.0	-7.0	-7.0	-7.0	-7.0	-7.0
R18									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	37.8	37.9	37.9	37.9	37.9	37.9	37.9	37.9	37.9
Margin Under / Over Noise Limit	-5.2	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1	-5.1
R19									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	37.3	37.4	37.4	37.4	37.4	37.4	37.4	37.4
Margin Under / Over Noise Limit	-5.7	-5.7	-5.6	-5.6	-5.6	-5.6	-5.6	-5.6	-5.6
R20									
Background Noise Curve	25.7	26.6	27.8	29.2	30.7	32.2	33.6	34.8	35.7
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	37.6	37.6	37.6	37.6	37.6	37.6	37.6	37.6
Margin Under / Over Noise Limit	-5.5	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4	-5.4
R21									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Margin Under / Over Noise Limit	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6
R22									
Background Noise Curve	23.7	24.8	26.4	28.4	30.6	32.9	32.9	32.9	32.9
ETSU-R-97 Derived Noise Limit	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
Wind Farm Turbine Noise	35.8	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
Margin Under / Over Noise Limit	-9.2	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0	-9.0

13.10.4 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 R2 and R3, where exceedances of between 0.6 to 1.8 dB are predicted at all wind speeds, resulting in

a potential **significant** effect. During the night-time, compliance is predicted at all receptors, resulting in a **not significant** effect.

13.10.5 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 directivity effects may have a significant influence at R2 and R3. The cumulative noise at R2 and R3 is dominated by the proposed development turbines 1 and 6, respectively. R2 and R3 will tend to be upwind of these turbines. During typical upwind conditions, the contribution from these turbines will be reduced, which in turn will reduce the cumulative noise at these receptors. If further analysis indicates that these turbines still contribute to an exceedance of the limits, then reduced power operating modes can be specified for these turbines to ensure compliance with the limits.

13.11 Significance conclusions

13.11.1 The results of the assessment of operational noise indicates that the ETSU-R-97[5] derived noise limits are unlikely to be exceeded at any receptor at any time, with the exception of R2 and R3 during the daytime. The assessment has been undertaken assuming a worst-case scenario of all receptors downwind of all turbines. The cumulative noise at R2 and R3 is dominated by the Proposed Development turbines 1 and 6. As R2 and R3 will tend to be upwind of the dominant turbines, it is considered that the daytime exceedances identified at R2 and R3 are likely to be overestimates.

13.11.2 Based on the above, it is considered that the identified exceedances may be reduced, when accounting for directivity. If, after further analysis, exceedances are still predicted at these receptors, then reduced power operating modes can be specified for proposed turbines 1 and 6 to ensure compliance with the limits. On this basis, the effect of operational noise on residences would be **not significant**.

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

Table 13.25 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 vibration: All NSRs	High	Negligible	Not Significant	The likelihood of vibration from potential piling activities giving rise to significant effects is considered to be negligible due to the separation distances involved (the nearest receptor is approximately 430 m from potential piling activities).
Construction noise 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.
Construction noise daytime: All NSRs	High	Likely negligible, subject to assessment in Final ES.	Likely not significant, subject to assessment in Final ES.	Limits contained in BS 5228-2:2009+A1:2014 are considered unlikely to be exceeded due to the separation distances between proposed turbines and the nearest dwellings.
Operational daytime: R2 and R3	High	High	Significant	ETSU-R-97 noise limits may be exceeded during the daytime period. However, when accounting for directivity it is considered that exceedances would be reduced. If, following further analysis, exceedances are still indicated, then reduced power operating modes for proposed turbines 1 and 6 can be specified to ensure compliance with the limits and reduce residual effects such that they are not significant.
Operational daytime: All other NSRs	High	Negligible	Not Significant	ETSU-R-97 noise limits are unlikely to be exceeded during the daytime period.
Operational night-time: All NSRs	High	Negligible	Not Significant	ETSU-R-97 noise limits are unlikely to be exceeded during the night-time period.

1. The sensitivity/importance/value of a receptor is defined using the criteria set out in Section 13.7 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.

Implementation of environmental measures

13.11.4 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 outlined in **Section 13.10**. Compliance of these limits can be proven with measurements taken at residential receptor locations once the wind farm is operational.

13.11.5 As discussed above it is considered that the daytime exceedances identified at R2 and R3 are likely to be an overestimate. If, following further analysis, exceedances are still indicated, then reduced power operating modes for proposed turbines 1 and 6 can be specified to ensure compliance with the limits and reduce residual effects such that they are not significant. Further analysis will be undertaken and presented in the Final ES.

13.12 Further work

13.12.1 Prior to undertaking the surveys and assessments to be presented in the Final ES, it is proposed to undertake consultation with Public Health Wales and RCTCBC on the survey and assessment methodology.

13.12.2 It is proposed that an additional baseline survey, alongside the full height met mast, will be undertaken to inform the revised assessment that will be presented in the Final ES.

13.12.3 Assessments of construction vibration and construction traffic noise will be undertaken and presented in the Final ES.

13.12.4 If, following further analysis, exceedances of the ETSU-R-97[5] derived noise limits are still indicated, then reduced power operating modes for proposed turbines 1 and 6 will be determined that will ensure compliance with the limits and reduce residual effects such that they are not significant.