Chapter 10: Noise and Vibration

Coolglass Windfarm EIAR Vol 2

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10.0 Introduction

This chapter summarises the assessment of the potential noise and vibration effects of all elements of the proposed development, as described in Section 3.5 of this EIAR, on the environment. A description of the proposed development is provided in Section 3.8.1 of this EIAR. The assessment considers the proposed development's construction, its operation and decommissioning. Whilst reasonable effort has been made to ensure that this chapter is easy to understand, it is technical in nature; to assist the reader, a glossary of terminology is included in Technical Appendix 10.1 found in Volume III of this EIAR.

Potential construction noise and vibration impacts have been determined with reference to British Standard 5228:2009+A1:2014 *Code of Practice for Noise and Vibration Control on Construction and Open Sites Part 1 Noise*.

The operational noise assessment documented in this chapter is based on guidance in relation to acceptable levels of noise from wind farms as contained in the document Wind Energy Development Guidelines for Planning Authorities published by the Department of the Environment, Heritage and Local Government in 2006 (the '2006 Guidelines'). Potential operational noise impacts associated with the proposed development have been determined with reference to the UK Institute of Acoustics' (IOA), A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise, 2013 (IOA GPG). Operational noise associated with the proposed development includes noise from the proposed wind turbines and substation.

Although in December 2019, the Draft Revised Wind Energy Development Guidelines December 2019 were published for consultation, these have yet to be finalised and are not considered best practice. The 2006 Guidelines, as supplemented by the ESTU-R-97 and IOA methodologies described below, are considered best practice and have been applied in this assessment. The methodology is described in further detail in Section 10.3.3.2.

Consideration has been given to the cumulative developments listed in Section 3.12 of this EIAR and none of the proposed or existing wind farms could satisfy the criteria described in Section 10.3.2 for cumulative contribution to overall noise levels. Therefore, no cumulative noise effect are likely.

Decommissioning noise and vibration impacts have been assessed with similar references to the construction noise assessment.

10.1 Statement of Authority

This assessment was prepared by Richard Carter CEng, BEng(Hons), MIOA, a Director at Bow Acoustics Ltd., on behalf of SLR. Richard has worked in the field of acoustics for over 18 years, with over 13 years' experience specialising in the assessment of wind farm noise. Richard has a bachelor of Engineering (BEng (Hons)), post graduate diploma in acoustics and noise control, is a member of the Institute of Acoustics (MIOA) and a Chartered Engineer (CEng). He has extensive experience in all aspects of environmental surveying, noise modelling and impact assessment for various sectors including, wind energy, industrial, commercial and residential.

The background noise measurements were undertaken by Aldona Binchy MSc. Eng PIEMA, MIAH, AAG Environmental Engineering, a Principal of SLR, with 19 years of experience conducting environmental noise surveys. Aldona completed the Environmental Noise Competency Course with INVC. Aldona has extensive experience of undertaking noise monitoring programmes in accordance with relevant standards and best practice methods.

10.2 Description of Noise and Vibration Impacts

10.2.1 Construction noise & vibration

Noise is generated from the construction of the turbine foundations, the erection of the turbines, the excavation of trenches for cables, and the construction of associated hard standings and access tracks, and construction of the substations.

Noise from vehicles on local roads and access tracks is also generated from the delivery of the turbine components and construction materials, notably aggregates, concrete and steel reinforcement.

Vibration is generated by construction activities such as rock breaking and passing heavy goods vehicles. The threshold of human perception of vibration is stated in British Standard 5228-2 (see 10.3.1.8) to be in the range of 0.14mm/s to 0.3mm/s, described as "might just be perceptible". The standard also provides guideline values for damage to buildings from vibration of 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. Typically, these levels of vibration are only experienced within a 10m of the above construction activities, depending on ground conditions and the extent of activity taking place. The nearest noise sensitive locations are sufficiently distant, over 500m, that vibration will not be perceivable by residents at their dwellings and building damage will not occur from construction incurred vibration for all permutations within the turbine range. As such, construction vibration will not be considered further in this chapter.

10.2.2 Operational Noise & Vibration

Once constructed and operating, wind turbines may emit two types of noise: aerodynamic noise from the blades, and mechanical noise from other component, which is easier to minimise by good engineering design. Aerodynamic noise tends to be perceived when the wind speeds are low, although at very low wind speeds the blades do not rotate or rotate very slowly and so, at these wind speeds, negligible aerodynamic noise is generated. In higher winds, aerodynamic noise is generally masked by the normal sound of wind blowing through trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise determines the subjective audibility of the proposed development. The relationship between wind turbine noise and the naturally occurring masking noise at residential dwellings around the site will therefore generally form the basis of the assessment of the levels of noise against accepted standards.

Ancillary equipment such as transformers at on-site substations can also generate noise; however, typically at a much lower level than the wind turbines. Operational noise impacts from the on-site substation have been considered in this chapter.

10.2.3 Blade Swish (Amplitude Modulation of Aerodynamic Noise)

Amplitude modulation (AM) is the periodic variation in the amplitude of aerodynamic noise generated during the operation of a wind turbine. The noise assessment methodology presented in ETSU-R-97, sets out noise limits which already account for typically encountered levels of amplitude modulation from wind turbines.

A study was carried out on behalf of the Department for Business, Enterprise and Regulatory Reform (BERR) by the University of Salford, which investigated the incidence of noise complaints associated with wind farms and whether these were associated with AM (University of Salford, 2007). This report defined AM as aerodynamic noise fluctuations from wind turbines at blade passing frequency. Its aims were to ascertain the prevalence of

AM on UK wind farm sites, to try to gain a better understanding of the likely causes, and to establish whether further research into AM is required.

The study concluded that AM with a greater degree of fluctuation than normal had occurred at only a small number of wind farms in the UK (4 of 133), and only for between 7% and 15% of the time. It also states that, at the time of writing, the causes of this were not well understood and that prediction of the effect was not currently possible.

This research was updated in 2013 by an in-depth study undertaken by Renewable UK, which considered 'other AM' (OAM) defined as AM with atypical characteristics which could not be explained by standard causal factors. The study identified that many of the previously suggested causes of OAM have little or no association to the occurrence of OAM in practice. The generation of OAM was likely based upon the interaction of several factors, the combination and contributions of which are unique to each site. With the current knowledge, it is not possible to predict whether any particular site is more or less likely to give rise to OAM.

In 2016, the IOA proposed a measurement technique to quantify the level of AM present in any particular sample of wind farm noise (Institute of Acoustics, 2016). This technique is supported by the Department of Business, Energy & Industrial Strategy (BEIS, formerly the Department of Energy & Climate Change) who have published guidance, which follows on from the conclusions of the IOA study in order to define an appropriate assessment method for AM, including a penalty scheme and an outline planning condition (BEIS, 2016).

Section 7.2.1 of the IOA GPG remains current, stating: *"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"*.

The Draft Revised Wind Energy Development Guidelines (December 2019) consider special audible characteristics and propose a 'Relative Rated Noise Limit (RRNL)'. The rated wind turbine noise level (LA rated, 10 min) is determined by the measured noise level attributable to or related to the wind energy development plus any rating penalties for special audible characteristics. The guidelines propose a penalty scheme for AM up to 5 dB. Low frequency noise and infrasound are discussed in Section 10.2.4 and tonal noise is discussed in Section 10.2.5.

At present there is no method for predicting OAM and as such it is best practice to not carry out an AM assessment and this will not be considered further in this chapter.

10.2.4 Infrasound & Low Frequency Noise

Low frequency noise is noise that occurs within the frequency range of 10 Hz to 160 Hz. Infrasound is noise occurring at frequencies below that at which sound is normally audible, that is, less than about 20 Hz, due to the significantly reduced sensitivity of the ear at such frequencies. In this frequency range, for sound to be perceptible, it must be at very high amplitude, and it is generally considered that when such sounds are perceptible then they can cause considerable annoyance.

A study, published in 2006 by acoustic consultants Hayes McKenzie on the behalf of the Department of Trade and Industry (DTI), investigated low frequency noise from wind farms (Hayes McKenzie, 2006). This study concluded that there is no evidence of health effects arising from infrasound or low frequency noise generated by wind turbines.

Further, in February 2013, the Environmental Protection Authority of South Australia published the results of a study into infrasound levels near wind farms (Environment Protection Authority, 2013). This study measured infrasound levels at urban locations, rural locations with wind turbines close by, and rural locations with no wind turbines in the vicinity. It found that infrasound levels near wind farms are comparable to levels away from wind farms in both urban and rural locations. Infrasound levels were also measured during organised shut downs of the wind farms; the results showed that there was no noticeable difference in infrasound levels whether the turbines were active or inactive.

Bowdler et al. (2009) concludes that: "...there is no robust evidence that low frequency noise (including 'infrasound') or ground-borne vibration from wind farms generally has adverse effects on wind farm neighbours."

Furthermore, the Draft Revised Wind Energy Development Guidelines (December 2019) state *"There is no evidence that wind turbines generate perceptible infrasound."* The guidelines go on to say that *"There is normally no excessive tonal or low frequency element in the noise from a wind turbine."* The statements in the 2019 Draft Guidelines are in agreement with the studies outlined above.

It is best practice to not carry out a specific assessment of infrasound and low-frequency noise and will not be considered further in this chapter.

10.2.5 Tonal Noise

Tonal noise is the concentrations of acoustic energy over relatively small bands of frequency. Tonality found in wind turbine sound is most often of mechanical origin, which over the years has been engineered out of modern machines and is generally caused by structural resonances in the mechanical parts of the turbine. Modern day wind turbines are highly unlikely to generate tonal noise unless there is a fault with a mechanical component such as the gearbox as a result of poor maintenance. Therefore, a correctly operating wind turbine would not produce noise of a tonal nature and will not be considered further in this chapter.

10.2.6 Vibration

Research undertaken by Snow found that levels of ground-borne vibration 100 m from the nearest wind turbine were significantly below criteria for 'critical working areas' given by British Standard BS 6472:1992 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz) and were lower than limits specified for residential premises by an even greater margin (Snow, 1997).

More recently, the Low Frequency Noise Report published by the Federal State of Baden-Württemberg simultaneously measured vibration at several locations, ranging from directly at the wind turbine tower to up to 285m distance from an operational Nordex N117 – 2.4 MW wind turbine with a hub height of 140.6m. The report concluded that at less than 300m from the turbine, the vibration levels had reduced such that they could no longer be differentiated from the background vibration levels.

The separation distances between the wind turbines and the receptors at the proposed development are at least 700m. Therefore, it is current best practice to not carry out a specific assessment of vibration arising from the operation of wind turbines and it is not considered further in this chapter. It should be noted that the receptor locations used for the noise assessment correspond to the amenity space and not necessarily the dwelling; therefore, the quoted minimum distance may differ from other assessments.

10.2.7 Decommissioning noise and vibration

The noise and vibration levels generated during the decommissioning of a wind farm are considered lower than those generated during its construction due to the reduced number of operations required, as discussed in 10.5.4. Therefore, as a worst case it is assumed that the noise and vibration impacts calculated for the construction phase will equally apply to the decommissioning phase.

10.3 Assessment Methodology

An overview of the methodology for the assessment of construction, operational and decommissioning noise and vibration impacts for the proposed development is as follows:

- review of relevant guidance;
- identification of Noise Sensitive Receptors (NSRs) and the likely extent of the study area;
- if required, measurement of prevailing wind speed dependant background noise levels at nearby properties to establish appropriate noise limits;
- prediction of the noise and vibration impact associated with the proposed development; and
- assessment of the significant effect of any impacts.

10.3.1 Relevant Guidance

A summary overview of the guidance documentation referenced in this assessment is provided below. The following sections provide further details of how they have been applied.

10.3.1.1 Guidelines on the Information to be Contained in Environmental Impact Assessment Reports, 2022

Published in May 2022 by the Environmental Protection Agency (EPA), these guidelines supersede draft 2017 guidelines and provide consistency on the information to be contained in Environmental Impact Assessment Reports (EIAR) with the objective of improving their quality.

10.3.1.2 Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4), 2016

Published in 2016 by the Environmental Protection Agency (EPS), these guidelines assist licensed sites with the assessment of their potential and actual noise impact on the local environment.

10.3.1.3 Laois County Development Plan 2021 – 2027, 2022

Appendix 5 of Laois County Development Plan 2021 – 2027, January 2022, provides details of the Council's wind energy strategy. Section 6.8 specifically addresses the control of noise for wind developments in County Laois. Permitted maximum noise levels at noise sensitive receptors are to be in compliance with the Department of Environment, Heritage and Local Government Wind Energy Guidelines, 2006. Once commissioned the development will be monitored to ensure compliance with the maximum noise levels.

10.3.1.4 Wind Energy Development Planning Guidelines, 2006

Published by the Department of Environment, Heritage and Local Government (DoEHLG), these Guidelines offer advice for many aspects of wind energy development, including noise, which is covered in Section 5.6. At the time of writing the 2006 guidelines remain adopted. Best practice for operational noise assessment is to apply the 2006 Guidelines as supplemented by ETSU-R-97 and IOA GPG (see below).

10.3.1.5 Draft Revised Wind Energy Development Guidelines, 2019

Published by the Department of Housing, Planning and Local Government (DoHPLG). These guidelines are currently under review and are yet to be adopted, with further revisions to the text, including noise guidance anticipated. Until such a time as these guidelines are re-published for public consultation, the 2006 guidelines remain in place. The lack of adoption and as the noise assessment section of the draft guidelines are not considered best practice, means it has not been applied in this assessment.

10.3.1.6 ETSU-R-97 The Assessment & Rating of Noise from Wind Farms, 1996

The Assessment and Rating of Noise From Wind Farms - ETSU-R-97, 1996, provides a framework for the assessment and rating of noise from wind farms. In Ireland, under the 2006 Guidelines, the determination of background noise levels and limits is carried out using the ETSU-R-97 methodology.

10.3.1.7 Institute of Acoustics Good Practice Guide, 2013

The Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise was published by the Institute of Acoustics in May 2013 (IOA GPG). The IOA GPG is supported by a suite of six Supplementary Guidance Notes, published in 2014. The guide presents current good practice in the application of ETSU-R-97 assessment methodology for wind turbine developments at the various stages of the assessment process.

10.3.1.8 Best Practice Guidelines for the Irish Wind Energy Industry, 2012

The Best Practice Guidelines for the Irish Wind Energy Industry, published by the Irish Wind Energy Association, sets various guidelines for the industry to encourage responsible and sensitive wind farm development, which takes into consideration the concerns of local communities, planners, and other interested groups. Section 6.3.3. addresses the assessment of noise and confirms that the DoEHLG 2006 Guidelines should be followed and reference is made to ETSU-R-97 as the appropriate method for the determination of existing background noise levels. Construction noise impacts should be assessed in accordance with British Standard BS 5228-1:2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites, Part 1: Noise.

10.3.1.9 British Standard BS 5228, 2014

British Standard BS 5228 refers to the need for the protection against noise (in Part 1) and vibration (in Part 2) for people living in the vicinity of construction or open sites.

Part 1, or BS 5228-1:2009+A1:2014, sets out a methodology for predicting noise levels arising from a wide variety of construction activities and it contains tables of sound power levels generated by mobile and fixed plant. Annex E of BS 5228-1 gives example criteria that may be used to consider the significant effect of any construction noise impact. The criteria are not mandatory and are presented as a set of example approaches that reflect the type of methods commonly applied to construction noise.

Part 2, or BS 5228-2:2009+A1:2014, gives recommendations for basic methods of vibration control relating to construction and open sites. Annexes E and F of BS 5228-2 includes guidance on the subject of vibration from blasting sites, whereas Annex G discusses air overpressure resulting from blasting.

10.3.1.10 International Standard ISO 9613-2, 1996

International Standard ISO 9613-2, Acoustics – Attenuation of Sound During Propagation outdoors – Part 2: General Method of Calculation, specifies an engineering method for accurately predicting levels of environmental noise at a distance from a variety of sources. It is recognised in current best practice, including the IOA GPG, as the appropriate method when calculating noise immission levels from wind turbines.

Note that in the above, and subsequently in this assessment, the term 'noise emission' relates to the sound power level of a wind turbine, whereas the term 'noise immission' relates to the sound pressure level experienced at a receptor location.

10.3.2 Study area

The study area for the construction and decommissioning noise is limited to the nearest Noise-Sensitive Receptors (NSRs) during the construction or decommissioning phase under assessment. Other, more distant NSRs would be exposed to lower levels of noise and do not need to be considered also.

The study area for the operational noise assessment comprises the area where noise levels from the proposed development are predicted to be within 10 dB of those from other relevant wind energy developments, and the predicted cumulative wind farm noise level is greater than 35 dB, $L_{A90,10min}$. The $L_{A90, 10min}$ parameter is used to describe wind turbine noise and it represents the level of noise exceeded for 90% of the measurement period, 10 minutes. No other wind energy developments have been identified that would contribute to the cumulative noise levels, so the study area for operational noise has been defined as the area where wind turbine noise from the proposed development is greater than 35 dB $L_{A90, 10min}$.

NSRs are properties within the study area which are potentially sensitive to noise and, as such, may require protection from nearby noise sources. The 2006 Guidelines lists NSRs as dwellings, hostels, health buildings, places of worship and may also include areas of particular scenic quality or specially recreational amenity importance.

The NSRs identified within this assessment are all residential properties and wind turbine noise immission levels are predicted to a location representative of each outdoor amenity area rather the façade of the property. This is in line with the IOA GPG which states (at paragraph 4.3.8) that *"calculations should be made at points representative of the relevant outdoor amenity area (as defined in ETSU-R-97) at locations nearest to the proposed wind farm development"*.

It is not always appropriate to assess impacts at all nearby NSRs, as a worst-case can be presented with a selection of NSRs. Where multiple NSRs are in the same general direction from the proposed development, it may be appropriate to present results for just one of these which represents the worst-case for all.

Table 10-1 details the identified NSRs for the assessment of operational and construction noise and Figure 10-1 shows the location of each NSR in relation to the proposed development.

Table 10-1 Noise Sensitive Receptors

NSR ID	Address	Eircode	Easting (ITM)	Northing (ITM)
NSR01	Orchard Lower	R32 D290	656076	689251
NSR02	Three Chimneys	R32 N2E0	657458	688679
NSR03	Fossy Lower	R32 K8A0	654198	688584
NSR04	Glen Fossy	R32 X6T4	654277	688002
NSR05	Aughoney	R32 W2K5	654691	687385
NSR06	Fossy Upper	R32 CR28	655863	687455
NSR07	Knocklaide	R32 X950	655894	687014
NSR08	Brennanshill	R32 R2R2	656698	686869
NSR09	Scotland	R32 D684	656665	686799
NSR10	Monamanty	R32 T611	657445	686701
NSR11	Coolglass	R15 CR40	657159	685778
NSR12	Coolglass House	R14 AE65	656707	685198
NSR13	Teach Chroi	R14 Y720	656492	685177
NSR14	Crissard	R14 PW32	658319	684869
NSR15	Aghadreen	R14 HT97	655841	684495
NSR16	Crissard	R14 KN28	658258	684340
NSR17	Moyadd	R14 XD23	655813	683602
NSR18	Fairbanks House	R14 NX23	657256	683110
NSR19	Cul Eala	R14 H563	657083	682822

10.3.3 Evaluation criteria

10.3.3.1 Construction Noise Criteria

There is no statutory Irish guidance relating to the maximum permissible noise level that may be generated during the construction phase of a project. In the absence of specific noise limits, appropriate emission criteria relating to permissible construction noise levels for a development of this scale may be found in the BS 5228-1 Annex E.

The criteria do not represent mandatory limits but rather a set of example approaches intended to reflect the type of methods commonly applied to construction noise. In broad terms, the example criteria are based on a set of fixed limit values which, if exceeded, may result in a significant effect unless ambient noise levels are sufficiently high to provide a degree of masking of construction noise.

The range of guidance values detailed in BS 5228-1 Annex E have been used to numerically define the magnitude of impact. As construction noise will always be an introduction of a noise source which would otherwise not be there, where impacts are identified to occur, they will always be adverse:

- where construction noise levels at receptors are below the adopted daytime noise limit of 65 dB L_{Aeq} for a sustained period of time, this is determined to be 'not significant'; and
- where construction noise levels at receptors are above the adopted daytime noise limit of 65 dB L_{Aeq} for a sustained period of time, this is determined to be 'significant'.

It should be noted that the parameter used to describe noise from construction activities is the L_{Aeq}, which is the equivalent continuous sound pressure level of a fluctuating noise over a given period.

10.3.3.2 Operational Noise Criteria

The operational noise assessment applies the current 2006 Guidelines and is supplemented by ETSU-R-97 and the IOA GPG where appropriate. As noted above, the draft 2019 Guidelines have not been adopted and are not considered best practice at the time of writing; therefore, it is not considered appropriate to consider these draft guidelines further.

The 2006 Guidelines contain recommended noise limits to control operational noise from wind farms and state:

> *In general, a lower fixed limit of 45 dB(A) or a maximum increase of 5dB(A) above background noise at nearby noise sensitive locations is considered appropriate to provide protection to wind energy development neighbours. However, in very quiet areas, the use of a margin of 5dB(A) above background noise at nearby noise sensitive properties is not necessary to offer a reasonable degree of protection and may unduly restrict wind energy developments which should be recognised as having wider national and global benefits. Instead, in low noise environments where background noise is less than 30 dB(A), it is recommended that the daytime level of the* $L_{A90,10min}$ *of the wind energy development noise be limited to an absolute level within the range of 35-40 dB(A).*
>
> *Separate noise limits should apply for day-time and for night-time. During the night, the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. A fixed limit of 43dB(A) will protect sleep inside properties during the night.*

The assessment of significance of effects from operational wind turbine noise immission at a NSR is:

- not significant if the noise limits derived according to the 2006 Guidelines is not exceeded; or
- significant if the noise limit derived according to the 2006 Guidelines is exceeded.

10.3.4 Significance of Impact

The EPAs 2022 EIAR guidelines provide criteria for determining the significance of environmental impacts and the effects in broad terms for all assessment topics. The EPA 2022 EIAR guidelines recognise that professional judgment and relevant guidance and standard play an important role in the determination of significance, and as such do not quantify the impacts in decibel terms.

For this assessment, it has been assumed that dwellings have a medium to high sensitivity. Set out above are the thresholds of significance for the construction and operational phases, if the predicted impacts are below these thresholds, it is considered that no significant effect occurs.

10.3.5 Consultation requirements

Chapter 2 of the EIAR refers to scoping consultation. Several submissions on noise were received as part of the consultation process. Submissions and feedback have informed the Project design and this EIAR chapter.

10.4 Existing environment

A baseline noise survey was carried out between Friday 5th August 2022 and Friday 9th September 2022 at a total of six noise measurement locations (NML) that are considered to represent the NSRs in the study area. This equates to a total of 35 days of background noise data, which exceeds the two-weeks recommended in the IWEI Best Practice Guidelines and the IOA GPG. One sound level meter, at survey location NML5, developed a fault not long after installation which was detected on Friday 19th September 2022 and a replacement meter was install on Monday 22nd September 2022. All data measured prior to the 22nd September 2022 at this location was discarded. Therefore, a total of 18 days of background noise data was measured at NML5, which also exceeds the recommended duration. **Table 10-2** details the background noise survey locations and **Figure 10-1** shows their location relative to the proposed development.

Table 10-2 Noise Measurement Locations

NML ID	Address	Eircode	Easting (ITM)	Northing (ITM)
NML1	Brennanshill	R32 R2R2	656696	686868
NML2	Mountain Springs	R32 TP82	654518	688574
NML3	Orchard Lower	R32 D290	656088	689265
NML4	Coolglass House	R14 AE65	656646	685265
NML5	Crissard	R14 PW32	658312	684901
NML6	Cul Eala	R14 H563	657139	682973

In line with the IOA GPG, the background survey data have been used as a proxy for some NSRs where monitoring was not carried out. This is considered appropriate due to the comparable distances from local roads or streams. Furthermore, as set out above, it is not necessary to assess every NSR in the area. Details of which survey location has been used as a proxy for the corresponding assessment location are included in **Table 10-3**.

Table 10-3 Proxy Locations for Noise Sensitive Receptors

NSR ID	Address	NML ID	Address
NSR01	Orchard Lower	NML3	Orchard Lower
NSR02	Three Chimneys	NML3	Orchard Lower
NSR03	Fossy Lower	NML2	Mountain Springs
NSR04	Glen Fossy	NML2	Mountain Springs
NSR05	Aughoney	NML2	Mountain Springs
NSR06	Fossy Upper	NML1	Brennanshill
NSR07	Knocklaide	NML1	Brennanshill
NSR08	Brennanshill	NML1	Brennanshill
NSR09	Scotland	NML1	Brennanshill
NSR10	Monamanty	NML1	Brennanshill
NSR11	Coolglass	NML4	Coolglass House
NSR12	Coolglass House	NML4	Coolglass House
NSR13	Teach Chroi	NML4	Coolglass House
NSR14	Crissard	NML5	Crissard
NSR15	Aghadreen	NML4	Coolglass House
NSR16	Crissard	NML5	Crissard
NSR17	Moyadd	NML6	Cul Eala
NSR18	Fairbanks House	NML6	Cul Eala
NSR19	Cul Eala	NML6	Cul Eala

The equipment used for the background noise survey comprised Class 1 logging sound level meters, each enclosed in environmental cases to protect from the weather. Outdoor enhanced windshields were used to reduce wind induced noise on the microphones and provide protection from rain. These windshields were supplied by the sound level meter manufacturer and maintain the required performance of the whole measurement system when fitted. The installed microphone height was approximately 1.5 m.

The sound level meters were located between 3.5 m and 20 m from the façade of the property and as far away as was practical from obvious atypical localised sources of noise such as running water, tall trees or boiler flues. It was not possible to locate the sound level meter within 20 m of the property façade at NML4, Coolglass House, due to the presence of many tall trees which were considered likely to elevate the background noise level. Therefore, for this location, the sound level meter was installed in an adjacent field approximately 60 m from the dwelling and 40 m from tall trees. Also, NML2, Mountain Springs Ranch, is not residential or classified as a NSR. Therefore, the data measured at this location has been used to inform the background noise levels at other nearby locations.

Details and photographs of the measurement locations can be found in Technical Appendix 10.2 found in Volume III of this EIAR.

Sound level meters were all field calibrated during their installation and collection, with no acoustically significant (>0.5 dB(A)) drifts in calibration observed. The equipment used and locations chosen followed the IOA GPG guidelines in all cases.

The sound level meters logged the $L_{A90,10min}$ and $L_{Aeq,10min}$ noise levels continuously over the survey period, using Coordinated Universal Time (UTC) time reference. Wind data were measured using a Light Detection and Ranging (LiDAR) remote sensing measurement system that also logged data using the same 10-minute periods and UTC time reference.

The use of a LiDAR to monitor the wind data is endorsed by the IOA GPG as one of three preferred methods of capturing such data. The LiDAR was installed on site (co-ordinates 56641, 86711) by ZX Measurement Services, experts in wind measurements for such applications. Further details regarding the LiDAR and the calculation of the corresponding wind speed referenced to a standardised height of 10 m in accordance with the IOA GPG are set out in Technical Appendix 10.5 found in Volume III of this EIAR.

NML1, Brennanshill, had a rain logger installed to monitor periods of rainfall during the background noise survey. The rain logger comprised a Davis tipping bucket detector, set to record if any rain was detected during the same 10-minute measurement period used by the sound level meters and wind data. The data from the rain logger was also synchronised to the UTC time reference.

10.4.1 Analysis of the Baseline Data

The measured background noise data, standardised wind speed data and rain data for identical periods have been collated and reviewed for atypical relationships between noise level and wind speed, periods of rain fall and any extraneous data. Where these traits have been identified this data has been excluded from the analysis. In the case of rainfall, its effects on noise can be detected both during (as it hits vegetation), and immediately after it stops, and in some cases for a short while after it has stopped (as streams and burns swell to carry run-off rainwater). Periods of rain plus the following 30-minute periods have been excluded. Data measured during 04:30 to 07:00 (local IST time) was excluded at all locations as it would have the potential to be influenced by the bird dawn chorus and is not representative of the noise climate all year round for the whole night-time period. Data measured at all locations between 07:00 Friday 2nd September 2022 and 18:00 Monday 4th September 2022 was excluded due to potential noise from the Electric Picnic Festival at Stradbally, approximately 10 km north of the proposed development. It was also noted that tree felling took place during the start of the noise survey, up to 8th August 2022 in

Aghoney. As a precaution, data measured at NML1 to NML4 excluded this period. Full details of excluded periods can be found in Technical Appendix 10.2 found in Volume III of this EIAR.

Best fit lines were generated through the remaining data using a polynomial fit of a maximum of 4th order, so as to best represent the typical values. These lines form the prevailing background noise level curve for each measurement location, as set out in **Error! Reference source not found.** and Technical Appendix 10.3 found in Volume III of this EIAR provides this information graphically.

If the prevailing background noise is shown to be higher at lower wind speeds, the lowest derived background noise level has been applied for all wind speeds below the minimum value, in accordance with the IOA GPG. Furthermore, the derived prevailing background noise polynomial curve was not extended beyond the range covered by adequate data points. Where a noise limit is required at higher wind speeds; it was restricted to the highest derived point, as indicated by an * in **Table 10-4**.

Table 10-4 Prevailing Background Noise Levels

NML ID	Period	Prevailing background noise level, dB $L_{A90,\ 10\ min}$ at standardised wind speed, m/s								
		4	5	6	7	8	9	10	11	12
NML1	Daytime	25.2	27.9	31.2	35.0	39.1	43.5	47.9	47.9*	47.9*
	Night-time	20.1	23.5	27.4	31.7	36.2	40.5	42.6*	42.6*	42.6*
NML2	Daytime	24.7	25.8	27.6	30.1	33.2	36.9	41.2	41.2*	41.2*
	Night-time	18.4	19.9	22.0	24.8	28.1	32.1	36.7	36.7*	36.7*
NML3	Daytime	22.8	23.8	25.9	29.3	34.2	34.2*	34.2*	34.2*	34.2*
	Night-time	19.3	20.5	21.6	22.6	23.4	24.1	24.1*	24.1*	24.1*
NML4	Daytime	21.8	23.6	26.7	30.8	35.5	40.2	43.7	43.7*	43.7*
	Night-time	16.0	17.7	20.3	23.9	28.7	38.2*	38.2*	38.2*	38.2*
NML5	Daytime	25.0	26.5	28.1	30.0	32.0	34.3	36.7	36.7*	36.7*
	Night-time	20.9	22.1	23.4	25.2	27.6	30.8	35.0	35.0*	35.0*
NML6	Daytime	25.7	26.9	28.6	30.8	33.4	36.7	40.6	40.6*	40.6*
	Night-time	19.8	20.6	21.7	23.3	25.8	29.2	31.3*	31.3*	31.3*

10.4.2 Wind Farm Noise Limits

The proposed development has been assessed against the 2006 Guidelines . The 2006 Guidelines provide guidance on the setting of appropriate noise limits, relative to wind speed. These limits comprise two elements: a lower fixed value; and a derived relative value equal to the prevailing background curve plus 5 dB(A), with the greater of these two elements at each integer wind speed forming the limit value. During the night-time a fixed limit of 43 dB L_{A90} is designed to prevent sleep disturbance indoors. During the daytime and in low noise environments, where the background noise levels are less than 30 dB L_{A90}, the 2006 Guidelines recommend a value of between 35 dB L_{A90} and 40 dB L_{A90} for the lower fixed element of the daytime noise limit. Where the prevailing background noise levels exceed 30 dB L_{A90} during the daytime, it is appropriate to set the fixed portion of the limit to 45 dB L_{A90}.

It is proposed that a value of 40 dB L_{A90} is set for the fixed element of the daytime noise limit for wind speeds where the background noise is less than 30 dB L_{A90}. This follows a review of the prevailing baseline noise survey data contained in this assessment and on-going developments in terms of Irish guidance on the issue of wind turbine noise and is considered appropriate in light of the following:

- The EPA document 'Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)' proposes a daytime noise criterion of 45 dB(A) in 'areas of low background noise'. The proposed lower threshold here is 5 dB more stringent than this level.

- It should be reiterated that the 2006 Wind Energy Development Guidelines for Planning Authorities states that "*An appropriate balance must be achieved between power generation and noise impact*." Based on a review of the aforementioned EPA NG4 national guidance in relation to acceptable noise levels in areas of low background noise it is considered that the criteria adopted as part of this assessment are robust.

In summary, the operational noise limits proposed for the development are:

- 40 dB L_{A90} for daytime windspeeds where the typical background noise is less than 30 dB L_{A90};
- 45 dB L_{A90} for daytime windspeeds where the typical background noise is greater than 30 dB L_{A90} or a maximum increase of 5 dB(A) above background noise (whichever is the higher); and
- 43 dB L_{A90} for night-time periods or a maximum increase of 5 dB(A) above background noise (whichever is the higher).

This set of criteria has been chosen as it is in line with the 2006 Guidelines and best practice, and is comparable to noise planning conditions applied to similar sites previously granted planning permission by An Bord Pleanála. The noise limits are detailed in **Table 10-5** and graphically in Technical Appendix 10.4 found in Volume III of this EIAR.

Table 10-5 Derived Noise Limits

NSR ID	Period	Derived noise limits, dB $L_{A90,\,10\,min}$ at standardised wind speed, m/s								
		4	5	6	7	8	9	10	11	12
NSR01	Daytime	40	40	40	40	45	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
NSR02	Daytime	40	40	40	40	45	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
NSR03	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43
NSR04	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43
NSR05	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43
NSR06	Daytime	40	40	45	45	45	49	53	53	53
	Night-time	43	43	43	43	43	46	48	48	48
NSR07	Daytime	40	40	45	45	45	49	53	53	53
	Night-time	43	43	43	43	43	46	48	48	48
NSR08	Daytime	40	40	45	45	45	49	53	53	53
	Night-time	43	43	43	43	43	46	48	48	48
NSR09	Daytime	40	40	45	45	45	49	53	53	53
	Night-time	43	43	43	43	43	46	48	48	48
NSR10	Daytime	40	40	45	45	45	49	53	53	53
	Night-time	43	43	43	43	43	46	48	48	48
NSR11	Daytime	40	40	40	45	45	45	49	49	49
	Night-time	43	43	43	43	43	43	43	43	43
NSR12	Daytime	40	40	40	45	45	45	49	49	49
	Night-time	43	43	43	43	43	43	43	43	43
NSR13	Daytime	40	40	40	45	45	45	49	49	49
	Night-time	43	43	43	43	43	43	43	43	43
NSR14	Daytime	40	40	40	40	45	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43

NSR ID	Period	Derived noise limits, dB $L_{A90, 10 min}$ at standardised wind speed, m/s								
		4	5	6	7	8	9	10	11	12
NSR15	Daytime	40	40	40	45	45	45	49	49	49
	Night-time	43	43	43	43	43	43	43	43	43
NSR16	Daytime	40	40	40	40	45	45	45	45	45
	Night-time	43	43	43	43	43	43	43	43	43
NSR17	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43
NSR18	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43
NSR19	Daytime	40	40	40	45	45	45	46	46	46
	Night-time	43	43	43	43	43	43	43	43	43

10.5 Potential impacts

10.5.1 Existing environment

Currently the proposed development is not constructed or operational, which if this remained to be the case, the existing noise environment would remain largely unchanged.

10.5.2 Potential impacts - Construction

10.5.2.1 Wind Farm and TDR

The level of construction noise that occurs at the surrounding properties will be highly dependent on a number of factors such as the final site programme, equipment types used for each process, and the operating conditions that prevail during construction. It is not practically feasible to specify each and every element of the factors that may affect noise levels, therefore it is necessary to make reasonable allowance for the level of noise emissions that may be associated with key phases of the construction. The construction noise assessment remains valid for all turbine types considered in Section 3.8 of the EIAR, and the dimensional permutations set out in Table 3.1 of Chapter 3 of the EIAR.

To determine representative emission levels for this study, reference has been made to the scheduled sound power data provided by BS 5228. Based on experience of the types and number of equipment usually associated with the key phases of constructing a wind farm, the scheduled sound power data has been used to deduce the upper sound emission level over the course of a working day. In determining the rating applicable to the working day, it has generally been assumed that the plant will operate for between 75% and 100% of the working day. In many instances, the plant would actually be expected to operate for a reduced percentage, thus resulting in noise levels lower than predicted in this assessment.

To relate the sound power emissions to predicted noise levels at surrounding properties, the prediction methodology outlined in BS 5228 has been adopted. The prediction method accounts for factors including screening and soft ground attenuation. The size of the site and resulting separation distances to surrounding properties allows the calculations to be reliably based on positioning all the equipment at a single point within a particular working area, for example: in the case of turbine erection, it is reasonable to assume all associated construction plant is positioned at the base of the turbine under consideration. In applying the BS 5228 methodology, it has been conservatively assumed that there are no screening effects, and that the ground cover is characterised as 50% hard / 50% soft.

Table 10-6 lists the key construction activities, the associated types of plant normally involved, the expected worst-case sound power level over a working day for each activity, the property which would be closest to the activity for a portion of construction, and the predicted noise level. It must be emphasised that these predictions only relate the noise level occurring during the time when the activity is closest to the referenced property. In many cases such as access track construction and turbine erection, the separating distances will be considerably greater for the majority of the construction period and the predictions are therefore the worst-case periods of the construction phase.

Table 10-6 Predicted Construction Noise Levels

Task Name	Plant	Total Sound Power Level, dB L_{WA}	Nearest Receiver	Minimum Distance to Receiver	Predicted Noise Level dB L_{Aeq}
Construct temporary site compounds	excavators / dump trucks / tippers / rollers/ delivery trucks	116	NSR06	530	51
Construct site tracks	excavators / dump trucks / tippers / dozers / vibrating rollers	114	NSR13	50	71
Construct Sub-Station	excavators / concrete trucks / delivery trucks	111	NSR05	520	46
Construct crane hard standings	excavators / dump trucks	112	NSR02	700	44
Construct turbine foundations	piling rigs / excavators / tippers / concrete trucks / mobile cranes / water pumps / pneumatic hammers / compressors / vibratory pokers	120	NSR02	720	52
Excavate and lay site cables	excavators / dump trucks / tractors & cable drum trailers / wacker plates	112	NSR01	470	48
Erect turbines	cranes / turbine delivery vehicles / artics for crane movement / generators / torque guns	118	NSR02	700	50
Reinstate crane bases	excavator / dump truck	113	NSR02	700	45
Lay cable to sub-station	JCB / saws / hydraulic breaker / dump truck/ tipper / wacker plate / tandem roller / tractor & cable drum trailer / delivery truck	117	NSR06	650	50
Borrow Pit Quarrying	Primary and secondary stone crushers / excavators / screening systems / pneumatic breakers / conveyors	126	NSR10	200	70

Comparing the above predicted construction noise levels to the range of background noise levels measured around the proposed development suggests that the noisier construction activities would be audible at various times throughout the construction phase. However, comparing the levels to the significance criteria presented previously indicates that for the majority of construction activities the noise generated would be not significant. When access track construction activity is closest to NSR13, predicted noise levels are likely to represent those for a very short term period when activity is closest to the receptor. Noise levels will quickly diminish as construction progresses, moving the activity further from the property. The short term nature of this activity consequently categorises the effects to be not significant.

At this stage, it is not apparent what plant would be required in the borrow pit. The assessment assumes a large crusher, two large excavators and screening plant all operating 80% of the time, together with field conveyor system operating continuously, some of which may not be required. This results in a calculated construction noise level during borrow pit quarrying above the threshold of significance for one receptor, NSR10. The calculation considers the minimum distance to the quarry, as more distant areas of the quarry are worked or plant moves further away, the level of noise will reduce. It is, however, considered unlikely that the increased distance alone would result in a sufficient reduction in noise during this phase for it to be classified as not significant. Therefore, mitigation has been recommended for these works.

10.5.2.2 Site Traffic

In addition to on site activities, construction traffic passing to and from the site will also represent a potential source of noise to surrounding properties. The traffic statement for the proposal presented in Chapter 12 of the EIA Report has identified that there will be additional light goods vehicles travelling to and from the site during the construction phase. These would be expected to peak during the morning and evening as contractors from the site arrive and depart for the day and are envisaged not to be a continuous source of noise emissions during a typical working day. The noise impact from construction personnel movements to and from the site is expected to be low. The construction traffic data remains the same for all potential turbine types considered in Section 3.8 of this EIA Report. Therefore, the assessment of noise from construction vehicles is appropriate for all turbines.

All deliveries of turbine components to the site will only be by way of the proposed transport route outlined in Chapter 12. The most intensive period of the works programme will be during months five and six. During this time several construction activities are programmed in parallel.

10.5.2.3 Cable Routes

The proposed development will include an onsite electricity substation, to which each wind turbine will be connected via underground cables. This substation will be connected to the grid via further underground cables that follow public roads. The likely plant to be in operation during the laying of underground cables for the connection of the onsite substation to the grid are provided in **Table 10-7** together with the corresponding noise levels calculated at set distances back.

Table 10-7 Predicted Cable Route Construction Noise Levels

Task Name	Plant	Sound Power Level, dB L_{WA}	on time (%)	Predicted Noise Level, dB L_{Aeq}			
				10 m	25 m	50 m	100 m
Dust suppression	Road sweeper	104	10	66	58	51	45
Breaking road surface	Mini excavator with hydraulic breaker	111	25	77	69	62	56
Rolling and compacting	Vibratory roller	105	50	74	66	59	53
Trenching	Wheeled excavator	98	50	67	59	52	46
Cutting concrete	Hand-held circular saw	114	10	76	68	61	55
Tipping fill	Dump truck tipping fill	107	10	69	61	54	48
Compaction	Petrol vibratory plate	108	10	70	62	55	49

The noise levels presented in Error! Reference source not found. may only occur for only short periods of time at a very limited number of dwellings. The nature of the construction work associated with the burying of cables under the existing roads will be comparable to other roadwork activity and will quickly diminish as work progresses along the road. There are very few dwellings located within 10 m of the cable route construction works and less than 50 that are within 25 m. For these dwellings, in some instances, the worst case predicted grid connection construction noise level exceeds the noise limit of 65 dB $L_{Aeq,1hr}$.

However, these elevated noise levels will only occur for short durations at a limited number of dwellings when construction activity is at its closest. Given the nature of the cable route works, construction activities will not occur over an extended period at any one location, regardless of which cable route to the grid is progressed. Notwithstanding this, mitigation measures are recommended in Section 10.5.5.

10.5.3 Potential impacts- Operational

10.5.3.1 Wind Farm – Input Parameters

The ISO 9613-2 model has been used to calculate the noise immission levels at the NSRs as advised in the IOA GPG. The model accounts for the attenuation due to geometric spreading, atmospheric absorption, and barrier and ground effects. All attenuation calculations have been made on an octave band basis and therefore account for the sound frequency characteristics of the turbines.

All noise level predictions have been undertaken using a receiver height of four metres above local ground level, mixed ground (G=0.5) and an air absorption based on a temperature of 10°C and 70% relative humidity. A receiver height of four metres will be typical of first floor windows and result in slightly higher predicted noise levels than if a 1.2 to 1.5 metre receiver height were chosen in the ISO 9613 algorithm. The attenuation due to terrain screening accounted for in the calculations has been limited to a maximum of 2 dB(A). In situations of propagation above concave ground, a correction of +3dB was added.

This method is consistent with the recommendations of the above-referenced IOA GPG which provides recommendations on the appropriate approach when predicting wind turbine noise levels. The IOA GPG also allows for directional effects to be taken into account within the noise modelling: under upwind propagation conditions between a given receiver and the wind farm the noise immission level at that receiver can be as much as 10 dB(A) to 15 dB(A) lower than the level predicted using the ISO 9613-2 model. However, predictions have been made assuming downwind propagation from every turbine to every receptor at the same time as a worst case.

The exact model of turbine that will be installed at the site will be the subject of a competitive procurement process prior to the construction of the wind farm which will be several years post-consent if the project is successful at the planning stage. The Siemens Gamesa SG155 6.6MW and the Vestas V162 7.2MW wind turbines are two such candidate turbines within the range proposed for this development which may be selected by the developer subject to availability and the above-mentioned procurement process at that time. These candidate machines have comparable noise emission levels to other turbines that are currently available of the scale and capacity assessed within this EIAR. Both machines have been modelled separately and are fully assessed in this chapter.

A total of 13 turbines have been modelled using the layout as indicated on **Figure 10-1**. The candidate turbines are variable speed, pitch regulated machines, the SG155 has a rotor diameter of 155 metres and a hub height of 102.5 metres, the V162 has a rotor diameter of 162m and a hub height of 99 metres. Due to their variable speed operation the sound power output of the turbines varies considerably with wind speed, being quieter at the lower wind speeds when the blades are rotating more slowly.

The assessment presented in this EIA Report assumes that all wind turbines are operating in their standard unconstrained mode. Noise reduced modes are available for the candidate turbines and are discussed further in Section 10.5.5.2.

Siemens Gamesa and Vestas have supplied noise emission data for the SG155 6.6 MW and the V162 7.2 MW turbines respectively, which represent the values that the manufacturers specify will not be exceeded in practice. In the absence of specific information about the uncertainty allowances in the SG155 data, a further correction factor of +2 dB was added to the Siemens Gamesa specification data in line with guidance in the IOA GPG. As outlined in manufacturer warranty documents provided by Vestas for Ireland, an uncertainty of +1 dB(A) has been applied; therefore, a further correction factor of +1 dB was added to the specification data for the V162 machine in line with these documents and in accordance with the IOA GPG. The sound power data for both machines have been made available for hub height wind speeds of 3 m/s to 15 m/s inclusive. In addition to the overall sound power data, sound power frequency distribution for the turbines has been specified, based on an energetic average of the available information at each octave band. The overall sound power and spectral data are presented in **Table 10-8** and **Table 10-9** for the SG155 machine and in **Table 10-10** and **Table 10-11** for the V162 machine.

Table 10-8 Siemens Gamesa SG6.6-155 Sound Power Levels, dB L_{WA}

Operational mode	Hub height wind speed, m/s. Sound power level dB L_{WA}. Data source D2359800/04, 2021-07-29							
	3	4	5	6	7	8	9	10 to cut-out
standard	94.0	94.0	96.8	100.8	104.1	107.0	107.0	107.0
N1	94.0	94.0	96.8	100.8	104.1	106.0	106.0	106.0
N2	94.0	94.0	96.8	100.8	104.1	105.5	105.5	105.5
N3	94.0	94.0	96.8	100.8	104.0	104.0	104.0	104.0
N4	94.0	94.0	96.8	100.8	103.0	103.0	103.0	103.0
N5	94.0	94.0	96.8	100.8	102.0	102.0	102.0	102.0
N6	94.0	94.0	96.8	100.8	101.0	101.0	101.0	101.0

Table 10-9 Siemens Gamesa SG6.6-155 Sound Power Frequency Distribution at Rated Power, dB L_{WA}

Operational mode	Octave Band Centre Frequency, Hz. Data source D2359800/04, 2021-07-29							
	63	125	250	500	1000	2000	4000	8000
All	80.4	87.8	92.4	94.7	94.5	94.8	88.6	73.2

Table 10-10 Vestas V162-7.2 Sound Power Levels, dB L_{WA}

Mode	Hub height wind speed, m/s. Sound power level dB L_{WA}. Data source 0114-3777 V03, 2022-07-01												
	3	4	5	6	7	8	9	10	11	12	13	14	15
standard	95.0	95.0	95.0	96.0	99.3	102.5	105.1	105.6	105.7	105.8	106.0	106.3	106.5
SO2	95.0	95.0	95.0	96.0	99.3	102.3	103.0	103.0	103.0	103.0	103.0	103.0	103.0
SO3	95.0	95.0	95.0	96.0	99.2	101.8	101.9	102.0	102.0	102.0	102.0	102.0	102.0
SO4	95.0	95.0	95.0	96.0	99.2	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0
SO5	95.0	95.0	95.0	96.0	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
SO6	95.0	95.0	95.0	96.0	98.8	99.0	99.0	99.0	99.0	99.0	99.0	99.0	99.0

Table 10-11 Vestas V162-7.2 Sound Power Frequency Distribution at Rated Power, dB L_{WA}

Operational mode	Octave Band Centre Frequency, Hz. Data source 0116-1715_03, 2023-01-13							
	63	125	250	500	1000	2000	4000	8000
All	89.2	96.8	100.0	100.2	98.5	93.9	86.3	75.5

10.5.3.2 Wind Farm – Operational Noise Immission Levels

The assessment of operational wind turbine noise for each of the survey locations (NMLs) is shown in **Table 10-12** and **Table 10-13** for the SG155 and V162 machines respectively. A negative exceedance indicates that the turbine immission level is below the appropriate limit. Predicted noise immission levels for standardised wind speed from 4 m/s to 10 m/s are presented for the NSRs with the highest predicted wind turbine immission level where that survey data are used as a proxy (see Table 10-3 to see which NSRs share the same NML), rather than all locations for brevity. The reason being that if compliance can be demonstrated at the NSR with the highest immission level of a group of receptors that share the same limit, then wind turbine noise at all the remaining NSRs within that group would also comply with the limit. The predictions assume unconstrained operation and downwind propagation. All these factors represent a worst case scenario. In practice, NSRs will not be downwind of all turbines at any one time and the actual noise levels would be lower than those presented in **Table 10-12** and **Table 10-13**. Calculations have been carried out to one decimal place and presented as whole numbers in **Table 10-12** and **Table 10-13**; therefore, in some cases the exceedance may not exactly equal the difference between the presented values for the limit and immission.

All wind farm noise immission levels in this report are presented in terms of the $L_{A90,T}$ noise indicator in accordance with the recommendations of the IOA GPG, obtained by subtracting 2 dB(A) from the calculated $L_{Aeq,T}$ noise levels based on the turbine sound power levels presented in **Table 10-8** to **Table 10-11**.

Table 10-12 Assessment of Predicted Wind Farm Noise Immission Levels – SG155-6.6MW Machine

NSR ID (NML ID)	Description	Standardised wind speed, m/s. Noise level dB L_{A90}						
		4	5	6	7	8	9	10 +
NSR06 (NML1)	Wind turbine immission	33	38	40	40	40	40	40
	Daytime limit	40	40	45	45	45	49	53
	Daytime exceedance	**-7**	**-2**	**-5**	**-5**	**-5**	**-9**	**-13**
	Night-time limit	43	43	43	43	43	46	48
	Night-time exceedance	**-10**	**-5**	**-3**	**-3**	**-3**	**-6**	**-8**
NSR05 (NML2)	Wind turbine immission	30	35	38	38	38	38	38
	Daytime limit	40	40	40	45	45	45	46
	Daytime exceedance	**-10**	**-5**	**-2**	**-7**	**-7**	**-7**	**-9**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-13**	**-8**	**-5**	**-5**	**-5**	**-5**	**-5**
NSR02 (NML3)	Wind turbine immission	31	36	39	39	39	39	39
	Daytime limit	40	40	40	40	45	45	45
	Daytime exceedance	**-9**	**-4**	**-1**	**-1**	**-6**	**-6**	**-6**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-12**	**-7**	**-4**	**-4**	**-4**	**-4**	**-4**
NSR12 (NML4)	Wind turbine immission	32	37	39	39	39	39	39
	Daytime limit	40	40	40	45	45	45	49
	Daytime exceedance	**-8**	**-3**	**-1**	**-6**	**-6**	**-6**	**-10**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-11**	**-6**	**-4**	**-4**	**-4**	**-4**	**-4**
NSR16 (NML5)	Wind turbine immission	32	36	39	39	39	39	39
	Daytime limit	40	40	40	40	45	45	45
	Daytime exceedance	**-8**	**-4**	**-1**	**-1**	**-6**	**-6**	**-6**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-11**	**-7**	**-4**	**-4**	**-4**	**-4**	**-4**
NSR18 (NML6)	Wind turbine immission	32	37	40	40	40	40	40
	Daytime limit	40	40	40	45	45	45	46
	Daytime exceedance	**-8**	**-3**	**-1**	**-6**	**-6**	**-6**	**-6**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-11**	**-6**	**-4**	**-4**	**-4**	**-4**	**-4**

Table 10-13 Assessment of Predicted Wind Farm Noise Immission Levels – V162-7.2MW Machine

NSR ID (NML ID)	Description	Standardised wind speed, m/s. Noise level dB L_{A90}						
		4	5	6	7	8	9	10 +
NSR06 (NML1)	Wind turbine immission	30	34	38	40	40	40	41
	Daytime limit	40	40	45	45	45	49	53
	Daytime exceedance	**-10**	**-6**	**-7**	**-5**	**-5**	**-8**	**-12**
	Night-time limit	43	43	43	43	43	46	48
	Night-time exceedance	**-13**	**-9**	**-5**	**-3**	**-3**	**-5**	**-5**
NSR05 (NML2)	Wind turbine immission	28	32	36	38	38	38	39
	Daytime limit	40	40	40	45	45	45	46
	Daytime exceedance	**-12**	**-8**	**-4**	**-7**	**-7**	**-7**	**-8**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-15**	**-11**	**-7**	**-5**	**-5**	**-5**	**-5**
NSR02 (NML3)	Wind turbine immission	29	33	37	39	39	39	39
	Daytime limit	40	40	40	40	45	45	45
	Daytime exceedance	**-11**	**-7**	**-3**	**-1**	**-6**	**-6**	**-6**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-14**	**-10**	**-6**	**-4**	**-4**	**-4**	**-4**
NSR12 (NML4)	Wind turbine immission	29	33	38	39	39	40	40
	Daytime limit	40	40	40	45	45	45	49
	Daytime exceedance	**-11**	**-7**	**-2**	**-6**	**-6**	**-6**	**-9**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-14**	**-10**	**-5**	**-4**	**-4**	**-4**	**-3**
NSR16 (NML5)	Wind turbine immission	29	33	37	39	39	39	40
	Daytime limit	40	40	40	40	45	45	45
	Daytime exceedance	**-11**	**-7**	**-3**	**-1**	**-6**	**-6**	**-6**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-14**	**-10**	**-6**	**-4**	**-4**	**-4**	**-4**
NSR18 (NML6)	Wind turbine immission	30	34	38	39	40	40	40
	Daytime limit	40	40	40	45	45	45	46
	Daytime exceedance	**-10**	**-6**	**-2**	**-6**	**-5**	**-5**	**-5**
	Night-time limit	43	43	43	43	43	43	43
	Night-time exceedance	**-16**	**-11**	**-7**	**-6**	**-6**	**-5**	**-5**

The results of the assessment shown in **Table 10-12** and **Table 10-13** confirm that the predicted wind farm noise immission levels for both candidate machines assessed do not exceed the daytime or night-time noise limits derived in accordance with the Wind Energy Guidelines (2006) under all wind speeds and at all locations. Accordingly, no significant effects are predicted during the operational phase.

Within the turbine range parameters proposed in Chapter 3, only the hub height affects the operational noise impacts. The overall tip height and rotor diameter of the turbine do not influence the noise emissions of any turbine selected with the range. The noise assessment has considered predicted noise levels for the Siemens Gamesa SG155-6.6MW machine with the highest hub height within the range of 102.5m, and the Vestas V162-7.2MW machine which has the lowest hub height within the range of 99m. As such, any difference associated with a change in hub height within the Turbine Range has also been assessed as it will be within the minimum and maximum hub height scenarios that have been set out in this chapter.

Aside from the hub height, sound power level and sound power frequency distribution may affect the operational noise effects. Whichever wind turbine is selected within the range will take into account these factors, to ensure that operational noise levels do not exceed the operational noise limits as set out in Table 10-5 and do not give rise to any significant operational noise effects.

10.5.3.3 Substation

In additional to the noise from wind turbines, noise will be produced by the transformers located in the substations. The noise level is likely to depend on the load on the transformer which is dependent on the wind speed, as the wind turbines producing more energy in high wind speeds.

Calculations are based on the Siemens TLPN7747 40000 / 50000 kVA, with a maximum sound power level of 93 dB L_{WA} which would occur when the wind turbines are at rated power. The octave band sound power frequency distribution for the transformer has been sourced from 'An Introduction to Sound Level Data for Mechanical and Electrical Equipment' published by CED Engineering. The A-weighted octave band data is presented in **Table 10-14**.

Table 10-14 Octave Band Sound Power Level for Transformer, dB L_{WA}

Octave Band Centre Frequency, Hz.									Overall L_{WA}
31.5	63	125	250	500	1000	2000	4000	8000	
81	87	89	84	84	78	73	68	61	93

The nearest NSR to the substation is NSR05. The predicted noise from the substation at this location is 29 dB L_{Aeq}, equivalent to 27 dB L_{A90}. Wind turbine noise at NSR05 is predicted to be 39 dB L_{A90} or 40 dB L_{A90} at rated power of the SG155 and V162 machines respectively. A noise level of 27 dB L_{A90} from the substation would not increase the predicted noise level of 39 dB L_{A90} from the turbines as they are at least 10 dB apart. Therefore, the noise from the substation will not be significant.

10.5.4 Potential Impacts – Decommissioning

Upon decommissioning of the proposed development, the wind turbines would be disassembled and all above ground components would be separated and removed off-site for recycling. Turbine foundations would remain in place underground and would be covered with earth and reseeded as appropriate. These activities would be undertaken during daytime hours, and noise, which would be of a lesser impact than for construction, will be controlled through the relevant guidance and standards in place at the time of decommissioning. As construction noise impacts would be not significant, decommissioning noise would also be not significant.

Site access tracks could be in use for purposes other than the operation of the proposed development by the time the decommissioning of the Project is to be considered, and therefore it may be more appropriate to leave the site access tracks in situ for future use. If the roads were not required in the future for any other useful purpose, they could be removed where required. This would involve removing hard core material and placement of topsoil. The impact is expected to be less than that during the construction stage and therefore not significant.

It is proposed that the underground cable will be cut back and it will remain in-situ. The works associated with the cutting back of the underground cable will have a negligible impact.

10.5.5 Mitigation Measures

10.5.5.1 Construction Mitigation

The predicted noise levels from onsite construction activity from the proposed development are predominantly below the noise limit for the threshold of significance. Some tasks, whilst at shortest distance to the nearest NSR, have the potential to temporarily exceed the limit. To reduce the potential effects of construction noise, the following types of mitigation measures will be implemented in full and are included in Section 5.6 of the CEMP found in Volume III of this EIAR:

- Those activities that may give rise to audible noise at the surrounding properties and heavy goods vehicle deliveries to the site will be limited to the hours 07:00 to 19:00 Monday to Friday and 07:00 to 13:00 on Saturdays. Turbine deliveries will only take place outside these times with the prior consent of the Council and the Police. Those activities that are unlikely to give rise to noise audible at the site boundary will continue outside of the stated hours. If turbine deliveries are required at night it will be subject to agreement with the relevant planning authority and it would be ensured that vehicles on local roads do not wait outside residential properties with their engines idling, and that the local residents will be informed of any activities likely to occur outside of normal working hours.
- Construction works traffic will be restricted to the approved access routes
- All construction activities will adhere to good practice as set out in BS 5228.
- All equipment will be maintained in good working order and any associated noise attenuation such as engine casing and exhaust silencers shall remain fitted at all times.
- Where flexibility exists, activities will be separated from residential neighbours by the maximum possible distances.
- A site management regime will be developed to control the movement of vehicles to and from the Development site.
- Construction plant capable of generating significant noise and vibration levels will be operated in a manner to restrict the duration of the higher magnitude levels.

10.5.5.2 Operational Mitigation

An assessment of the operation noise levels has been undertaken in accordance with current best practice guidelines and procedures as outlined in Sections 10.3 of this Chapter. This assessment has assumed SG155-6.6 MW and the V162-7.2MW turbine technology operating in standard mode. The findings of the assessment confirm that the predicted operational noise levels are within the noise criteria. As such, mitigation measures are not required.

As noted in section 10.5.3.2, a change in hub height will not change the significance of the effects and so no mitigation is required, regardless of which turbine parameters are installed within the range of the set out in Chapter 3.

Aside from the hub height, sound power level and sound power frequency distribution may affect the operational noise effects. The make or model of turbine which is eventually selected for installation within the ranges assessed in this EIAR, will take into account these factors and adhere to the noise levels set out in this chapter. If the selected turbine has the potential to exceed the limits, the turbine will operate in noise reduced modes to ensure the limits are not exceeded and there are no significant operational effects. This allows the sound power output of the turbine to be reduced across a range of operational wind speeds, albeit with some loss of electrical power generation, to enable the best compromise to be achieved in any given situation between emitted noise and electrical power generation. These systems are generally similar in that they rely on the turbine's computer based controller adjusting either the pitch of the blades or holding back the rotational speed of the blades to reduce emitted noise under selected wind conditions (direction, speed or some combination of the two). In this manner noise management only comes into play, and therefore potential power generation capacity is only lost, for those conditions under which it is required.

10.5.5.3 Monitoring

Post commissioning noise surveys will be carried out in agreement with Laois County Council by a suitably qualified acoustician to ensure compliance with the noise limits set out above, unless otherwise prescribed by any noise conditions applied to the development. In the unlikely instance that an exceedance of these noise criteria is identified, the assessment guidance outlined in the IOA GPG and Supplementary Guidance Note 5: Post Completion Measurements (July 2014) will be followed and relevant corrective actions will be taken to ensure that the noise levels are exceeded. For example, implementation of noise reduced modes resulting in curtailment of turbine operation can be implemented for specific turbines in specific wind conditions to ensure predicted noise levels are within the relevant noise levels.

10.5.6 Residual Impacts

10.5.6.1 Construction Noise

With mitigation measures, the construction and decommissioning noise levels would be below the relevant noise limit of 65 dB $L_{Aeq,1hr}$ for operations exceeding one month, and therefore construction noise impacts are not considered to be significant.

The residual construction noise impacts would therefore be not significant.

10.5.6.2 Operational Noise

Based on the two candidate machines assessed, no mitigation is necessary for the control of operation noise to comply with current best practice Guidelines; therefore, the residual impacts would remain not significant. If the selected installed turbine has the potential to exceed the limits, assessments and mitigation measures will be implemented to ensure the limits are not exceeded; therefore the residual impact would remain not significant.

10.6 Conclusion

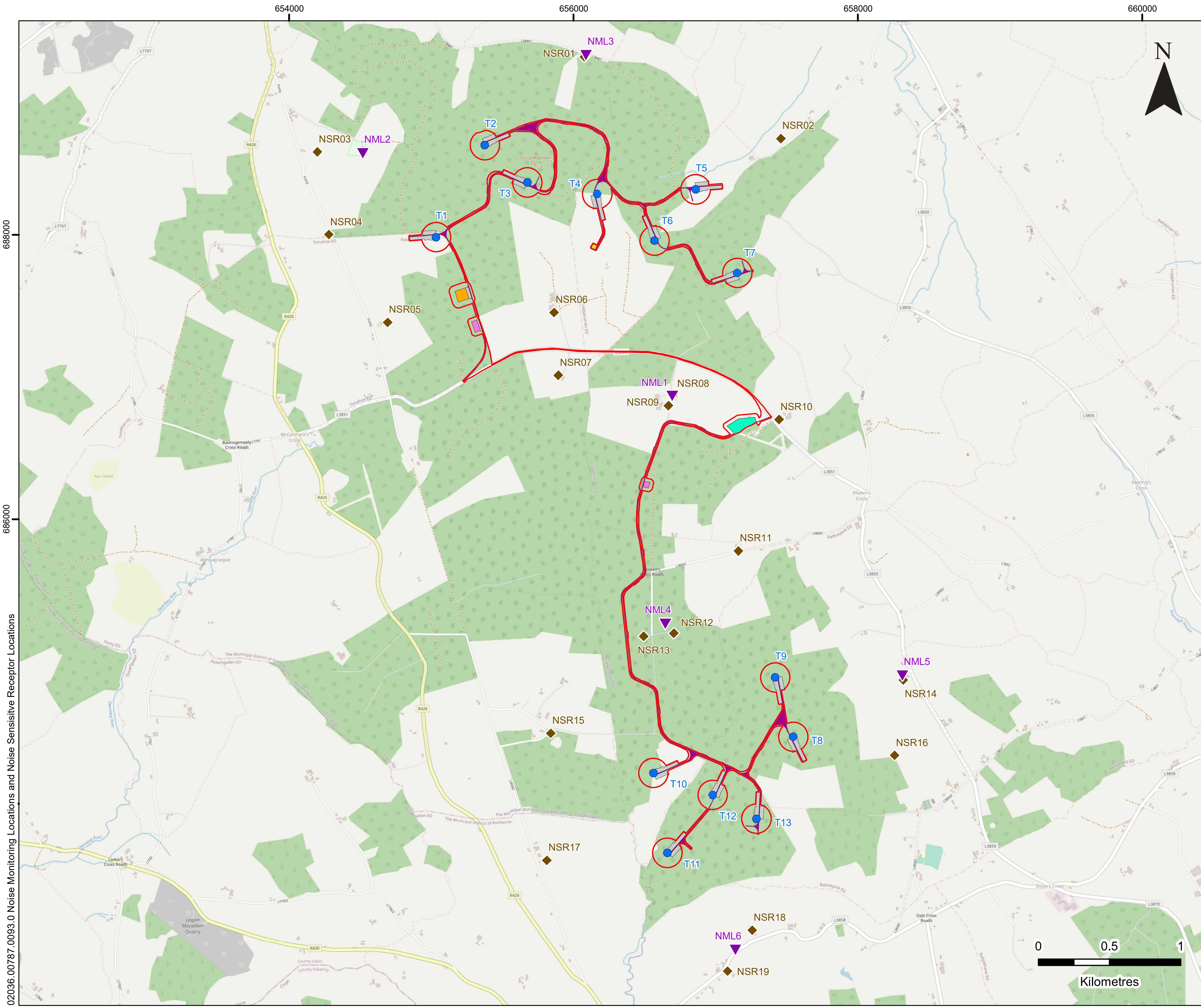
When considering a development of this nature, the potential noise and vibration effects on the environment must be considered for the construction, operation and decommissioning phases.

This chapter comprehensively assesses all scenarios within the Turbine Range which is described in section 3.8. The potential impacts that could arise from the proposed development during the construction, and decommissioning phases relate to increases in noise due to construction and decommissioning activities. There will be no change to the potential impacts or predicted effects irrespective of which turbine is selected within the Turbine Range.

The construction noise assessment has determined that mitigation will be required for the control of noise and that the associated residual levels are expected to be audible at various times throughout the construction programme, but remain with acceptable limits such that their temporary effects are not significant.

Operational noise from the Proposed Development has been assessed in accordance with current best practice. It has been demonstrated that both the daytime and night time noise limits will be satisfied at all properties across all wind speeds without any constraint. These operation effects are not significant. As described in this Chapter, this assessment applies to all parameters within the range of permutations set out in Chapter 3 of the EIAR. The candidate machines have comparable noise emission levels to other turbines that are currently available and any installed turbine will operate within the noise limits set out in this Chapter and in any planning condition.

In summary, the noise and vibration impact of the proposed development is not significant in the context of best practice.



02036.00787.0093.0 Noise Monitoring Locations and Noise Sensisitve Receptor Locations

LEGEND

- Proposed Development Site Boundary
- Proposed Turbine Layout
- Proposed Substation Compound
- Proposed Temporary Construction Compound
- Proposed Borrow Pit
- Proposed Hardstanding
- Proposed Access Track
- Proposed Met Mast Hardstanding
- Noise Sensitive Receptor
- Noise Monitoring Location

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NOISE AND VIBRATION

NOISE MONITORING LOCATIONS AND NOISE SENSITIVE RECEPTOR LOCATIONS

FIGURE 10-1

Scale 1:25,000 @ A3 | Date JUNE 2023

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