APPENDIX 12-2a

WIND TURBINE OPERATIONAL NOISE REPORT

A specialist energy consultancy

Appendix 12-2

Operational Noise Report

Lackareagh Wind Farm, Co. Clare

EDF Renewables Ireland

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Executive Summary

TNEI Ireland Ltd was commissioned by MKO on behalf of EDF Renewables Ireland ('the Applicant') to undertake predictions of the wind turbine noise that would be emitted by the operation of the proposed Lackareagh Wind Farm (hereinafter referred to as 'the Proposed Project'). The noise predictions were used to assess the potential impact of operational noise from the Proposed Project on the nearest noise sensitive receptors.

The Irish Government Department of Environment Heritage and Local Government document 'Wind Energy Development Guidelines, 2006' (WEDG 2006, also referred to as DoEHLG 2006) are the current guidelines for setting noise limits for wind energy developments. The information relating to noise in the WEDG 2006, is very limited and it is widely agreed that the limits proposed in the WEDG 2006 were drafted to broadly align with the UK guidance ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms'. In 2013, the UK guidance was supplemented by a document produced by the Institute of Acoustics 'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise' (IOA GPG). Reference has been made to guidance contained in ETSU-R-97 and the IOA GPG to supplement the WEDG 2006.

The operational noise assessment has been undertaken in three stages:

- Stage 1 – establish the Total WEDG Noise Limits for nearby receptors based on measured background noise levels;
- Stage 2 – undertake a cumulative assessment based on likely predictions for all relevant turbines in the area (existing and proposed (in planning)) and compare the cumulative noise predictions against the Total WEDG Noise Limits; and
- Stage 3 – establish the Proposed Wind Farm Site Specific Noise Limits (at levels below the Total WEDG Noise Limits, where limit apportionment is required) and compare the noise predictions from the Proposed Wind Farm on its own against the proposed Site Specific Noise Limits.

Background noise monitoring was undertaken at seven noise sensitive receptors. The monitoring locations were considered to be representative of the noise sensitive receptors located closest to the Proposed Wind Farm.

There are 160 Noise Sensitive Receptors (NSRs) in proximity to the Proposed Wind Farm. Of the 160 identified NSRs, a total of 19 NSRs were chosen as Noise Assessment Locations (NALs). The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Wind Farm. Additional receptors were also included to consider cumulative noise impacts. The modelling results for the NALs have been presented within the main body of this report whilst an assessment for all NSRs have been included within an Annex to the report. For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations deemed representative of the expected background noise environment was used to assess the wind turbine noise impact at those receptors.

Wind speed and direction data were measured using a LiDAR unit located within the Proposed Wind Farm site. The wind data measured at 100 m and 110 m height was used to calculate hub height wind speeds (at 105 m). These hub height wind speeds were then standardised to a height of 10m in accordance with current good practice. Analysis of the measured data has been undertaken in accordance with the WEDG 2006, ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits at each of the NALs.

Two sets of noise limits have been derived; the Total WEDG Noise limits apply to the cumulative noise level of all turbines operating in the area including the Proposed Wind Farm turbines, whilst the Site Specific Noise limits apply to operational noise from the Proposed Wind Farm only.

Based on the guidance in the WEDG 2006 and to reflect the presence of permitted wind turbines in the area, the daytime Total WEDG Noise Limit was set at 40 dB(A) where background noise levels were <30 dB and 45 dB(A) or background plus 5 dB whichever is the greater where background noise levels were >30 dB. The night-time Total WEDG Noise Limit has been set at 43 dB(A) or background plus 5 dB whichever is the greater.

Predictions of wind turbine noise for the Proposed Wind Farm were made, based upon the sound power level data for a candidate wind turbine, the Vestas V150 6.0 MW with serrated trailing edge blades and a hub height of 105 m The Vestas V150 6.0 MW has been chosen as the main candidate for the assessment as it is the loudest of the candidates being considered and therefore provides the most precautionary scenario. In order to consider the full design envelope for the site, additional modelling has been undertaken using two other candidates, the Nordex N149 5.7 MW with serrated trailing edge blades and a hub height of 105 m and the Siemens Gamesa SG 6.0-155 6.6 MW with a hub height of 102.5 m. Predictions for these other two candidates have been included when assessing the Proposed Wind Farm against its Site Specific Noise Limits, and the results have been included within an Annex to this report. All candidates modelled are considered to be representative of the type of turbine that could be installed at the site. Whatever the final turbine choice is, the Proposed Wind Farm will meet the noise limits determined and contained within any condition applied as part of consent.

Modelling was undertaken using the ISO 9613: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* noise prediction model which accords with current good practice and is considered to provide a realistic impact assessment. For the other schemes, predictions have been undertaken using sound power level data for the installed turbines or a suitable candidate. The model of turbine was either identified through an online search, or through the use of the County Council's Planning Application Portal.

A cumulative assessment was undertaken at the NALs where predictions from the Proposed Wind Farm were found to be within 10 dB of the noise predictions from all other schemes. The assessment of likely cumulative noise levels undertaken at the NALs shows that the Proposed Wind Farm can operate concurrently with the other wind farm developments in the area, whilst meeting the Total WEDG Noise Limit, at all NALs.

Site Specific Noise Limits have also been derived that take account (where required) of the other wind farm developments. Where wind turbine immissions from the other wind turbines at a given receptor were found to be at least 10 dB below the Total WEDG Noise Limit, it is considered that they will be using a negligible proportion of the limit, as such it was considered appropriate to allocate the entire noise limit to the Proposed Wind Farm. For the receptors where turbine predictions were found to be within 10 dB of the Total WEDG Noise Limit, apportionment of the Total WEDG Noise Limits was undertaken in accordance with the IOA GPG.

Predicted noise levels indicate that at all NALs, except NAL11, the wind turbine noise immissions were below the Site Specific Noise Limits when considering the Vestas V150, Siemens Gamesa SG 6.0-155 and Nordex N149 as a candidate turbine. At NAL11, an exceedance of the night time Site Specific Noise Limit by a maximum of 1.2 dB within the standardised wind speed range 7 to 12 ms^{-1} is predicted. This is for both the Vestas V150 and Nordex N149 turbines, whereas predictions for the Siemens-Gamesa SG 6.0-155 still adhere to the Site Specific Noise Limit. The use of low noise modes would mitigate this exceedance and the predicted levels presented in this report include the necessary mitigation.

The use of Site Specific Noise Limits would ensure that the Proposed Wind Farm could operate concurrently with other proposed (in planning), permitted or operational turbines in the area and would also ensure that the Proposed Wind Farm's individual contribution could be measured and enforced if required.

Should planning permission be granted for the Proposed Wind Farm, it would be appropriate to include a set of noise related planning conditions, which detail the noise limits applicable to the Proposed Wind Farm. A set of suggested planning conditions for the Proposed Wind Farm have been included within Annex 8.

There are a number of wind turbine makes and models that may be suitable for the Proposed Wind Farm. Should the Proposed Wind Farm receive planning permission the final choice of turbine would be subject to a competitive tendering process. As such, predictions of wind turbine noise are for informational and assessment purposes only. The final choice of turbine would, however, need to meet the noise limits determined and contained within any condition imposed.

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TABLES

ANNEXES

1 Introduction

1.1 Brief

1.1.1 TNEI Ireland Ltd was commissioned by MKO on behalf of EDF Renewables Ireland ('the Applicant') to undertake an operational noise assessment for the proposed Lackareagh Wind Farm (hereinafter referred to using the following terminology as outlined in Chapter 1, Section 1.1.1: the 'Proposed Project', 'the Proposed Wind Farm', 'the Proposed Grid Connection', and the 'proposed development'. The following steps summarise the noise assessment process:

- Measure and analyse existing background noise levels and present the measured noise data with reference to existing government guidance and the recommendations of the Department of Environment Heritage and Local Government (DoEHLG) which are contained in the '*Wind Energy Development Guidelines, 2006'* [(1)] (WEDG 2006, also referred as DoEHLG 2006), in conjunction with the guidance produced by the United Kingdom's Department of Trade and Industry Noise Working Group on Noise from Wind Turbines which are contained within ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'* [(2)] and *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* [(3)] (IOA GPG) which represents current good practice in the UK;
- Determine the Total WEDG 2006 Noise Limits applicable to all wind farms in the area;
- Assess and undertake a cumulative noise assessment, where required, to take account of other proposed, permitted or operational schemes near to the Proposed Wind Farm;
- Derive Site Specific Noise Limits for the Proposed Wind Farm. These derived noise limits will be suitable for inclusion in a noise related planning condition should Clare County Council grant planning permission for the Proposed Wind Farm;
- Undertake predictions of the operational wind turbine noise immission from the Proposed Wind Farm that will be incident at neighbouring noise sensitive receptors, considering noise data for candidate wind turbine models;
- Compare the predictions of the operational wind turbine noise immission from the Proposed Wind Farm against the Site Specific Noise; and
- Assess the impact of noise from the Proposed Wind Farm with reference to existing Government Guidance and the recommendations of the DoEHLG which are contained in the WEDG 2006.

1.2 Background

1.2.1 The Proposed Project is located immediately east of Kilbane village, and approximately 6km west of Killaloe in County Clare. The approximate Irish Transverse Mercator (ITM) reference for the centre of the Proposed Wind Farm site is 563410, 672451 and the proposed layout is comprised of 7 wind turbines as shown on Figure A1.1a in Annex 1.

1.2.2 In the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Vestas V150 6.0 MW with serrated trailing edge blades and a hub height of 105 m. The Vestas V150 6.0 MW has been chosen as the main candidate for the assessment as it is the loudest of the candidates being considered and therefore provides the most precautionary scenario In order to consider the full design envelope for the site, additional modelling has been undertaken using two other candidates, the Nordex N149 5.7 MW with serrated trailing edge blades and a hub height of 105 m and the Siemens Gamesa SG 6.0-155 6.6 MW and a hub height of 102.5 m.. Predictions for these other two candidates have been included when assessing the Proposed Wind Farm against its Site Specific Noise Limits (the results are included within Annex 5). All candidates modelled are considered to be representative of the type of turbine that could be installed at the site.

1.2.3 The noise assessment has considered schemes that are operational, permitted and proposed (planning application submitted) but not those in the pre-planning stage. The schemes considered in the assessment are summarised in Table 1.1. Not considered within the noise assessment are Oatfield Wind Farm, located approximately 6km to the west of the Proposed Wind Farm site, which is currently in the planning system, having been lodged to An Bord Pleanála in Late 2023, and Knockshanvo Wind Farm (located adjacent to Oatfield Wind Farm, approximately 5km to the west of the Proposed Wind Farm site), which, at the time of writing, is currently at pre-planning stage. These developments are sufficiently far away from the Proposed Wind Farm, such that noise predictions are low and therefore will not be having a meaningful contribution to the predicted cumulative noise levels at the NALs.

Table 1.1 Cumulative Wind Farm/ Turbine Developments

Wind Farm/ Wind Turbine	Number of Turbines	Status	Make and Model of Turbine Considered in Modelling
Carrownagowan	19	Permitted	Nordex N133, 4.8 MW, serrated blades
Fahy Beg	8	Permitted	Nordex N133, 4.8 MW, serrated blades

1.2.4 Figure A1.1b in Annex 1 shows the location of the above developments relative to the Proposed Project. The turbine type modelled for each of the schemes detailed in Table 1.1 was chosen using information contained within the Environmental Impact Assessment Reports for the schemes or using information detailed on the specific project websites.

1.2.5 For the purposes of assessing the above schemes in conjunction with the Proposed Project the following terms have been referred to throughout the assessment:

- 'Total WEDG Noise Limits'; defined as being the limit that should not be exceeded from the cumulative operation of all wind farm developments, including the Proposed Project; and
- 'Site Specific Noise Limits'; defined as being the limit that is specific to the Proposed Project only, and derived through the apportionment (where required), of the 'Total WEDG Noise Limits' in accordance with current good practice (IOA GPG).

1.2.6 Note that the term 'noise emission' relates to the sound power level emitted from each wind turbine, whereas the term 'noise immission' relates to the sound pressure level received at any receptor location, due to the operation of the wind turbines. All references to dB are dB(A), unless otherwise stated. Wind speeds are standardised to 10 m height and grid coordinates are in ITM unless otherwise stated. A full glossary of terms is provided in Section 8.

2 Noise Planning Policy and Guidance

2.1 Overview of Noise Planning Policy and Guidance

2.1.1 In assessing the potential noise impacts of the Proposed Wind Farm, the following guidance and policy documents have been considered:

- National Planning Policy;
- Regional Planning Policy;
- Local Policy;
- Department of Environment Heritage and Local Government (DoEHLG) '*Wind Energy Development Guidelines,'(WEDG* 2006 also referred as DoEHLG 2006);
- ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms'*; and
- Institute of Acoustics *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG) May 2013.

2.2 National Planning Policy

2.2.1 The National Planning Framework 'Project Ireland 2040' (4) was adopted on 29 May 2018. The document sets out a number of National Policy Objectives, of which number 65 relates to noise.

2.2.2 National Policy Objective 65 states;

"Promote the pro-active management of noise where it is likely to have significant adverse impacts on health and quality of life and support the aims of the Environmental Noise Regulations through national planning guidance and Noise Action Plans."

2.2.3 The document does not contain specifics with regards to the assessment of noise. Rather, it states (page 5):

'The National Planning Framework, is a planning framework to guide development and investment over the coming years. It does not provide every detail for every part of the country; rather it empowers each region to lead in the planning and development of their communities, containing a set of national objectives and key principles from which more detailed and refined plans will follow.'

2.2.4 Accordingly, it is necessary to look at regional and local guidance and policy for further direction.

2.3 Regional Spatial and Economic Strategies (RSES) 2026-2031

2.3.1 The Southern RSES (5) (applicable to Co. Clare) provides a high-level development framework for the Southern Regional Assembly of Ireland, supporting the implementation of the National Planning Framework. In relation to renewable energy, it includes a Regional Policy Objective (RPO) 221 which states:

'RPO 221 Renewable Energy Generation and Transmission Network

a. Local Authority City and County Development Plans shall support the sustainable development of renewable energy generation and demand centres such as data centres which can be serviced with a renewable energy source (subject to appropriate environmental assessment and the planning process) to spatially suitable locations to ensure efficient use of the existing transmission network;

b. The RSES supports strengthened and sustainable local/community renewable energy networks, micro renewable generation, climate smart countryside projects and connections from such initiatives to the grid. The potential for sustainable local/community energy projects and micro generation to both mitigate climate change and to reduce fuel poverty is also supported;

c. The RSES supports the Southern Region as a Carbon Neutral Energy Region.'

2.3.2 The RSES does not include any information specific to wind turbine noise.

2.4 Local Policy

2.4.1 The Clare County Development Plan (2023-2029) (6) was adopted on 20 April 2023. The final plan is currently being prepared and graphically designed. Meanwhile, an Interim Version of the Development Plan is available. In Volume 1, Clare County's first Goal is defined as follows:

'A county that is resilient to climate change, plans for and adapts to climate change and flood risk, is the national leader in renewable energy generation, facilitates a low carbon future, supports energy efficiency and conservation and enables the decarbonisation of our lifestyles and economy.'

2.4.2 Chapter 1 *'Introduction'* of Volume 6 *'Clare Wind Energy Strategy'* states the following:

'To develop a Wind Energy Strategy having regard to the Wind Energy Development Guidelines, Guidelines for Planning Authorities (DoEHLG, 2006) (the Planning Guidelines issued by the Department of Environment, Heritage, and Local Government).'

2.4.3 Section 6.1 of Volume 6, 'Wind Energy Strategy' states that:

'Clare County Council will require compliance with the Wind Energy Development Guidelines, Guidelines for Planning Authorities (DEHLG, 2006) in preparing planning applications.'

2.4.4 As a part of Annex A: Best Practice and General Considerations for wind energy developments in County Clare, section 6.9 outlines the following in relation to noise:

'In relation to noise, please address noise assessment, mitigation and thresholds stated in the Planning Guidelines for Wind Energy Development for Planning Authorities 2006 Noise impact assessments may also be required for construction activities as part of the EIA.'

2.5 Wind Energy Development Guidelines, 2006

2.5.1 The current guidelines for setting noise limits are detailed in the DoEHLG, WEDG 2006.

2.5.2 The information relating to noise in the WEDG 2006 is very limited (for example there is no guidance on where or how to measure background noise levels and how to correlate these with wind speed on the Proposed Wind Farm site. There is also no mention of how to consider cumulative effects). The WEDG 2006 guidelines do, however, include guidance on how to derive limits for daytime and night time periods.

2.5.3 The daytime limits take account of existing background noise levels and include a fixed limit of 45 dB or background + 5 dB, whichever is the greater, except in low background noise environments where a fixed minimum limit in the range 35-40 dB should be considered. TNEIs interpretation of these limits is that turbine noise should not exceed:

- 45 dB $L_{A90,\ 10\ min}$ or background noise + 5 dB, whichever is the greater, for daytime hours (applicable where background noise levels are greater than 30 dB L_{A90}); or,
- 35 to 40 dB $L_{A90,\ 10\ min}$ where background noise is less than 30 dB L_{A90};

2.5.4 The WEDG states that a *"fixed limit of 43dB(A) will protect sleep inside properties during the night",* however, whilst it is not explicit within the WEDG guidance, the addition of a night time 'background noise +5 dB' parameter is commonly applied in wind turbine noise assessments. This is detailed in numerous examples of planning conditions issued by local authorities and An Bord Pleanála. On that basis, the night time noise limits used in this assessment have been based on 43 dB or background noise + 5 dB, whichever is the greater.

2.5.5 It is widely agreed that the limits proposed in the WEDGs were drafted to broadly align with the UK guidance *ETSU-R-97 'The Assessment and Rating of Noise from Wind Farms'*. In 2013 this UK guidance was supplemented by a document produced by the Institute of Acoustics' (IOA) *'A good practice guide to the application of ETSU-R-97 for the assessment and rating of wind turbine noise'* (IOA GPG). Given the lack of detail in parts of the WEDG, information contained in ETSU-R-97 and the IOA GPG is often used to supplement the WEDGs and to inform wind farm noise assessments in Ireland.

2.6 Draft 2019 WEDG

2.6.1 It is noted that the WEDG 2006 are currently under review and a set of 'Draft WEDG 2019' updated guidelines were issued for consultation in December 2019. Significant concerns were raised during the public consultation process on the Draft WEDG 2019 Guidelines, including concerns raised by a group of wind farm acousticians (7), regarding the noise section of the draft guidelines and how the authors had misinterpreted existing guidance and incorporated a number of errors within the technical approaches proposed. In light of these concerns, and the fact that significant changes would need to be made before they could be adopted, an assessment using the Draft WEDG 2019 Guidelines is not, in the professional opinion of TNEI, technically feasible or appropriate and has not therefore been undertaken.

2.6.2 Timelines for the conclusion of the Draft WEDG 2019 review are still unclear however the Government of Irelands Climate Action Plan 2024 (8) includes a 2024 Action (EL/24/5) to 'Publish the Revised Wind Energy Development Guidelines for onshore wind.' No timescales for completion are provided.

2.6.3 Therefore, at time of writing this Operational Noise Report, the DoEHLG 2006 Guidelines remain the relevant statutory guidelines and, as a result, they have been used for this assessment, appropriately supplemented by the guidance in ETSU-R-97 and the IOA GPG, which are considered by TNEI to represent current best practice. This report has been prepared by suitably qualified Acousticians, affiliated with the IOA. Based on the experience of TNEI of undertaking wind farms noise assessment projects with a combined rated capacity of >5 GW, considerate is considered that the use of these documents to represent best available evidence is the most robust approach.

2.7 ETSU-R-97 The Assessment and Rating of Noise from Wind Farms

2.7.1 As wind farms started to be developed in the UK in the early 1990's, it became apparent that existing noise standards did not fully address the issues associated with the unique characteristics of wind farm developments and there was a need for an agreed methodology for defining acceptable noise limits for wind farm developments. The methodology was developed for the former Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.7.2 The WGNWT comprised a number of interested parties including, amongst others, Environmental Health Officers, wind farm operators, independent acoustic consultants and legal experts who:

'…between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms.'

2.7.3 In this way it represented the views of all the stakeholders that are involved in the assessment of noise impacts of wind farm developments. The recommendations of the WGNWT are presented in the DTI Report – ETSU-R-97 *'The Assessment and Rating of Noise from Wind Farms (1996).'*

2.7.4 The basic aim of the WGNWT in arriving at the recommendations was the intention to provide:

'Indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding to the costs and administrative burdens on wind farm developers or local authorities.'

2.7.5 ETSU-R-97 makes it clear from the outset that any noise restrictions placed on a wind farm must balance the environmental impact of the wind farm against the national and global benefits that would arise through the development of renewable energy sources:

'The planning system must therefore seek to control the environmental impacts from a wind farm whilst at the same time recognising the national and global benefits that would arise through the development of renewable energy sources and not be so severe that wind farm development is unduly stifled.'

2.7.6 ETSU-R-97 states that noise limits should reflect the variation in both turbine source noise and background noise with wind speed. Absolute lower limits, different for daytime and night time, are applied where low levels of background noise are measured. The wind speed range that should be considered ranges between the cut-in wind speed for the turbines (usually about 2 to 3 ms^{-1}) and up to 12 ms^{-1}, where all wind speeds are referenced to a 10 metre measurement height.

2.7.7 Separate noise limits apply for daytime and for night time. Daytime limits are chosen to protect a property's external amenity, and night time limits are chosen to prevent sleep disturbance indoors, with windows open.

2.7.8 The daytime noise limit is derived from background noise data measured during so-called 'quiet periods of the day', which comprise weekday evenings (18:00 to 23:00), Saturday afternoons and evenings (13:00 to 23:00) and all day and evening on Sundays (07:00 to 23:00). Multiple samples of 10 minute background noise levels using the $L_{A90,10min}$ measurement index are logged continuously over a range of wind speed conditions. These measured noise levels are then plotted against concurrent wind speed data and a 'best fit' curve is fitted to the data to establish the background noise level as a function of wind speed. The ETSU–R-97 daytime noise limit, sometimes referred to as a 'criterion curve', is then set at a level 5 dB(A) above the best fit curve over the desired wind speed range; subject to an appropriate daytime fixed minimum limit.

2.7.9 The night time noise limit is derived from background noise data measured during the night time periods (23:00 to 07:00), with no differentiation being made between weekdays and weekends. The 10 minute L_{A90} noise levels measured over the night time periods are plotted against concurrent wind speed data and a 'best fit' correlation is established. The night time noise limit is also based on a level 5 dB(A) above the best fit curve over the 0 - 12 ms^{-1} wind speed range, with a fixed minimum limit of 43 dB L_{A90}.

2.7.10 The exception to the setting of both the daytime and night time fixed minimum limits occurs where a property occupier has a financial involvement in the wind farm development. Paragraph 24 of ETSU-R-97 states:

'The Noise Working Group recommends that both day and night time lower fixed limits can be increased to 45 dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.'

2.7.11 ETSU-R-97 provides a robust basis for determining the noise limits for wind turbine(s) and since its introduction has become the accepted standard for such developments across the UK.

2.7.12 As detailed above, the ETSU-R-97 guidance will be used to supplement the guidance provided within the WEDG 2006.

2.8 Current Good Practice

A Good Practice Guide on the Application of ETSU-R-97

2.8.1 In May 2013, the Institute of Acoustics issued *'A Good Practice Guide to the Application of ETSU-R-97 for the Assessment and Rating of Wind Turbine Noise'* (IOA GPG). The document provides guidance on background noise data collection, data analysis and limit derivation, noise predictions, cumulative issues, reporting requirements and other matters such as noise related planning conditions.

2.8.2 The Authors of the IOA GPG sets out the scope of the document in Section 1.2:

'This guide presents current good practice in the application of the ETSU-R-97 assessment methodology for all wind turbine developments above 50 kW, reflecting the original principles within ETSU-R-97, and the results of research carried out and experience gained since ETSU-R-97 was published. The noise limits in ETSU-R-97 have not been examined as these are a matter for Government.'

2.8.3 The guidance document was endorsed by all Governments within the UK. As with ETSU-R-97, for this assessment the recommendations included in the IOA GPG have been used to supplement the guidance provided within the WEDG 2006.

2.8.4 The IOA GPG refers to six Supplementary Guidance Notes and where applicable these have also been considered in this report.

2.8.5 To summarise, the assessment of operational noise from the Proposed Wind Farm has been undertaken in accordance with WEDG 2006, supplemented by the guidance presented in ETSU-R-97 and the IOA GPG where appropriate.

2.9 WSP BEIS Report

2.9.1 In February 2023, WSP (an independent consultancy) published 'A review of noise guidance for onshore wind turbines' ('WSP BEIS report' (9)), The WSP BEIS report, which was subsequently re-issued as version 4 in May 2023, was commissioned by (the former) UK Government Department for Business, Energy & Industrial Strategy (BEIS). The primary aim of the review was to make a recommendation on whether, in view of government policies on noise and Net Zero, and available evidence, the existing UK guidance requires updating.

2.9.2 The WSP BEIS report concluded that:

'the guidance would benefit from further review and updating of the aspects identified. This could be supported by currently available evidence, which is summarised in this report. However, the study has also highlighted gaps in the state of knowledge, which should be addressed by further research, to support any updates to the guidance.'

2.9.3 A series of recommendations are made regarding further research whilst some additional suggestions are included regarding the development of new or updated guidance. The following recommendation is included on page 26 of the WSP BEIS report:

'the separation of the 'policy position' (addressing the balance between controlling noise impact and enabling renewable energy development), 'technical guidance' (application of the assessment approach), and 'technical justification' (the supporting evidence) into discrete, linked documents'

2.9.4 The WSP BEIS report notes at the outset that 'Any views expressed within it do not necessarily represent the views of the UK government or the governments of any of the devolved administrations'. The report does state on page 25 that:

'Consideration should be given to including a clear position statement in guidance confirming the intended policy balance between protection from noise impact, and enabling of renewable energy development (to achieve Net Zero), linked with the wider policies that underpin the government approach to noise management.'

2.9.5 At time of writing this report, there has been no official response to the report from BEIS or any of the new UK Government departments which are being created to replace BEIS. In the event that a decision is made to follow up on the recommendations within the WSP BEIS report, it is unknown how new guidelines would account for the UK Governments' Net Zero targets nor is there any indication of timescales within which updated guidance would be produced.

2.9.6 The guidance contained within ETSU-R-97 and the IOA GPG has therefore been used to supplement the 2006 WEDGs.

3 Potential Impacts

3.1 Operational Noise Sources

3.1.1 Wind turbines may emit two types of noise. Firstly, aerodynamic noise is a more natural sounding 'broad band' noise, albeit with a characteristic modulation, or 'swish', which is produced by the movement of the rotating blades through the air. Secondly, mechanical noise may emanate from components within the nacelle of a wind turbine. Potential sources of mechanical noise include gearboxes or generators.

3.1.2 Aerodynamic noise is usually perceived when the wind speeds are generally low although at very low wind speeds the blades either do not rotate, or rotate very slowly, and so negligible aerodynamic noise is generated. In higher winds, aerodynamic noise may be masked by the normal sound of wind blowing through the trees and around buildings. The level of this natural 'masking' noise relative to the level of wind turbine noise is one of the several factors that determine the subjective audibility of the wind turbines (10).

3.1.3 The potential impact assessed in this report considers the overall noise levels of wind farms inclusive of expected Normal Amplitude Modulation (NAM) and tonality, as described in ETSU-R-97. Other topics relating to operational wind farm noise characteristics, such as Low Frequency Noise (LFN) and Other Amplitude Modulation (OAM) are discussed below.

3.2 Infrasound, Low Frequency Noise and Vibration

3.2.1 The term infrasound can be defined as the frequency range below 20 Hz, while low frequency noise (LFN) is typically in the frequency range 20 – 200 Hz (11). An average young healthy adult has an audible range from 20 Hz to 20,000 Hz, although the sensitivity of the ear varies with frequency and is most sensitive to sounds with frequencies between 500 Hz and 4,000 Hz. Wind turbines do produce low frequency sounds (12), but our threshold of hearing at such low frequencies is relatively high and they therefore go unnoticed. Infrasound from wind turbines is often at levels below that of the noise generated by wind around buildings and other obstacles.

3.2.2 In 2004, the former Department of Trade and Industry (DTI) commissioned The Hayes McKenzie Partnership to report on claims that infrasound or LFN emitted by wind turbine generators (WTGs) were causing health effects. Of the 126 wind farms operating in the UK, five had reported LFN problems, therefore, such complaints are an exception, rather than a general problem that exists for all wind farms. Hayes McKenzie investigated the effects of infrasound and LFN at three wind farms for which complaints had been received and the results were reported in May 2006 (13). The report concluded that:

- *'infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;*
- *low frequency noise was measurable on a few occasions but below the existing permitted Night Time Noise Criterion. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was always lower than that of local road traffic noise;*
- *that the common cause of complaint was not associated with LFN, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed*

that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep.'

3.2.3 The Applied and Environmental Geophysics Research Group at Keele University was commissioned by the Ministry of Defence (MOD), the DTI and the British Wind Energy Association (BWEA) to undertake microseismic and infrasound monitoring of LFN and vibrations from wind farms for the purposes of siting wind farms in the vicinity of Eskdalemuir in Scotland. Whilst the testing showed that vibration can be detected several kilometres away from wind turbines, the levels of vibration from wind turbines were so small that only the most sophisticated instrumentation can reveal their presence and they are almost impossible to detect. Nevertheless, the Renewable Energy Foundation alleged potential adverse health effects and when that story was picked up in the popular press, notably the Scotsman, the report's authors expressed concern over the way in which their work had been misinterpreted and issued a rebuttal statement [14] in August 2005:

'Vibrations at this level and in this frequency range will be available from all kinds of sources such as traffic and background noise – they are not confined to wind turbines. To put the level of vibration into context, they are ground vibrations with amplitudes of about one millionth of a millimetre. There is no possibility of humans sensing the vibration and absolutely no risk to human health.'

3.2.4 In response to concerns that wind turbines emit infrasound and cause associated health problems, Dr Geoff Leventhall, Consultant in Noise Vibration and Acoustics and author of the Defra Report on Low Frequency Noise and its Effects, said in the article in the Scotsman ('Wind farm noise rules 'dated'- James Reynolds, 5 August 2005'):

'I can state quite categorically that there is no significant infrasound from current designs of wind turbines.'

3.2.5 An article [15] published in the IOA Bulletin (March/April 2009) concluded that there is no robust evidence that either low frequency noise (including 'infrasound') or ground-borne vibration from wind farms, has an adverse effect on wind farm neighbours.

3.2.6 Work [16] by Dr Leventhall looked at infrasound levels within the ear compared to external sources and concluded:

'The conclusion is that the continuous inner ear infrasound levels due to internal sources, which are in the same frequency range as wind turbine rotational frequencies, are higher than the levels produced in the inner ear by wind turbines, making it unlikely that the wind turbine noise will affect the vestibular systems, contrary to suggestions made following the measurements at Shirley. The masking effect is similar to that in the abdomen (Leventhall 2009). The body, and vestibular systems, appear to be built to avoid disturbance from the high levels of infrasound which are produced internally from the heartbeat and other processes. In fact, the hearing mechanisms and the balance mechanisms, although in close proximity, have developed to minimise interaction (Carey and Amin 2006).'

3.2.7 During a planning Appeal (PPA-310-2028, Clydeport Hunterston Terminal Facility, approximately 2.5 km south-west of Fairlie, 9 Jan 2018), the health impacts related to LFN associated with wind turbines were considered at length by the appointed Reporter (Mr M Croft). The Reporter considered evidence from Health Protection Scotland and the National Health Service. In addition, he also considered LFN surveys undertaken by the Appellant and the Local Authority, both of which demonstrated compliance with planning conditions and did not identify any problems attributable to the turbine operations; some periods with highest levels of low frequency noise were in fact recorded when the turbines were not operating.

3.2.8 The Reporter concluded that:

- The literature reviews by bodies with very significant responsibilities for the health of local people found insufficient evidence to confirm a causal relationship between wind turbine noise and the type of health complaints cited by some local residents;
- The NHS's assessment is that concerns about health impact are not supported by good quality research; and
- Although given the opportunity, the Community Council failed to provide evidence that can properly be set against the general tenor of the scientific evidence.

3.2.9 The WSP BEIS report notes on page 113 that:

'Several studies have investigated the claimed links between adverse health symptoms and infrasound emissions from wind turbines. Although some experimental studies have linked infrasonic signals with activation of physiological sensory processing, these have tended to be based on signals that are not representative of wind turbine infrasound. There remains no compelling evidence of adverse health effects associated with wind turbine infrasound exposure at sound frequencies and levels expected to be present at noise-sensitive receptor locations in the vicinity of wind farms.'

3.2.10 The WSP BEIS report goes on to note on page 114 that:

'Overall, the findings from the existing evidence base indicate that infrasound from wind turbines at typical exposure levels has no direct adverse effects on physical or mental health, and reported symptoms of ill-health are more likely to be psychogenic in origin.'

3.2.11 It is noted that research into infrasound is ongoing but the WSP BEIS report concluded that:

'It is expected that further evidence from ongoing studies into wind turbine infrasound effects will emerge soon, in particular from the NHMRC studies in Australia. However, based on the existing scientific evidence, it does appear probable that the above findings will not be contradicted by newer evidence.'

3.2.12 Since the publication of the WSP BEIS report, the study that was granted funding by NHMRC (the National Health and Medical Research Council of Australia) was published in the Environmental Health Perspectives (EHP) journal which is published by the United States National Institute of Environmental Health. The study [(17)] aimed to test the effect of exposure to 72 hours of infrasound (designed to simulate a wind turbine infrasound signature) exposure on human physiology, particularly sleep. The study concluded that:

'Our findings did not support the idea that infrasound causes WTS[i] .High level, but inaudible, infrasound did not appear to perturb any physiological or psychological measure tested in these study participants.'

[i] WTS stands for Wind Turbine Syndrome which is a term for adverse human health effected related to the proximity of wind turbines.

3.2.13 It is therefore not considered necessary to carry out specific assessments of LFN and it has not been considered further in the noise assessment.

3.3 Amplitude Modulation of Aerodynamic Noise (AM)

3.3.1 In the context of wind turbine noise, amplitude modulation describes a variation in noise level over time; for example, observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past. Amplitude Modulation of aerodynamic noise is an inherent characteristic of wind turbine noise and was noted in ETSU-R-97, on page 68:

'The modulation or rhythmic swish emitted by wind turbines has been considered by some to have a characteristic that is irregular enough to attract attention. The level and depth of modulation of the blade noise is, to a degree, turbine-dependent and is dependent upon the position of the observer. Some wind turbines emit a greater level of modulation of the blade noise than others. Therefore, although some wind turbines might be considered to have a character that may attract one's attention, others have noise characteristics which are considerably less intrusive and unlikely to attract one's attention and be subject to any penalty.

This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dBA (peak to trough) when measured close to a wind turbine. As distance from the wind turbine [or] wind farm increases, this depth of modulation would be expected to decrease as atmospheric absorption attenuates the high frequency energy radiated by the blade.'

3.3.2 The Acoustics community has sought to make a distinction between the AM discussed within ETSU-R-97, which is expected at most wind farms and as such may be considered as 'Normal Amplitude Modulation' (NAM), compared to the unusual AM that has sometimes been heard at some wind farms, hereinafter referred to as 'Other Amplitude Modulation' (OAM). The term OAM is used to describe an unusual feature of aerodynamic noise from wind turbines, where a greater than normal degree of regular fluctuation in sound level occurs at blade passing frequency, typically once per second. In some appeal decisions it may also be referred to as 'Excess Amplitude Modulation' (EAM). It should be noted that the noise assessment and rating procedure detailed in ETSU-R-97 fully takes into account the presence of the intrinsic level of NAM when setting acceptable noise limits for wind farms.

3.3.3 On 16 December 2013, RenewableUK (RUK) released six technical papers [(18)] on OAM, which reflected the outcomes of research commissioned over the previous three years, together with a template planning condition. Whilst this research undoubtedly improved understanding of OAM and its effects, it should be noted that at the time of writing it has not been endorsed by any relevant body such as the Institute of Acoustics (IOA).

3.3.4 On 22 January 2014, the IOA released a statement regarding the RUK research and the proposed planning condition to deal with the issue of amplitude modulation from a wind turbine and stated:

'This research is a significant step forward in understanding what causes amplitude modulation from a wind turbine, and how people react to it. The proposed planning condition, though, needs a period of testing and validation before it can be considered to be

good practice. The IOA understands that RenewableUK will shortly be making the analysis tool publicly available on their website so that all interested parties can test the proposed condition, and the IOA will review the results later in the year. Until that time, the IOA cautions the use of the proposed planning condition.'

3.3.5 In April 2015, an Amplitude Modulation Working Group (AMWG) formed by the IOA issued a discussion document entitled 'Methods for Rating Amplitude Modulation in Wind Turbine Noise'. The document presented three methods that can be used to quantify the level of AM at a given measurement location. After extensive consultation a preferred method of measuring OAM was recommended by the IOA in a report called 'Final Report - A Method for Rating Amplitude Modulation in Wind Turbine Noise' dated 9th August 2016, which details a preferred method for practitioners to measure and rate AM near operational wind farms. The method calculates an amplitude modulation depth value in decibel (dB) for any given 10 minute period, and the executive summary states:

'The AMWG has not addressed the question of what level of AM in wind turbine noise (when measured by a specific metric) is likely to result in adverse community response or how that response should be evaluated. The psycho-acoustic aspects of AM are not within the scope of this study, but the proposed metric is intended to assist with such further research.'

3.3.6 On 3 August 2015, the UK Department for Energy and Climate Change (DECC), subsequently the Department for Business, Energy and Industrial Strategy (BEIS), commissioned independent consultants WSP Parsons Brinkerhoff to carry out a literature review on OAM (which they refer to simply as AM). The stated aims were as follows:

- *'To review the available evidence on Amplitude Modulation (AM) in relation to wind turbines, including but not limited to the research commissioned and published by RenewableUK in December 2013;*
- *To work closely with the Institute of Acoustics' AM working group, who are expected to recommend a preferred metric and methodology for quantifying and assessing the level of AM in a sample of wind turbine noise data;*
- *To review the robustness of relevant dose response relationships, including the one developed by the University of Salford as part of the RenewableUK study, on which the correction (or penalty) for amplitude modulation proposed as part of its template planning condition is based;*
- *To consider how, in a policy context, the level(s) of AM in a sample of noise data should be interpreted, in particular determining at what point it causes a significant adverse impact;*
- *To recommend how excessive AM might be controlled through the use of an appropriate planning condition; and*
- *To consider the engineering/cost trade-offs of possible mitigation measures.'*

3.3.7 Their report [19], 'Wind Turbine AM Review – Phase 2 Report' was published in August 2016 at the same time as the release of the IOA AMWG Final Report, and concluded that there is sufficient robust evidence that excessive AM leads to increased annoyance from wind turbine noise and recommended that excessive AM is controlled through a suitably worded planning condition, which will control it during periods of complaint. Those periods should be identified by measurement using the metric proposed by the IOA, and enforcement action would rely upon professional judgement by Local Authority Environmental Health Officers, based on the duration and frequency of occurrence. It is not clear within the body of the report what evidence the authors relied upon to arrive at their conclusions, although the Executive Summary states (page 4):

'It is noted that none of the Category 1 or 2 papers have been designed to answer the main aim of the current review in its entirety. The Category 1 studies have limited representativeness due to sample constraints and the artificiality of laboratory environments, whereas the Category 2 studies generally do not directly address the issue of AM WTN exposure-response. A meta - analysis of the identified studies was not possible due to the incompatibility of the various methodologies employed. Notwithstanding the limitations in the evidence, it was agreed with DECC that the factors to be included in a planning condition should be recommended based on the available evidence, and supplemented with professional experience'.

3.3.8 The report (19) states that any planning condition must accord with existing planning guidance and should be subject to legal advice on a case by case basis. Existing guidance would include compliance with the six tests of a planning condition, which in Ireland are embodied in Development Management Guidelines 2007 Chapter 7. The report's authors did not dictate a particular condition to be used but did suggest that any condition should include the following elements (p5):

- *'The AM condition should cover periods of complaints (due to unacceptable AM);*
- *The IoA-recommended metric should be used to quantify AM (being the most robust available objective metric);*
- *Analysis should be made using individual 10-minute periods, applying the appropriate decibel 'penalty' to each period, with subsequent analysis;*
- *The AM decibel penalty should be additional to any decibel penalty for tonality;* [tonality means mechanical sound already covered by ETSU noise limits]*; and*
- *An additional decibel penalty is proposed during the night time period to account for the current difference between the night and day limits on many sites to ensure the control method works during the most sensitive period of the day.'*

3.3.9 In 2017 a potential noise related planning condition which included consideration of OAM was published in the Acoustics Bulletin magazine (by the IOA) written by a number of acousticians working in the field of wind farm noise in the UK. The approach outlined in the document was not subject to any wider consultation nor has it been endorsed by the IOA, the UK Government or Scottish Government. The lack of robust information regarding the second element is highlighted in the article itself which notes:

'Whilst local authorities and developers have waited for a planning condition that could be applied to newly consented wind farms, or to those already consented but with a suspensive condition, the report Wind Turbine AM Review (WTAMR) by WSP/Parsons Brinckerhoff for DECC arguably did not provide that. In addition there have been a number of comments on WTAMR that we consider should be addressed. The introductory sections and the conditions text represent the broad consensus view of those whose names appear below, following a period of discussion, compromise and agreement. This approach is

proposed based on the current state of understanding, but may be subject to modification in light of new research and further robust information.'

'As various people before us have discovered, the derivation of a penalty is not easy. There is not sufficient reliable research to be confident that a penalty system would always provide a fair indication of the impact of AM.'

3.3.10 The article goes on to note that:

'However, to do nothing would be unfair on those wind farm neighbours adversely affected by AM and, in any case, there seems to be general agreement amongst many stakeholders on all sides of the debate that a robust condition including AM is required.'

3.3.11 The topic of AM from wind turbine noise was considered again in the UK in 2022, with a review of evidence commissioned by the UK Government published in the WSP BEIS report 'A review of Noise Guidance for Onshore Wind Turbines,' (October 2022). The report notes that the IOA preferred metric provides a suitable approach to measure and quantify AM near operational wind farms (whilst noting that work is ongoing to refine the approach) but also highlights that further work is required to develop a robust mechanism for controlling AM that can be incorporated into a planning condition. In relation to the potential for a penalty scheme to control AM, the WSP BEIS report notes on page 208 that:

'In practice, the details of applying such a penalty scheme are complicated by the complexities of wind turbine sound measurements. These often involve a considerable amount of data filtering and data aggregation to address the practical difficulties of measuring a highly variable source, which is often also at a level that is relatively low compared with other, fluctuating residual sounds present in the acoustic environment. Such details will need to be carefully considered in further study, and the example planning condition proposed by a group of IOA members in 2017 should be considered as a starting point.'

3.3.12 Until such a 'further study' is completed, and additional guidance is published, the approach set out in the IOA GPG remains valid, the document states (paragraph 7.2.10):

'7.2.1 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.'

3.3.13 Persistent OAM can be a source of nuisance to wind farm neighbours. A recent decision of the Irish High Court on the 8th of March 2024 found that frequent and sustained periods of OAM arising from the operational Ballyduff Wind Farm, Co. Wexford, was an unreasonable interference with a neighbour's use and enjoyment of their property, which was located approximately 359 m from the nearest turbine. The issue of damages and/or an injunction were held over for later determination by the court but, in the meantime, the court directed all parties to engage in mediation with a view to devising 'appropriate mitigation measures and, if possible, to resolve all outstanding issues between them'. Therefore, for instances in which OAM arises, mitigation is possible and is the appropriate response.

3.3.14 As a summary, a significant amount of research has been undertaken in relation to OAM and key outcomes of the research are that:

- It is clear that OAM, if it occurs frequently and for sustained periods, it has the potential to result in adverse impacts for wind farm neighbours;
- It is not currently possible to predict if and when OAM will occur at a proposed wind farm site. On sites where OAM has been identified it occurs intermittently and varies in terms of severity;
- There are methodologies available that can be used to measure and quantify OAM, in particular the method produced by the Amplitude Modulation Working Group (AMWG), which was formed by the Institute of Acoustics. The methodology was presented in a report 'Methods for Rating Amplitude Modulation in Wind Turbine Noise' which was published in April 2015;
- Whilst it is possible to measure and quantify OAM using the AMWG methodology (which provides an AM rating for each 10 minute period), further study is still required to help quantify what level of OAM, if any, is acceptable. This is complicated by the fact that it is unclear whether a small amount of OAM that occurs regularly is likely to be more (or less) annoying than a large amount of OAM that occurs very infrequently; and
- Notwithstanding a lack of a defined threshold detailing what level of OAM is acceptable, there are measures available which have been shown to mitigate OAM should it occur. Measures can include:
    - Changes to the operation of the relevant wind turbine(s) by changing parameters such as blade pitch;
    - Addition of blade furniture (such has vortex generators) to alter the flow of air over the wind turbine blades; and, in extreme cases,
    - Targeted wind turbine shutdowns in specific conditions where OAM is found to occur.

Where mitigation is required, it needs to be designed on a site-specific basis.

4 Methodology

4.1 Assessing Operational Noise Impact

4.1.1 To undertake an assessment of the operational noise impact in accordance with the requirements of the WEDG 2006, the following steps are required:

- Specify the location of the wind turbines for the Proposed Wind Farm;
- Measure the background noise levels as a function of on-site wind speed at a selection of representative Noise Monitoring Locations (NML);
- Establish for each NML the 'Total WEDG Noise Limits' on analysis of the measured background noise levels;
- Identify the locations of all nearby noise sensitive receptors and select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise data;
- Specify the likely noise emission characteristics of the wind turbines for the Proposed Wind Farm and all nearby cumulative wind turbines;
- Calculate the likely noise immission levels due to the cumulative operation of all relevant wind turbines and compare it to the Total WEDG Noise Limits;
- Determine the 'Site Specific Noise Limits,' which take account of the noise limit already allocated to, or could theoretically be used by other schemes in the area; and
- Calculate the likely noise immission levels due to the operation of the Proposed Wind Farm on its own and compare it to the Proposed Wind Farm's Site Specific Noise Limits.

4.1.2 In order to consider the steps outlined above the assessment has been split into three separate stages:

- Stage 1 –establish the Total WEDG 2006 Noise Limits for each NAL (where noise limits are not already set) based on the measured background noise levels;
- Stage 2 – undertake a cumulative assessment for locations where noise predictions from the Proposed Wind Farm are within 10 dB of the total noise predictions from the other wind farms/turbines and compare cumulative predictions against the Total WEDG Noise Limits; and
- Stage 3 – establish the Proposed Wind Farm's Site Specific Noise Limits (at levels below the Total WEDG Noise Limits, where limit apportionment is required) and compare the noise predictions from the Proposed Wind Farm on its own against the proposed Site Specific Noise Limits.

4.1.3 There are a range of turbine makes and models that may be appropriate for the Proposed Wind Farm. As stated in Section 1.2.2 above, in the absence of a confirmed turbine model, this noise assessment models a candidate turbine, the Vestas V150 6.0 MW with serrated trailing edge blades and a hub height of 102.5 m. In order to consider the full design envelope for the site, additional modelling has been undertaken using two other candidates, the Nordex N149 5.7 MW with serrated trailing edge blades and a hub height of 102.5 m and the Siemens Gamesa SG 6.0-155 6.6 MW and a hub height of 102.5 m. All candidates modelled are considered to be representative of the type of turbine that could be installed at the site.

4.1.4 Consultation

Scoping Opinion (dated 11 January 2023)

4.1.5 The Environmental Health Service (HSE) stated the following in relation to noise:

4.1.6 *'The potential impacts for noise and vibration from the proposed development on all noise sensitive locations must be clearly identified in the EIAR. The EIAR must also consider the appropriateness and effectiveness of all proposed mitigation measures to minimise noise and vibration.*

4.1.7 *A baseline noise monitoring survey should be undertaken to establish the existing background noise levels. Noise from any existing turbines in the area should not be included as part of the back ground levels.*

4.1.8 *In addition, an assessment of the predicted noise impacts during the construction phase and the operational phase of the proposed windfarm development must be undertaken which details the change in the noise environment resulting from the proposed development.*

The Draft Revised Wind Energy Development Guidelines were published in December 2019. Whilst these have yet to be adopted, any proposed wind farm development should have consideration of the draft Guidelines.'

4.2 Stage 1 Assessment Methodology – Setting the Total DoEHLG 2006 Guidelines Noise Limits

Wind Shear

4.2.1 Wind shear can be defined as *'the change in the relationship between wind speed at different heights'.* Due to wind shear, wind speeds recorded on one meteorological mast at different heights are usually different, generally the higher the anemometer the higher the wind speed recorded. For example, if a wind speed of 4 ms^{-1} is recorded at 80 m height, 3.5 ms^{-1} may be recorded at 40 m and 2.5 ms^{-1} may be recorded at 10 m.

4.2.2 Hub height wind speed is the key wind speed for a wind farm noise assessment, as it is the wind speed at hub height which will determine the noise emitted by the wind turbines and informs the turbine control system. Ideally, both wind turbine noise predictions and background noise level measurements should refer to hub height wind speed (or a representation thereof), ensuring that there is no discrepancy between the wind speed at which the noise is emitted and the wind speed at which the corresponding background noise is measured.

4.2.3 The IOA GPG states that one of three methods of wind speed measurement may be adopted. For this assessment wind speeds were recorded by a LIDAR device for a range of heights between 39 m and 200 m. In line with 'Method A' of Section 2.6.3 of the IOA GPG, the wind speed data recorded at the two heights closest to hub height (100 m and 110 m) were used to calculate hub height wind speeds (105 m) which was then standardised to 10 m height.

Noise Impact Criteria in the WEDG

4.2.4 Analysis of the measured data has been undertaken in accordance with ETSU-R-97 and current good practice to determine the pre-existing background noise environment and to establish the daytime and night-time Total WEDG Noise Limits for each NAL.

4.2.5 The Total WEDG Noise Limits for the daytime have been set at:

- 40 dB(A) where background noise levels are below 30 dB(A); and,
- 45 dB(A) or background noise plus 5 dB, whichever is the greater, where background noise levels are greater than 30 dB(A).

4.2.6 Total WEDG Noise Limits at night time has been set at 43 dB(A) or background plus 5 dB, whichever is the greater.

4.2.7 This 'Total' limit relates to noise from all wind farm developments in the area. The limit was chosen with due regard to the guidance in the 2006 WEDGs and following a review of the predicted levels from existing wind turbines in the area (and consideration of the noise limit that has effectively been allocated already to those consented developments).

4.2.8 The acceptable limits for wind turbine operational noise are clearly defined for all time periods by the application of the 2006 WEDG methodology. Consequently, the test applied to operational noise is whether or not the predicted wind turbine noise immission levels at nearby noise sensitive properties lie below the 2006 WEDG Noise Limits. Depending on the levels of background noise, the satisfaction of the WEDG derived limits can lead to a situation whereby, at some locations under some wind conditions and for a certain proportion of the time, the wind turbine noise would be audible.

4.3 Assessment of likely effects and the requirement for a cumulative assessment (Stage 2)

4.3.1 The 2006 WEDGs do not include an information on assessment cumulative noise impacts, therefore the guidance provided within the IOA GPG (2013) has been adopted. The IOA GPG contains a detailed section on cumulative noise and provides guidance on where a cumulative assessment is required. Section 5.1.4 and 5.1.5 of the GPG state:

'During scoping of a new wind farm development consideration should be given to cumulative noise impacts from any other wind farms in the locality. If the proposed wind farm produces noise levels within 10 dB of any existing wind farm/s at the same receptor location, then a cumulative noise impact assessment is necessary.

Equally, in such cases where noise from the proposed wind farm is predicted to be 10 dB greater than that from the existing wind farm (but compliant with ETSU-R-97 in its own right), then a cumulative noise impact assessment would not be necessary.'

4.3.2 An assessment was undertaken at each of the noise sensitive receptors proximate to the Proposed Wind Farm and other nearby operational and proposed wind farm developments to determine whether the wind turbine noise immission from the Proposed Wind Farm were within 10 dB of the wind turbine noise immission from the other schemes. Where predictions were found to be within 10 dB of each other, then a cumulative noise assessment was undertaken to determine the likely impacts of the Proposed Wind Farm, however, if wind turbine immission were more than 10 dB apart then a cumulative noise assessment was not required.

Noise Prediction / Propagation Model

4.3.3 The ISO 9613-2: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* [20] model algorithm provides a robust prediction method for calculating the noise immission levels at the nearest receptors. A European Commission (EC) research project into wind farm noise propagation over large distances, published as 'Development of a Wind Farm Noise Prediction Model,' JOULE project JOR3-CT95-0051 in 1998, identified a simplified version of ISO 9613-2 as the most suitable at that time, but the full method has been used for this assessment.

4.3.4 Guidance on noise prediction and propagation modelling is not provided within the 2006 WEDGs, however the use of ISO 9613-2 is discussed within the IOA GPG which states, in Section 4.1.4:

'ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made.'

4.3.5 There is currently no standard approach to specifying error bands on noise predictions, however, Table 5 of ISO 9613-2 suggests, at best, an estimated of accuracy of ± 3 dB(A). The work undertaken as part of the EC research study concluded that the ISO 9613-2 algorithm reliably predicted noise levels that would generally occur under downwind propagation conditions. The error bands referenced in the ISO standard itself relate to the general application of the standard. Additional, wind farm specific studies, have also been undertaken to validate the use of the standard to predict wind farm noise and these are referenced in Section 4 of the IOA GPG which goes on to conclude that:

"The outcome of this research has demonstrated that the ISO 9613-2 standard in particular, which is widely used in the UK, can be applied to obtain realistic predictions of noise from on-shore wind turbines during worst case propagation conditions (i.e. sound speed gradients due to downwind conditions or temperature inversions), but only provided that the appropriate choice of input parameters and correction factors are made."

4.3.6 TNEIs experience of undertaking compliance monitoring for operational wind farms indicates that the predictions undertaken using the guidance in the IOA GPG show a good correlation with measured levels.

4.3.7 The ISO 9613-2 model can take account of the following factors that influence sound propagation outdoors:

- Geometric divergence;
- Atmospheric absorption;
- Reflecting obstacles;

- Screening;
- Vegetation; and
- Ground attenuation.

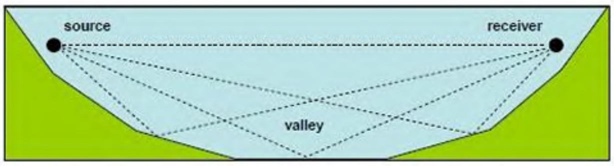
4.3.8 The model uses the octave band sound power output of the turbine as the acoustic input data. It then calculates attenuation due to the factors mentioned above, on an octave band basis where appropriate.

4.3.9 The IOA GPG quotes a comparative study undertaken in Australia that indicated ISO 9613-2 can, in some conditions, under-predict ground attenuation effects and the potential for additional reflection paths 'across a valley', whilst slightly over-predicting on flat terrain. It should be noted, however, that the wind farm layouts studied were untypical for the UK, with rows of turbines spreading over 10 km on an elevated ridge. It also should be noted that no correction for background contribution was undertaken and the monitoring locations were located as far as 1.7km from the nearest turbine, where turbine noise may be at similar levels to background noise and therefore difficult to differentiate. For the study's modelling work topographic height data was included as an input, which is consistent with ISO 9613-2 methodology generally, but not with how barrier attenuations are calculated using the topography data as part of the requirements of the IOA GPG.

4.3.10 The model used in this assessment does not model barrier attenuation using the method in ISO 9613-2, but instead uses the guidance in the IOA GPG to consider whether any topographical corrections are required as set out below in Sections 4.4.10 to 4.4.13. Any differences in ground height (AOD) between the receptors and the turbines are considered when calculating the propagation distance between each source and receiver.

4.3.11 The IOA GPG states that a *'further correction of +3 dB should be added to the calculated overall A-weighted level for propagation 'across a valley', i.e. a concave ground profile or where the ground falls away significantly between a turbine and the receiver location.'* The potential reflection paths are illustrated in Schematic 4.1 below.

Schematic 4.1: Multiple reflection paths for sound propagation across concave ground



Source: IOA GPG, page 21, Figure 5

4.3.12 A formula from the JOULE Project JOR3-CT95-0051 dated 1998 is suggested for determining whether a correction is required.

$$h_m \geq 1.5 \text{ x } (abs\ (h_s - h_r) / 2)$$

where h_m is the mean height above the ground of the direct line of sight from the receiver to the source (as defined in ISO 9613-2, Figure 3), and h_s and h_r are the heights above local ground level of the source and receiver respectively).

4.3.13 The calculation of h_m requires consideration of the digital terrain model and needs to be performed for each path between every turbine and every receiver. Interpretation of the results of the calculation above and the subsequent inclusion of a concave ground profile correction requires careful consideration with any topographical variation considered in the context of a site.

4.3.14 The IOA GPG also discusses the potential for topographical screening effects of the terrain surrounding a wind farm and the nearby noise sensitive receptors. Although barrier screening effects in ISO 9613-2 can make corrections of up to 15 dB, the IOA GPG states that where there is no line of sight between the highest point on the rotor and the receiver location a reduction of no more than 2 dB may be applied.

4.4 Noise Propagation Parameters

4.4.1 The noise immission levels have been calculated using the full IOS 9613-2 model with a receiver height of 4.0 m above local ground level, mixed ground (G=0.5) and air absorption based on a temperature of 10 °C and 70 % relative humidity. The modelling parameters reflect current good practice as detailed within the IOA GPG.

4.4.2 The wind turbine noise immission levels are based on the $L_{A90,10\ minute}$ noise indicator in accordance with the recommendations in the 2006 WEDGs, which were obtained by subtracting 2dB(A) from the turbine sound power level data (L_{Aeq} indicator).

4.4.3 A topographical assessment has been undertaken between each NSR and wind turbine location to determine whether any concave ground profiles exist between the source and receiver (noise sensitive receptor). Analysis undertaken using a combination of CadnaA [21] and an Excel model found that if the formula in the IOA GPG is applied directly a +3 dB correction is required for some turbines at a number of receptors as summarised in Annex 6.

4.4.4 In addition, an assessment has been undertaken to determine whether any topographical screening effects of the terrain occur where there is no direct line of sight between the highest point on the turbine rotor and the receiver location. Upon analysis of each NSR it was found that a barrier correction of -2 dB could be applied for some turbines at a number of receptors as detailed in Annex 6. In reality, there is significant screening at some of the locations so more attenuation may occur in practice. The use of a 2 dB value is therefore considered to be conservative as it results in the highest predicted levels. All corrections have been applied, where necessary, in all of the tables and graphs in this report.

4.4.5 The need to include a concave ground/screening correction may change depending on the final location of the turbines (following micrositing) and the final turbine hub height. Nevertheless, turbine noise levels will have to meet the noise limits detailed in planning conditions regardless of any difference in noise propagation caused by topography. Should planning permission be granted for the Proposed Wind Farm, the need to apply a concave slope correction will need to be considered by the Applicant prior to the final selection of a turbine model for the Proposed Wind Farm.

4.4.6 The cumulative assessment has taken into account directivity effects in line with good practice. The directivity of wind turbines has been recognised for some time. Building on earlier work by NASA, in 1988 Wyle Laboratories studied sound propagation using an omnidirectional loudspeaker source elevated 80 ft above ground, in upwind, downwind and cross wind situations, and in both flat and hilly terrain, then compared those measurements to measured data from actual wind turbines. Their study quantified directivity factors for a limited frequency range, but was unable to conclusively demonstrate the anticipated directivity effects on real wind turbines. It also highlighted, but was unable to explain, measured differences observed between flat and hilly terrain.

4.4.7 Hubbard (1990) (IOA GPG Section 4.4.3) described a number of factors believed to influence propagation and directivity, notably refraction caused by vertical wind and temperature gradients. In the downwind direction the wind gradient causes the sound rays to bend toward the ground, whereas in the upwind direction the rays curve upward away from the ground. Upwind of the turbine this results in a region of increased attenuation termed the 'shadow zone'. The excess attenuation is frequency dependent, with lowest frequencies least attenuated. Relating this to the earlier NASA studies, Hubbard noted that the distance from the source to the edge of the shadow zone is related to the wind speed gradient and the elevation of the source, which for a typical turbine source was calculated to be approximately 5 times the source height.

4.4.8 This observation was adopted in the IOA GPG, which states (Section 4.4.2) 'Such reductions (due to "shadow zone" refraction effects) will in practice only progressively come into play at distances of between 5 and 10 turbine tip heights', while Section 4.4.3 provides graphical examples of increasing broadband directivity with increasing tip height scaling in both flat and hilly terrain, without qualifying either of those designations.

4.4.9 The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The noise model can consider the effect of directivity and in line with current good practice the attenuation values used are in detailed in Table 4.1 These are based upon the examples given in the IOA GPG (Section 4.4.2), using interpolation where required.

Table 4.1 Wind Directivity Attenuation Factors used in Modelling

Direction (º)	0	15	30	45	60	75	90	105	120	135	150	165
Attenuation dB(A))	-10	-9.9	-9.3	-8.3	-6.7	-4.6	-2	0	0	0	0	0
Direction (º)	180	195	210	225	240	255	270	285	300	315	330	345
Attenuation (dB(A))	0	0	0	0	0	0	-2	-4.6	-6.7	-8.3	-9.3	-9.9

4.5 Setting the Site Specific Noise Limits (Stage 3)

4.5.1 Summary Box 21 of the IOA GPG states:

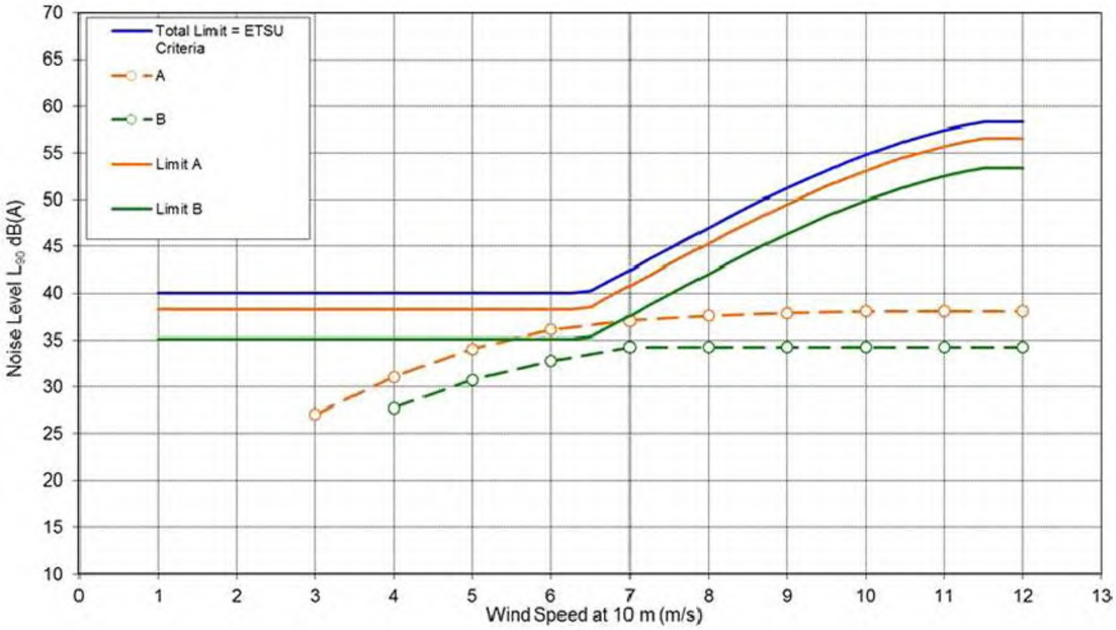
'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

4.5.2 In order to determine Site Specific Noise Limits at receptors in proximity to the Proposed Wind Farm (where required), the guidance detailed within Section 5.4 of the IOA GPG has been considered. The options detailed within Section 5.4 of the IOA GPG are summarised below.

Limit Apportionment

4.5.3 Limit apportionment considers the noise limit already allocated to other wind farms in the area. This approach is demonstrated in Graph 4.1 below which is reproduced from the Section 5.4 of the IOA GPG. In this example the total limit (shown in blue) is shared between two proposed wind farms (A and B). The two noise limits for a given receptor (the solid orange and green lines) when added together equate to the total noise limit, and the predicted levels for each wind farm (the dashed lines) meet the specific limits established for each wind farm.

Graph 4.1: Limit Apportionment Example



Significant Headroom

4.5.4 The limit derivation can also be undertaken with consideration to the amount of headroom between another scheme's predictions and the Total Noise Limit. With regard to this Section 5.4.11 of the IOA GPG states:

'In cases where there is significant headroom (e.g. 5 to 10 dB) between the predicted noise levels from the existing wind farm and the Total Noise Limits, where there would be no realistic prospect of the existing wind farm producing noise levels up to the Total Noise Limits, agreement could be sought with the LPA as to a suitable predicted noise level (including an appropriate margin to cover factors such as potential increases in noise) from the existing wind farm to be used to inform the available headroom for the cumulative assessment without the need for negotiation or cumulative conditioning. This may be the case particularly at low wind speeds.'

4.5.5 With this in mind, where appropriate, an additional 2 dB buffer has been added to the other schemes' turbine noise predictions. This is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60% increase in emitted noise levels from the other schemes.

10 dB Rule

4.5.6 Where predicted wind turbine noise levels from the nearby wind farms/ turbine schemes are found to be >10 dB below the Total WEDG Noise Limits then it has been deemed appropriate to allocate the entire noise limit to the Proposed Wind Farm. Further information on the approach to apportionment is provided in Section 6.5 below.

5 Baseline

5.1 Identification of Potential Noise Receptors

5.1.1 The 2006 WEDGs state that *'a noise sensitive location includes any occupied dwelling house, hostel, health building or place of worship and may include areas of particular scenic quality or special recreational amenity importance.'* Following a review of NSRs surrounding the Proposed Wind Farm, the closest receptors were found all to be residential properties.

5.1.2 Of the identified receptors, a total of seven Noise Monitoring Locations (NMLs) were selected as being appropriate locations to determine a representative baseline for all of the identified NSRs. The NMLs were to the north east, east, west and north west of the Proposed Wind Farm.

5.1.3 The NMLs were selected following a detailed review of the area using aerial photography. Where possible, locations were selected that were subject to minimal influence from other noise sources, such as local watercourses and vegetation.

5.2 Background Noise Survey

5.2.1 Background noise monitoring was undertaken for the purposes of setting the Total WEDG Noise Limits. Data was recorded over the period 4th April – 21st June 2023 at the seven NSRs. The equipment at NML2 malfunctioned after the first 6 days of the survey due to the equipment being moved by the resident, resulting in the loss of data from the 10th April to 4th May. Noise monitoring equipment at all other NMLs was present and operational for the full duration of the survey.

5.2.2 Details of the exact monitoring periods, the rationale behind the exact kit location and the dominant noise sources observed at each of the NMLs are detailed in the Field Data Sheets (FDS) and installation report included in Annex 2.

5.2.3 The NML is the position that the sound level meter was sited at each property, as shown on Figure A1.1a (Annex 1) and summarised in Table 5.1 below.

Table 5.1 Noise Monitoring Locations

NML	X (ITM)	Y (ITM)
NML1	561618	673080
NML2	562785	672805
NML3	562514	671783
NML4	565447	671967
NML5	564770	672512
NML6	564793	673086
NML7	564748	673758

5.3 Noise Monitoring Equipment

5.3.1 Section 2.4 of the IOA GPG includes information on the type and specification of noise monitoring equipment that should be used for background noise surveys and states:

'Noise measurement equipment and calibrators used on site should comply with Class 1/Type 1 of the relevant standard(s). Enhanced microphone windscreens should be used. Standard windshields of a diameter of less than 100 mm cannot be relied upon to provide sufficient reduction of wind noise in most circumstances.'

5.3.2 The noise monitoring equipment used for the background noise survey meets with the requirements of the IOA GPG. Details of the noise monitoring equipment used, the calibration drift recorded and photographs at each NML are detailed in the FDS included in Annex 2. The IOA GPG states that for calibration drift greater than 1 dB the measurements should be discarded. The maximum calibration drift recorded during the noise survey was -0.4 dB as detailed in the FDS therefore no correction was applied to the noise data.

5.3.3 Copies of the calibration/conformance certificates for the sound level meters and sound level calibrator used for the noise survey are included in Annex 3. All sound level meters conform to Class 1/ Type 1.

5.3.4 The microphones were all mounted between 1.2 m and 1.5 m above local ground level, situated between 3.5 m and 20 m from the dwelling and were located *'in an area frequently used for rest and relaxation'* (Section 2.5.1 of IOA GPG), and away from obvious local sources of noise such as boiler flues, fans and running water[ii]. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

5.3.5 All measurement systems were set to log the L_{A90} and L_{Aeq} noise levels in ten minute intervals continuously over the deployment period.

5.4 Meteorological Data

5.4.1 The 2006 WEDGs state on Page 29 that:

'Noise limits should be applied to external locations, and should reflect the variation in both turbine source noise and background noise with wind speed.'

5.4.2 ETSU-R-97 states on Page 84 that:

'background noise measurements should be correlated with wind speed measurements performed at the proposed site, such that the actual operating noise levels from the turbines may be compared with the noise levels that would otherwise be experienced at a dwelling.'

5.4.3 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.2.1.

[ii] NMLs 1 and 3 - 7 were influenced on occasion by a nearby watercourse. The affected data were clearly identifiable in the time series graphs and have been removed in accordance with good practice.

5.4.4 For the Proposed Wind Farm, concurrent wind speed and direction were recorded using LiDAR unit which was located within the site. The meteorological data was collected and provided by the Applicant. The installation report and calibration information for the LiDAR can be provided upon request.

5.4.5 A tipping bucket rain gauge was installed at NML1 and NML5 for the duration of the noise survey to record periods of rainfall, time synchronised to the sound measurements. Rain data were collected by TNEI. As per the recommendations in Section 3.1.9 of the IOA GPG, the rain data were analysed by TNEI and the 10 minute periods that contained a registered rainfall event and the preceding 10 minute periods have been excluded. All excluded rainfall periods are shown on Figures A1.2a-A1.2g (Annex 1) as blue squares.

5.4.6 The area in which the NMLs were installed experienced periods of heavy rainfall during the survey. These periods were identified as 4th April – 22nd April, and 6th May – 18th May. Due to the proximity to watercourses at NMLs 1 and 3 – 7, measured data within these time periods was manually excluded as a result of the elevated noise levels associated with the increased flow rate of the watercourses. Noise data was only excluded at windspeeds at which the background noise levels were being dominated by the watercourses, typically identified as flat banding of measured data across a range of windspeeds.

5.4.7 Wind speed and direction data were collected over the same time-scale, and averaged over the same ten minute periods as the noise data to provide the analysis of the measured background noise as a function of wind speed and direction.

5.4.8 Wind speed and direction data were measured using a LiDAR unit located within the Proposed Wind Farm site. The wind data measured at 100 m and 110 m height was used to calculate hub height wind speeds (at 105 m). These hub height wind speeds were then standardised to a height of 10m in accordance with current good practice.

5.5 Influence of Existing Turbines on Background Measurements

5.5.1 ETSU-R-97 states that background noise levels should be determined such that they are not influenced by existing turbine noise, whilst the IOA GPG details that, in situations where measurement locations are potentially influenced by existing turbine noise, the following approaches can be adopted:

1. The existing wind turbines can be switched off (assuming the applicant has control of those turbines and noting that there would be associated cost implications);
2. The contribution of the wind turbines can be accounted for by filtering the measured data by direction (only including background data when a receptor is upwind of the wind turbines) or by subtracting predicted turbine noise from the measured levels;
3. Limits can be set using 'proxy' datasets measured at location(s) outside of the influence of the wind turbines; or
4. Limits can be set using data collected as part of previous background noise assessments undertaken before the wind turbines were operational, providing the equipment and both noise and meteorological data obtained are appropriate.

5.5.2 The closest operational wind farm at the time of surveying to the NMLs is over 13 km away, therefore an assessment to consider the potential influence of existing wind turbines was not required.

5.6 Directional Filtering of Background Noise

5.6.1 In Section 3.1.22 of the IOA GPG the need to directionally filter background noise data is discussed. Where a receiver is located upwind of a dominant local noise source whilst also being systematically downwind of the turbines then it may be necessary to filter background noise data particularly when this corresponds to the prevailing wind direction.

5.6.2 For this site there are no dominant local noise sources so no directional filtering was undertaken.

5.7 Analysis of Measured Data

5.7.1 Analysis of the measured data has been undertaken in accordance with the recommendations in the 2006 WEDGs, ETSU-R-97 and the IOA GPG.

5.7.2 Meteorological data was screened upon receipt by TNEI and where rainfall occurred, the noise and wind speed data has been excluded from the assessment as detailed in Section 5.4 above.

5.7.3 Time series graphs are provided in Annex 4, which show the variation in measured wind speed/direction and noise level over the monitoring period. These graphs also show where data was excluded, either due to rainfall, birdsong (dawn chorus) or manual exclusions due to atypical data.

5.8 Prevailing Background Noise Level

5.8.1 Table 5.2 and Table 5.3 summarise the derived prevailing background noise levels from the baseline survey.

Table 5.2 Summary of Prevailing Background Noise Levels during Quiet Daytime Periods ($L_{A90,10\ min}$ dB(A))

NML	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	34.5*	34.5	34.5	34.7	35.2	36.1	37.3	38.7	40.2	42.0	43.9	45.8
NML2	29.4	30.5	31.4	32.2	33.0	33.6	34.1	34.5	34.6	34.6	34.6*	34.6*
NML3	33.0*	33.0	33.0	33.3	34.0	34.8	35.9	37.0	38.3	39.5	40.7	41.7
NML4	31.7*	31.7*	31.7	31.8	31.9	32.3	33.0	34.1	35.6	37.6	40.1	43.2
NML5	31.1*	31.1	31.2	31.4	31.8	32.5	33.4	34.6	36.2	38.2	40.6	43.3
NML6	32.4*	32.4	32.5	33.2	34.2	35.4	36.7	38.1	39.3	40.3	40.9	41.1
NML7	29.8*	29.8	30.1	30.7	31.7	32.8	34.1	35.4	36.8	38.0	39.0	39.8

**restricted where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.8.4.*

Table 5.3 Summary of Prevailing Background Noise Levels during Night-time Periods ($L_{A90,10\ min}$ dB(A))

NML	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	31.8*	31.8	31.9	32.4	33.3	34.3	35.6	37.2	38.9	40.7	40.7*	40.7*
NML2	24.1	25.6	26.6	27.3	28.1	29.2	30.8	33.1	36.5	41.1	41.1*	41.1*
NML3	28.6*	28.6	28.7	29.5	30.8	32.3	33.8	35.0	35.8	35.7	35.7*	35.7*
NML4	25.5*	25.5*	25.5	25.9	26.8	28.1	29.6	31.3	32.9	34.4	34.4*	34.4*
NML5	25.5*	25.5*	25.5	25.7	26.5	27.9	29.8	32.2	35.2	38.7	38.7*	38.7*
NML6	26.2*	26.2*	26.2	27.4	29.4	31.9	34.5	36.9	38.8	39.7	39.7*	39.7*
NML7	25.0*	25.0*	25.0	26.0	27.6	29.6	31.6	33.3	34.4	34.6	34.6*	34.6*

**restricted where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.8.4.*

5.8.2 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a - A1.2g (Annex 1). There is a set of graphs for each NML, which show the range of wind speeds and directions recorded during the survey, the 10 minute average wind speed plotted against the recorded $L_{A90,\ 10min}$ noise level, and a calculated 'best fit' polynomial regression line for both quiet daytime and night time periods. Each Figure also includes a table with the number of measured data points per integer wind speed bin and the prevailing measured background noise level. An additional set of time series graphs showing the excluded data have been included within Annex 4.

5.8.3 The background noise levels have been calculated using a best fit polynomial regression line of no more than a fourth order through the measured $L_{A90,\ 10min}$ noise data, as required by ETSU-R-97 and the IOA GPG.

5.8.4 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for the low speed conditions has been flatlined at the lower wind speeds where the derived minimum occurs. This is presented on the figures, the final regression analysis curve is shown as a continuous black line and the original polynomial line of best fit through the data is shown as a dashed black line.

5.8.5 Section 2.9.5 of the IOA GPG recommends that no fewer than 200 valid data points should be recorded in each of the quiet daytime and night-time periods, with no fewer than 5 valid data points in any 1 ms^{-1} wind speed bin. Where the background noise data has been filtered by wind direction the IOA GPG (Section 2.9.6) recommends that 100 data points and 3 per wind speed bin may be appropriate. Where the minimum number of data points in a wind speed bin was not achieved, data in that bin has been manually excluded from the assessment.

5.8.6 ETSU-R-97 states (Page 101) that data may not be extrapolated beyond the measured range of wind speeds. It is however reasonable to assume that background noise levels will not decrease at higher wind speeds. As such, in the interest of protecting residential amenity, the noise levels for higher wind speeds where data has not been collected have been set equal to those derived for lower wind speeds as set out below (as per Section 3.1.20 of the IOA GPG).

5.8.7 A summary of the analysis applied to the individual datasets as recommended by the IOA GPG is included in Table 5.4 below.

Table 5.4 Analysis of Measured Datasets

NML	Quiet Daytime	Night-time
NML1	Flatlined below 2 ms^{-1} (minimum level recorded)	Flatlined below 2 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML2	Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).	Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML3	Flatlined below 2 ms^{-1} (minimum level recorded)	Flatlined below 2 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML4	Flatlined below 3 ms^{-1} (minimum level recorded)	Flatlined below 3 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML5	Flatlined below 2 ms^{-1} (minimum level recorded)	Flatlined below 3 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML6	Flatlined below 2 ms^{-1} (minimum level recorded)	Flatlined below 3 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).
NML7	Flatlined below 2 ms^{-1} (minimum level recorded)	Flatlined below 3 ms^{-1} (minimum level recorded) Flatlined beyond 10ms^{-1} (insufficient datapoints in the 11-12ms^{-1} bin).

5.8.8 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a - A1.2g (Annex 1). The Figures also show the final prevailing background noise levels which have been determined following the analysis detailed above.

6 Noise Assessment Results

6.1 Noise Sensitive Receptors and Noise Assessment Locations

6.1.1 As part of the initial noise modelling work all NSRs in proximity to the Proposed Wind Farm were identified. A total of nineteen NSRs were chosen as representative Noise Assessment Locations (NAL). The NALs were chosen to represent the noise sensitive receptors located closest to the Proposed Wind Farm and also some additional receptors were included to consider cumulative noise impacts. The modelling results for the NALs have been presented within the main body of this report whilst an assessment for all other NSRs has been included within Annex 5 of this report for completeness. Each NAL and NSR are shown on Figures A1.1c-e (Annex 1).

6.1.2 Predictions of noise at the NALs ensures that the assessment reports the worst case (loudest) noise immission level expected at each group of NSRs. Table 6.1 details which NML has been used to set noise limits for each NAL and a similar table detailing which NML has been used to set limits at each NSR has also been included within Annex 5.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance from Perceived Amenity Area to Nearest Lackareagh Turbine* (m)	Distance to Dwelling (m)	Background Noise Data Used
NAL1 (NSR10)	564702	673649	199	769 (T3)	812 (T3)	NML7
NAL2 (NSR2)	564689	673091	184	708 (T3)	720 (T3)	NML6
NAL3 (NSR7)	564759	672513	161	781 (T5)	775 (T5)	NML5
NAL4 (NSR65)	565439	671960	139	1507 (T5)	1532 (T5)	NML4
NAL5 (NSR87)	565486	671238	146	1878 (T5)	1881 (T5)	NML4
NAL6 (NSR100)	565226	670667	134	2107 (T5)	2149 (T5)	NML4
NAL7 (NSR126)	564748	669620	93	2632 (T7)	2661 (T7)	NML4
NAL8 (NSR133)	563181	669141	93	2749 (T7)	2776 (T7)	NML3
NAL9 (NSR105)	562940	669710	99	2221 (T7)	2264 (T7)	NML3
NAL10 (NSR75)	562417	670511	54	1688 (T7)	1702 (T7)	NML3
NAL11 (NSR55)	562467	670972	60	1305 (T7)	1369 (T7)	NML3
NAL12 (NSR39)	562401	671529	65	1062 (T7)	1080 (T7)	NML3

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance from Perceived Amenity Area to Nearest Lackareagh Turbine* (m)	Distance to Dwelling (m)	Background Noise Data Used
NAL13 (NSR16)	562540	671813	78	865 (T7)	877 (T7)	NML3
NAL14 (NSR34)	562288	672235	74	1028 (T6)	1045 (T6)	NML3
NAL15 (NSR4)	562790	672791	154	725 (T6)	749 (T6)	NML2
NAL16 (NSR8)	562253	672814	102	774 (T2)	782 (T2)	NML2
NAL17 (NSR13)	561663	673086	85	797 (T2)	823 (T2)	NML1
NAL18 (NSR46)	561078	673791	139	1146 (T1)	1173 (T1)	NML1
NAL19 (NSR78)	560491	674179	190	1727 (T1)	1747 (T1)	NML1

** Please note the distances to nearest turbines quoted above may differ from those reported elsewhere. Distances for the noise assessment are taken from the nearest turbine to the closest edge of the amenity area (usually the garden) and not the house.*

6.2 Noise Emission Characteristics of the Wind Turbines

6.2.1 There are a range of wind turbine models which may be suitable for installation at the Proposed Wind Farm. As stated in Section 1.2.2 above, this assessment considers the Vestas V150 6.0 MW with serrated trailing edge blades and a hub height of 102.5 m, modelling was also undertaken using two other candidates, the Nordex N149 5.7 MW with serrated trailing edge blades and a hub height of 102.5 m and the Siemens Gamesa SG 6.0-155 6.6 MW and a hub height of 102.5 m.

6.2.2 For the cumulative assessment the turbines considered are summarised in Annex 6 and the noise immission levels from the cumulative schemes are included within Annex 5. Data for the candidate turbines used in this assessment has not been included due to data confidentiality. The detailed noise data would be available upon request subject to the signing of the appropriate Non-Disclosure Agreement.

6.2.3 Due to the differences in the way in which levels are provided by the different manufacturers, TNEI has accounted for uncertainty using the guidance contained within Section 4.2 of the IOA GPG (2013). Details of the sound power level, octave data and measurement uncertainty used for the turbine types considered in this assessment which are not subject to data confidentiality are included in Annex 7.

6.2.4 The source data provided for each turbine does not indicate a tonal component and as such no tonal penalty (as envisaged in ETSU-R-97) was applicable. This is consistent with the guidance provided in the IOA GPG which states, in Section 4.2.7:

'It is highly unlikely that any specific information on tonality at representative receptor separation distances in accordance with the ETSU-R-97 methodology will be available at the planning application stage. When such information is available, it should be

appropriately applied. It is standard to control the potential presence of tones in practice through the use of suitable planning conditions.'

6.2.5 Manufacturer noise level data is usually supplied based on a turbine of a specific hub height although the noise levels are presented as standardised to 10 m height. Accordingly, the noise data used in this assessment corrects the published turbine noise data following the guidance detailed in Section 4.3 of IOA GPG Supplementary Guidance Note 4, where applicable. The hub heights considered for the cumulative wind farm/turbine developments are summarised in Annex 6.

6.2.6 The location of the wind turbines are shown on Figure A1.1b and grid references are included in Annex 6.

6.3 Total WEDG Noise Limits (Stage 1)

6.3.1 The Total WEDG Noise Limits have been established for each of the NALs as detailed in Table 6.2 and Table 6.3 below, based on a fixed minimum level of 40 dB(A) (daytime) and 43 dB(A) (night-time).

Table 6.2 Total WEDG Noise Limits Daytime

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (NSR10)	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL2 (NSR2)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
NAL3 (NSR7)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
NAL4 (NSR65)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL5 (NSR87)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL6 (NSR100)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL7 (NSR126)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
NAL8 (NSR133)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL9 (NSR105)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL10 (NSR69)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL11 (NSR75)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL12 (NSR39)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL13 (NSR16)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL14 (NSR34)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
NAL15 (NSR4)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL16 (NSR8)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
NAL17 (NSR13)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
NAL18 (NSR46)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
NAL19 (NSR78)	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8

Table 6.3 Total WEDG Noise Limits Night-time

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL1 (NSR10)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL2 (NSR2)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
NAL3 (NSR7)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7
NAL4 (NSR65)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL5 (NSR87)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL6 (NSR100)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL7 (NSR126)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL8 (NSR133)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL9 (NSR105)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL10 (NSR75)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL11 (NSR55)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL12 (NSR39)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL13 (NSR16)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL14 (NSR34)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
NAL15 (NSR4)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
NAL16 (NSR8)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
NAL17 (NSR13)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
NAL18 (NSR46)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
NAL19 (NSR78)	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7

6.4 Predicting the requirement for a cumulative assessment and the likely effects (Stage 2)

6.4.1 A likely cumulative noise assessment was undertaken for all NALs and the results are summarised in tabular form in Table 6.4 and Table 6.5. The results show that the predicted cumulative wind turbine noise immission levels (assuming a Vestas V150 as the candidate turbine for the Proposed Wind Farm) meet the 'Total WEDG Noise limits' under all conditions. The predicted 'likely' cumulative levels are the actual levels expected at a NAL and include the addition of an appropriate level of uncertainty to the turbine data as per Section 4.2 of the IOA GPG. The uncertainty level added is generally +2 dB but this can vary depending on the turbine manufacturer data available for each turbine.

6.4.2 Figures A1.3a-s (Annex 1) show predictions at each NAL from the Proposed Wind Farm and 'cumulative (including Proposed Wind Farm)' against the 'Total WEDG Noise Limits'. The individual contribution of the cumulative schemes are also included.

Table 6.4 WEDG Compliance Table – Likely Cumulative Noise - Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1	Total Noise Limit: WEDG L_{A90}	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.2	36.7	37.5	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-16.2	-11.8	-8.3	-7.5	-7.4	-7.4	-7.4	-7.4	-7.4
NAL2	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	35.2	38.7	39.4	39.5	39.5	39.5	39.5	39.5
	Exceedance Level	-	-	-	-14.2	-9.8	-6.3	-5.6	-5.5	-5.5	-5.8	-6.4	-6.6
NAL3	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	38.9	39.7	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-14.0	-9.6	-6.1	-5.3	-5.2	-5.2	-5.2	-5.8	-8.5
NAL4	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.9	30.6	34.1	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-19.1	-14.4	-10.9	-10.2	-10.1	-10.1	-10.1	-10.2	-13.3
NAL5	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.7	35.2	35.7	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-18.4	-13.3	-9.8	-9.3	-9.2	-9.2	-9.2	-9.3	-12.4
NAL6	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.5	39.1	39.5	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-14.7	-9.5	-5.9	-5.5	-5.4	-5.4	-5.4	-5.5	-8.6

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
NAL7	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.9	36.2	39.7	40.2	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-14.1	-8.8	-5.3	-4.8	-4.8	-4.8	-4.8	-4.9	-8.0
NAL8	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	34.3	37.9	38.4	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-15.9	-10.7	-7.1	-6.6	-6.6	-6.6	-6.6	-7.3	-8.3
NAL9	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.6	40.2	40.6	40.7	40.7	40.7	40.7	40.7
	Exceedance Level	-	-	-	-13.6	-8.4	-4.8	-4.4	-4.3	-4.3	-4.3	-5.0	-6.0
NAL10	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-14.4	-9.2	-5.7	-5.2	-5.2	-5.2	-5.2	-5.9	-6.9
NAL11	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	35.5	39.1	39.6	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-14.5	-9.5	-5.9	-5.4	-5.4	-5.4	-5.4	-6.1	-7.1
NAL12	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	33.9	37.5	38.1	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-15.7	-11.1	-7.5	-6.9	-6.8	-6.8	-6.8	-7.5	-8.5

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL13	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.0	38.6	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-14.4	-10.0	-6.4	-5.7	-5.6	-5.6	-5.6	-6.3	-7.3
NAL14	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	34.3	37.8	38.6	38.7	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-15.1	-10.7	-7.2	-6.4	-6.3	-6.3	-6.3	-7.0	-8.0
NAL15	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.7	36.1	39.6	40.3	40.4	40.4	40.4	40.4	40.4
	Exceedance Level	-	-	-	-13.3	-8.9	-5.4	-4.7	-4.6	-4.6	-4.6	-4.6	-4.6
NAL16	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-14.3	-10.0	-6.5	-5.7	-5.6	-5.6	-5.6	-5.6	-5.6
NAL17	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.5	33.9	37.4	38.2	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-15.5	-11.1	-7.6	-6.8	-6.8	-7.0	-8.8	-10.7	-12.6
NAL18	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	31.9	35.5	36.2	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-17.6	-13.1	-9.5	-8.8	-8.7	-8.9	-10.7	-12.6	-14.5

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL19	Total Noise Limit: WEDG L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.8	30.6	34.2	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-19.2	-14.4	-10.8	-10.2	-10.1	-10.3	-12.1	-14.0	-15.9

Table 6.5 WEDG Compliance Table – Likely Cumulative Noise – Night-time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	28.8	33.2	36.7	37.5	37.6	37.6	37.6	37.6	37.6
	Exceedance Level	-	-	-	-14.2	-9.8	-6.3	-5.5	-5.4	-5.4	-5.4	-5.4	-5.4
NAL2	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.8	35.2	38.7	39.4	39.5	39.5	39.5	39.5	39.5
	Exceedance Level	-	-	-	-12.2	-7.8	-4.3	-3.6	-3.5	-4.3	-5.2	-5.2	-5.2
NAL3	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.0	35.4	38.9	39.7	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-12.0	-7.6	-4.1	-3.3	-3.2	-3.2	-3.9	-3.9	-3.9
NAL4	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.9	30.6	34.1	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-17.1	-12.4	-8.9	-8.2	-8.1	-8.1	-8.1	-8.1	-8.1
NAL5	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	26.6	31.7	35.2	35.7	35.8	35.8	35.8	35.8	35.8
	Exceedance Level	-	-	-	-16.4	-11.3	-7.8	-7.3	-7.2	-7.2	-7.2	-7.2	-7.2
NAL6	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.3	35.5	39.1	39.5	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-12.7	-7.5	-3.9	-3.5	-3.4	-3.4	-3.4	-3.4	-3.4

Location		Wind Speed (ms[-1]) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.9	36.2	39.7	40.2	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-	-12.1	-6.8	-3.3	-2.8	-2.8	-2.8	-2.8	-2.8	-2.8
NAL8	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.1	34.3	37.9	38.4	38.4	38.4	38.4	38.4	38.4
	Exceedance Level	-	-	-	-13.9	-8.7	-5.1	-4.6	-4.6	-4.6	-4.6	-4.6	-4.6
NAL9	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.4	36.6	40.2	40.6	40.7	40.7	40.7	40.7	40.7
	Exceedance Level	-	-	-	-11.6	-6.4	-2.8	-2.4	-2.3	-2.3	-2.3	-2.3	-2.3
NAL10	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.8	39.3	39.8	39.8	39.8	39.8	39.8	39.8
	Exceedance Level	-	-	-	-12.4	-7.2	-3.7	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2
NAL11	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.5	35.5	39.1	39.6	39.6	39.6	39.6	39.6	39.6
	Exceedance Level	-	-	-	-12.5	-7.5	-3.9	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4
NAL12	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.3	33.9	37.5	38.1	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-13.7	-9.1	-5.5	-4.9	-4.8	-4.8	-4.8	-4.8	-4.8

Location		Wind Speed (ms-1) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL13	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.6	35.0	38.6	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.4	-8.0	-4.4	-3.7	-3.6	-3.6	-3.6	-3.6	-3.6
NAL14	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.9	34.3	37.8	38.6	38.7	38.7	38.7	38.7	38.7
	Exceedance Level	-	-	-	-13.1	-8.7	-5.2	-4.4	-4.3	-4.3	-4.3	-4.3	-4.3
NAL15	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	31.7	36.1	39.6	40.3	40.4	40.4	40.4	40.4	40.4
	Exceedance Level	-	-	-	-11.3	-6.9	-3.4	-2.7	-2.6	-2.6	-5.7	-5.7	-5.7
NAL16	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-	-12.3	-8.0	-4.5	-3.7	-3.6	-3.6	-6.7	-6.7	-6.7
NAL17	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	29.5	33.9	37.4	38.2	38.2	38.2	38.2	38.2	38.2
	Exceedance Level	-	-	-	-13.5	-9.1	-5.6	-4.8	-4.8	-5.7	-7.5	-7.5	-7.5
NAL18	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	27.4	31.9	35.5	36.2	36.3	36.3	36.3	36.3	36.3
	Exceedance Level	-	-	-	-15.6	-11.1	-7.5	-6.8	-6.7	-7.6	-9.4	-9.4	-9.4

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL19	Total Noise Limit: WEDG L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Cumulative Wind Turbine Noise L_{A90}	-	-	-	25.8	30.6	34.2	34.8	34.9	34.9	34.9	34.9	34.9
	Exceedance Level	-	-	-	-17.2	-12.4	-8.8	-8.2	-8.1	-9.0	-10.8	-10.8	-10.8

**Mode management applied to the Proposed Wind Farm (see Section 6.5.7 below for further information)*

6.5 Derivation of Site Specific Noise Limits (Stage 3)

6.5.1 In order to protect residential amenity, the IOA GPG (2013) recommendations are that cumulatively, all schemes operate within the Total WEDG Noise Limits. This can be found in summary box SB21 of the IOA GPG (2013) which states:

'Whenever a cumulative situation is encountered, the noise limits for an individual wind farm should be determined in such a way that no cumulative excess of the total ETSU-R-97 noise limit would occur.'

6.5.2 The Site Specific Noise Limit has been set at 40 dB where background noise levels are below 30 dB and 45 dB or background noise plus 5 dB, whichever is the greater, where background noise levels are greater than 30 dB. It also assumes that the permitted turbines at Carrownagowan and Fahy Beg are built.

6.5.3 The Site Specific Noise Limits have been derived to take account of the proportion of the noise limit that has been allocated to, or could theoretically be used by, other wind farm developments in proximity to the Proposed Wind Farm. Table 6.6 summarises the approach adopted at each NAL to derive the Site-Specific Noise Limits.

Table 6.6 Limit Derivation Strategy

NAL	Limit Derivation Strategy
NALs 1-4, 14-19	The likely noise predictions from the other schemes were found to be more than 10 dB below the Total WEDG Noise Limits during the daytime and nighttime and as such the entire noise limits have been allocated to the Proposed Wind Farm.
NALs 5, 12-13	The likely noise predictions from the other schemes were found to be more than 10 dB below the Total WEDG Noise Limits during the daytime and as such the entire noise limits have been allocated to the Proposed Wind Farm during the daytime. The likely predictions level from other schemes were found to be within 10 dB of the Total WEDG Noise Limits during the night-time. As such, the limit has been apportioned based on a cautious prediction of cumulative turbine noise. During the night-time, the noise predictions for the other permitted schemes show that there is, in theory, significant headroom between the likely predicted levels and the Total WEDG Noise Limit (>5 dB). In accordance with Section 4.5 above, a 2 dB buffer was therefore added to the turbine noise predictions for each of the other developments; this is considered to be a suitable buffer in accordance with Section 5.4.11 of the IOA GPG and would represent a 60 % increase in emitted noise levels from the other schemes. The resulting 'cautious' predictions of cumulative wind turbine noise have then been logarithmically subtracted from the Total WEDG Noise Limit to determine the 'residual noise limit'. The night-time Site Specific Noise Limit is set to the residual noise limit.
NALs 6-8, 10-11	The likely predictions from other schemes were found to be within 10 dB of the Total WEDG Noise Limits during the daytime. As such, the limit has been

NAL	Limit Derivation Strategy
	apportioned based on a cautious prediction of cumulative turbine noise. The daytime Site Specific Noise Limit is set to the residual noise limit. The likely predictions from the other schemes were found to be within 5 dB of the Total WEDG Noise Limits during the night-time and as such the night-time Site Specific Noise Limit has been set 10 dB below Total WEDG Noise Limit.
NAL9	The likely predictions from the other schemes were found to be within 5 dB of the Total WEDG Noise Limits during both the daytime and night-time and as such the Site Specific Noise Limits have been set 10 dB below Total WEDG Noise Limit.

6.5.4 Please note the buffers detailed above are in addition to the appropriate level of uncertainty already added to the turbine data as per Section 4.2 of the IOA GPG.

6.5.5 As summarised in Table 6.6 above, it is proposed that the full WEDG Noise Limits be allocated to the Proposed Wind Farm at a number of noise assessment locations, as the other schemes do not need a portion of the limit. For the remaining noise assessment locations, apportionment was required in order to allow the Proposed Wind Farm and the other wind farm developments to co-exist to within the Total WEDG Noise Limits.

6.5.6 Table 6.7 and Table 6.8 show the daytime and night time Site Specific Noise Limits, noise predictions for the Proposed Wind Farm (Vestas V150 candidate turbine) and the exceedance level. A negative exceedance demonstrates compliance with the Site Specific Noise Limits.

6.5.7 The Stage 3 assessment shows that the predicted wind turbine noise levels from the Proposed Wind Farm meet the Site Specific Noise Limits at all locations except NAL11. At NAL11, there was an exceedance initially predicted for two of the three candidate turbines during the night-time period between 7- 12 ms^{-1} by up to 1.2 dB. Predicted noise levels have therefore been reduced to ensure that the limits are met, this would be achieved by the adoption of low noise modes, but this would only be required for a limited range of wind speeds and wind directions. The Tables show that, subject to the adoption of low noise modes to ensure compliance, the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night-time periods.

6.5.8 A series of graphs to show the predicted wind turbine noise from the Proposed Wind Farm compared to the Site Specific Noise Limits are included as Figures A1.4a-s (Annex 1). There is a set of graphs for each of the NALs, which show the Total WEDG Noise Limit (solid red line), the Site Specific Noise Limit (dashed red line with triangles) and the predicted wind turbine noise from the Proposed Wind Farm (solid blue line – Vestas V150, dashed blue line – N149, dashed blue line with triangular markers – SG155).

Table 6.7 Site Specific Noise Limits Compliance Table – Daytime

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1	Site Specific Noise Limit L_{A90}	40.0	40.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Wind Turbine Noise L_{A90}	-	-	25.1	28.5	32.8	36.3	37.1	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-19.9	-16.5	-12.2	-8.7	-7.9	-7.8	-7.8	-7.8	-7.8	-7.8
NAL2	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.3	45.9	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	27.2	30.6	34.9	38.4	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-17.8	-14.4	-10.1	-6.6	-5.8	-5.7	-5.7	-6.0	-6.6	-6.8
NAL3	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.6	48.3
	Predicted Wind Turbine Noise L_{A90}	-	-	27.3	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-17.7	-14.3	-10.0	-6.5	-5.7	-5.6	-5.6	-5.6	-6.2	-8.9
NAL4	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Wind Turbine Noise L_{A90}	-	-	21.0	24.4	28.7	32.2	33.0	33.1	33.1	33.1	33.1	33.1
	Exceedance Level	-	-	-24.0	-20.6	-16.3	-12.8	-12.0	-11.9	-11.9	-11.9	-12.0	-15.1
NAL5	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.1	48.2
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-28.3	-24.9	-20.6	-17.1	-16.3	-16.2	-16.2	-16.2	-16.3	-19.4
NAL6	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	44.2	42.9	42.6	42.6	42.6	42.6	42.8	47.2
	Predicted Wind Turbine Noise L_{A90}	-	-	15.8	19.2	23.5	27.0	27.8	27.9	27.9	27.9	27.9	27.9
	Exceedance Level	-	-	-29.2	-25.8	-20.7	-15.9	-14.8	-14.7	-14.7	-14.7	-14.9	-19.3

Location		**Wind Speed (ms^{-1}) as standardised to 10 m height**											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
NAL7	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	44.0	42.3	42.0	42.0	42.0	42.0	42.2	47.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.0	17.4	21.7	25.2	26.0	26.1	26.1	26.1	26.1	26.1
	Exceedance Level	-	-	-31.0	-27.6	-22.3	-17.1	-16.0	-15.9	-15.9	-15.9	-16.1	-20.9
NAL8	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	43.5	43.3	43.3	43.3	43.3	44.3	45.6
	Predicted Wind Turbine Noise L_{A90}	-	-	14.6	18.0	22.3	25.8	26.6	26.7	26.7	26.7	26.7	26.7
	Exceedance Level	-	-	-30.4	-27.0	-22.7	-17.7	-16.7	-16.6	-16.6	-16.6	-17.6	-18.9
NAL9	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	43.9	42.1	35.0	35.0	35.0	35.0	43.0	44.7
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-28.3	-24.9	-19.5	-14.2	-6.3	-6.2	-6.2	-6.2	-14.2	-15.9
NAL10	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	44.2	43.0	42.7	42.7	42.7	42.7	43.9	45.3
	Predicted Wind Turbine Noise L_{A90}	-	-	19.7	23.1	27.4	30.9	31.7	31.8	31.8	31.8	31.8	31.8
	Exceedance Level	-	-	-25.3	-21.9	-16.8	-12.1	-11.0	-10.9	-10.9	-10.9	-12.1	-13.5
NAL11	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	43.5	43.3	43.3	43.3	43.3	44.3	45.6
	Predicted Wind Turbine Noise L_{A90}	-	-	22.1	25.5	29.8	33.3	34.1	34.2	34.2	34.2	34.2	34.2
	Exceedance Level	-	-	-22.9	-19.5	-15.2	-10.2	-9.2	-9.1	-9.1	-9.1	-10.1	-11.4
NAL12	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Wind Turbine Noise L_{A90}	-	-	24.3	27.7	32.0	35.5	36.3	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-20.7	-17.3	-13.0	-9.5	-8.7	-8.6	-8.6	-8.6	-9.3	-10.3

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL13	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Wind Turbine Noise L_{A90}	-	-	26.4	29.8	34.1	37.6	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-18.6	-15.2	-10.9	-7.4	-6.6	-6.5	-6.5	-6.5	-7.2	-8.2
NAL14	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.7	46.7
	Predicted Wind Turbine Noise L_{A90}	-	-	26.0	29.4	33.7	37.2	38.0	38.1	38.1	38.1	38.1	38.1
	Exceedance Level	-	-	-19.0	-15.6	-11.3	-7.8	-7.0	-6.9	-6.9	-6.9	-7.6	-8.6
NAL15	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Wind Turbine Noise L_{A90}	-	-	28.1	31.5	35.8	39.3	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-16.9	-13.5	-9.2	-5.7	-4.9	-4.8	-4.8	-4.8	-4.8	-4.8
NAL16	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0
	Predicted Wind Turbine Noise L_{A90}	-	-	27.0	30.4	34.7	38.2	39.0	39.1	39.1	39.1	39.1	39.1
	Exceedance Level	-	-	-18.0	-14.6	-10.3	-6.8	-6.0	-5.9	-5.9	-5.9	-5.9	-5.9
NAL17	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	25.6	29.0	33.3	36.8	37.6	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-19.4	-16.0	-11.7	-8.2	-7.4	-7.3	-7.5	-9.3	-11.2	-13.1
NAL18	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	23.0	26.4	30.7	34.2	35.0	35.1	35.1	35.1	35.1	35.1
	Exceedance Level	-	-	-22.0	-18.6	-14.3	-10.8	-10.0	-9.9	-10.1	-11.9	-13.8	-15.7

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL19	Site Specific Noise Limit L_{A90}	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.0	45.2	47.0	48.9	50.8
	Predicted Wind Turbine Noise L_{A90}	-	-	20.2	23.6	27.9	31.4	32.2	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-24.8	-21.4	-17.1	-13.6	-12.8	-12.7	-12.9	-14.7	-16.6	-18.5

Table 6.8 Site Specific Noise Limits Compliance Table – Night time

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL1	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	25.1	28.5	32.8	36.3	37.1	37.2	37.2	37.2	37.2	37.2
	Exceedance Level	-	-	-17.9	-14.5	-10.2	-6.7	-5.9	-5.8	-5.8	-5.8	-5.8	-5.8
NAL2	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.8	44.7	44.7	44.7
	Predicted Wind Turbine Noise L_{A90}	-	-	27.2	30.6	34.9	38.4	39.2	39.3	39.3	39.3	39.3	39.3
	Exceedance Level	-	-	-15.8	-12.4	-8.1	-4.6	-3.8	-3.7	-4.5	-5.4	-5.4	-5.4
NAL3	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.7	43.7	43.7
	Predicted Wind Turbine Noise L_{A90}	-	-	27.3	30.7	35.0	38.5	39.3	39.4	39.4	39.4	39.4	39.4
	Exceedance Level	-	-	-15.7	-12.3	-8.0	-4.5	-3.7	-3.6	-3.6	-4.3	-4.3	-4.3
NAL4	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	21.0	24.4	28.7	32.2	33.0	33.1	33.1	33.1	33.1	33.1
	Exceedance Level	-	-	-22.0	-18.6	-14.3	-10.8	-10.0	-9.9	-9.9	-9.9	-9.9	-9.9
NAL5	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.0	41.8	41.8	41.8	41.8	41.8	41.8
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-26.3	-22.9	-18.6	-14.1	-13.1	-13.0	-13.0	-13.0	-13.0	-13.0
NAL6	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.6	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	15.8	19.2	23.5	27.0	27.8	27.9	27.9	27.9	27.9	27.9
	Exceedance Level	-	-	-27.2	-23.8	-18.1	-6.0	-5.2	-5.1	-5.1	-5.1	-5.1	-5.1

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
NAL7	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.3	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.0	17.4	21.7	25.2	26.0	26.1	26.1	26.1	26.1	26.1
	Exceedance Level	-	-	-29.0	-25.6	-19.6	-7.8	-7.0	-6.9	-6.9	-6.9	-6.9	-6.9
NAL8	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.0	40.3	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	14.6	18.0	22.3	25.8	26.6	26.7	26.7	26.7	26.7	26.7
	Exceedance Level	-	-	-28.4	-25.0	-19.7	-14.5	-6.4	-6.3	-6.3	-6.3	-6.3	-6.3
NAL9	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.2	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	16.7	20.1	24.4	27.9	28.7	28.8	28.8	28.8	28.8	28.8
	Exceedance Level	-	-	-26.3	-22.9	-16.8	-5.1	-4.3	-4.2	-4.2	-4.2	-4.2	-4.2
NAL10	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	41.7	33.0	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	19.7	23.1	27.4	30.9	31.7	31.8	31.8	31.8	31.8	31.8
	Exceedance Level	-	-	-23.3	-19.9	-14.3	-2.1	-1.3	-1.2	-1.2	-1.2	-1.2	-1.2
NAL11	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	42.0	40.3	33.0	33.0	33.0	33.0	33.0	33.0
	Predicted Wind Turbine Noise L_{A90}	-	-	22.1	25.5	29.8	33.3	**33.0***	**33.0***	**33.0***	**33.0***	**33.0***	**33.0***
	Exceedance Level	-	-	-20.9	-17.5	-12.2	-7.0	0.0	0.0	0.0	0.0	0.0	0.0
NAL12	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	42.1	42.0	42.0	42.0	42.0	42.0	42.0
	Predicted Wind Turbine Noise L_{A90}	-	-	24.3	27.7	32.0	35.5	36.3	36.4	36.4	36.4	36.4	36.4
	Exceedance Level	-	-	-18.7	-15.3	-11.0	-6.6	-5.7	-5.6	-5.6	-5.6	-5.6	-5.6

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL13	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	42.2	42.2	42.2	42.2	42.2	42.2
	Predicted Wind Turbine Noise L_{A90}	-	-	26.4	29.8	34.1	37.6	38.4	38.5	38.5	38.5	38.5	38.5
	Exceedance Level	-	-	-16.6	-13.2	-8.9	-5.4	-3.8	-3.7	-3.7	-3.7	-3.7	-3.7
NAL14	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0
	Predicted Wind Turbine Noise L_{A90}	-	-	26.0	29.4	33.7	37.2	38.0	38.1	38.1	38.1	38.1	38.1
	Exceedance Level	-	-	-17.0	-13.6	-9.3	-5.8	-5.0	-4.9	-4.9	-4.9	-4.9	-4.9
NAL15	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	28.1	31.5	35.8	39.3	40.1	40.2	40.2	40.2	40.2	40.2
	Exceedance Level	-	-	-14.9	-11.5	-7.2	-3.7	-2.9	-2.8	-2.8	-5.9	-5.9	-5.9
NAL16	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	46.1	46.1	46.1
	Predicted Wind Turbine Noise L_{A90}	-	-	27.0	30.4	34.7	38.2	39.0	39.1	39.1	39.1	39.1	39.1
	Exceedance Level	-	-	-16.0	-12.6	-8.3	-4.8	-4.0	-3.9	-3.9	-7.0	-7.0	-7.0
NAL17	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	25.6	29.0	33.3	36.8	37.6	37.7	37.7	37.7	37.7	37.7
	Exceedance Level	-	-	-17.4	-14.0	-9.7	-6.2	-5.4	-5.3	-6.2	-8.0	-8.0	-8.0
NAL18	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	23.0	26.4	30.7	34.2	35.0	35.1	35.1	35.1	35.1	35.1
	Exceedance Level	-	-	-20.0	-16.6	-12.3	-8.8	-8.0	-7.9	-8.8	-10.6	-10.6	-10.6

Location		Wind Speed (ms^{-1}) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL19	Site Specific Noise Limit L_{A90}	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.0	43.9	45.7	45.7	45.7
	Predicted Wind Turbine Noise L_{A90}	-	-	20.2	23.6	27.9	31.4	32.2	32.3	32.3	32.3	32.3	32.3
	Exceedance Level	-	-	-22.8	-19.4	-15.1	-11.6	-10.8	-10.7	-11.6	-13.4	-13.4	-13.4

**Mode management applied*

6.5.9 The assessment shows that the predicted wind turbine noise immission levels meet the Site Specific Noise Limits under all conditions and at all locations for both daytime and night time periods at all receptors, subject to the adoption of mode management to meet the night-time limit at NAL11.

6.5.10 In the event that planning permission is granted for the Proposed Wind Farm it would be appropriate to set noise limits equal to the Site Specific Noise Limits contained Table 6.7 and Table 6.8.

7 Summary and Conclusions

7.1.1 This report has assessed the potential impact of operational noise from the Proposed Wind Farm on nearby NSRs using the guidance contained within the WEDG 2006. Reference was also made to guidance contained in ETSU-R-97 and the IOA GPG to supplement the WEDG 2006.

7.1.2 Background noise monitoring was undertaken by TNEI at seven NSRs neighbouring the Proposed Wind Farm. A total of 160 NSRs were identified, of which 19 were chosen as Noise Assessment Locations (NALs). For the assessment locations where no background noise measurements were undertaken, noise data collected at proxy locations considered representative of the expected background noise environment was used to assess the noise impact at those receptors.

7.1.3 Concurrent wind speed data was collected using a LiDAR unit located within the Proposed Wind Farm site. The data collected at 100 m and 110 m height, which were used to calculate hub height wind speeds (105 m), were then standardised to 10 m height in accordance with current good practice.

7.1.4 Analysis of the measured data was undertaken to determine the pre-existing background noise environment and to establish the daytime and night-time noise limits for each of the assessment locations. A 'Total WEDG Noise Limit' of 40 dB(A), where background noise levels are below 30 dB, and 45 dB or background noise plus 5 dB, whichever is the greater, where background noise levels are above 30 dB was set for the daytime period. A limit of 43 dB(A) or background noise plus 5 dB, whichever is the greater, was used for the night-time period.

7.1.5 Predictions of wind turbine noise for the Proposed Wind Farm were made, based upon the sound power level data for the Vestas V150 6.0 MW, Nordex N149 5.7MW and Siemens Gamesa SG 6.0-155 which are candidate turbines that fall within the range of turbine dimensions proposed as part of the application. The V150 and N149 have been assumed with a proposed hub height of 105 m and the SG 6.0-155 with a proposed hub height of 102.5 m. These candidate turbine models are considered representative of the type of turbine that could be installed at the Proposed Wind Farm site.

7.1.6 There are a number of permitted wind farms in proximity to the Proposed Wind Farm. A cumulative assessment was undertaken at all NALs. The results show that the predicted cumulative wind farm noise immission levels would meet the Total WEDG Noise Limits at all NALs (and all identified NSRs) during both the daytime and night-time periods.

7.1.7 Site Specific Noise Limits have also been derived for the Proposed Wind Farm at all NALs. In deriving the Site-Specific Noise Limits consideration was given to the noise limit already allocated to or which could theoretically be used by other permitted wind farms in proximity to the Proposed Wind Farm. An assessment was undertaken to determine whether the Proposed Wind Farm could operate within the 'Site Specific Noise Limits' and it was found that at all receptors turbine noise immission were below the Site Specific Noise Limits when considering all threes candidate turbines. At NAL11 initial predicted noise levels when assuming a candidate in full mode exceeded the night-time Site-Specific Noise Limit from 7 ms^{-1} onwards, with a maximum exceedance of 1.2 dB, however the use of low noise modes was assumed to mitigate this exceedance so the predicted levels presented in this report meet the Site Specific Noise Limits.

7.1.8 The use of Site Specific Noise Limits for the operational phase will ensure that the Proposed Wind Farm could operate concurrently with other operational wind farm developments in the area and would also ensure that the Proposed Wind Farm's individual contribution could be measured and enforced if required.

7.1.9 For completeness, the cumulative noise predictions for all other NSRs have been included within Annex 5.

7.1.10 The wind turbine models assumed in this assessment were chosen in order to allow a representative assessment of the noise impacts. Should the Proposed Wind Farm receive planning permission, the final choice of wind turbine would be subject to a competitive tendering process and the final choice of wind turbine will, however, meet the noise limits in the noise assessment. A suggested noise related planning condition has been included in Annex 8.

8 Glossary of Terms

AOD: Above Ordnance Datum is the height above sea level.

Amplitude Modulation: a variation in noise level over time; for example observers may describe a 'whoosh whoosh' sound, which can be heard close to a wind turbine as the blades sweep past.

Attenuation: the reduction in level of a sound between the source and a receiver due to any combination of effects including: distance, atmospheric absorption, acoustic screening, the presence of a building façade, etc.

Background Noise: the noise level rarely fallen below in any given location over any given time period, often classed according to daytime, evening or night time periods. The L_{A90} indices (see below) is often used to represent the background noise level.

Bin: subset or group into which data can be sorted; in the case of wind speeds, bins are often centred on integer wind speeds with a width of 1 m/s. For example the 4 m/s bin would include all data with wind speeds of 3.5 to 4.5 m/s.

Dawn Chorus: noise due to birds which can occur at sunrise.

Broadband Noise: noise with components over a wide range of frequencies.

Decibel (dB): the ratio between the quietest audible sound and the loudest tolerable sound is a million to one in terms of the change in sound pressure. A logarithmic scale is used in noise level measurements because of this wide range. The scale used is the decibel (dB) scale which extends from 0 to 140 decibels (dB) corresponding to the intensity of the sound level.

dB(A): the ear has the ability to recognise a particular sound depending on its pitch or frequency. Microphones cannot differentiate noise in the same way as the ear, and to counter this weakness the noise measuring instrument applies a correction to correspond more closely to the frequency response of the human ear. The correction factor is called 'A Weighting' and the resulting measurements are written as dB(A). The dB(A) is internationally accepted and has been found to correspond well with people's subjective reaction to noise. Some typical subjective changes in noise levels are:

- a change of 3 dB(A) is just perceptible;
- a change of 5 dB(A) is clearly perceptible;
- a change of 10 dB(A) is twice (or half) as loud.

Directivity: the property of a sound source that causes more sound to be radiated in one direction than another.

Frequency: the pitch of a sound in Hz or kHz. See Hertz.

Ground Effects: the modification of sound at a receiver location due to the interaction of the sound wave with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard), 0.5 (mixed) and 1 (soft).

Hertz (Hz): sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_w: is the sound power level. It is a measure of the total noise energy radiated by a source of noise, and is used to calculate noise levels at a distant location. The L_{WA} is the A-weighted sound power level.

L_{eq}: is the equivalent continuous sound level, and is the sound level of a steady sound with the same energy as a fluctuating sound over the same period. It is possible to consider this level as the ambient noise encompassing all noise at a given time. The $LA_{eq,T}$ is the A-weighted equivalent continuous sound level over a given time period (T).

L_{90}: index represents the noise level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background noise level. The $L_{A90,10min}$ is the A-weighted background noise level over a ten minute measurement sample.

Noise emission: the noise energy emitted by a source (e.g. a wind turbine).

Noise immission: the sound pressure level detected at a given location (e.g. the nearest dwelling).

Night Time Hours: ETSU-R-97 defines the night time hours as 23.00 to 07.00 every day.

Quiet Daytime Hours: ETSU-R-97 defines the amenity hours as 18.00 to 23.00 Monday to Friday, 13.00 to 23.00 on Saturdays and 07.00 to 23.00 on Sundays.

Sound Level Meter: an instrument for measuring sound pressure level.

Sound Power Level: the total sound power radiated by a source, in decibels.

Sound Pressure Level: a measure of the sound pressure at a point, in decibels**.**

Standardised Wind Speed: a wind speed measured at a height different than 10 m (generally measured at the turbine hub height) which is expressed to a reference height of 10 m using a roughness length of 0.05 for standardisation purpose (in accordance with the IEC 61400-11 standard).

Tonal Noise: noise which covers a very restricted range of frequencies (e.g. a range of ≤20 Hz). This noise can be more annoying than broadband noise.

Wind Shear: the increase of wind speed with height above the ground.

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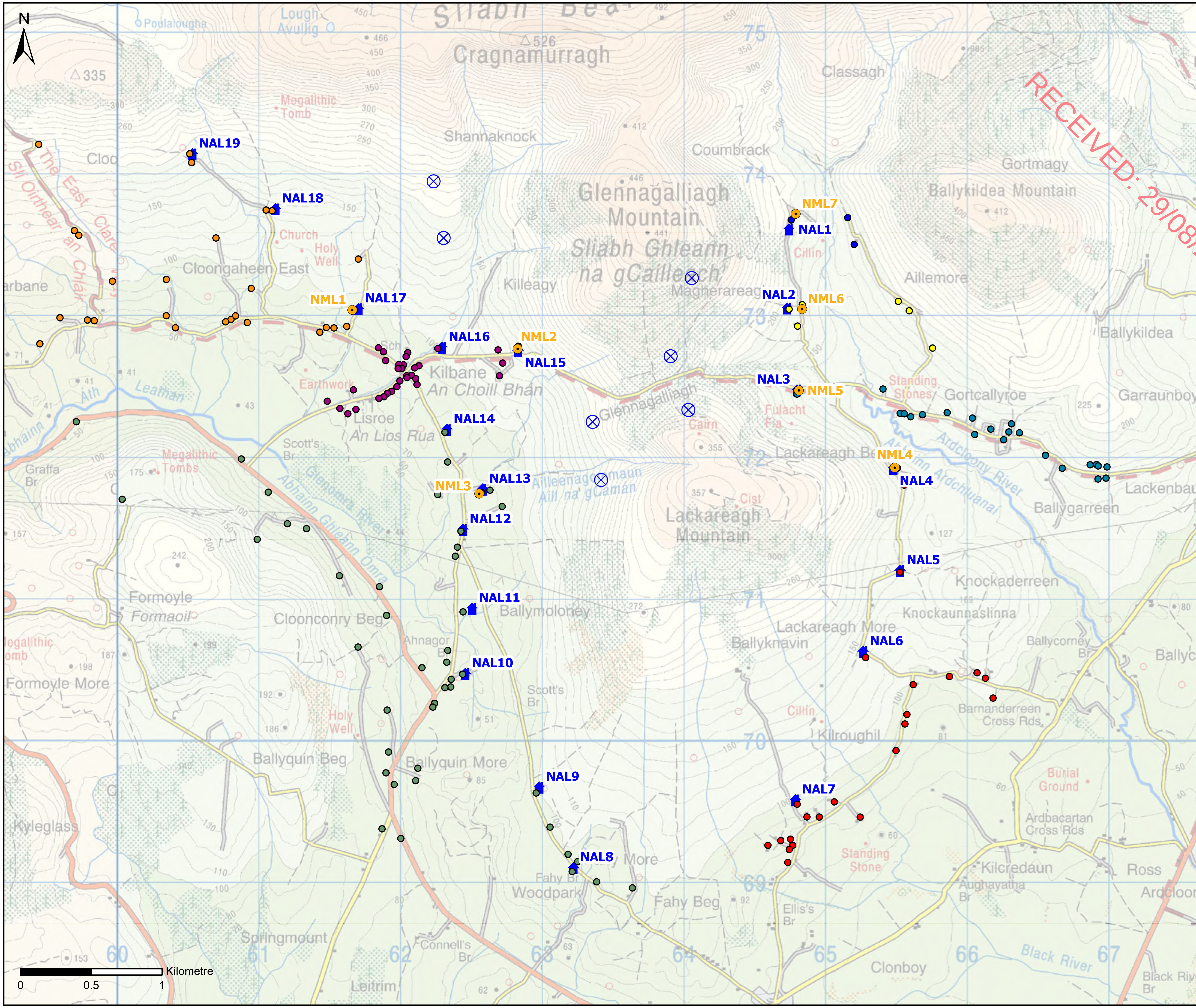
Annex 1 – Figures



LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

Rev.	Date	Amendment Details	Drawn	Approved
1	31/07/2024	FINAL ISSUE	MR	AD

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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE A1.1a - NOISE MONITORING AND ASSESSMENT LOCATIONS

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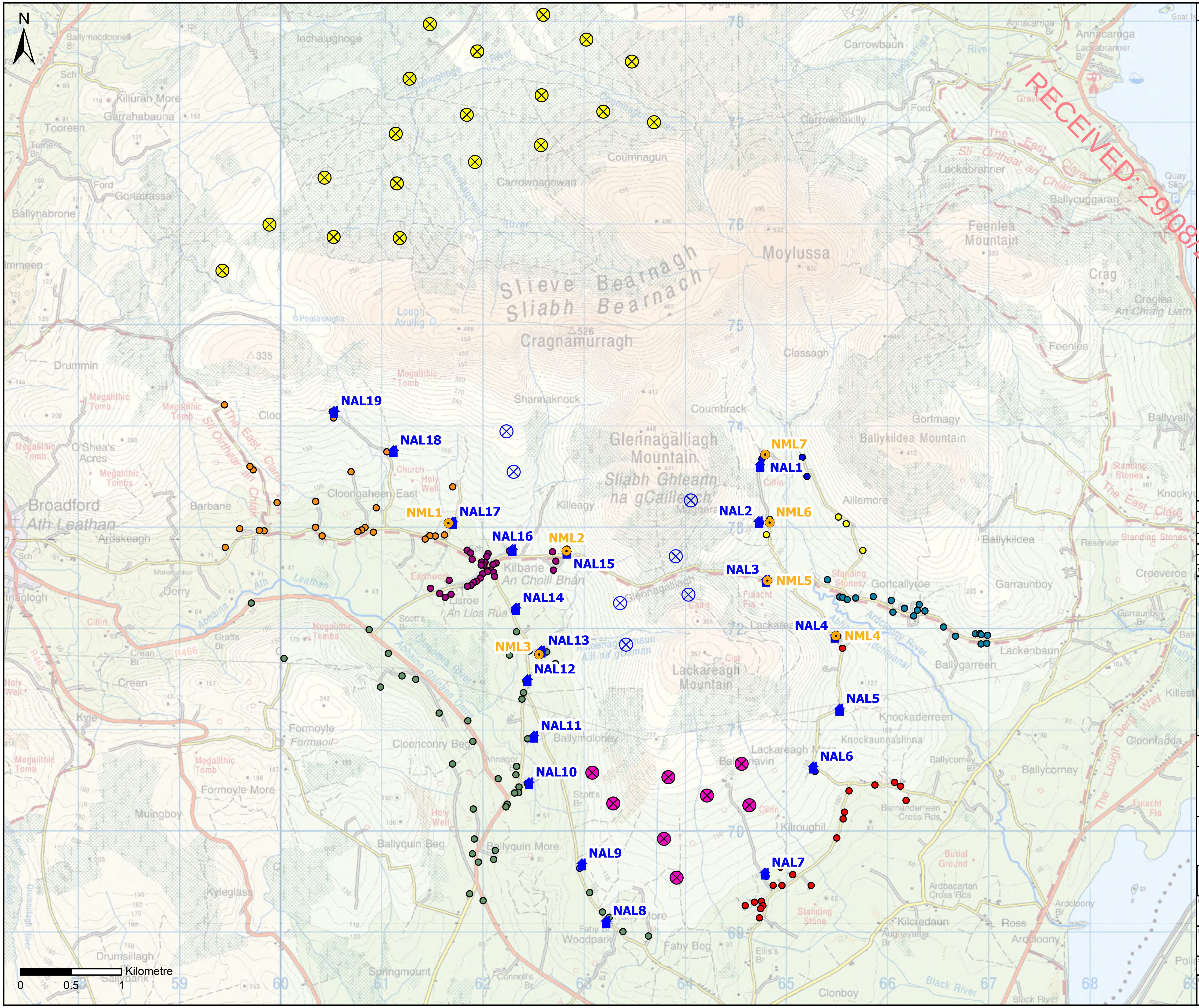

LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations
- Fahy Beg Wind Farm
- Carrownagowan Wind Farm

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE A1.1b - CUMULATIVE WIND FARM LOCATIONS

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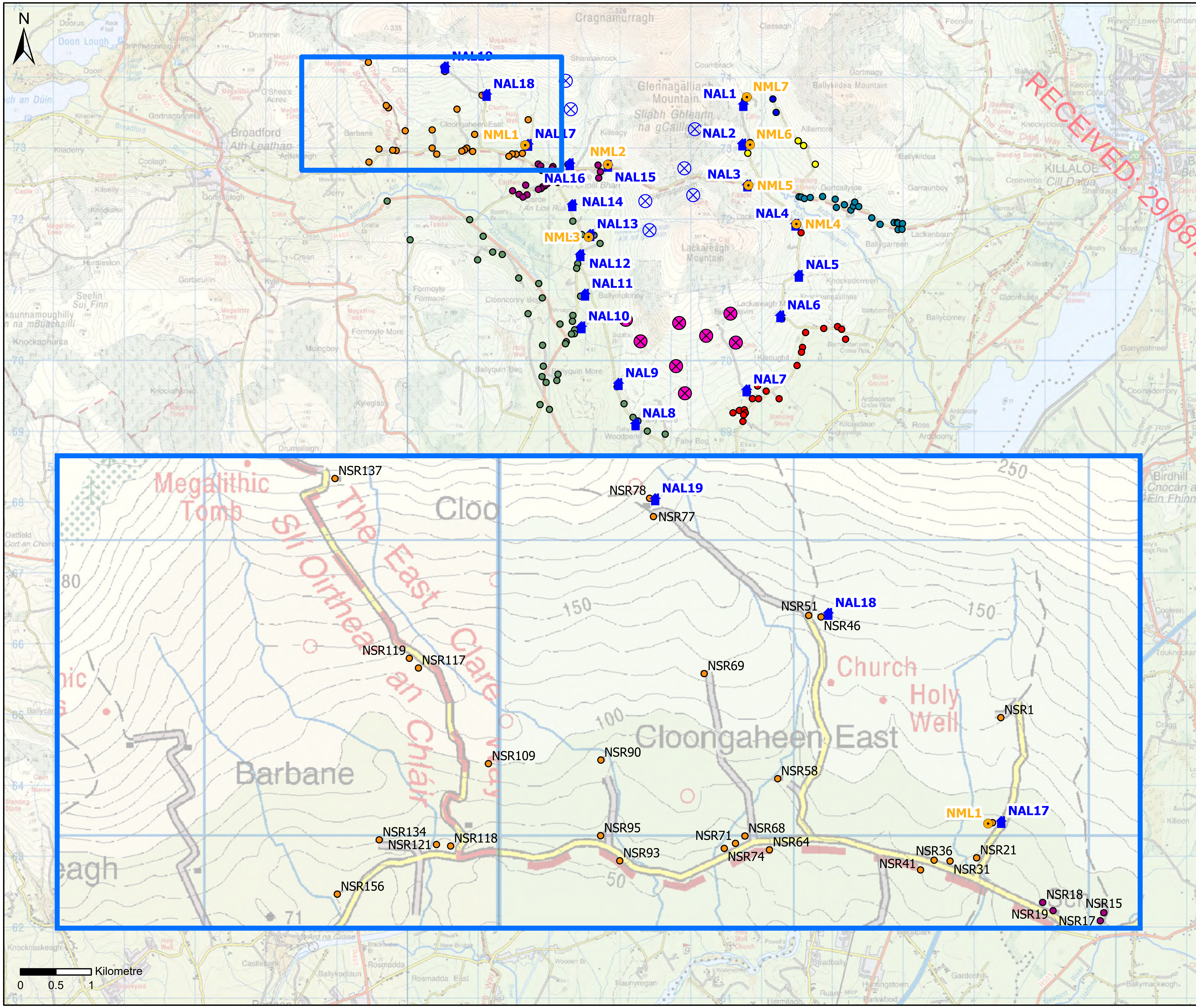

LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations
- Carrownagowan Wind Farm
- Fahy Beg Wind Farm

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE A1.1c - NOISE SENSITIVE RECEPTORS

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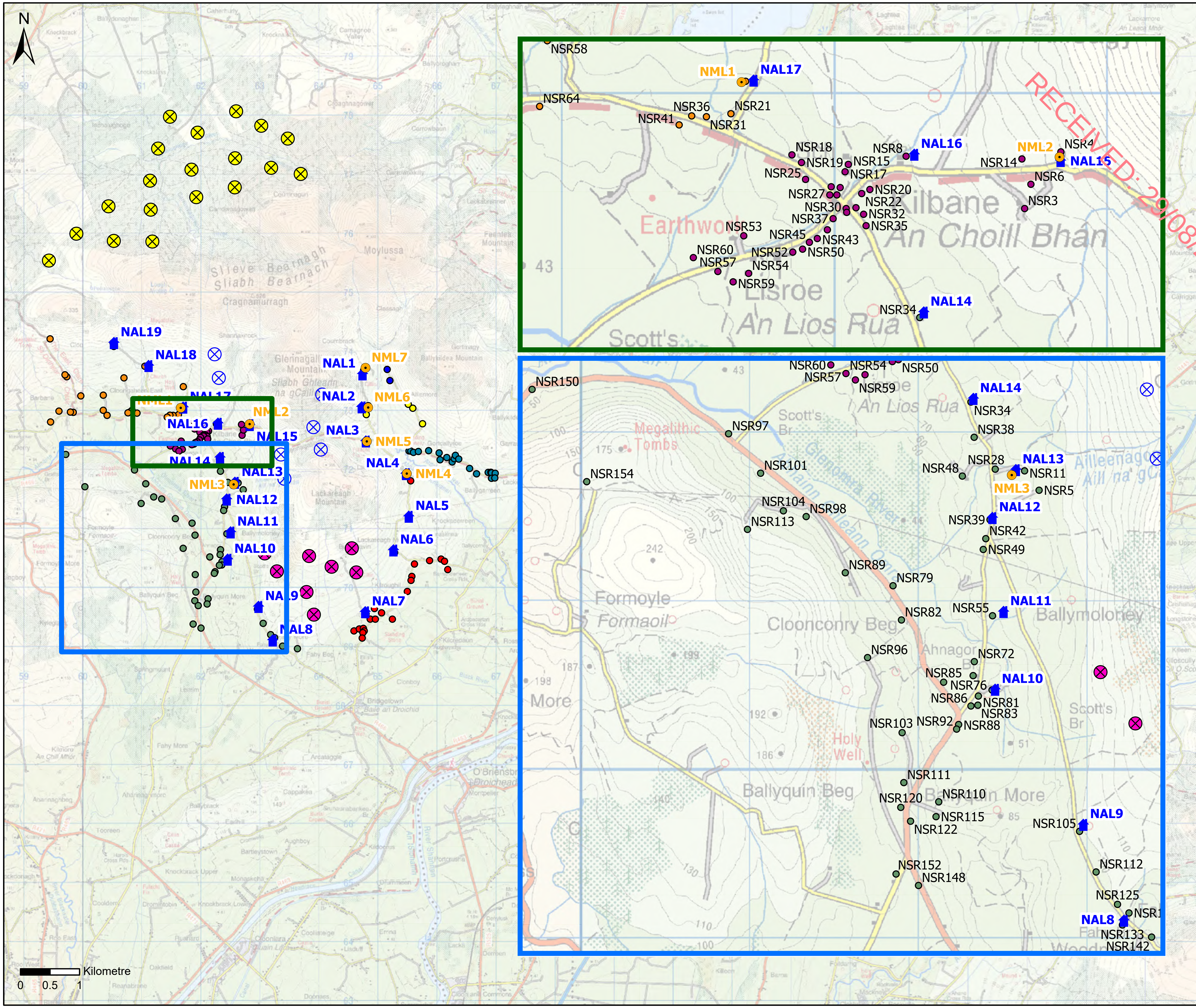

LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations
- Fahy Beg Wind Farm
- Carrownagowan Wind Farm

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

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Client: EDF renewables

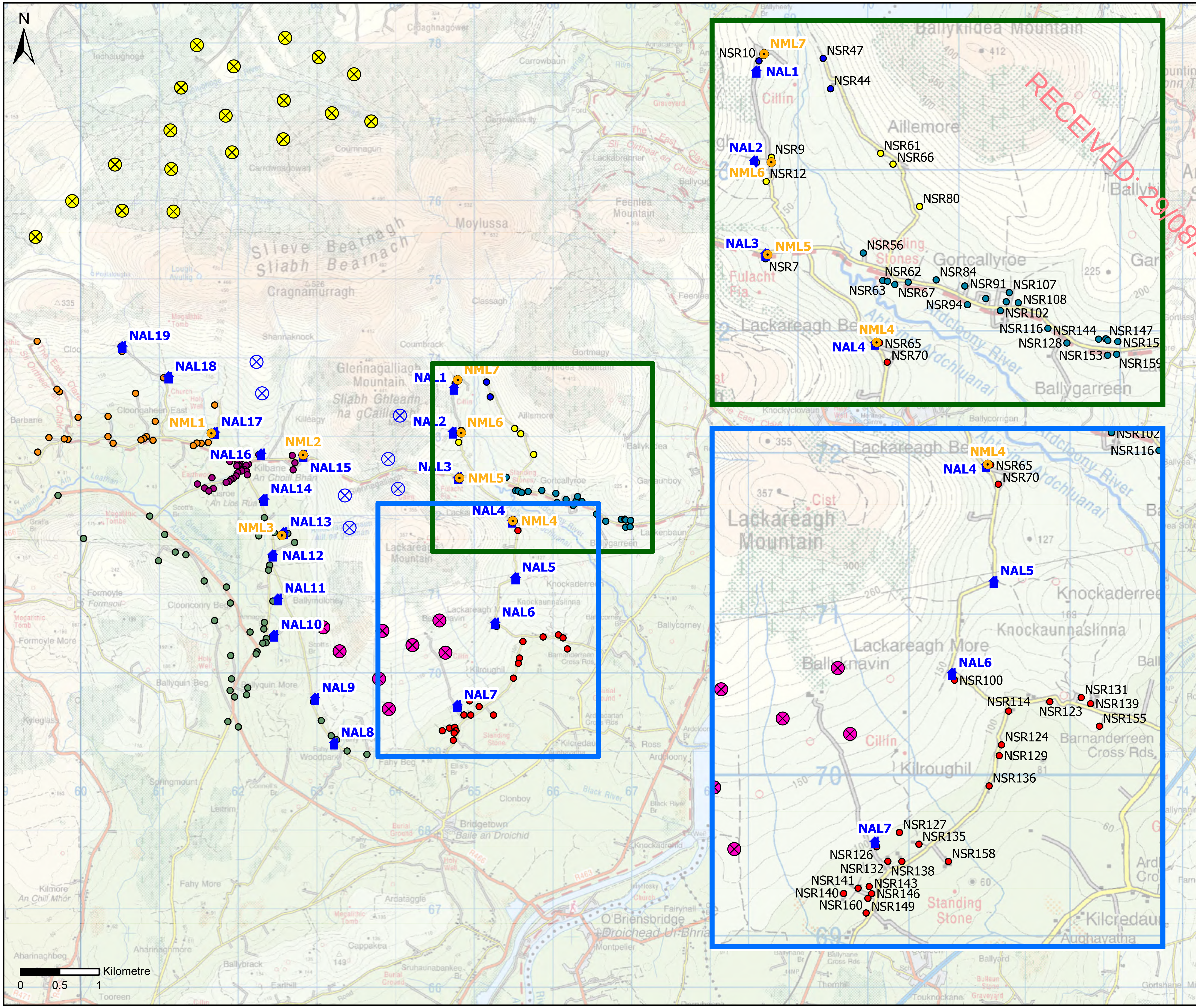
Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE A1.1d - NOISE SENSITIVE RECEPTORS

Scale: 1:60,000 | Original Size: A3 | Spatial Reference: IRENET95 Irish Transverse Mercator

Drawing Number: IE00101-007



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LEGEND

- Noise Assessment Locations (NALs)
- Noise Monitoring Locations (NMLs)
- Proposed Turbine Locations
- Fahy Beg Wind Farm
- Carrownagowan Wind Farm

Noise Sensitive Receptors (NSRs)

- NSRs Represented by NML1
- NSRs Represented by NML2
- NSRs Represented by NML3
- NSRs Represented by NML4
- NSRs Represented by NML5
- NSRs Represented by NML6
- NSRs Represented by NML7

Rev.	Date	Amendment Details	Drawn	Approved
1	31/07/2024	FINAL ISSUE	MR	AD

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Client: EDF renewables

Drawing Status: FOR PLANNING

Project Title: LACKAREAGH WIND FARM, CO. CLARE

Drawing Title: FIGURE A1.1e - NOISE SENSITIVE RECEPTORS

Scale:	Original Size:	Spatial Reference:
1:45,000	A3	IRENET95 Irish Transverse Mercator

Drawing Number: IE00101-010