APPENDIX 12-2

OPERATIONAL NOISE REPORT

A specialist energy consultancy

Appendix 12-2

Operational Noise Report

Clonberne Wind Farm

Clonberne Wind Farm Limited

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Executive Summary

TNEI was commissioned by MKO Ireland on behalf of Clonberne Wind Farm Limited ('the Applicant') to undertake an operational noise assessment for the proposed Clonberne Wind Farm (hereinafter referred to as 'the Proposed Project'). The noise assessment was undertaken to assess the potential impact of operational noise from the Proposed Project on the nearest Noise Sensitive Receptors, which are primarily scattered residential dwellings.

The Irish Governments '*Wind Energy Development Guidelines, 2006*' (WEDG 2006), produced by the Department of Environment Heritage and Local Government (DoEHLG), 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 each NAL based on measured background noise levels;
- Stage 2 – compare the noise predictions from the Proposed Project on against the Total WEDG Noise Limits.

A total of 239 Noise Sensitive Receptors (NSRs) were identified in a wide area surrounding the Proposed Project, of which eight were chosen as Noise Assessment Locations (NALs) for a detailed assessment. All were residential properties. The NALs were chosen to represent the receptors located closest to the Proposed Project in all directions. The assessment results have been presented within the main body of this report for the selected NALs, whilst an assessment for all NSRs has also been included for further information within Annex 5 this report. For clarity, all NSRs are labelled with the letter 'H', to ensure consistency with the labelling within the rest of the Environmental Impact Assessment Report (EIAR).

Background noise monitoring was undertaken by TNEI at five Noise Monitoring Locations (NMLs), at or near the NALs. For the NALs were no background noise measurements were undertaken, noise data collected at the nearest proxy NML was used to represent the expected background noise levels. Concurrent wind speed data was collected using a LIDAR unit located within the Proposed Site. Analysis of the measured noise and wind 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 noise limits at each of the NALs.

Based on the guidance in the WEDG 2006 and recent planning permissions issued from An Bord Pleanála, 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.

Other proposed, consented and operational wind turbine developments in the area around the Proposed Project have been identified. The nearest is the proposed Cooloo Wind Farm, located approximately 6 km to the south of the Proposed Project, and which has yet to enter planning. The nearest in planning, permitted or operational wind turbine development is Cloonlusk Wind Farm, located over 11 km away. At these distances, there is no realistic prospect of cumulative wind farm noise effects occurring at the NSRs considered in this assessment, and as such a detailed cumulative noise assessment is not considered necessary and no cumulative impact is anticipated during the operational phase.

Predictions of wind turbine noise for the Proposed Project were made, based upon the sound power level data for a candidate wind turbine, the Vestas V162 7.2 MW with serrated trailing edge blades and a hub height of 99 m. The candidate turbine is considered to be representative of the type of turbine that could be installed.

A noise assessment was undertaken to compare predicted noise levels from the Proposed Project to the Total WEDG Noise Limits. The results show that the predicted wind farm noise levels would meet the Total WEDG Noise Limits at all NALs (and all other identified NSRs) during both the daytime and night time periods, with one small exception at NAL5 where a marginal exceedance of 0.6dB is observed only in daytime at 7m/s. This minor exceedance would be removed by using low noise mode for the candidate turbine in that specific wind speed and in specific wind directions only, by reducing uncertainties on warranted sound power levels, or by using an alternative candidate turbine.

The Total WEDG Noise Limits can be used to condition the operation of the Proposed Project. There are a number of wind turbine makes and models that would be suitable for the Proposed Project. Should the proposal receive planning permission, the final choice of turbine would be subject to a competitive tendering process, and as such predictions of wind turbine noise are for information only. The final choice of turbine would, however, have to meet the noise limits determined and contained within any conditions imposed.

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1 Introduction

1.1 Brief

1.1.1 TNEI was commissioned by MKO Ireland on behalf of Clonberne Wind Farm Limited ('the Applicant') to undertake an operational noise assessment for the proposed Clonberne Wind Farm (hereinafter referred to as 'the Proposed Project').

1.1.2 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) 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;
- Undertake predictions of the operational wind turbine noise immissions from the Proposed Project that will be incident at neighbouring noise sensitive receptors;
- Compare the predictions of the operational wind turbine noise immissions from the Proposed Project against the Total WEDG 2006 Noise Limits; and
- Assess the impact of noise from the Proposed Project with reference to existing Government Guidance and the recommendations of the Department of Environment Heritage and Local Government which are contained in the WEDG 2006.

1.2 Background

1.2.1 The Proposed Project is located approximately 14 km to the north-east of Tuam and approximately 6.5 km to the south-east of Dunmore in Co Galway. The approximate Irish Transverse Mercator (ITM) grid reference for the centre if the site is X554464, Y756549 and the proposed layout is shown on Figure A1.1a in Annex 1.

1.2.2 This noise assessment models a candidate turbine, the Vestas V162 7.2 MW with serrated trailing edge blades and a hub height of 99 m, which is considered to be representative of the type of turbine that could be installed at the site. Figure A1.1b in Annex 1 shows the location of the to the Proposed Project in relation to nearby Noise Sensitive Receptors (NSRs).

1.2.3 For the purposes of this assessment, the term 'Total WEDG Noise Limits' is defined as being the limit that should not be exceeded from the operation of all wind farms.

1.2.4 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 refer to A weighted decibel levels 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 Project, 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,'* 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) 2020-2032

2.3.1 The Northern & Western RSES (applicable to Co. Galway) provides a high-level development framework for the Northern and Western Regional Assembly of Ireland, supporting the implementation of the National Planning Framework. In relation to renewable energy, it states (page 163):

'It is important that our region sets out its ambitions concerning renewable energy in this context and shows its ability to help contribute to achieving national targets.'

2.3.2 The RSES does not include any information specific to noise but state the following:

'The forthcoming Renewable Electricity Policy and Development Framework will aim to identify strategic areas for the sustainable development of renewable electricity projects of scale, in a sustainable manner, compatible with environmental and cultural heritage, landscape and amenity considerations. The development of the Wind Energy Guidelines and the Renewable Electricity Development Plan will also facilitate informed decision making, in relation to renewable energy infrastructure.'

2.3.3 The Irish Government's Department of Environment, Climate and Communications (DECC) is currently preparing the Renewable Electricity and Policy Development Framework (REPDF). This document has not been published at the time of writing, and therefore has not been considered in this report.

2.4 Local Policy

2.4.1 The Galway County Development Plan (2022-2028) was formally adopted in June 2022. Chapter 14 *'Climate Change, Energy and Renewable Resource'* of Volume 1 (Section 14.8.1) details that a Local Authority Renewable Energy Strategy (LARES) has been prepared for the county. The LARES outlines the potential for a range of renewable resources, including wind, and sets out renewable energy resource targets for the county.

2.4.2 LARES Policy Objective RE 3 'Wind Energy Developments' is:

'Promote and facilitate wind farm developments in suitable locations, having regard to areas of the County designated for this purpose in the Local Authority Renewable Energy Strategy. The Planning Authority will assess any planning application proposals for wind energy production in accordance with the Local Authority Renewable Energy Strategy, the DoEHLG Guidelines for Planning Authorities on Wind Energy Development, 2006 (or any updated/superseded documents), having due regard to the Habitats Directive and to the detailed policy objectives and Development Standards set out in the Local Authority Renewable Energy Strategy.'

2.5 Wind Energy Development Guidelines, 2006

2.5.1 The current guidelines for setting noise limits are detailed in the Department of Environment Heritage and Local Government (DoEHLG), *'Wind Energy Development Guidelines, 2006'* (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'*. The Association of Acoustic Consultants of Ireland (AACI) Environmental Noise Guidance (5) states the following in relation to the WEDG 2006:

'The document includes daytime and night-time noise criteria. As criteria included in the document are evidently derived from ETSU-R-97, it is considered more robust to base noise assessments on the ETSU and IOA documents, particularly as the DoEHLG document is somewhat vague. The document has been undergoing a protracted review process for several years.'

2.5.6 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.

Draft WEDG 2019

2.5.7 It is noted that the WEDG 2006 are currently under review and a set of 'draft WEDG 2019' were issued for consultation in December 2019. The draft WEDG 2019 included reference to, and reliance upon, some elements of ETSU-R-97 and the IOA GPG, however, significant concerns were raised during the consultation process regarding the noise section of the draft and at the time of writing this report, no further updates have been issued. Given the limitations of the draft WEDGs 2019 and the likelihood that significant changes would need to be made to them before they could be adopted, an assessment using those draft guidelines has not been undertaken.

2.5.8 Timelines for the conclusion of the WEDG 2019 review are still unclear as of May 2023 when preparing this report. It is possible that an updated version of the WEDG will be issued in due time, although it is expected that it would be materially different to the draft WEDG 2019.

2.5.9 As such, the guidance in the WEDG 2006 remain the applicable guidance and it has been used to assess operational noise from the Proposed Project. This was supplemented with guidance from ETSU-R-97 and the IOA GPG where appropriate.

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

2.6.1 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 UK Department of Trade and Industry (DTI) by the Working Group on Noise from Wind Turbines (WGNWT).

2.6.2 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.'

2.6.3 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).'*

2.6.4 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.'

2.6.5 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.'

2.6.6 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.

2.6.7 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.

2.6.8 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.

2.6.9 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}.

2.6.10 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.'

2.6.11 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.

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

2.7 IOA Good Practice Guide on the Application of ETSU-R-97

2.7.1 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.

2.7.2 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.'

2.7.3 The guidance document was endorsed by all Governments within the UK. In addition to the core document, there are six Supplementary Guidance Notes (SGN) and where applicable these have also been considered in this report.

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

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 fairly 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 (6).

3.1.3 This assessment considers the potential overall wind turbine noise levels at receptors (i.e. residential properties) in detail and other topic such as low frequency noise and amplitude modulation are not assessed, however they 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 (7). 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 (8), 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 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(9). 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 (10) 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 (11) 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 (12) 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 More recently 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 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 the blade passing frequency, typically once per second. In some literature 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 [(13)] on AM, 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 Other Amplitude Modulation (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), now 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, 'Wind Turbine AM Review – Phase 2 Report' (14) 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 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):

"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. Indeed, in a recent decision of the Irish High Court on the 8th of March 2024, the court found that frequent and sustained periods of OAM arising from the operational Ballyduff Wind Farm 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'. In summary, therefore, where 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.

3.3.15 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, the following steps are required:

- Specify the location of the wind turbines for the Proposed Project;
- Identify the locations of all nearby Noise Sensitive Receptors (NSRs) and measure the background noise levels as a function of on-site wind speed at a selection of representative Noise Monitoring Locations (NML). Measure wind conditions at the site at the same time;
- Review and analyse noise and wind data to establish prevailing background noise levels at each NML.
- Select a sample of relevant Noise Assessment Locations (NAL). For each NAL, identify the most representative measured background noise dataset;
- Establish for each NAL the Total WEDG Noise Limits, relative to prevailing background levels and also the status of the property (i.e. financially involved property or not);
- Calculate the likely noise immission levels due to the operation of the Proposed Project and compare it to the Total WEDG Noise Limits.

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

- Stage 1 – determine existing Total WEDG Noise Limits, which are already set for other wind farms within the vicinity of the Proposed Project at each NAL or establish the Total WEDG Noise Limits for each NAL (where noise limits are not already set) based on the measured background noise levels;
- Stage 2 –compare the noise predictions from the Proposed Project against the Total WEDG Noise Limits.

4.1.3 This noise assessment models a candidate turbine, the Vestas V162, 7.2 MW with serrated trailing edge blades and a hub height of 99 m, which is considered to be representative of the type of turbine that could be installed at the site.

4.2 Consultation

4.2.1 The scoping and consultation exercise carried out as part of the Proposed Project is described in Section 2.6 in Chapter 2 of the EIAR. The National Environmental Health Service issued a scoping response in February 2024, which included the following in relation to noise:

'Noise & Vibration

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.

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 background levels.

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.

https://www.housing.gov.ie/sites/default/files/public-consultation/files/draft_revised_wind_energy_development_guidelines_december_2019.pdf .'

4.2.2 This report addresses the requirements of the Scoping Responses in relation to operational noise. A summary of the noise impact assessment, including the baseline survey and suitable mitigation measures, is detailed below.

4.2.3 Predicted noise levels and average background noise levels are presented in detail in Sections 5 and 6. Both background noise levels and wind turbine noise levels vary with wind speed and direction making the calculation of a change in noise level difficult to define, noise impact criteria are discussed in Section 4.3. The Draft Revised Wind Energy Development Guidelines published in December 2019 are discussed in Section 2.5.

4.3 Setting the Total WEDG Noise Limits (Stage 1)

Identify Existing Noise Limits

4.3.1 There are no existing Total WEDG Noise Limits at the noise sensitive receptors surrounding the Proposed Project. As such, this assessment assumes new Total WEDG Noise limits at all receptors, based on the background noise levels established for this assessment at a sample of locations.

Wind Speed

4.3.2 When setting wind turbine noise limits, variation in background noise level with wind speed is an important consideration.

4.3.3 The WEDG 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.'

4.3.4 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.'

4.3.5 The preferred methodologies for measuring or calculating wind shear are detailed in Section 4.3.6.

Wind Shear

4.3.6 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.

4.3.7 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.

4.3.8 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 wind speed between 10 and 200m. In line with 'Method A' of Section 2.6.3 of the IOA GPG, the wind speed as measured near the proposed hub height (i.e. 100m for the current candidate) was standardised to 10 m height, hence wind shear is fully taken into account. More information is provided in the Section 5 'Baseline' below.

Noise Impact Criteria in the WEDG

4.3.9 Analysis of the measured data has been undertaken in accordance with the WEDG 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.

4.3.10 The Total WEDG Noise Limits for the daytime have been set at;

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

4.3.11 Total WEDG Noise Limits at night-time has been set at;

- 43 dB(A) or background plus 5 dB, whichever is the greater.

4.3.12 This 'Total' WEDG Noise limit relates to noise from all wind farm developments in the area (including the Proposed Project). The daytime fixed minimum noise limits limit were chosen with due regard to the limits included within recent planning decisions issued by An Bord Pleanála.

4.3.13 The acceptable limits for wind turbine operational noise are clearly defined for all time periods by the application of the 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 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.

4.4 Assessment of likely effects, predictions compared to limits (Stage 2)

Noise Propagation Model

4.4.1 The ISO 9613-2: 1996 *'Acoustics – Attenuation of sound during propagation outdoors Part 2: General method of calculation'* [15] 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.

4.4.2 Guidance on noise prediction and propagation modelling is not provided within the WEDG, 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.'

4.4.3 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."

4.4.4 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.

4.4.5 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.

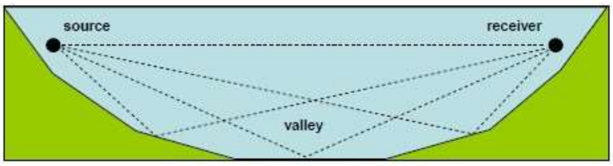
4.4.6 The model uses as its acoustic input data the octave band sound power output of the turbine and calculates, on an octave band basis, attenuation due to the factors above, as appropriate.

4.4.7 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 1.7 km 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 the requirements of the IOA GPG.

4.4.8 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.

4.4.9 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

4.4.10 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).

4.4.11 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.

4.4.12 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.

4.4.13 All the final noise modelling parameters used in this assessment are detailed below.

Noise Propagation Parameters used for the Noise Predictions

4.4.14 The noise immission levels have been calculated using the full ISO 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.

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

4.4.16 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. Analysis undertaken using a combination of CadnaA (17) and an Excel model found that if the formula in the IOA GPG is applied directly, no correction due to concave ground profile is required at any of the eight NALs, as shown in the Table in Annex 6.

4.4.17 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 no correction due to blocked line of sight is required at any of the eight NALs or 239 NSRs shown in the Table in Annex 5.

4.4.18 The predictions take into account directivity effects in line with good practice. The IOA GPG recommends (Section 4.4.1) that directivity attenuation factors adopted in any assessment should be clearly stated. The TNEI 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

5 Baseline

5.1 Identification of Cumulative Wind Turbine Developments

5.1.1 A cumulative search has been undertaken in order to identify all nearby wind turbines (within 15 km of the Proposed Project) that are operational, consented or proposed (planning application submitted). The following developments were identified as part of this search:

- Cloonlusk Wind Farm, consisting of two operational wind turbines with a 78 m hub height and an 82 m rotor diameter, located over 11 km to the south west (planning reference 08/2407 (EOD 14/518));
- Cloncoon East Wind Turbine, consisting of a single permitted turbine with a 60 m hub height and a 70.5 m rotor diameter, located over 11 km to the north east (planning reference 201617); and
- Cloonascragh Wind Turbine, consisting of a single proposed turbine with a 100 m hub height and a 136 m rotor diameter, located over 12 km to the south west (planning reference 22/1175).

5.1.2 In addition to the developments listed above, the proposed Cooloo Wind Farm, consisting of nine wind turbines with a hub height of 99 m and a rotor diameter of 162 m, is located approximately 6 km to the south. Cooloo Wind Farm is currently proposed, but not yet in planning.

5.1.3 Due to the considerable distances between these turbines and the Proposed Project, there is no realistic prospect of cumulative wind turbine noise effects at the receptors considered in this assessment. As such, cumulative noise has not been considered further in this report.

5.2 Identification of Noise Sensitive Receptors

5.2.1 The WEDG 2006 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.'*

5.2.2 A desk-based review was undertaken to identify potential Noise Sensitive Receptors (NSRs) in proximity to the Proposed Project. Following the review, 239 NSRs were identified, all of which are residential properties.

5.3 Background Noise Survey at sample Noise Monitoring Locations

5.3.1 Background noise monitoring was undertaken for the purposes of setting the Total WEDG Noise Limits. Noise levels were measured over the period 19th February – 21st April 2020

5.3.2 A total of five Noise Monitoring Locations (NMLs) were selected by TNEI as being appropriate locations to determine a representative baseline for all of the identified NSRs. The selected NMLs were to the north west, north east, east, south and west of the Proposed Project.

5.3.3 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, operational wind turbines and vegetation. The final NMLs were also subject to agreement to access properties with the owners.

5.3.4 Details of the exact monitoring periods, the rationale behind the exact kit location following installation 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. At NML5 incorrect settings of the measurement range occurred for the first part of the survey and was corrected at the intermediate maintenance site visit, but as a result the first 26 days of data were discarded.

5.3.5 For clarity, a NML in the remaining part of this report is defined as the position that the sound level meter was sited, as shown on Figure A1.1 (Annex 1) and summarised in Table 5.1 below.

Table 5.1 Noise Monitoring Locations (NMLs)

NML ID	Easting	Northing
NML1	557115	756420
NML2	555521	754284
NML3	552801	755730
NML4	553965	758300
NML5	556608	758134

5.4 Noise Monitoring Equipment

5.4.1 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.'

5.4.2 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 0.2 dB as detailed in the FDS (included in Annex 2) therefore no correction has been applied to the noise data.

5.4.3 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.

5.4.4 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. The sound level meters were situated as far away from hard reflective surfaces such as fences and walls as practicable.

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

5.5 Meteorological Data

5.5.1 For the Proposed Project, concurrent wind speed and direction were recorded using a LIDAR unit which was located within the site (ITM grid reference 554930, 757034). The meteorological data was collected and provided by the Applicant.

5.5.2 The measured wind speed and direction data from the LIDAR device were averaged over the same ten minute periods as the noise data to allow an analysis of the measured background noise levels as a function of wind speed and direction, as requested by ETSU-R-97.

5.5.3 In accordance with the IOA GPG, methodology A, has been adopted for this assessment which involved using data collected near hub height of the proposed candidate turbine (ie. 100m) which, in turn, were standardised to a height of 10 m above ground.

5.5.4 Tipping bucket rain gauges were installed at NML1 and NML4 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-A1.2e (Annex 1) as blue squares.

5.6 Influence of Existing Turbines on Background Measurements

5.6.1 The WEDG state that background noise levels should be determined such that they are not influenced by existing turbine noise. The closest operational wind farm to the Proposed Project is Cloonlusk Wind Farm which is over 11 km away (see Section 5.1) and no wind turbines were seen or heard during the noise survey site visits. Therefore the measured background noise levels have not been influenced by existing turbine noise.

5.7 Prevailing Background Noise Level

5.7.1 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.

5.7.2 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 (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	29.6*	29.6*	29.6	29.7	30.3	31.3	32.8	34.7	36.8	39.3	42.0	44.8
NML2	28.7*	28.7*	28.7*	28.7	29.4	30.8	32.7	35.1	37.8	40.8	43.9	47.1
NML3	24.0*	24.0*	24.0	24.4	25.8	28.0	30.9	34.0	37.3	40.4	43.2	45.3
NML4	23.4*	23.4*	23.4	23.8	25.7	28.8	32.6	37.0	41.4	45.7	49.5	52.4
NML5	23.8*	23.8*	23.8	23.8	24.8	26.6	29.1	32.0	35.3	38.7	42.0	42.0*

**flat-lined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7.5.*

Table 5.3 Summary of Prevailing Background Noise Levels during Night time Periods (dB(A))

NML	Prevailing Background Noise Level $L_{A90,10\ min}$											
	1	2	3	4	5	6	7	8	9	10	11	12
NML1	22.5*	22.5*	22.5*	22.5	23.1	24.6	26.8	29.6	33.0	36.8	41.0	45.5
NML2	18.4*	18.4*	18.4*	18.4	19.5	22.0	25.7	30.0	34.6	39.3	43.5	47.0
NML3	16.2*	16.2*	16.2*	16.2	17.8	21.0	25.2	30.0	34.8	39.0	42.3	44.1
NML4	16.4*	16.4*	16.4*	16.4	18.4	22.6	28.3	34.8	41.1	46.7	50.6	52.1
NML5	15.7*	15.7*	15.7*	15.7	16.5	19.0	22.7	27.2	32.3	37.4	42.2	42.2*

**flat-lined where derived minimum occurs at lower wind speeds and derived maximum occurs at higher wind speeds, see Section 5.7.5.*

5.7.3 A series of graphs are presented for each of the NMLs to illustrate the data collected, these are included as Figures A1.2a – A1.2e (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.

5.7.4 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.

5.7.5 In line with the recommendations included in Section 3.1.21 of the IOA GPG, where relevant, the polynomial background curve for 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.

5.7.6 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.

5.7.7 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).

5.7.8 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 3 ms^{-1} (minimum level recorded)	Flatlined below 4 ms^{-1} (minimum level recorded)
NML2	Flatlined below 4 ms^{-1} (minimum level recorded)	Flatlined below 4 ms^{-1} (minimum level recorded)
NML3	Flatlined below 3 ms^{-1} (minimum level recorded)	Flatlined below 4 ms^{-1} (minimum level recorded)
NML4	Flatlined below 3 ms^{-1} (minimum level recorded)	Flatlined below 4 ms^{-1} (minimum level recorded)
NML5	Flatlined below 3 ms^{-1} (minimum level recorded) and above 11 ms^{-1} (insufficient datapoints in the 12 ms^{-1} bin)	Flatlined below 4 ms^{-1} (minimum level recorded) and above 11 ms^{-1} (insufficient datapoints in the 12 ms^{-1} bin)

5.7.9 The number of data points measured in each wind speed bin for each receptor, once exclusions were applied, are summarised in Figures A1.2a – A1.2e (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 desk-based review, a total of 239 Noise Sensitive Receptors (NSRs) were identified. Of all the NSRs, a sample of 8 were chosen as Noise Assessment Locations (NALs) located closest to the Proposed Project. The NSRs and NALs are all residential properties.

6.1.2 Predictions and assessment of noise at the NALs ensures that the assessment assess the noise impact expected at the most sensitive NSRs surrounding the Proposed Project. If predicted wind farm noise levels meet the noise limits at the selected NALs then it infers compliance at other NSRs located further away from the Proposed Project.

6.1.3 The noise assessment 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.

6.1.4 Each NAL and NSR is shown on Figure A1.1 (Annex 1). The NSRs are labelled with the letter 'H', to ensure consistency with the labelling of these receptors within the rest of the Environmental Impact Assessment Report (EIAR).

6.1.5 Table 6.1 details the NALs coordinates, distance to nearest wind turbine and which NML has been used to set noise limits.

Table 6.1 Noise Assessment Locations

Noise Assessment Location (NAL)	Easting (m)	Northing (m)	Elevation (m AOD)	Approximate Distance to Nearest Proposed Wind Turbine* (m)	Background Noise Data Used
NAL1 (H1)	553330	756117	81	726 (T8)	NML3
NAL2 (H2)	554608	755045	72	776 (T09)	NML2
NAL3 (H3)	555462	755228	66	735 (T10)	NML2
NAL4 (H4)	553667	757425	79	779 (T7)	NML4
NAL5 (H5)	555597	758045	87	759 (T2)	NML5
NAL6 (H8)	553916	755170	73	806 (T9)	NML3
NAL7 (H9)	556399	756886	78	818 (T5)	NML1
NAL8 (H234)	553992	758015	86	1028 (T3)	NML4

** Please note the NAL coordinates and distances to nearest turbines quoted above may differ from those reported elsewhere. Coordinates for the NALs have been selected by TNEI to be 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 Project. This assessment considers the Vestas V162, 7.2 MW with serrated trailing edge blades and a hub height of 99 m, which is considered representative of the type of turbine which could be installed on site.

6.2.2 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). Sound power level data for the Vestas V162 7.2 MW wind turbine is confidential and subject to a Non-Disclosure Agreement. Details of the sound power level and octave band data used in the predictions presented within this report, including measurement uncertainty, are available upon request.

6.2.3 The manufacturer sound power level was in reference to hub height wind speed and TNEI has converted it (shift along the wind speed axis) with reference to a specific 99m hub height standardised to 10 m height. This was done in accordance with the guidance detailed in Section 4.3 of IOA GPG Supplementary Guidance Note 4.

6.2.4 The locations of the wind turbines are shown on Figure A1.1a and grid references are included in Annex 6.

6.3 Establishing 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 40dB(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 (H1)	40	40	40	40	40	40	45	45	45	45.4	48.2	50.3
NAL2 (H2)	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
NAL3 (H3)	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
NAL4 (H4)	40	40	40	40	40	40	45	45	46.4	50.7	54.5	57.4
NAL5 (H5)	40	40	40	40	40	40	40	45	45	45	47	47
NAL6 (H8)	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
NAL7 (H9)	40	40	40	40	45	45	45	45	45	45	47	49.8
NAL8 (H234)	40	40	40	40	40	40	45	45	46.4	50.7	54.5	57.4

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 (H1)	43	43	43	43	43	43	43	43	43	44	47.3	49.1
NAL2 (H2)	43	43	43	43	43	43	43	43	43	44.3	48.5	52
NAL3 (H3)	43	43	43	43	43	43	43	43	43	44.3	48.5	52
NAL4 (H4)	43	43	43	43	43	43	43	43	46.1	51.7	55.6	57.1

Location	Wind Speed (ms^{-1}) as standardised to 10m height											
	1	2	3	4	5	6	7	8	9	10	11	12
NAL5 (H5)	43	43	43	43	43	43	43	43	43	43	47.2	47.2
NAL6 (H8)	43	43	43	43	43	43	43	43	43	44.3	48.5	52
NAL7 (H9)	43	43	43	43	43	43	43	43	43	43	46	50.5
NAL8 (H234)	43	43	43	43	43	43	43	43	46.1	51.7	55.6	57.1

6.4 Assessment of likely effects, predictions compared to limits (Stage 2)

6.4.1 The Stage 2 noise assessment has been undertaken to compare predicted noise immission levels from the Proposed Project to the Total WEDG Noise Limits. The results are summarised in graphical form in Figures A1.3a-A1.3h and in tabular form in Table 6.4 and Table 6.5 below.

6.4.2 The results show that the predicted wind turbine noise immission levels meet the 'Total WEDG Noise limits' under all conditions. The only exception is at NAL5, where a marginal exceedance of 0.6dB is observed only in daytime at 7m/s. To put the exceedance into context, it is worth noting that decibels are logarithmic units meaning that a 3 dB change represents a doubling (or halving) of the sound energy. In terms of human perception, the WEDG state that 'A 10 dB(A) increase in sound level represents a doubling of loudness. A change of 3 dB(A) is the minimum perceptible under normal circumstances.' Such minor exceedance would be removed by using low noise mode for the candidate turbine in that specific wind speed and in specific directions only, or alternatively by using an alternative candidate turbine.

Table 6.4 WEDG Compliance Table – Likely 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 (H1)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	40	45	45	45	45.4	48.2	50.3
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	30	30.7	34.8	39	40.6	40.7	41	41.4	41.5	41.5
	Exceedance Level (dB $_{LA90}$)	-	-	-10	-9.3	-5.2	-1	-4.4	-4.3	-4	-4	-6.7	-8.8
NAL2 (H2)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.4	30.1	34.2	38.4	40	40.1	40.3	40.7	40.9	40.9
	Exceedance Level (dB $_{LA90}$)	-	-	-10.6	-9.9	-5.8	-6.6	-5	-4.9	-4.7	-5.1	-8	-11.2
NAL3 (H3)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.8	29.6	33.7	37.9	39.4	39.6	39.8	40.2	40.3	40.3
	Exceedance Level (dB $_{LA90}$)	-	-	-11.2	-10.4	-6.3	-7.1	-5.6	-5.4	-5.2	-5.6	-8.6	-11.8
NAL4 (H4)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	40	45	45	46.4	50.7	54.5	57.4
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.5	30.2	34.3	38.6	40.1	40.3	40.5	40.9	41	41
	Exceedance Level (dB $_{LA90}$)	-	-	-10.5	-9.8	-5.7	-1.4	-4.9	-4.7	-5.9	-9.8	-13.5	-16.4
NAL5 (H5)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	40	40	45	45	45	47	47
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	30	30.7	34.8	39	40.6	40.7	41	41.4	41.5	41.5
	Exceedance Level (dB $_{LA90}$)	-	-	-10	-9.3	-5.2	-1	**0.6**	-4.3	-4	-3.6	-5.5	-5.5
NAL6 (H8)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	45	45	45	45	45.8	48.9	52.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.6	29.3	33.4	37.7	39.2	39.4	39.6	40	40.1	40.1
	Exceedance Level (dB $_{LA90}$)	-	-	-11.4	-10.7	-6.6	-7.3	-5.8	-5.6	-5.4	-5.8	-8.8	-12

Location		Wind Speed (ms-1) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
NAL7 (H9)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	45	45	45	45	45	45	47	49.8
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.3	30	34.1	38.3	39.9	40	40.2	40.6	40.8	40.8
	Exceedance Level (dB $_{LA90}$)	-	-	-10.7	-10	-10.9	-6.7	-5.1	-5	-4.8	-4.4	-6.2	-9
NAL8 (H234)	Total WEDG Noise Limit (dB L_{A90})	40	40	40	40	40	40	45	45	46.4	50.7	54.5	57.4
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.3	29	33.1	37.3	38.9	39	39.2	39.6	39.8	39.8
	Exceedance Level (dB $_{LA90}$)	-	-	-11.7	-11	-6.9	-2.7	-6.1	-6	-7.2	-11.1	-14.7	-17.6

Note: For the noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 3 ms^{-1} therefore no predictions are included for wind speeds less than 3 ms^{-1}.

Table 6.5 WEDG Compliance Table – Likely 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 (H1)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	44	47.3	49.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	30	30.7	34.8	39	40.6	40.7	41	41.4	41.5	41.5
	Exceedance Level (dB $_{LA90}$)	-	-	-13	-12.3	-8.2	-4	-2.4	-2.3	-2	-2.6	-5.8	-7.6
NAL2 (H2)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	44.3	48.5	52
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.4	30.1	34.2	38.4	40	40.1	40.3	40.7	40.9	40.9
	Exceedance Level (dB $_{LA90}$)	-	-	-13.6	-12.9	-8.8	-4.6	-3	-2.9	-2.7	-3.6	-7.6	-11.1
NAL3 (H3)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	44.3	48.5	52
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.8	29.6	33.7	37.9	39.4	39.6	39.8	40.2	40.3	40.3
	Exceedance Level (dB $_{LA90}$)	-	-	-14.2	-13.4	-9.3	-5.1	-3.6	-3.4	-3.2	-4.1	-8.2	-11.7
NAL4 (H4)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	46.1	51.7	55.6	57.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.5	30.2	34.3	38.6	40.1	40.3	40.5	40.9	41	41
	Exceedance Level (dB $_{LA90}$)	-	-	-13.5	-12.8	-8.7	-4.4	-2.9	-2.7	-5.6	-10.8	-14.6	-16.1
NAL5 (H5)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	43	47.2	47.2
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	30	30.7	34.8	39	40.6	40.7	41	41.4	41.5	41.5
	Exceedance Level (dB $_{LA90}$)	-	-	-13	-12.3	-8.2	-4	-2.4	-2.3	-2	-1.6	-5.7	-5.7
NAL6 (H8)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	44.3	48.5	52
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.6	29.3	33.4	37.7	39.2	39.4	39.6	40	40.1	40.1
	Exceedance Level (dB $_{LA90}$)	-	-	-14.4	-13.7	-9.6	-5.3	-3.8	-3.6	-3.4	-4.3	-8.4	-11.9
NAL7 (H9)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	43	43	46	50.5

Location		Wind Speed (ms-1) as standardised to 10 m height											
		1	2	3	4	5	6	7	8	9	10	11	12
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	29.3	30	34.1	38.3	39.9	40	40.2	40.6	40.8	40.8
	Exceedance Level (dB $_{LA90}$)	-	-	-13.7	-13	-8.9	-4.7	-3.1	-3	-2.8	-2.4	-5.2	-9.7
NAL8 (H234)	Total WEDG Noise Limit (dB L_{A90})	43	43	43	43	43	43	43	43	46.1	51.7	55.6	57.1
	Predicted Wind Turbine Noise (dB $_{LA90}$)	-	-	28.3	29	33.1	37.3	38.9	39	39.2	39.6	39.8	39.8
	Exceedance Level (dB $_{LA90}$)	-	-	-14.7	-14	-9.9	-5.7	-4.1	-4	-6.9	-12.1	-15.8	-17.3

Note: For the noise predictions the noise model considers the range of noise data available for each turbine type modelled. For some turbines noise data was not available for wind speeds less than 3 ms^{-1} therefore no predictions are included for wind speeds less than 3 ms^{-1}.

7 Summary and Conclusions

7.1.1 This report has assessed the potential impact of operational noise from the Proposed Project on nearby Noise Sensitive Receptors (NSRs). The guidance contained within the WEDG 2006 in conjunction with ETSU-R-97 and current good practice (IOA GPG) has been used.

7.1.2 A total of 239 NSRs were identified in a wide area surrounding the Proposed Project, of which eight were chosen as Noise Assessment Locations (NALs) for a detailed assessment. All were residential properties. The NALs were chosen to represent the NSRs located closest to the Proposed Project in all directions.

7.1.3 Background noise monitoring was undertaken by TNEI at five Noise Monitoring Locations at or near some of the NALs. For the NALs where no background noise measurements were undertaken, noise data collected at a proxy NML, selected based on proximity, was used to represent the expected background noise levels. Concurrent wind speed data was collected using a LIDAR unit located within the Proposed Site.

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. A limit of 43 dB(A) or background noise plus 5 dB, whichever is the greater, was used for night time.

7.1.5 The candidate turbine considered for the Proposed Project in this assessment is the Vestas V162 7.2 MW with serrated trailing edge blades, which is considered representative of the type of turbine which could be installed on the site.

7.1.6 The nearest identified nearby wind turbine development is the proposed Cooloo Wind Farm, located approximately 6 km to the south of the Proposed Development, and which has yet to enter planning. The nearest in planning, permitted or operational wind turbine development is Cloonlusk Wind Farm, located over 11 km away. At these distances, there is no realistic prospect of cumulative wind farm noise effects occurring at the NSRs considered in this assessment, and as such a detailed cumulative noise assessment is not considered necessary and no cumulative impact is anticipated during the operational phase.

7.1.7 A detailed noise assessment was undertaken to compare predicted noise levels from the Proposed Project to the Total WEDG Noise Limits. The results show that the predicted wind farm noise levels would meet the Total WEDG Noise Limits at all NALs (and all other identified NSRs) during both the daytime and night time periods, with one small exception at NAL5 where a marginal exceedance of 0.6dB is observed only in daytime at 7m/s. This minor exceedance would be removed by using low noise mode for the candidate turbine in that specific wind speed and in specific wind directions only, by reducing uncertainties on warranted sound power levels or by using an alternative candidate turbine.

7.1.8 The Total WEDG Noise Limits can be used to condition the operation of the Proposed Project. There are a number of wind turbine makes and models that would be suitable for the Proposed Project. Should the proposal 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 information only. The final choice of turbine would, however, have to meet the noise limits determined and contained within any condition imposed.

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.

9 References

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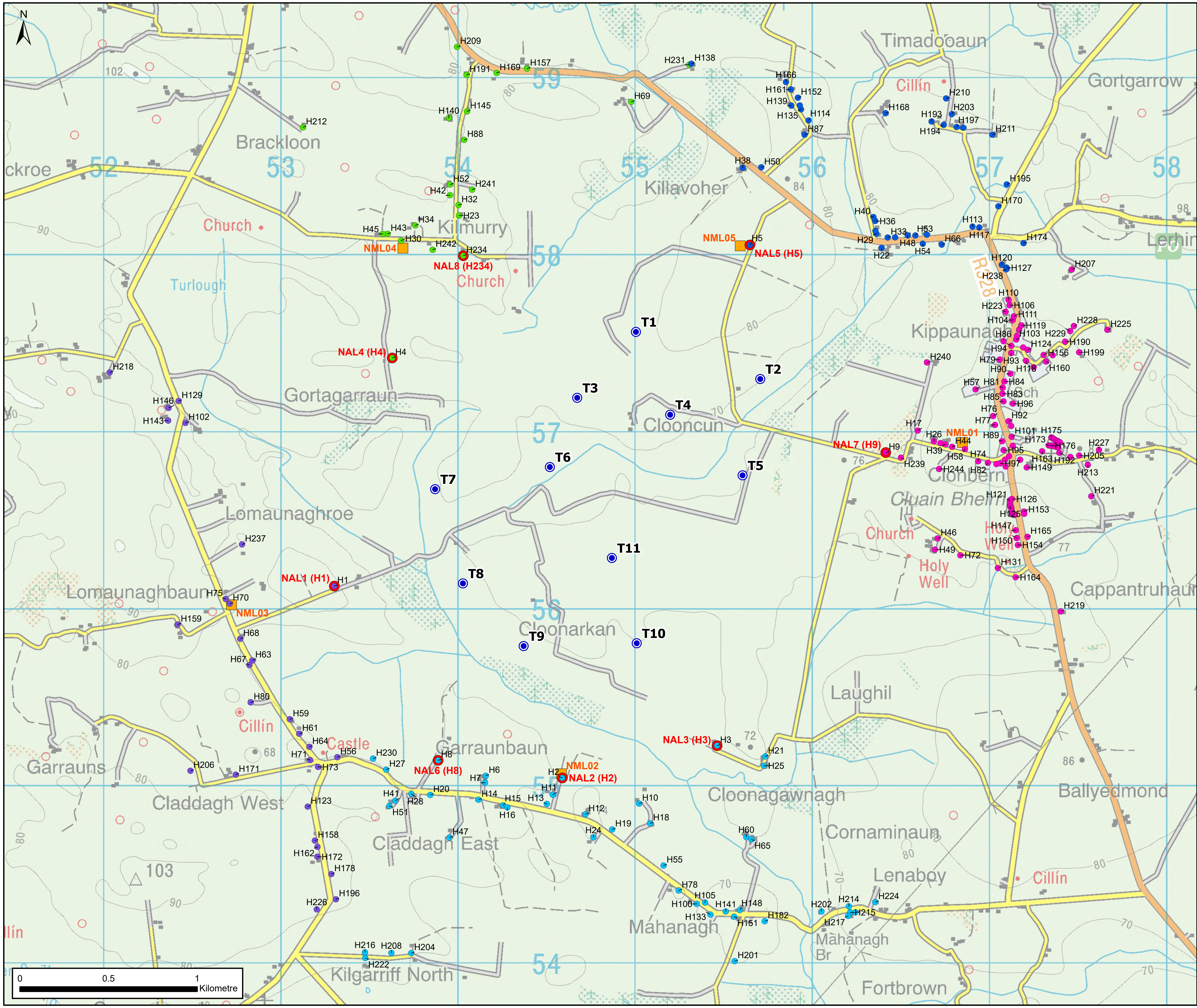
Annex 1 – Figures



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Legend

- Proposed Wind Turbines
- Noise Monitoring Locations (NMLs)
- Noise Assessment Locations (NALs)

Noise Sensitive Receptors (NSRs)

- NSRs represented by data from NML1
- NSRs represented by data from NML2
- NSRs represented by data from NML3
- NSRs represented by data from NML4
- NSRs represented by data from NML5

Rev.	Date	Amendment Details	Drw'n	Chk'd	App'd
R2	27/02/24	Third Issue	MT	MC	MC
R0	11/12/23	Second Issue	MT	JM	JM
R0	06/07/23	First Issue	MT	JM	JM

Castlebar
COUNTY ROSCOMMON
Longford
Roscommon
COUNTY GALWAY
Athlone
Galway
Esri, HERE, Garmin, USGS, Esri, HERE

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MKO

Drawing Status: FOR PLANNING

Project Title: Clonberne Wind Farm

Drawing Title: Figure A1.1 Operational Noise Monitoring and Assessment Locations

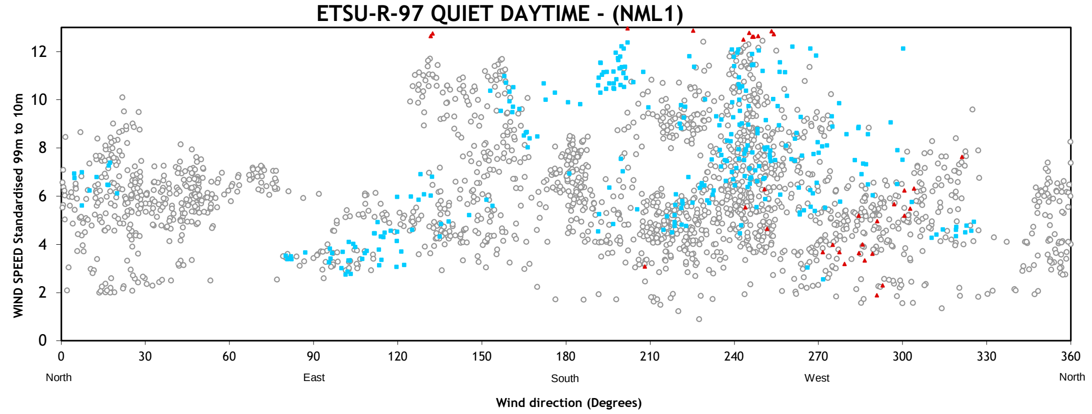
Scale	Designed	Drawn	Checked	Approved
1:20,000	MT	MT	MC	MC
Original Size: A3	Date: 27/02/2024	Date: 27/02/2024	Date: 27/02/2024	Date: 27/02/2024

Drawing Number: 13772-008

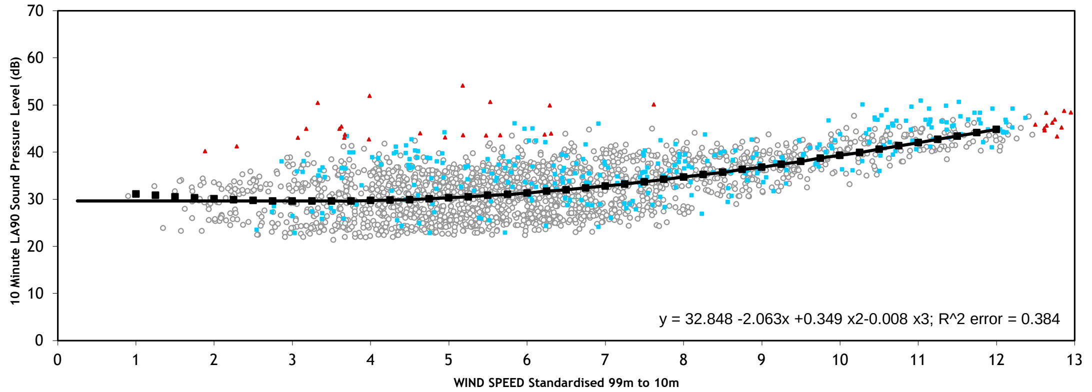
Revision: 2

ETSU-R-97 QUIET DAYTIME - (NML1)

Wind Conditions Quiet Daytime



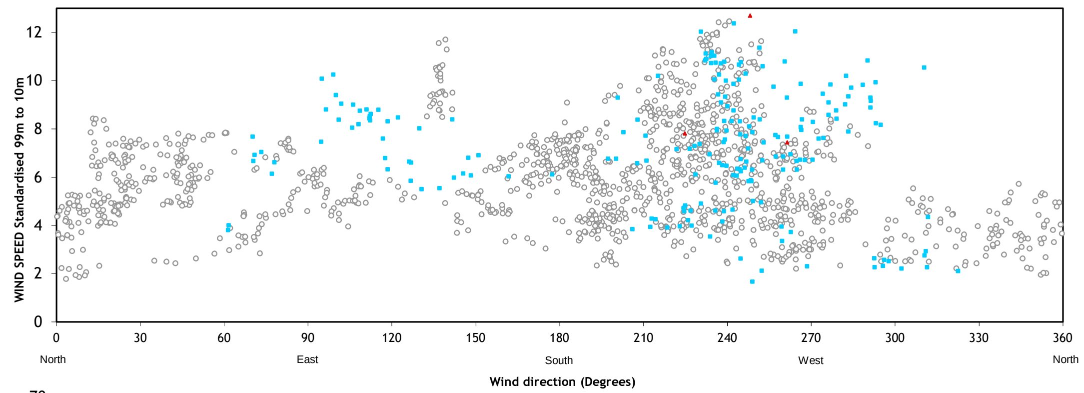
Regression Analysis Quiet Daytime



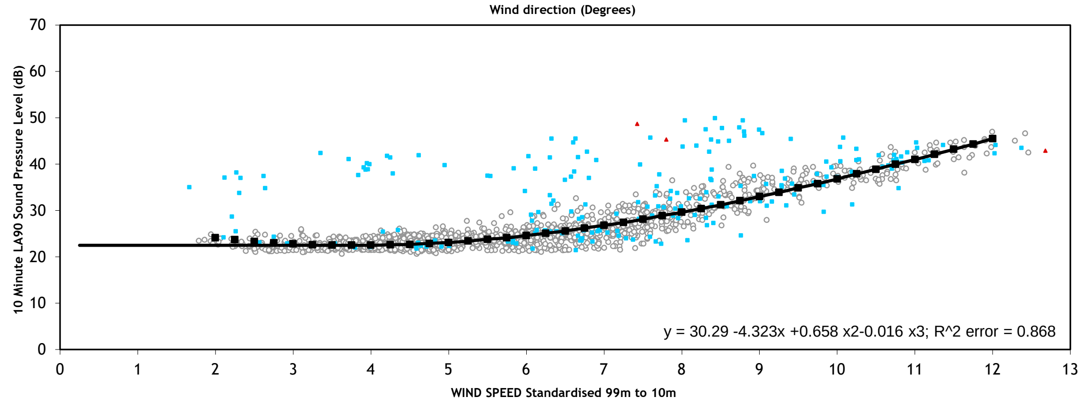
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	66	119	258	377	394	257	162	145	75	65	22	1940
Prevailing Background	29.6	29.6	29.7	30.3	31.3	32.8	34.7	36.8	39.3	42	44.8	

ETSU-R-97 NIGHT-TIME - (NML1)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	25	108	221	259	216	229	122	74	44	38	16	1352
Prevailing Background	22.5	22.5	22.5	23.1	24.6	26.8	29.6	33	36.8	41	45.5	

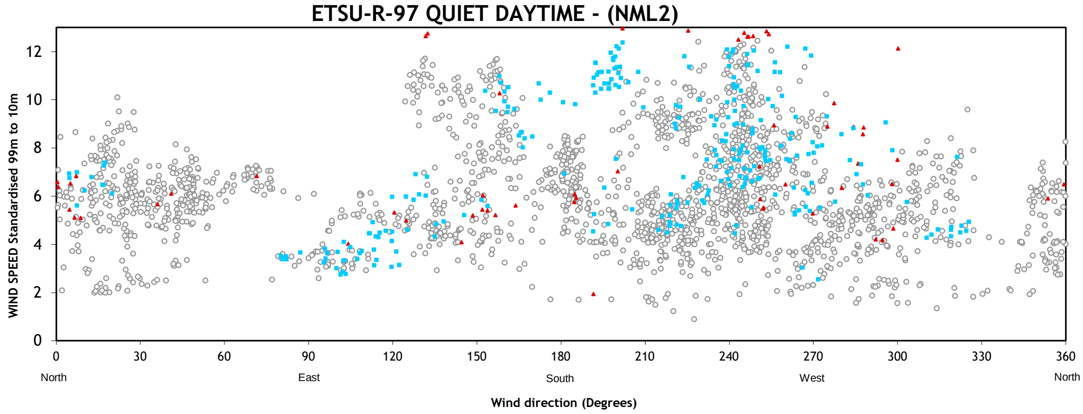
Legend:

- O — L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- ▲ Excluded Data-Manual exclusion
- ■ Excluded Data-Rain

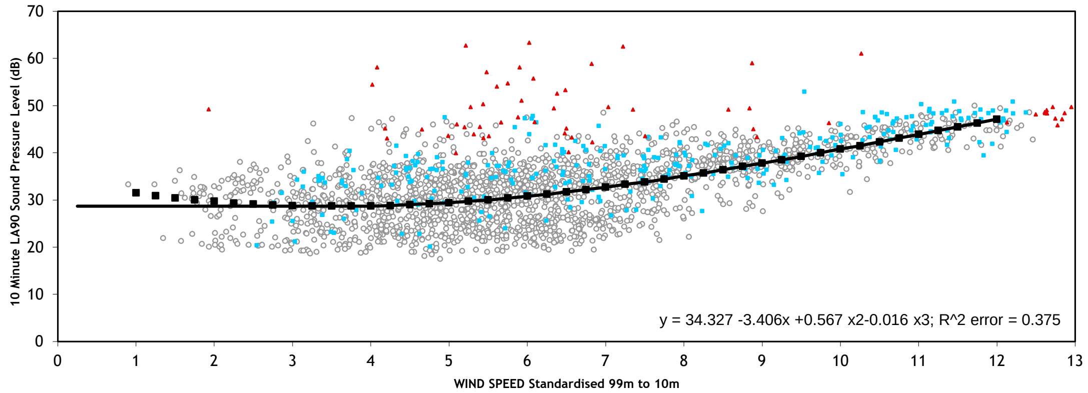
Project	Clonberne Wind Farm
Client	MKO
Title	Wind Conditions&Regression Analysis
Figure Number	A1.2a
Drawn	MT
Checked	MC
Date	05/12/2023
Document Reference	13772-BGN

ETSU-R-97 QUIET DAYTIME - (NML2)

Wind Conditions Quiet Daytime



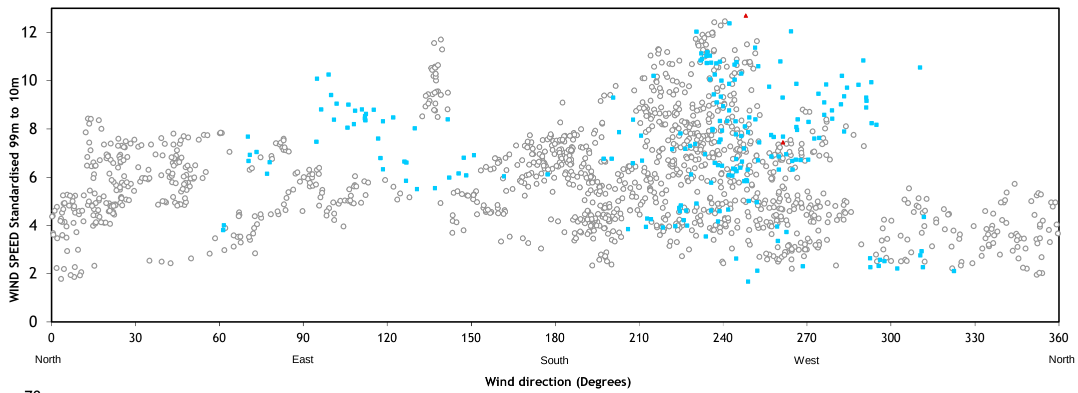
Regression Analysis Quiet Daytime



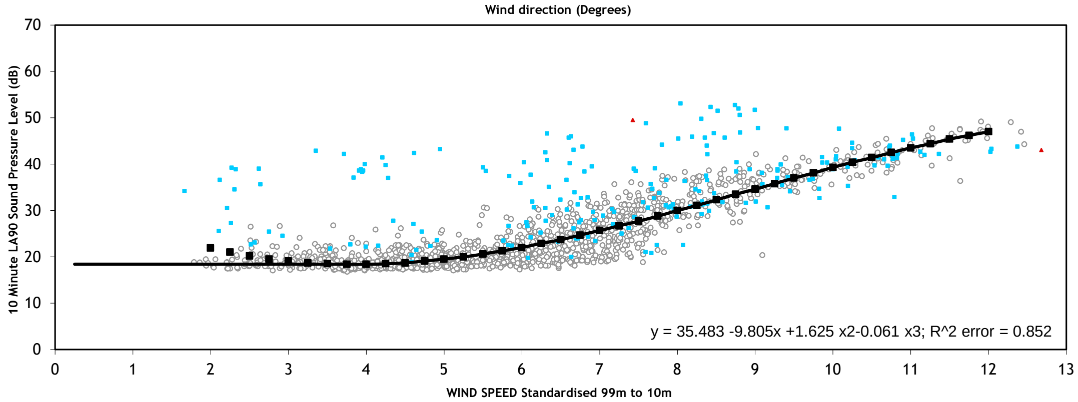
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	67	122	261	370	386	252	162	144	74	65	22	1925
Prevailing Background	28.7	28.7	28.7	29.4	30.8	32.7	35.1	37.8	40.8	43.9	47.1	

ETSU-R-97 NIGHT-TIME - (NML2)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	25	108	221	259	216	229	122	74	44	38	16	1352
Prevailing Background	18.4	18.4	18.4	19.5	22	25.7	30	34.6	39.3	43.5	47	

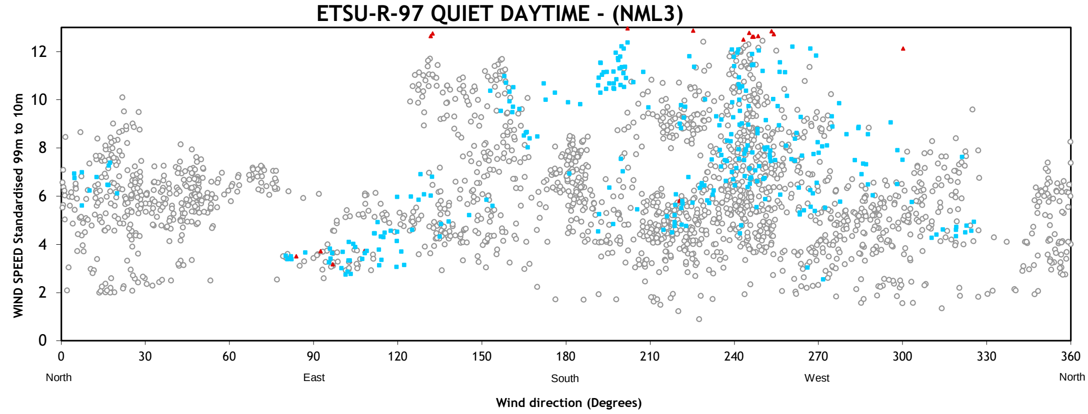
Legend:

- O — L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

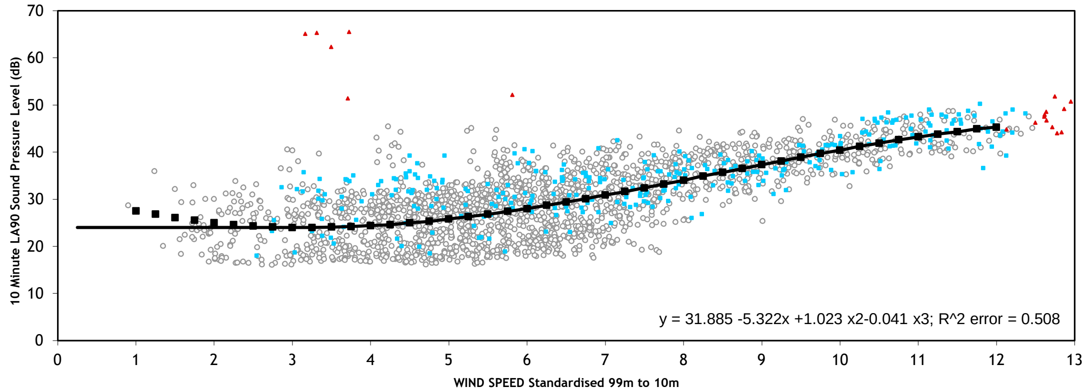
Project	Clonberne Wind Farm
Client	MKO
Title	Wind Conditions&Regression Analysis (NML2)
Figure Number	A1.2b
Drawn	MT
Checked	MC
Date	05/12/2023
Document Reference	13772-BGN

ETSU-R-97 QUIET DAYTIME - (NML3)

Wind Conditions Quiet Daytime



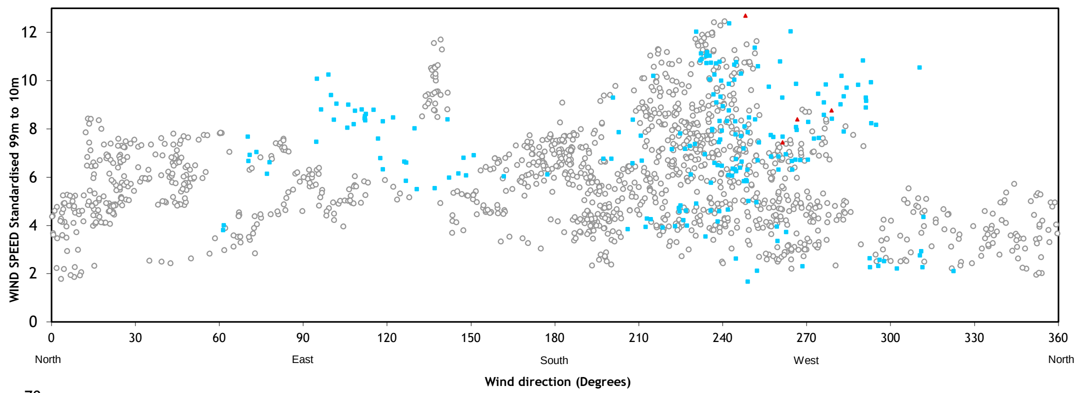
Regression Analysis Quiet Daytime



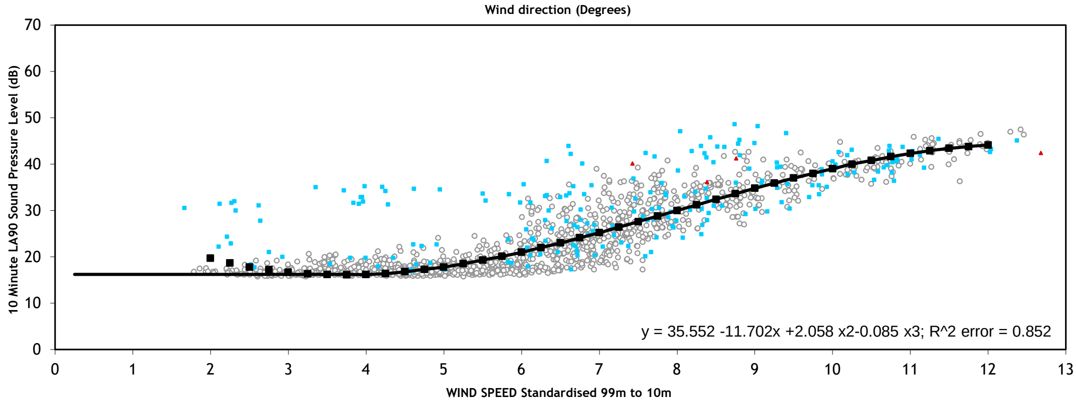
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	68	119	262	382	398	257	162	145	75	65	22	1955
Prevailing Background	24	24	24.4	25.8	28	30.9	34	37.3	40.4	43.2	45.3	

ETSU-R-97 NIGHT-TIME - (NML3)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	25	108	221	259	216	229	122	74	44	38	16	1352
Prevailing Background	16.2	16.2	16.2	17.8	21	25.2	30	34.8	39	42.3	44.1	

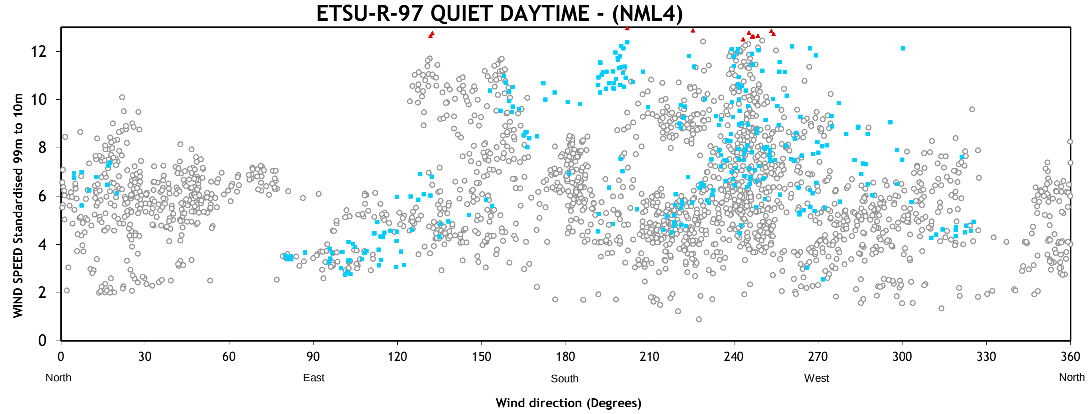
Legend:

- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

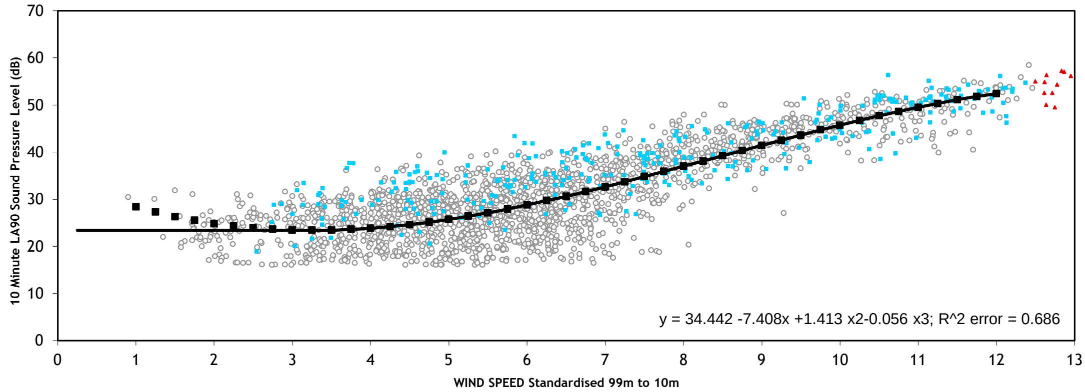
Project	Clonberne Wind Farm
Client	MKO
Title	Wind Conditions&Regression Analysis (NML3)
Figure Number	A1.2c
Drawn	MT
Checked	MC
Date	05/12/2023
Document Reference	13772-BGN

ETSU-R-97 QUIET DAYTIME - (NML4)

Wind Conditions Quiet Daytime



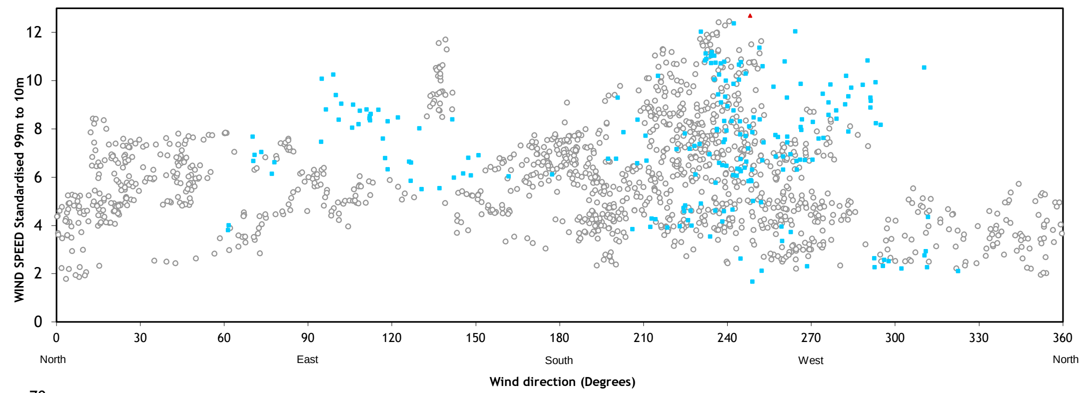
Regression Analysis Quiet Daytime



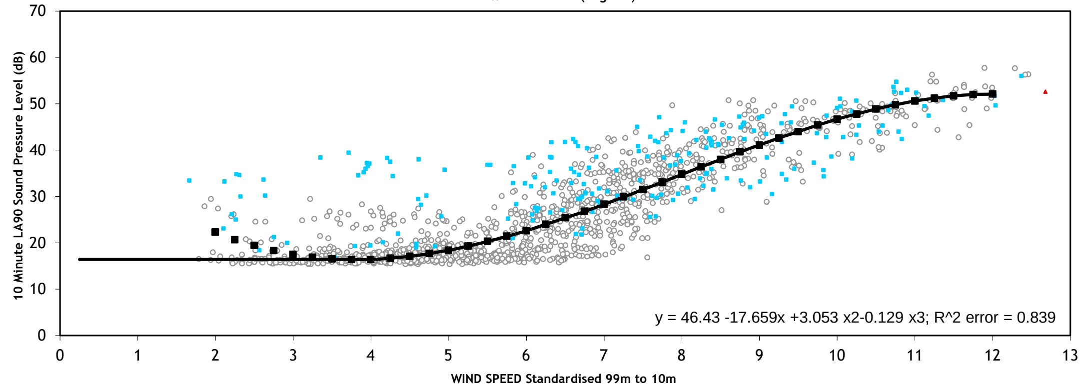
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	68	122	264	382	399	257	162	145	75	65	22	1961
Prevailing Background	23.4	23.4	23.8	25.7	28.8	32.6	37	41.4	45.7	49.5	52.4	

ETSU-R-97 NIGHT-TIME - (NML4)

Wind Conditions Night-Time



Regression Analysis Night-Time



Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	25	108	221	259	216	229	122	74	44	38	16	1352
Prevailing Background	16.4	16.4	16.4	18.4	22.6	28.3	34.8	41.1	46.7	50.6	52.1	

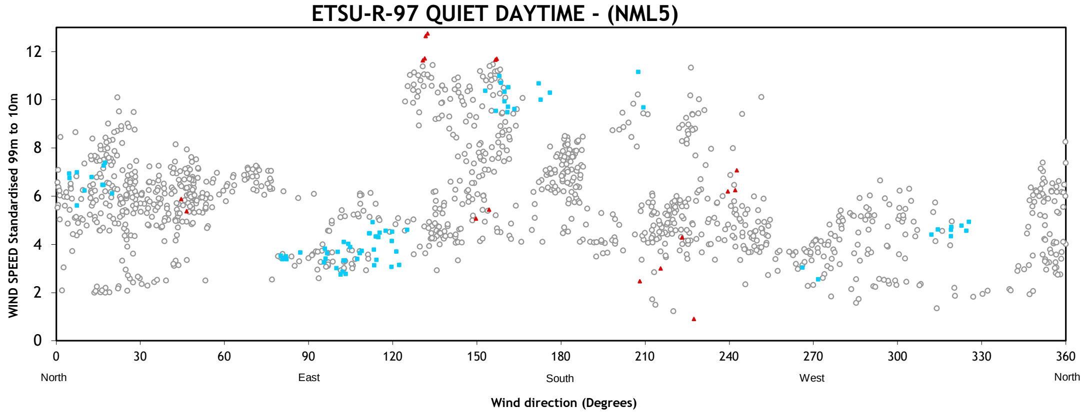
Legend:

- O L_{A90} 10 Minute Measurement Point
- Line of best fit (dotted)
- Line of best fit flat lined where appropriate(Prevailing Background)
- ▲ Excluded Data-Manual exclusion
- ■ Excluded Data-Rain

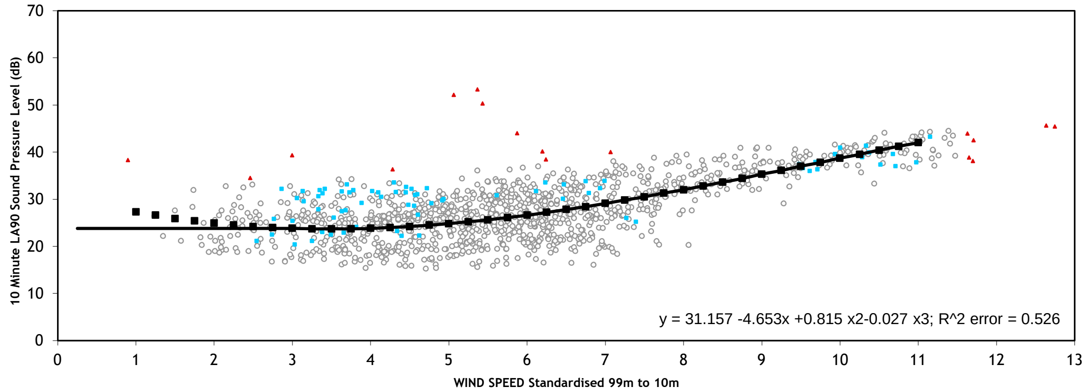
Project	Clonberne Wind Farm
Client	MKO
Title	Wind Conditions&Regression Analysis (NML4)
Figure Number	A1.2d
Drawn	MT
Checked	MC
Date	05/12/2023
Document Reference	13772-BGN

ETSU-R-97 QUIET DAYTIME - (NML5)

Wind Conditions Quiet Daytime



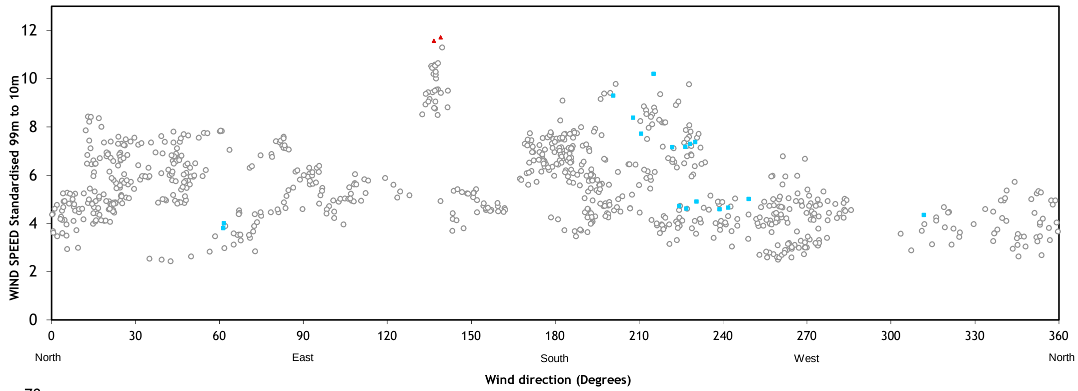
Regression Analysis Quiet Daytime



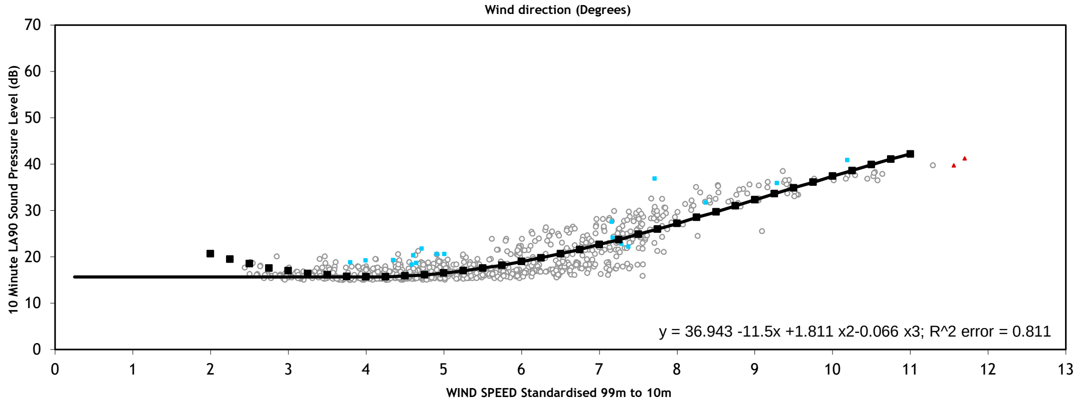
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	42	83	185	221	249	152	87	55	33	36	0	1143
Prevailing Background	23.8	23.8	23.8	24.8	26.6	29.1	32	35.3	38.7	42	-	

ETSU-R-97 NIGHT-TIME - (NML5)

Wind Conditions Night-Time



Regression Analysis Night-Time



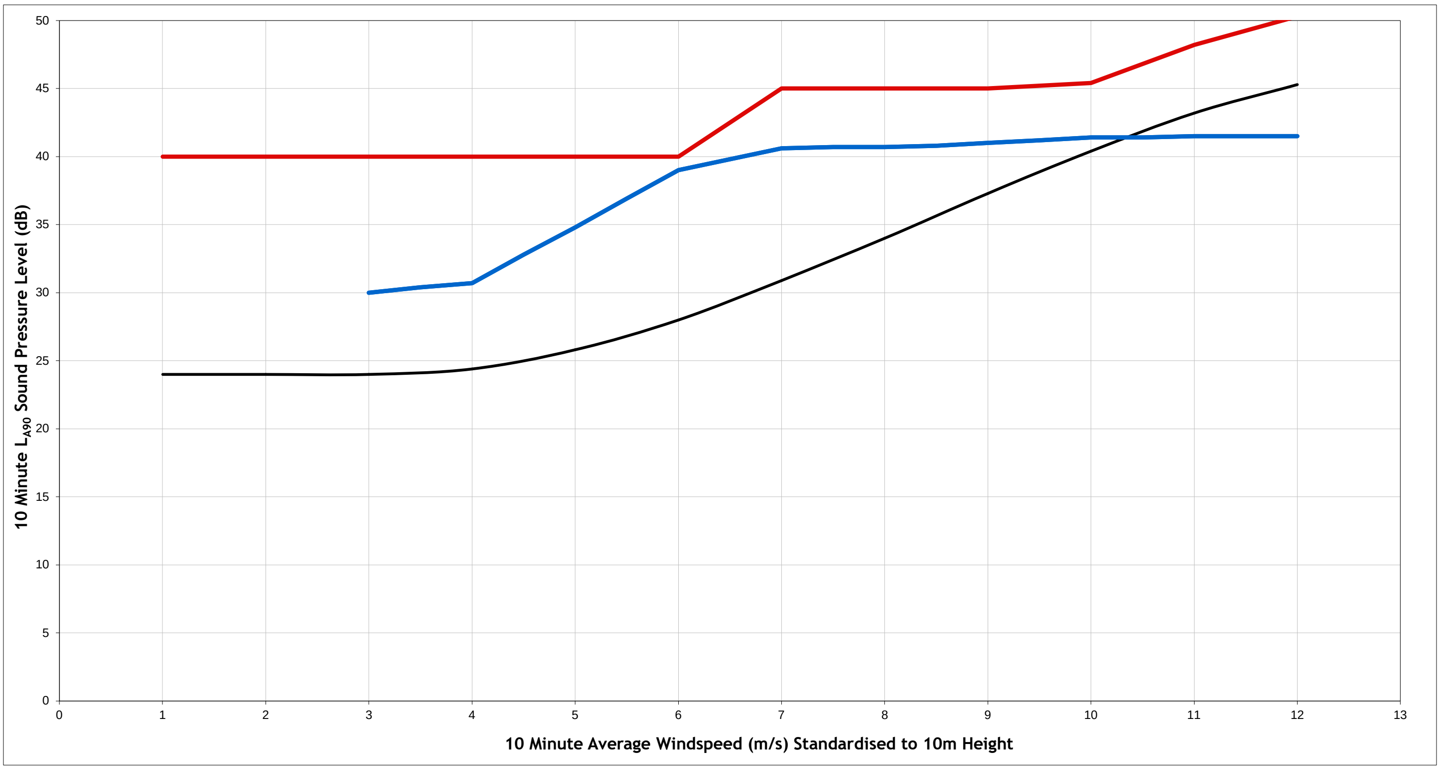
Wind Speed (m/s)	2	3	4	5	6	7	8	9	10	11	12	Total
Number of data points	1	71	167	204	143	129	62	25	11	6	0	819
Prevailing Background	15.7	15.7	15.7	16.5	19	22.7	27.2	32.3	37.4	42.2	-	

Legend:

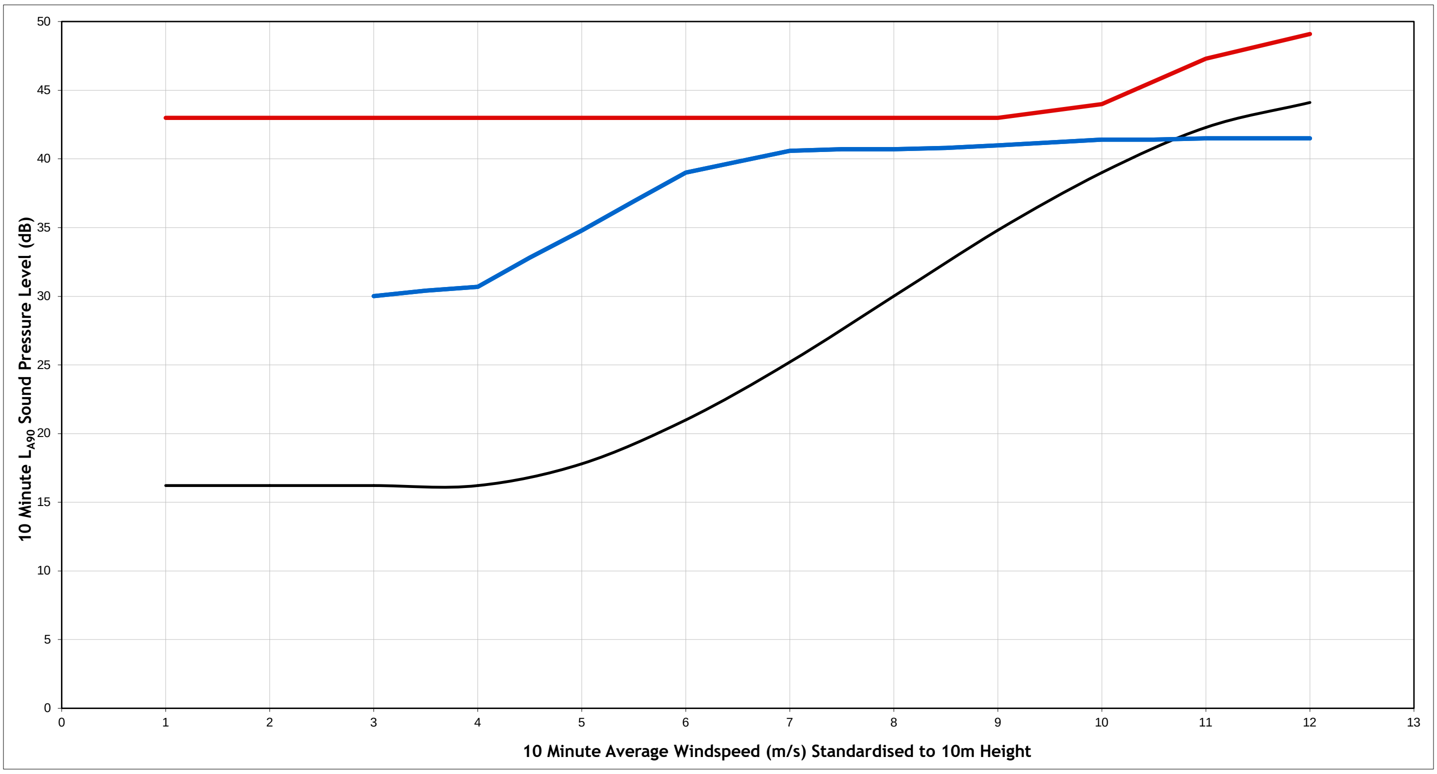
- L_{A90} 10 Minute Measurement Point
- Line of best fit
- Line of best fit flat lined where appropriate(Prevailing Background)
- Excluded Data-Manual exclusion
- Excluded Data-Rain

Project	Clonberne Wind Farm
Client	MKO
Title	Wind Conditions&Regression Analysis (NML5)
Figure Number	A1.2e
Drawn	MT
Checked	MC
Date	05/12/2023
Document Reference	13772-BGN

Daytime - NAL1 (H01)



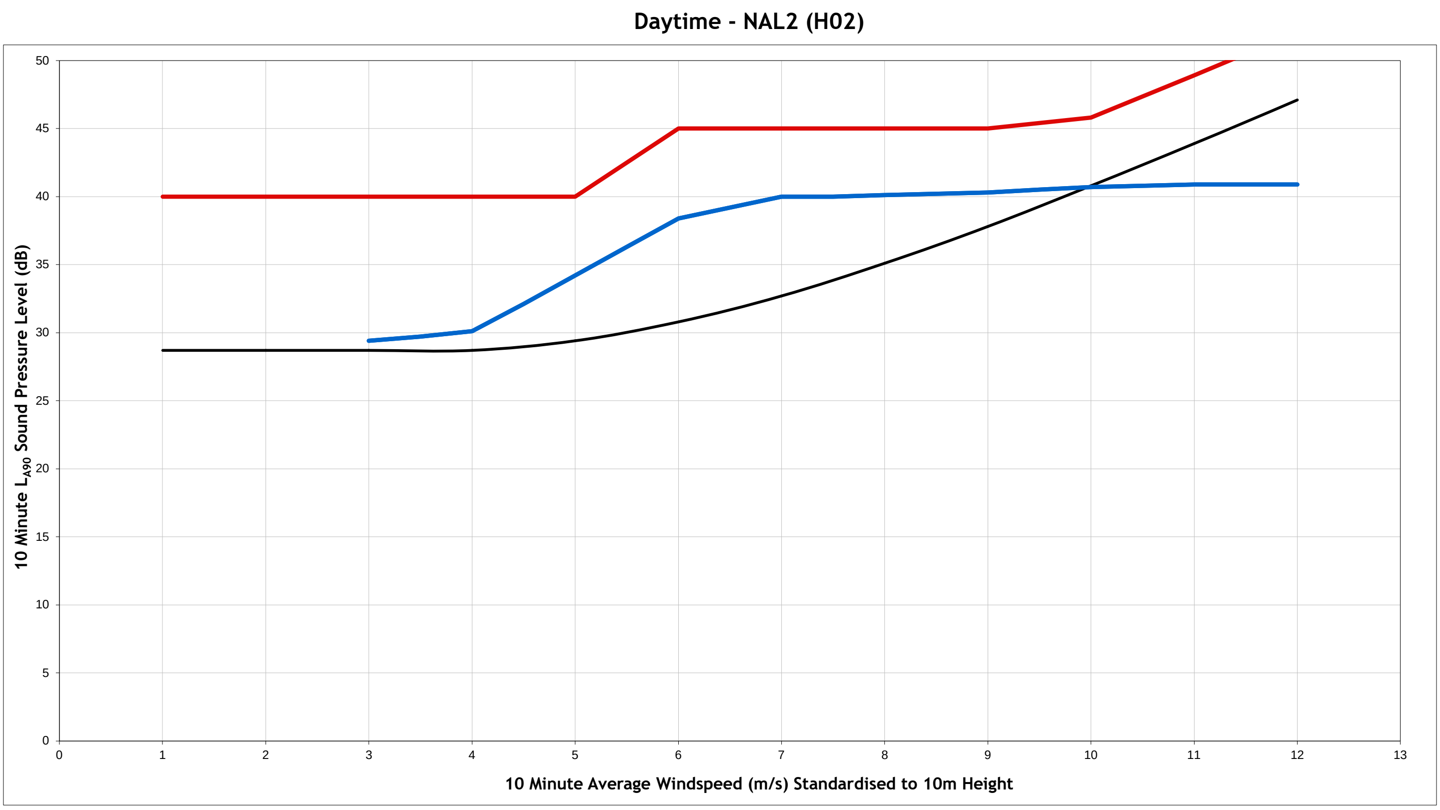
Night Time - NAL1 (H01)

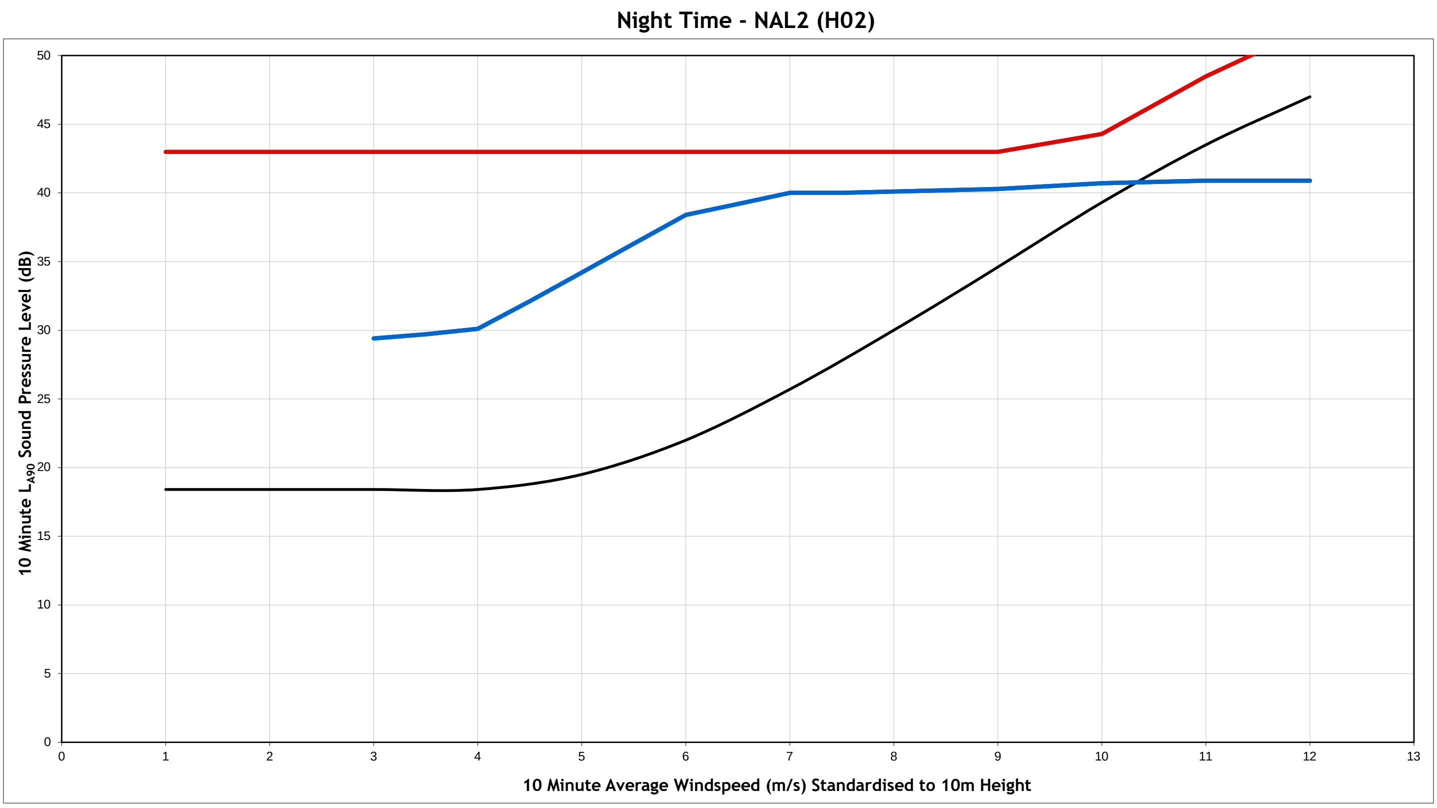


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL1 (H01)
Figure Number	Figure A1.3a
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models



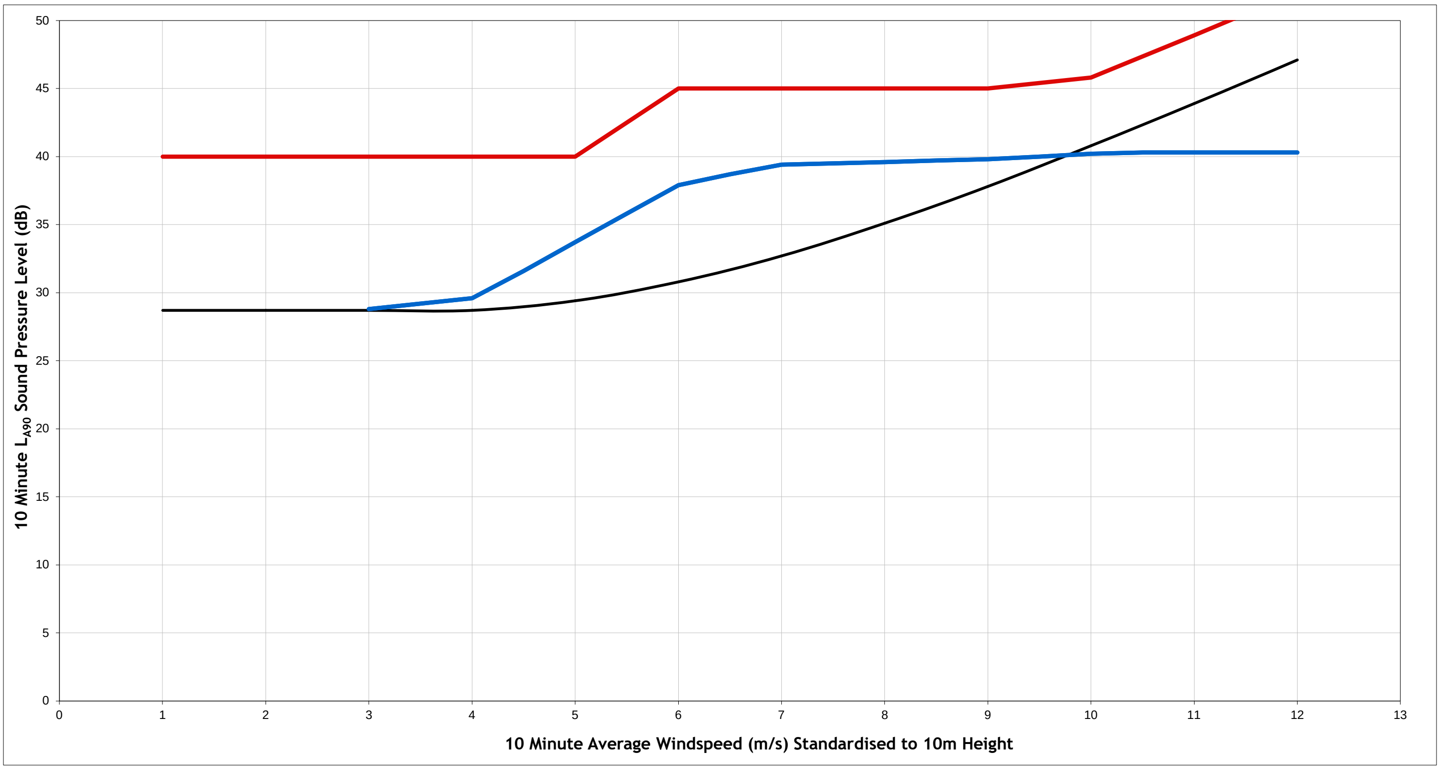


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL2 (H02)
Figure Number	Figure A1.3b
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

Daytime - NAL3 (H03)



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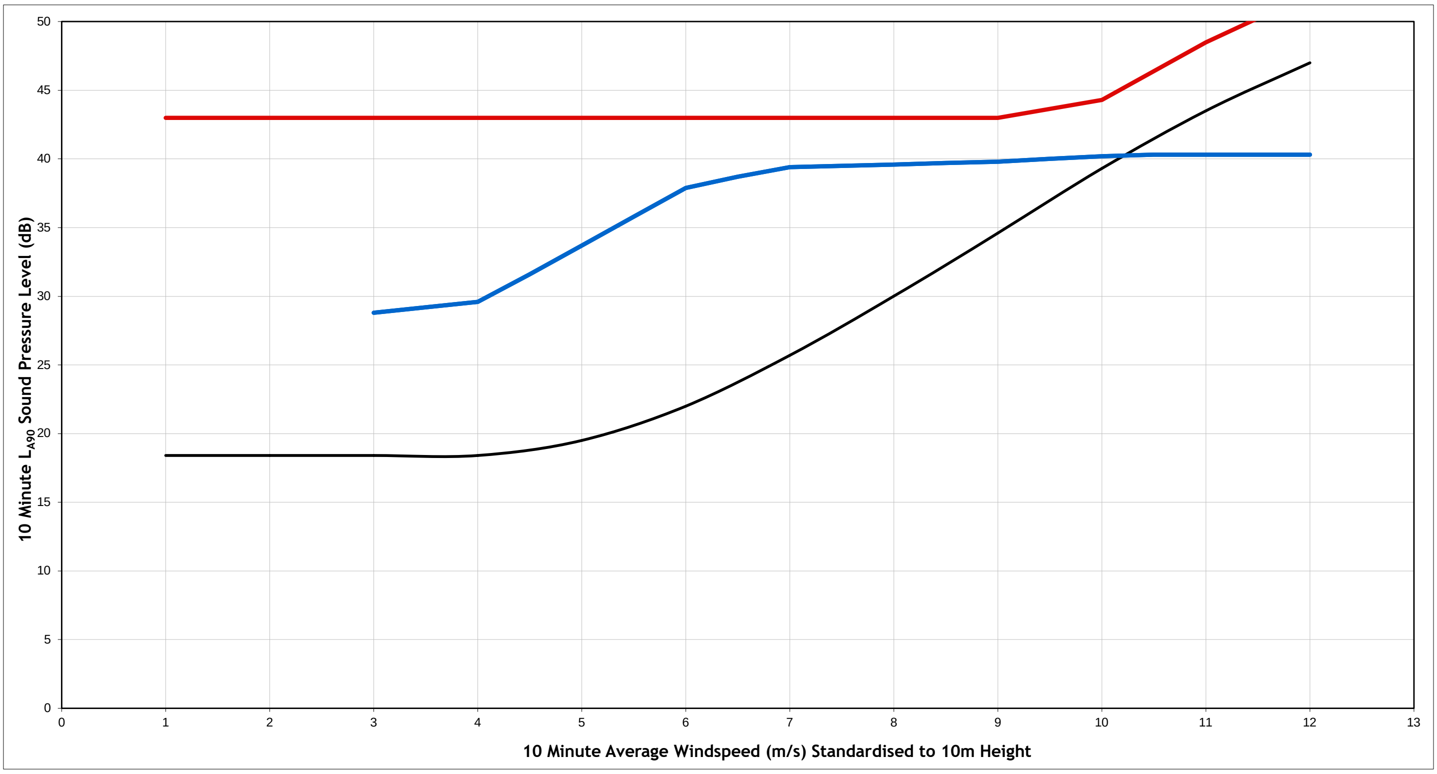
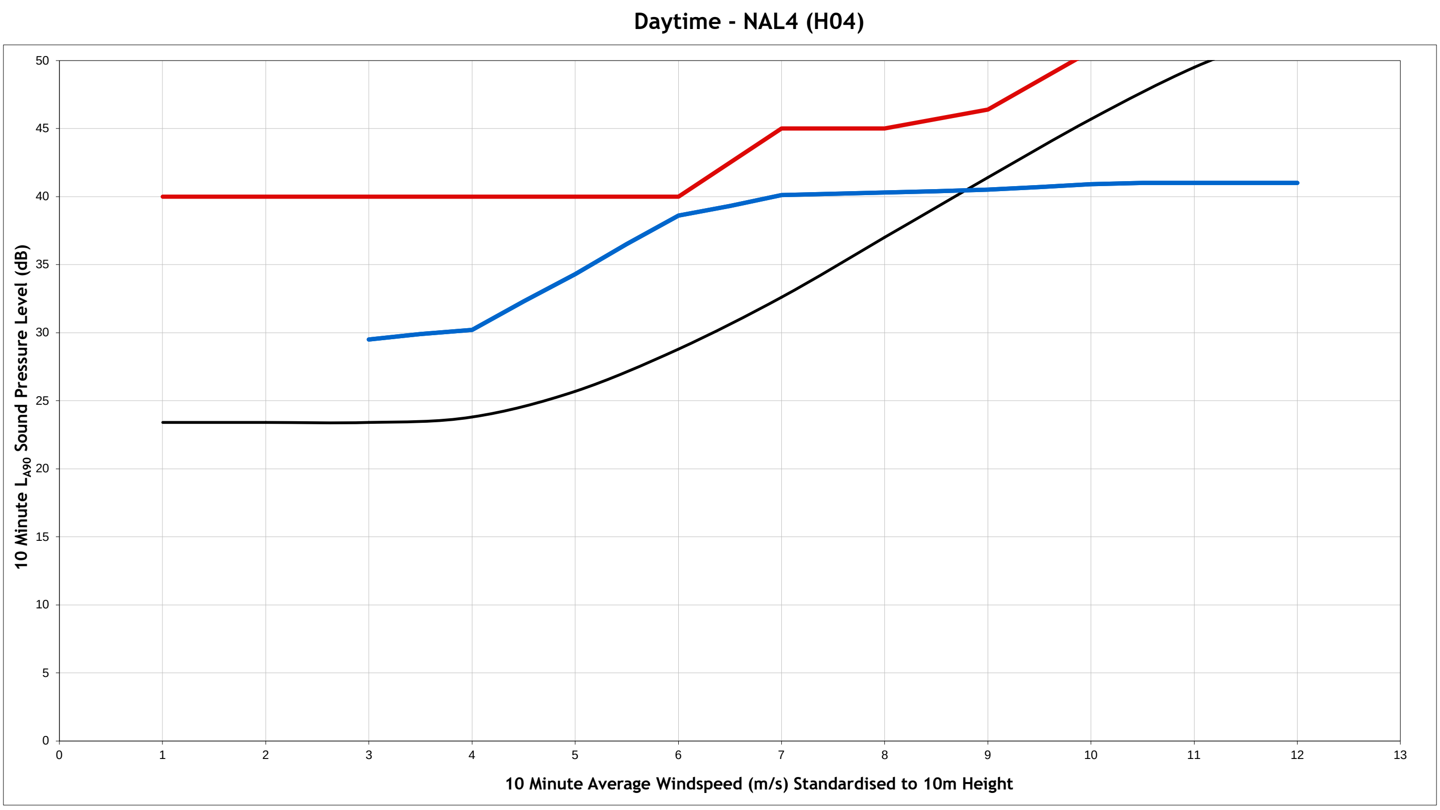
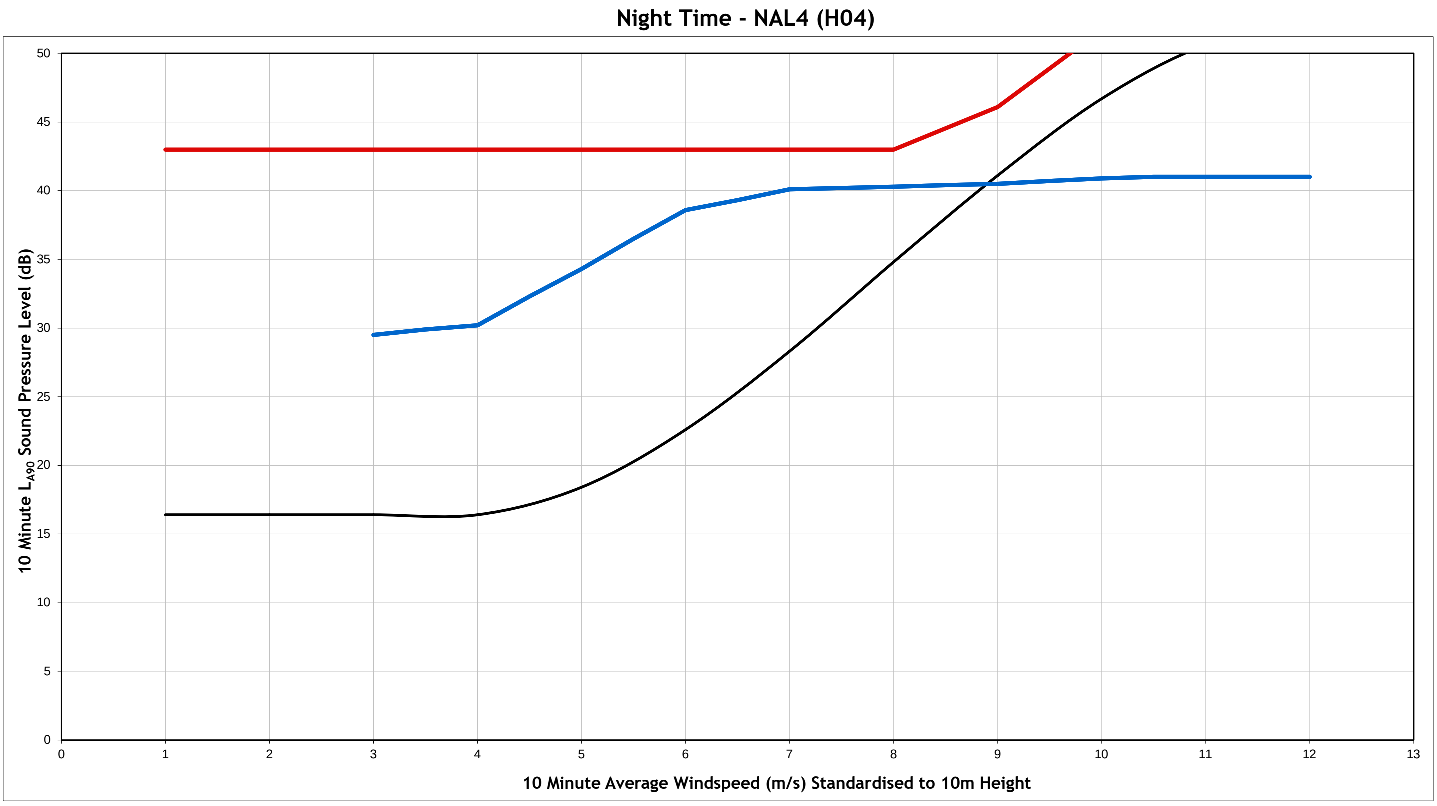


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL3 (H03)
Figure Number	Figure A1.3c
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

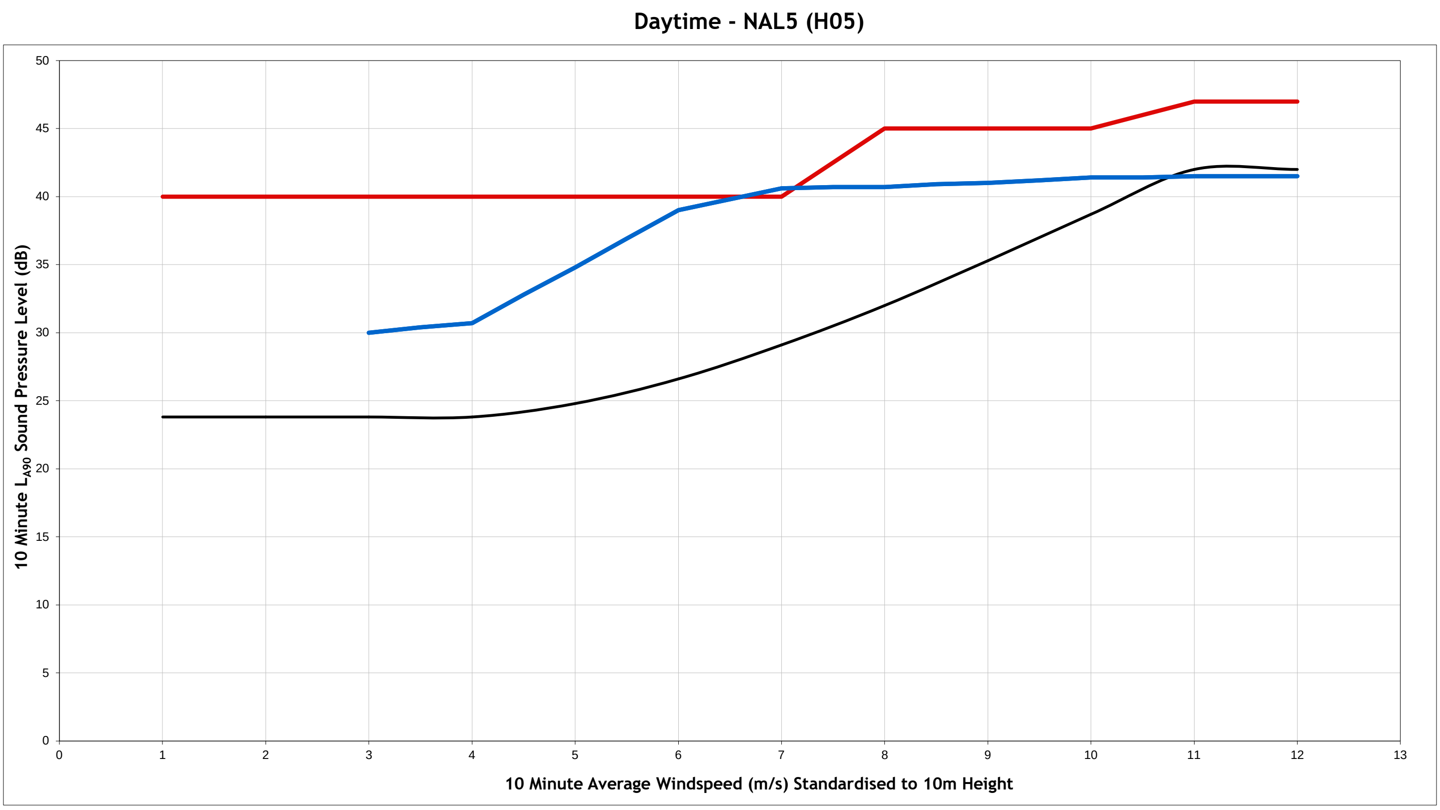


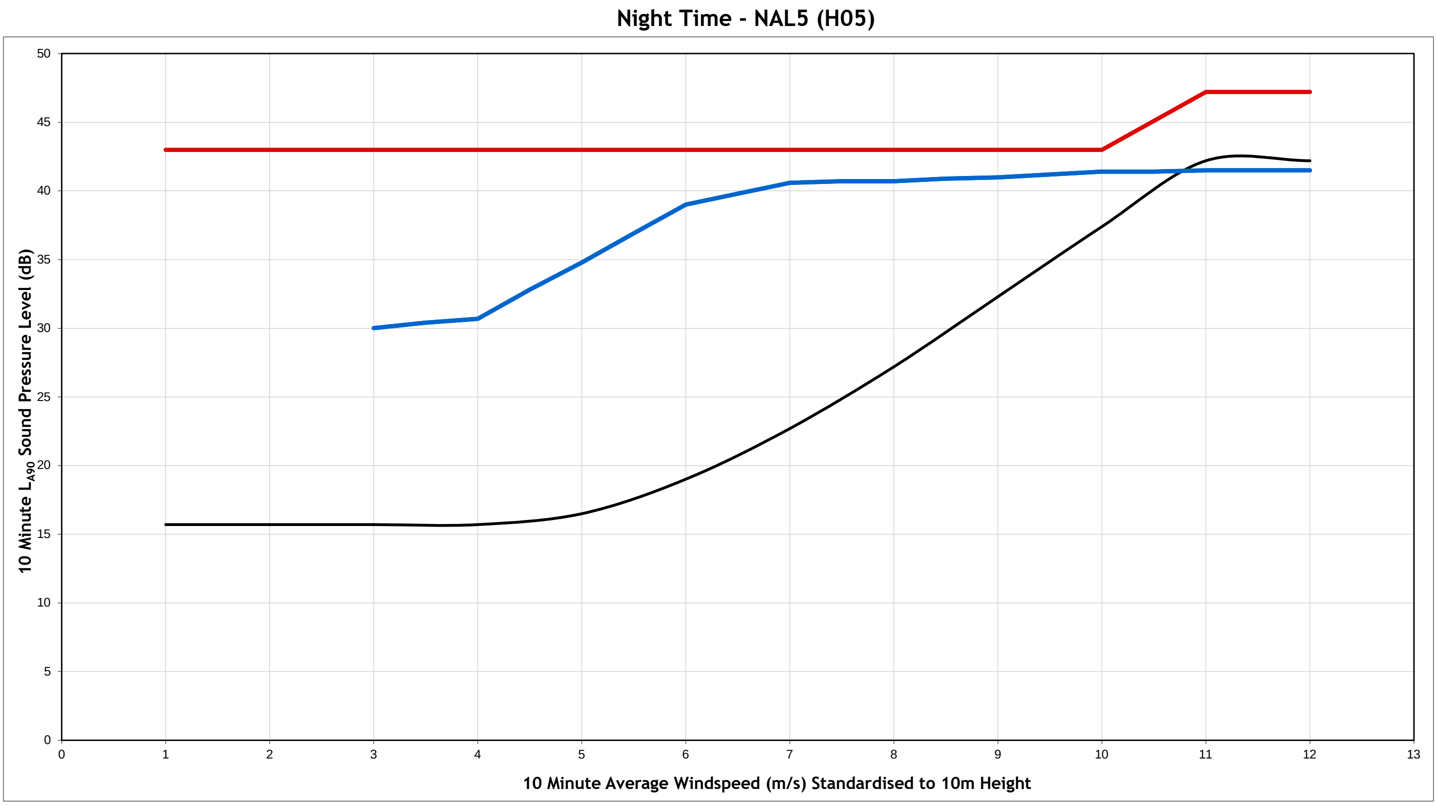


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL4 (H04)
Figure Number	Figure A1.3d
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

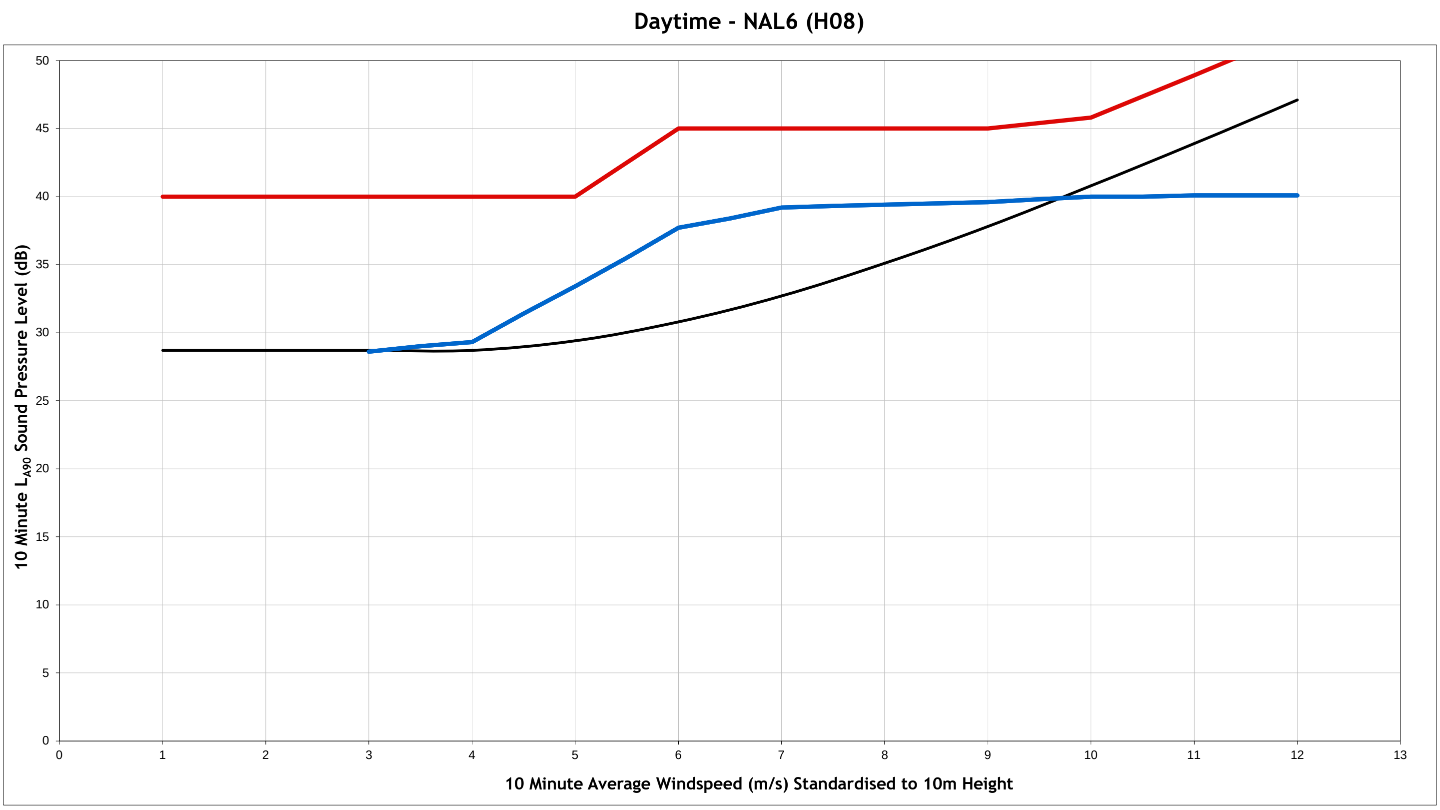


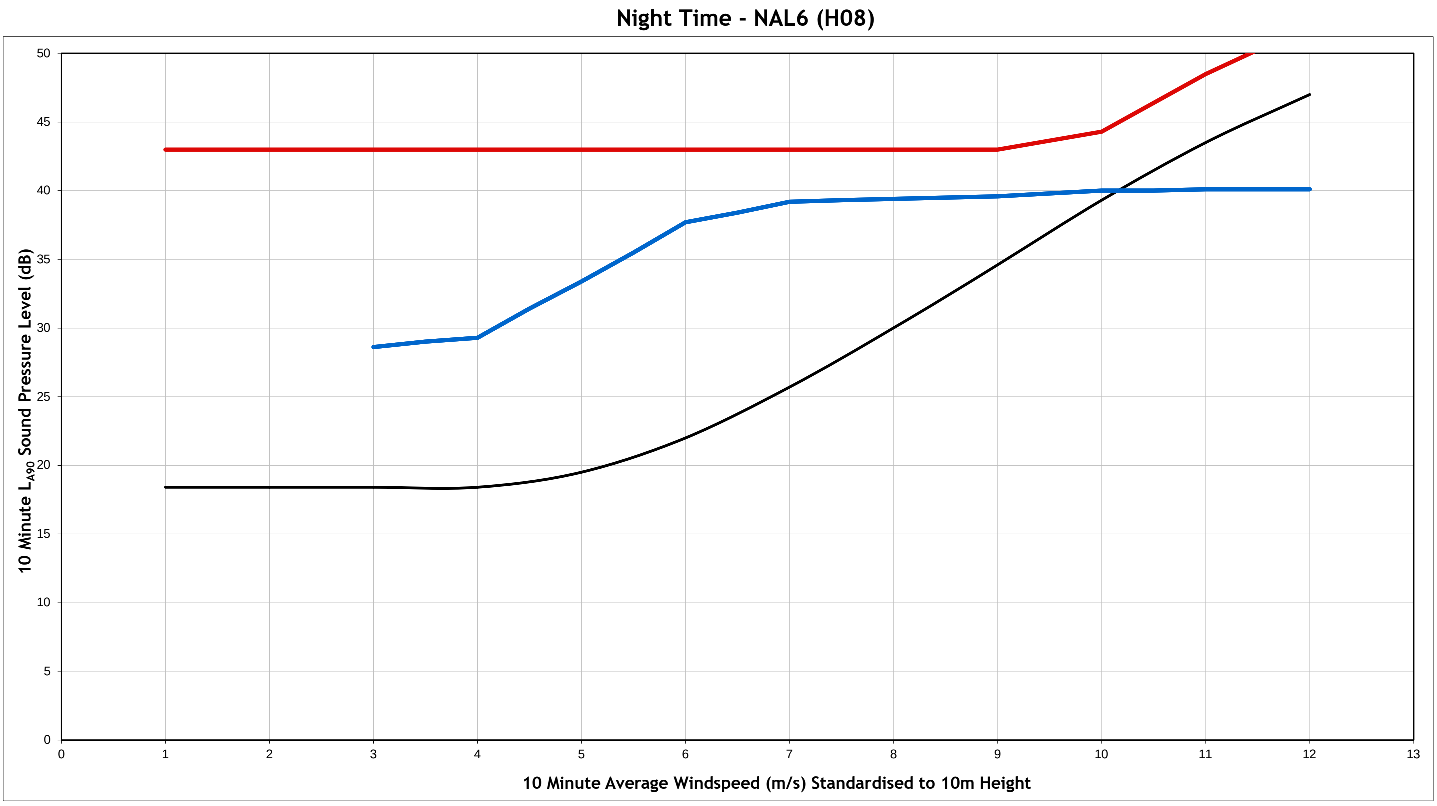


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL5 (H05)
Figure Number	Figure A1.3e
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

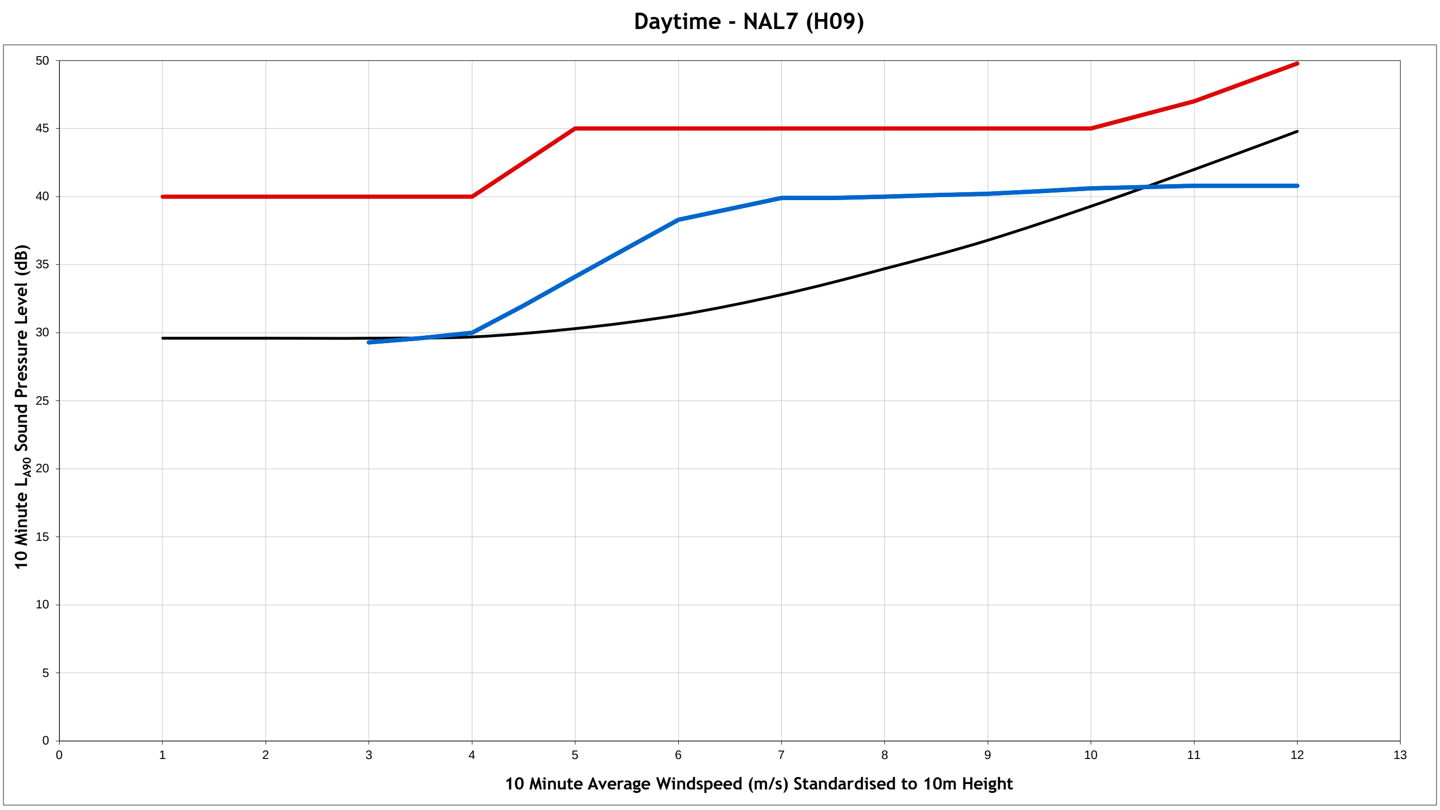


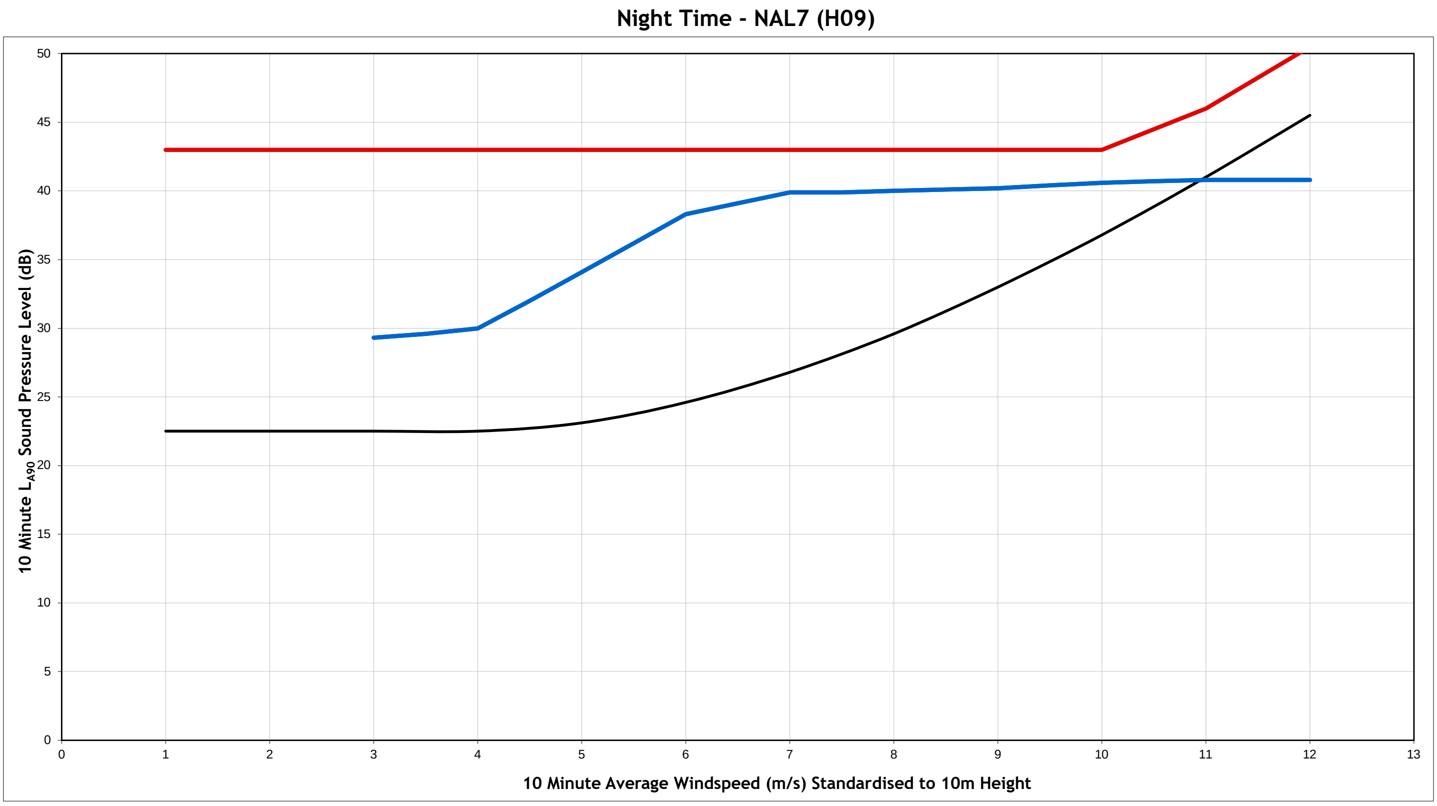


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL6 (H08)
Figure Number	Figure A1.3f
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

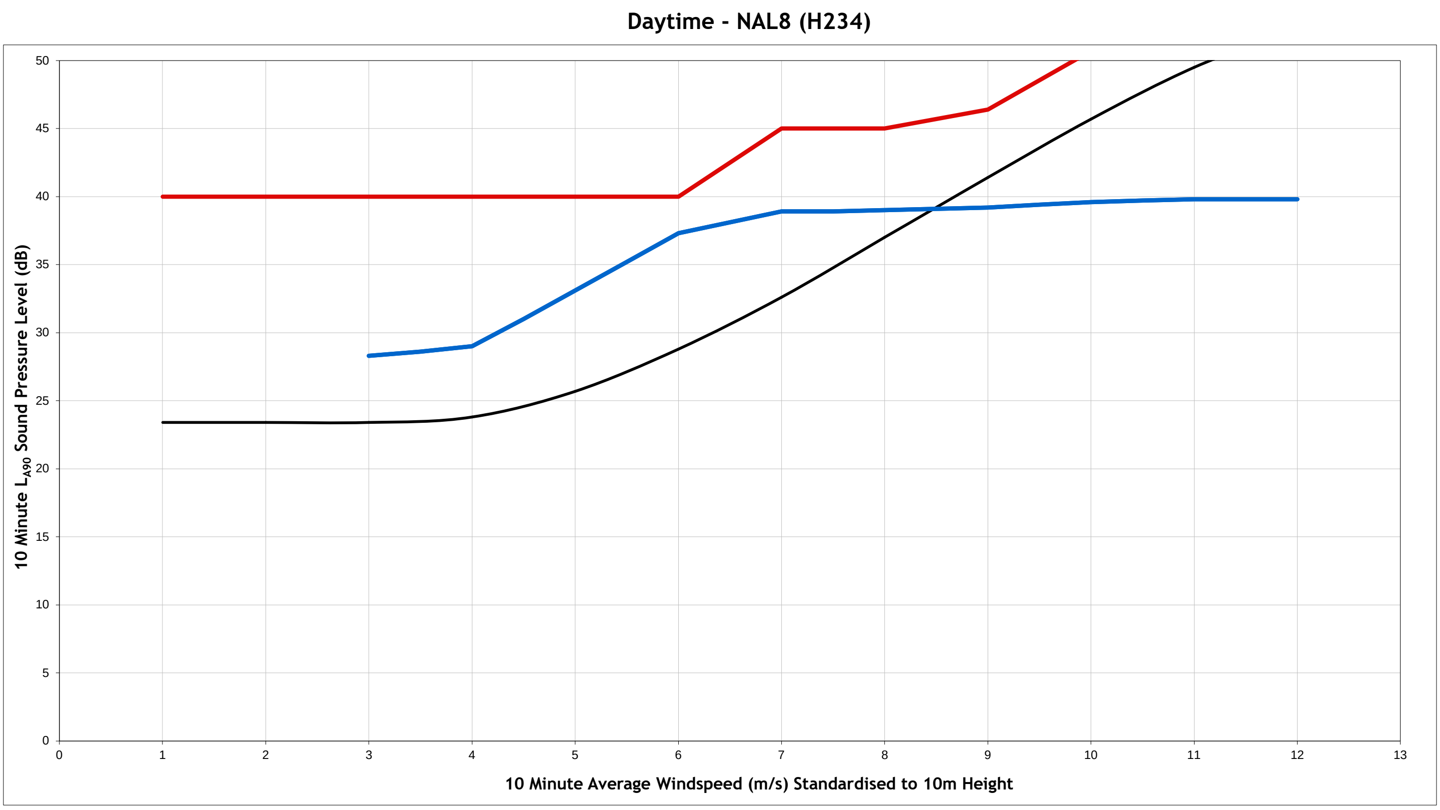


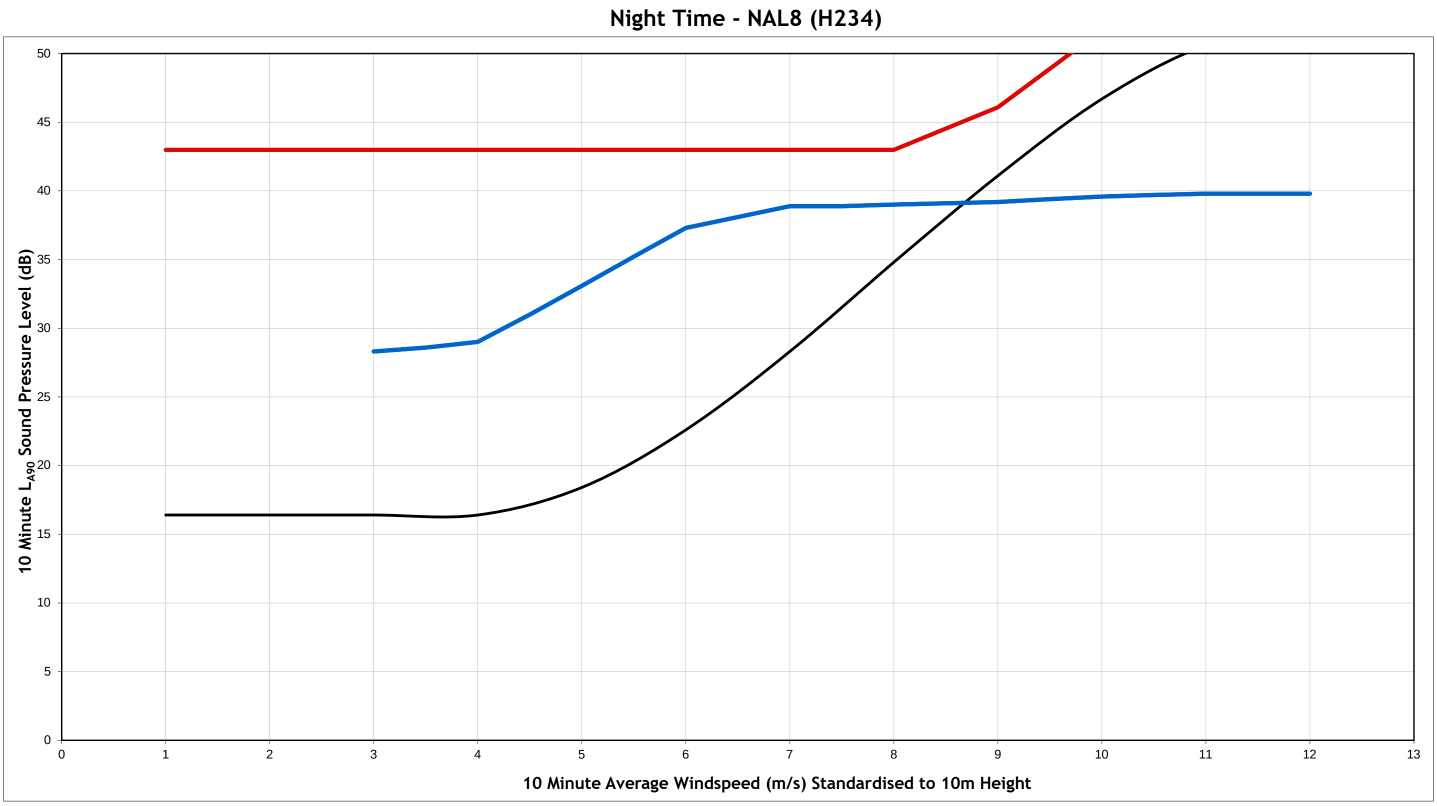


Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL7 (H09)
Figure Number	Figure A1.3g
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models





Legend:

- Background Noise Trendline
- Total WEDG Noise Limit
- Proposed Clonberne Wind Farm

Project	Clonberne Wind Farm
Client	MKO
Title	Noise Assessment NAL8 (H234)
Figure Number	Figure A1.3h
Drawn	MT
Checked	MC
Date	11/12/2023
Document Reference	13772 - ETSU models

Annex 2 – Field Data Sheets & Installation Report

Clonberne Wind Farm Noise Survey - Installed Noise Monitoring Locations

Present during the course of the installation:

- Jim Singleton & Owen Cahill, TNEI Ireland Ltd

Unless specified, all noise meters were installed at least 3.5 m from any hard-reflecting surface except the ground and less than 20 m from the dwelling and away from obvious noise sources, such as boiler flues.

Detailed information and pictures for each of the installed locations are provided below. The original full-size pictures are available on request.

Noise Monitoring Location (NML) Coordinates - ITM

NML	ITM X	ITM Y
NML 01	557115	756420
NML 02	555521	754284
NML 03	552801	755730
NML 04	553965	758300
NML 05	556608	758134

NML01

Reproduced under Google Earth pro licence

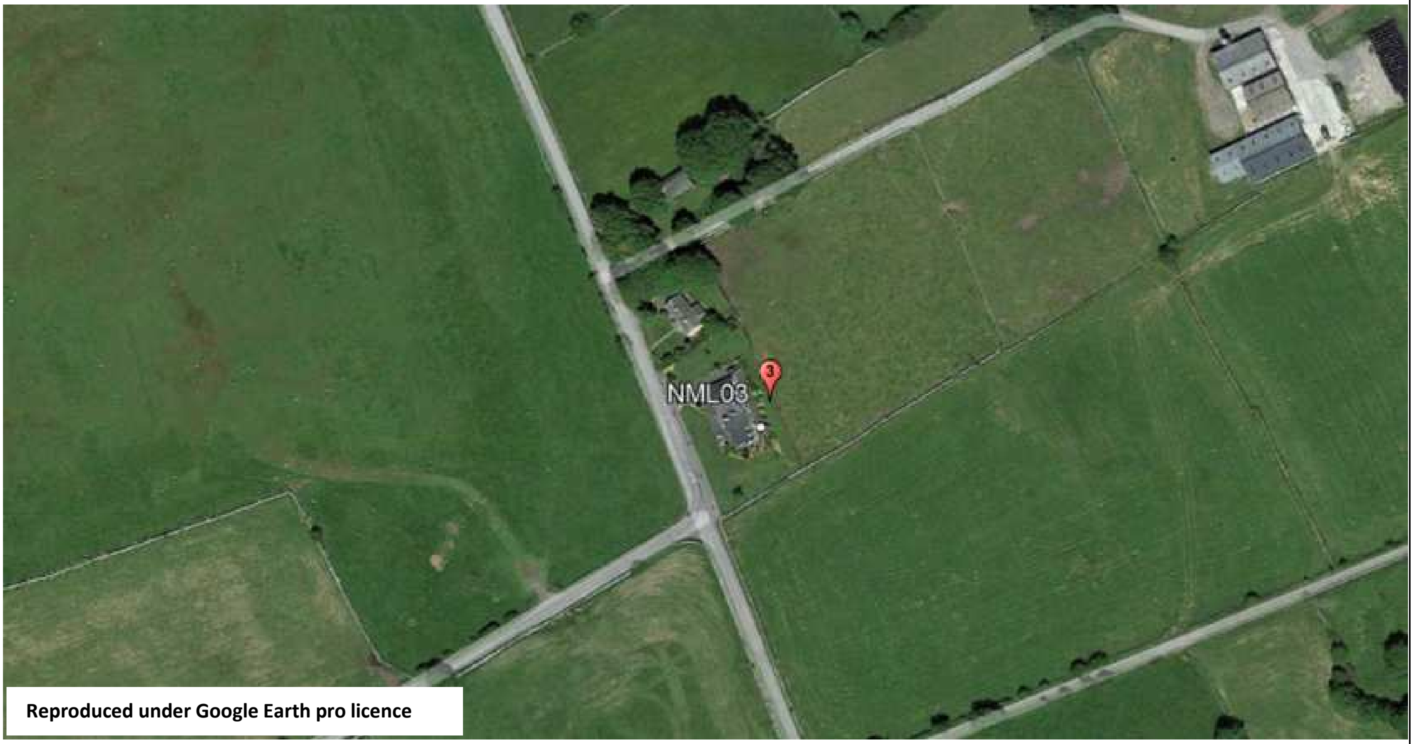
North	South
	
East	**West**
	

Description
The noise monitoring equipment was installed at a proxy location to the north property. The location was chosen due to its proximity to the west of the proposed development. Extremely poor weather during installation. High levels of wind dominating the soundscape. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. Bushes were adjacent the noise kit. A rain gauge was installed at this location.

NML02

North	South
	
East	**West**
	

Description
The noise monitoring equipment was installed in front of the property which was north-west of the house. The location was chosen due to its proximity to the south of the proposed development. Extremely poor weather during installation. High levels of wind dominating the soundscape. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. A farm yard was adjacent the noise kit.

<table>
<tr><th colspan="2">NML03</th></tr>
<tr><td colspan="2">
</td></tr>
<tr><th>North</th><th>South</th></tr>
<tr><td></td><td></td></tr>
<tr><th>East</th><th>West</th></tr>
<tr><td></td><td></td></tr>
</table>

Description
The noise monitoring equipment was installed to the east of the property. The location was chosen due to its proximity to the west of the proposed development. Extremely poor weather during installation. High levels of wind dominating the soundscape. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. A farm yard was adjacent the noise kit.

NML04	
	
North	**South**
	
East	**West**
	

Description
The noise monitoring equipment was installed in back amenity area to the south-east of the property. The location was chosen due to its proximity to the north-west of the proposed development. Extremely poor weather during installation. High levels of wind dominating the soundscape. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. Bushes, trees and shrubs were adjacent the noise kit. A rain gauge was installed at this location.

NML05	
	
North	South
	
East	West
	

Description
The noise monitoring equipment was installed in back amenity area to the south-west of the property. The location was chosen due to its proximity to the north-east of the proposed development. Extremely poor weather during installation. High levels of wind dominating the soundscape. The noise meter was located in a free field position, greater than 3.5m from any hard reflecting surface except the ground. Fencing was adjacent the noise kit.

Noise Monitoring Field Data Sheet

Project Title	Clonberne Wind Farm	Project Number	13772
Client	MKO	Surveyor	OC/JS

MONITORING LOCATION

Location Name	Noise Monitoring Location (NML) 1
Description	The location was chosen due to its proximity to the east of the proposed development. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground). The NML is the closest NSR in this area that is not likely to be influenced by noise from nearby trees and as such represents a conservative baseline. A rain gauge was installed at this location.
Approximate Irish Transverse Mercator (ITM) Reference	557115, 756420
Noise sources noted during installation, weekly inspection and removal	The predominant sounds that were audible were the wind and the surrounding soundscape.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 007	NL32	00972335	12/07/2019
Pre Amplifier	Rion	NH-21	25120	12/07/2019
Microphone	Rion	UC-53a	313224	12/07/2019
Calibrator	Cal 003	NC-74	35173441	07/03/19
	Cal 001	NC-74	34762316	22/01/20

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0101	12:30 19/02/20	09:30 16/03/20	94.0	93.8	0.2	**19/02: Installation:** Extremely poor weather during installation. High levels of wind dominating the soundscape. No other significant noise sources identified. A walk around the property was undertaken to identify any potential water courses, drains etc and other noise sources, such as boiler flues, pumps etc.
0102	10:00 16/03/20	09:30 21/04/20	94.0	94.0	0	**16/03: Maintenance:** None noted. **21/04: Equipment Decommission:** None noted.

PHOTOGRAPHS

Noise Monitoring Field Data Sheet

Project Title	Clonberne Wind Farm	Project Number	13772
Client	MKO	Surveyor	OC/JS

MONITORING LOCATION

Location Name	Noise Monitoring Location (NML) 2
Description	The location was chosen due to its proximity to the south of the proposed development. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground). The NML is the closest NSR in this area that is not likely to be influenced by noise from nearby trees and as such represents a conservative baseline.
Approximate Irish Transverse Mercator (ITM) Reference	555521, 754284
Noise sources noted during installation, weekly inspection and removal	The predominant sounds that were audible were the wind and the surrounding soundscape.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 026	NL32	00703295	03/06/2019
Pre Amplifier	Rion	NH-21	33386	03/06/2019
Microphone	Rion	UC-53a	317047	03/06/2019
Calibrator	Cal 003	NC-74	35173441	07/03/19
Calibrator	Cal 001	NC-74	34762316	22/01/20

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	13:30 19/02/20	10:30 16/03/20	94.0	94.0	0	**19/02: Installation:** Extremely poor weather during installation. High levels of wind dominating the soundscape. No other significant noise sources identified. A walk around the property was undertaken to identify any potential water courses, drains etc and other noise sources, such as boiler flues, pumps etc.
0202	11:00 16/03/20	10:30 21/04/20	94.0	94.0	0	**16/03: Maintenance:** None noted. **21/04: Equipment Decommission:** None noted.

PHOTOGRAPHS

Noise Monitoring Field Data Sheet

Project Title	Clonberne Wind Farm	Project Number	13772
Client	MKO	Surveyor	OC/JS

MONITORING LOCATION

Location Name	Noise Monitoring Location (NML) 3
Description	The location was chosen due to its proximity to the south-west of the proposed development. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground). The NML is the closest NSR in this area that is not likely to be influenced by noise from nearby trees and as such represents a conservative baseline.
Approximate Irish Transverse Mercator (ITM) Reference	552801, 755730
Noise sources noted during installation, weekly inspection and removal	The predominant sounds that were audible were the wind and the surrounding soundscape.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 014	NL31	01273102	12/07/2019
Pre Amplifier	Rion	NH-21	26021	12/07/2019
Microphone	Rion	UC-53a	313359	12/07/2019
Calibrator	Cal 003	NC-74	35173441	07/03/19
Calibrator	Cal 001	NC-74	34762316	22/01/20

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	13:30 19/02/20	10:30 16/03/20	94.0	94.0	0	**19/02: Installation:** Extremely poor weather during installation. High levels of wind dominating the soundscape. No other significant noise sources identified. A walk around the property was undertaken to identify any potential water courses, drains etc and other noise sources, such as boiler flues, pumps etc.
0202	11:00 16/03/20	10:30 21/04/20	94.0	94.0	0	**16/03: Maintenance:** None noted. **21/04: Equipment Decommission:** None noted.

PHOTOGRAPHS

Noise Monitoring Field Data Sheet

Project Title	Clonberne Wind Farm	Project Number	13772
Client	MKO	Surveyor	OC/JS

MONITORING LOCATION

Location Name	Noise Monitoring Location (NML) 4
Description	The location was chosen due to its proximity to the north-west of the proposed development. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground). The NML is the closest NSR in this area that is not likely to be influenced by noise from nearby trees and as such represents a conservative baseline. A rain gauge was installed at this location.
Approximate Irish Transverse Mercator (ITM) Reference	553965, 758300
Noise sources noted during installation, weekly inspection and removal	The predominant sounds that were audible were the wind and the surrounding soundscape.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 013	NL31	01273096	12/07/2019
Pre Amplifier	Rion	NH-21	36881	12/07/2019
Microphone	Rion	UC-53a	313300	12/07/2019
Calibrator	Cal 003	NC-74	35173441	07/03/19
Calibrator	Cal 001	NC-74	34762316	22/01/20

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	13:30 19/02/20	10:30 16/03/20	94.0	94.0	0	**19/02: Installation:** Extremely poor weather during installation. High levels of wind dominating the soundscape. No other significant noise sources identified. A walk around the property was undertaken to identify any potential water courses, drains etc and other noise sources, such as boiler flues, pumps etc.
0202	11:00 16/03/20	10:30 21/04/20	94.0	94.0	0	**16/03: Maintenance:** None noted. **21/04: Equipment Decommission:** None noted.

PHOTOGRAPHS

Noise Monitoring Field Data Sheet

Project Title	Clonberne Wind Farm	Project Number	13772
Client	MKO	Surveyor	OC/JS

MONITORING LOCATION

Location Name	Noise Monitoring Location (NML) 5
Description	The location was chosen due to its proximity to the north-east of the proposed development. The kit was placed greater than 3.5 m away from any reflective surfaces (excluding the ground). The NML is the closest NSR in this area that is not likely to be influenced by noise from nearby trees and as such represents a conservative baseline.
Approximate Irish Transverse Mercator (ITM) Reference	556608, 758134
Noise sources noted during installation, weekly inspection and removal	The predominant sounds that were audible were the wind and the surrounding soundscape.

NOISE MONITORING EQUIPMENT DETAILS

Survey	Kit Number	Model	Serial Number	Last Calibrated/ Conformance Checked
Sound Level Meter	SLM 023	NL32	00703297	12/04/2019
Pre Amplifier	Rion	NH-21	33388	12/04/2019
Microphone	Rion	UC-53a	317049	12/04/2019
Calibrator	Cal 003	NC-74	35173441	07/03/19
Calibrator	Cal 001	NC-74	34762316	22/01/20

NOISE MONITORING EQUIPMENT SETTINGS

	Network (A,B,Z)	Index and Time	Time Weighting (Slow, Fast)	Range (dB)	Audio
Parameters Recorded	A	$L_{A9010min}$, $L_{Aeq10min}$	Fast	20-110	No

DATA

File Name	Start Time	End Time	Cal. at Start	Cal. at End	Drift	Observations
0201	13:30 19/02/20	10:30 16/03/20	94.0	93.9	-0.1	**19/02: Installation:** Extremely poor weather during installation. High levels of wind dominating the soundscape. No other significant noise sources identified. A walk around the property was undertaken to identify any potential water courses, drains etc and other noise sources, such as boiler flues, pumps etc.
0202	11:00 16/03/20	10:30 21/04/20	94.0	94.0	0	**16/03: Maintenance:** None noted. **21/04: Equipment Decommission:** None noted.

PHOTOGRAPHS

Lidar Installation Report

Clonberne Wind Farm

DOCUMENT DETAILS

Client:	**Clonberne Windfarm Limited**
Project Title:	**Clonberne Wind Farm**
Project Number:	**180740**
Document Title:	**Lidar Installation Report**
Document File Name:	**LiDAR Installation Report_Clonberne - 2020.02.21 - 180740.**
Prepared By:	**MKO** **Tuam Road** **Galway** **Ireland** **H91 VW84**

Planning and Environmental Consultants

Rev	Status	Date	Author(s)	Approved By
01	Draft	21/02/2020	OC	MW
02	Final	21/02/2020	OC	MW

Site Details

Site Name: Clonberne Wind Farm **Client Name:** Clonberne Wind Farm

Project Number: 180740

Site Information			
Deployment Start date & Time	21/02/2020 @ 14.00	**Client Contact Details**	(091) 757 034
Landowner contact details	Arranged by client	**Site Access Procedure**	Call Landowner (arranged by client)
Site Access Route	53°33'43.6"N 8°40'47.9"W	**Nearest Town/ Postcode**	Clonberne Village Tuam

Observed Conditions			
Wind Speed	Wind Direction	Precipitation	Visibility
5.468m/s	200.592 degrees	0.5mm	Wet and Blustery

Deployment Information	
Installation Engineer(s)	David Noble and Owen Cahill
Model of Device	Zephir ZX300
Device Serial Number	859

Location Information	
Unit Location Grid Coordinates	**53.56097 -8.68025**
Elevation	75m
Location Description	In actively grazed agricultural grassland.
Road Type	Paved road, up to field gate then agricultural grassland
Distance from Access Road	30m from field entrance
Vehicle Requirements	Renault Kangoo

Location Information	
Terrain Type	Agricultural grassland
Current Land Use	Pasture
Seasonal Land Use (e.g., crops)	Seasonal Grazing land, untilled

Communications			
Router Hardware	Sim Card Number	Sim Card IP address	Signal Strength
Waltz Software	No SIM card	n/a	n/a

Power Supply			
Type	Distance From Device (Cable Length)	Fuel Level	Lifespan
Mains	<10m	n/a	n/a

Device Configuration		
Alignment	Due North	
Scan Type	FD Horizontal Wind Speed (m/s) at Scan Centre at Rm	
Max Range	Met Station is positioned on the ZX300. Clear span around field is approx. 100m	
VAD Processing	ON	~~OFF~~
Hourly Scan Home	ON	~~OFF~~
Hourly Window Wipe	ON	~~OFF~~
Auto Clean	ON	~~OFF~~
Heat up Before Start	ON	~~OFF~~
Software Version	Zephir Lidar ZP573	
Target Description	N/A	
Distance to Target	N/A	

Device Configuration	
Target Coordinates	53.56097 -8.68025
Target Elevation	63m to 199m

Notes
ZX300 measurement heights set to: 199m ,169m, 159m, 149m, 139m, 129m, 119m, 109m, 99m, 54m, 38m
Site Description: From the ZX300 – • North – Ground remains level. Tree line and field boundary 40m north. • East – Ground remains level. Shed building 6m east. • South – Ground level drops slightly into agricultural field. Broken treeline 20m south. • West – Ground remains level into the field is intersected by treeline 40m west. **Note:** ZX300 is elevated off ground level so therefore a 1m offset approx. in reported height vs ground level set in software.

Annex 3 – Calibration & Conformance Certificates for Sound Level Meters and Calibrator

CAL3

M E A S U R E M E N T   S Y S T E M S

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION
0653

Date of Issue: 07 March 2019

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Certificate Number: UCRT19/1292

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA			
Order No.	5001			
Test Procedure	Procedure TP 1	Calibration of Sound Calibrators		
Description	Acoustic Calibrator			
Identification	*Manufacturer* Rion	*Instrument* Calibrator	*Model* NC-74	*Serial No.* 35173441

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS19/03150	
Date Received	06 March 2019	
Date Calibrated	07 March 2019	
Previous Certificate	*Dated*	15 January 2018
	Certificate No.	UCRT18/1034
	Laboratory	0653

Measurements

The sound pressure level generated by the calibrator in its WS2 configuration was measured five times by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below. It is corrected to the standard atmospheric pressure of 101.3 kPa (1013 mBar) using original manufacturers information.

Test Microphone	*Manufacturer*	*Type*
	Brüel & Kjær	4134

Results

The level of the calibrator output under the conditions outlined above was

94.01 ± 0.10 dB rel 20 μPa

Functional Tests and Observations

The frequency of the sound produced was	1001.78 Hz	±	0.13 Hz
The total distortion was	1.22 %	±	6.7 % of Reading

During the measurements environmental conditions were

Temperature	23	to	23	°C
Relative Humidity	37	to	43	%
Barometric Pressure	97.8	to	97.9	kPa

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties refer to the measured values only with no account being taken of the ability of the instrument to maintain its calibration.

A small correction factor may need to be applied to the sound pressure level quoted above if the device is used to calibrate a sound level meter which is fitted with a free-field response microphone. See manufacturers handbook for details.

.... END ....

Note:

Calibrator adjusted prior to calibration?	NO	
Initial Level	N/A	dB
Initial Frequency	N/A	Hz

Additional Comments

None

Calibrated by: B. Bogdan

CERTIFICATE OF CALIBRATION

0653

Date of Issue: 22 January 2020 **Certificate Number: UCRT20/1101**

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle Upon Tyne NE1 3PA			
Order No.	5001			
Test Procedure	Procedure TP 1 Calibration of Sound Calibrators			
Description	Acoustic Calibrator			
Identification	*Manufacturer*	*Instrument*	*Model*	*Serial No.*
	Rion	Calibrator	NC-74	34762316

The calibrator has been tested as specified in Annex B of IEC 60942:2003. As public evidence was available from a testing organisation (PTB) responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the class 1 requirements of IEC 60942:2003.

ANV Job No.	UKAS20/01052	
Date Received	21 January 2020	
Date Calibrated	22 January 2020	
Previous Certificate	*Dated*	16 January 2019
	Certificate No.	UCRT19/1063
	Laboratory	0653

Measurements

The sound pressure level generated by the calibrator in its WS2 configuration was measured five times by the Insert Voltage Method using a microphone as detailed below. The mean of the results obtained is shown below. It is corrected to the standard atmospheric pressure of 101.3 kPa (1013 mBar) using original manufacturers information.

Test Microphone	*Manufacturer*	*Type*
	Brüel & Kjær	4134

Results

The level of the calibrator output under the conditions outlined above was

94.03 ± 0.10 dB rel 20 µPa

Functional Tests and Observations

The frequency of the sound produced was	1002.51	Hz	±	0.13	Hz
The total distortion was	1.41	%	±	6.6	% of Reading

During the measurements environmental conditions were

Temperature	22	to	22	°C
Relative Humidity	32	to	39	%
Barometric Pressure	102.6	to	102.7	kPa

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties refer to the measured values only with no account being taken of the ability of the instrument to maintain its calibration.

A small correction factor may need to be applied to the sound pressure level quoted above if the device is used to calibrate a sound level meter which is fitted with a free-field response microphone. See manufacturers handbook for details.

………………………………………………. END ……………………………………………….

Note:

Calibrator adjusted prior to calibration?	NO	
Initial Level	N/A	dB
Initial Frequency	N/A	Hz

Additional Comments

The results on this certificate only relate to the items calibrated as identified above.

None

Calibrated by: B. Bogdan

SLM 7

CERTIFICATE OF CALIBRATION

Date of Issue: 12 July 2019

Issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Certificate Number: TCRT19/1562

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One, Forth Banks Newcastle Upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-32	00972335
	Rion	Firmware		1.0009
	Rion	Pre Amplifier	NH-21	25120
	Rion	Microphone	UC-53A	313224
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 11 July 2019 ANV Job No. TRAC19/07303

Date Calibrated 12 July 2019

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	16 February 2018	TCRT18/1164	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No		See comment on page 3
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No		See comment on page 3
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No		See comment on page 3
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	27 June 2019		
Calibrator cert. number	UCRT19/1727		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.94	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End			
Temperature	22.76	22.97	±	0.30	°C
Humidity	53.2	52.3	±	3.00	%RH
Ambient Pressure	100.50	100.52	±	0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.3	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z	
	13.2	dB	UR	18.7	dB	UR	23.9	dB
Uncertainty of the electrical self generated noise ±							0.12	dB

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ...." are set to NO above, then the following applies.

No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: B. Bogdan R 1

.... END ....

Additional Comments

None

SLM13

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

Date of Issue: 12 July 2019

Certificate Number: TCRT19/1558

Issued by:
ANV Measurement Systems
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E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer
TNEI Services Ltd
7th Floor
West One, Forth Banks
Newcastle Upon Tyne
NE1 3PA

Order No. 5001

Description: Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-31	01273096
Rion	Firmware		1.050
Rion	Pre Amplifier	NH-21	36881
Rion	Microphone	UC-53A	313300
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class: 1

Test Procedure: TP 2.SLM 61672-3 TPS-49
Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received: 11 July 2019 ANV Job No. TRAC19/07303

Date Calibrated: 12 July 2019

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	22 May 2018	TCRT18/1446	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-21 NL-31 Instruction Manual	
SLM instruction manual ref / issue	32006 09-04	
SLM instruction manual source	Manufacturer	
Internet download date if applicable	N/A	
Case corrections available	Yes	
Uncertainties of case corrections	No	See comment on page 3
Source of case data	Manufacturer	
Wind screen corrections available	Yes	
Uncertainties of wind screen corrections	No	See comment on page 3
Source of wind screen data	Manufacturer	
Mic pressure to free field corrections	Yes	
Uncertainties of Mic to F.F. corrections	No	See comment on page 3
Source of Mic to F.F. corrections	Manufacturer	
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes	
Specified or equivalent Calibrator	Specified	
Customer or Lab Calibrator	Lab Calibrator	
Calibrator adaptor type if applicable	NC-74-002	
Calibrator cal. date	27 June 2019	
Calibrator cert. number	UCRT19/1727	
Calibrator cal cert issued by Lab.	ANV Measurement Systems	
Calibrator SPL @ STP	94.01 dB	Calibration reference sound pressure level
Calibrator frequency	1001.94 Hz	Calibration check frequency
Reference level range	30 - 120 dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End		
Temperature	22.64	22.61	±	0.30 °C
Humidity	52.0	51.4	±	3.00 %RH
Ambient Pressure	100.44	100.47	±	0.03 kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1 dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±			0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	11.8	dB	UR	17.1	dB	UR	23.2	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ...." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: B. Giles

R 2

.... END ....

Additional Comments

None

SLM 14

MEASUREMENT SYSTEMS

CERTIFICATE OF CALIBRATION

Date of Issue: 12 July 2019

Certificate Number: TCRT19/1557

Issued by:
ANV Measurement Systems
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Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One, Forth Banks Newcastle Upon Tyne NE1 3PA

Order No.	5001			
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator			
Identification	*Manufacturer*	*Instrument*	*Type*	*Serial No. / Version*
	Rion	Sound Level Meter	NL-31	01273102
	Rion	Firmware		1.400
	Rion	Pre Amplifier	NH-21	26021
	Rion	Microphone	UC-53A	313359
	Rion	Calibrator	NC-74	34536109
		Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 11 July 2019 ANV Job No. TRAC19/07303

Date Calibrated 12 July 2019

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

	Dated	*Certificate No.*	*Laboratory*
Previous Certificate	22 May 2018	TCRT18/1450	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-21 NL-31 Instruction Manual		
SLM instruction manual ref / issue	32006 09-04		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No		See comment on page 3
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No		See comment on page 3
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No		See comment on page 3
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	27 June 2019		
Calibrator cert. number	UCRT19/1727		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	94.01	dB	Calibration reference sound pressure level
Calibrator frequency	1001.94	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests		Start	End			
	Temperature	22.65	22.69	±	0.30	°C
	Humidity	53.3	52.4	±	3.00	%RH
	Ambient Pressure	100.40	100.43	±	0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	11.2	dB	UR	17.3	dB	UR	23.0	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ...." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: B. Giles

R 2

.... END ....

<u>Additional Comments</u>
None

Slm 23

CERTIFICATE OF CALIBRATION

Date of Issue: 12 April 2019

Certificate Number: TCRT19/1298

Issued by:
ANV Measurement Systems
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E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer	TNEI Services Ltd 7th Floor West One Forth Banks Newcastle upon Tyne NE1 3PA
Order No.	5001
Description	Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703297
Rion	Firmware		1.400
Rion	Pre Amplifier	NH-21	33388
Rion	Microphone	UC-53A	317049
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received 11 April 2019 ANV Job No. TRAC19/04158

Date Calibrated 12 April 2019

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	14 March 2018	TCRT18/1212	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

MEASUREMENT SYSTEMS

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No		See comment on page 3
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No		See comment on page 3
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No		See comment on page 3
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	29 March 2019		
Calibrator cert. number	UCRT19/1384		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	93.98	dB	Calibration reference sound pressure level
Calibrator frequency	1001.93	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End			
Temperature	22.82	22.74	±	0.30	°C
Humidity	35.1	33.9	±	3.00	%RH
Ambient Pressure	101.58	101.56	±	0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.0	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise — This test is currently not performed by this Lab.

Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z	
	9.6	dB	UR	15.4	dB	UR	21.4	dB
Uncertainty of the electrical self generated noise ±							0.12	dB

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ...." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

Calibrated by: B. Bogdan R 2

.... END ....

Additional Comments
None

SCM 026

CERTIFICATE OF CALIBRATION

MEASUREMENT SYSTEMS

Date of Issue: 03 June 2019

Certificate Number: TCRT19/1435

Issued by:
ANV Measurement Systems
Beaufort Court
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E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Approved Signatory

K. Mistry

Customer: TNEI Services Ltd
7th Floor
West One
Forth Banks
Newcastle
NE1 3PA

Order No.: 5001

Description: Sound Level Meter / Pre-amp / Microphone / Associated Calibrator

Identification:

Manufacturer	*Instrument*	*Type*	*Serial No. / Version*
Rion	Sound Level Meter	NL-32	00703295
Rion	Firmware		1.400
Rion	Pre Amplifier	NH-21	33386
Rion	Microphone	UC-53A	317047
Rion	Calibrator	NC-74	34536109
	Calibrator adaptor type if applicable		NC-74-002

Performance Class: 1

Test Procedure: TP 2.SLM 61672-3 TPS-49

Procedures from IEC 61672-3:2006 were used to perform the periodic test.

Type Approved to IEC 61672-1:2002 No Approval Number

If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003

Date Received: 31 May 2019 ANV Job No. TRAC19/05238

Date Calibrated: 03 June 2019

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full requirements of IEC 61672-1:2002 because evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002 and because the periodic tests of IEC 61672-3:2006 cover only a limited subset of the specifications in IEC 61672-1:2002.

Previous Certificate	*Dated*	*Certificate No.*	*Laboratory*
	11 July 2018	TCRT18/1595	ANV Measurement Systems

CERTIFICATE OF CALIBRATION

Sound Level Meter Instruction manual and data used to adjust the sound levels indicated.

SLM instruction manual title	NL-22 NL-32 Instruction Manual		
SLM instruction manual ref / issue	33625 09-06		
SLM instruction manual source	Manufacturer		
Internet download date if applicable	N/A		
Case corrections available	Yes		
Uncertainties of case corrections	No		See comment on page 3
Source of case data	Manufacturer		
Wind screen corrections available	Yes		
Uncertainties of wind screen corrections	No		See comment on page 3
Source of wind screen data	Manufacturer		
Mic pressure to free field corrections	Yes		
Uncertainties of Mic to F.F. corrections	No		See comment on page 3
Source of Mic to F.F. corrections	Manufacturer		
Total expanded uncertainties within the requirements of IEC 61672-1:2002	Yes		
Specified or equivalent Calibrator	Specified		
Customer or Lab Calibrator	Lab Calibrator		
Calibrator adaptor type if applicable	NC-74-002		
Calibrator cal. date	23 May 2019		
Calibrator cert. number	UCRT19/1621		
Calibrator cal cert issued by Lab.	ANV Measurement Systems		
Calibrator SPL @ STP	93.96	dB	Calibration reference sound pressure level
Calibrator frequency	1001.93	Hz	Calibration check frequency
Reference level range	30 - 120	dB	

Accessories used or corrected for during calibration - None
Note - if a pre-amp extension cable is listed then it was used between the SLM and the pre-amp.

Environmental conditions during tests	Start	End			
Temperature	22.69	22.76	±	0.30	°C
Humidity	48.7	49.0	±	3.00	%RH
Ambient Pressure	100.20	100.22	±	0.03	kPa

Response to associated Calibrator at the environmental conditions above.

Initial indicated level	94.1	dB	Adjusted indicated level	94.0	dB
The uncertainty of the associated calibrator supplied with the sound level meter ±				0.10	dB

Self Generated Noise	This test is currently not performed by this Lab.		
Microphone installed (if requested by customer) = Less Than	N/A	dB	A Weighting
Uncertainty of the microphone installed self generated noise ±	N/A	dB	

Microphone replaced with electrical input device - UR = Under Range indicated

Weighting	A			C			Z		
	11.9	dB	UR	19.3	dB	UR	25.3	dB	
Uncertainty of the electrical self generated noise ±							0.12	dB	

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with the Guide to the Expression of Uncertainty in Measurement published by the International Organisation for Standards (ISO).

Comments

For the test of the frequency weightings as per paragraph 12. of IEC 61672-3:2006 the actual microphone free field response was used.

The acoustical frequency tests of a frequency weighting as per paragraph 11 of IEC 61672-3:2006 were carried out using an electrostatic actuator.

If any of the "Uncertainties of ...." are set to NO above, then the following applies.
No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data given in the instruction manual or obtained from the manufacturer or supplier of the sound level meter, or the manufacturer of the microphone, or the manufacturer of the multi-frequency sound calibrator, or the manufacturer of the electrostatic actuator was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of the measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not conform to the requirements of IEC 61672-1:2002.

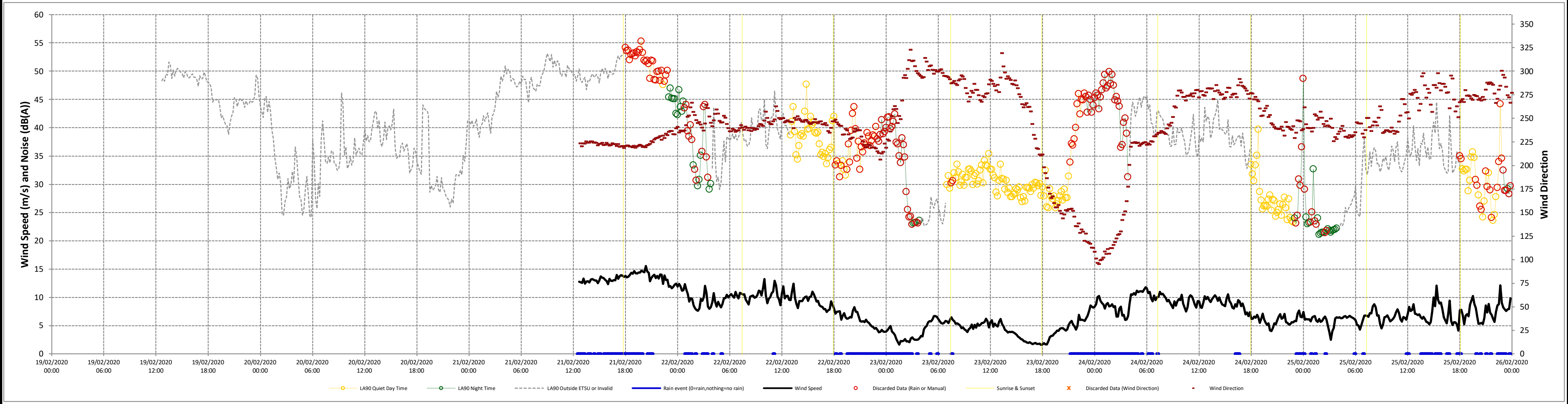
Calibrated by: B. Bogdan R 2

.... END ....

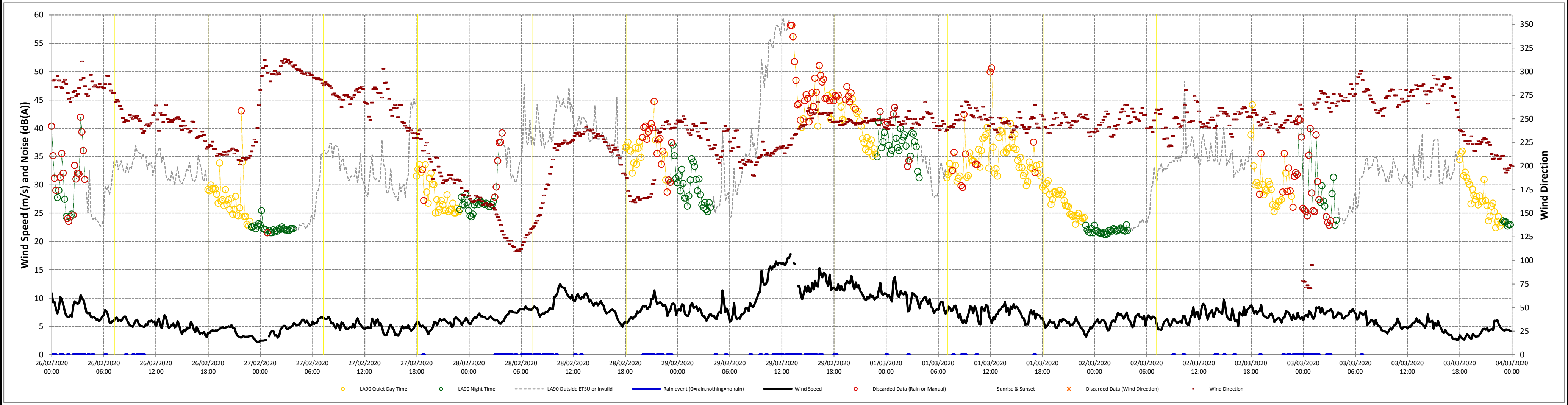
Additional Comments
None

Annex 4 – Time Series Graphs

19/02/2020 to 26/02/2020



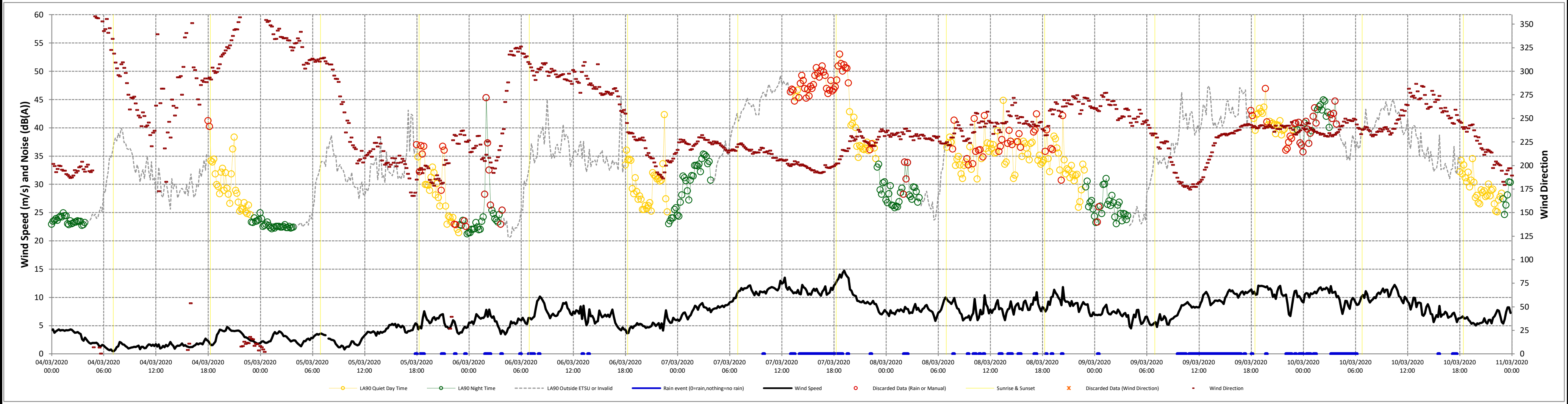
26/02/2020 to 04/03/2020



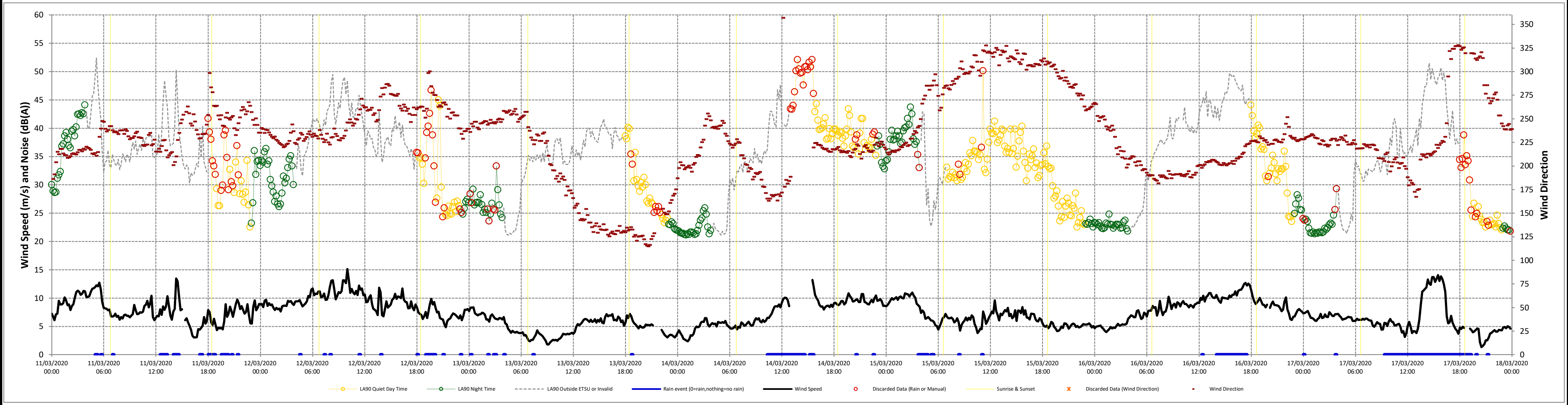
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML1 Page 1 of 4
Date	05/12/2023

tnei

04/03/2020 to 11/03/2020



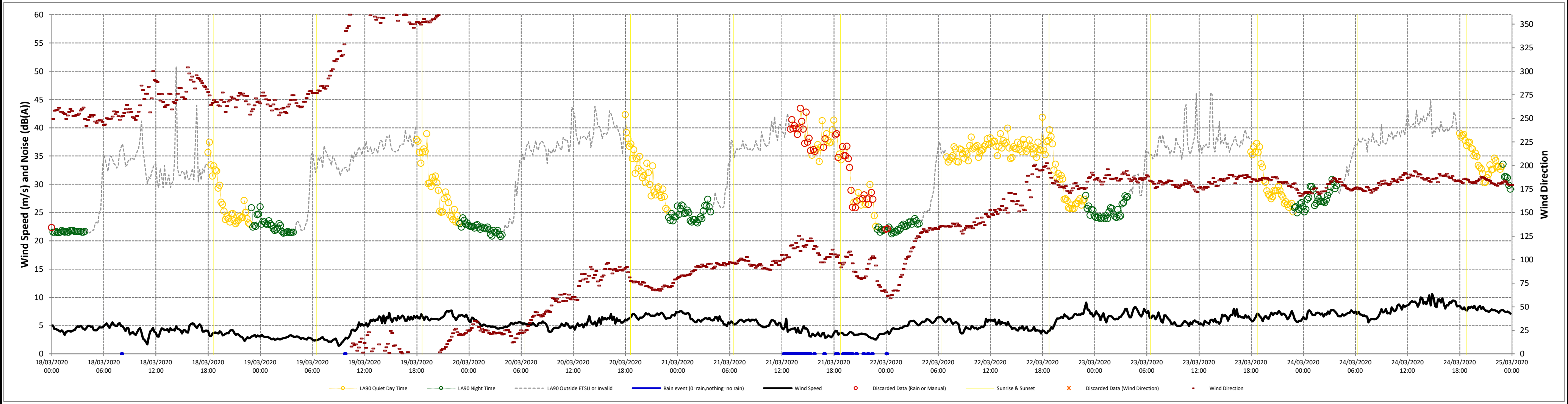
11/03/2020 to 18/03/2020



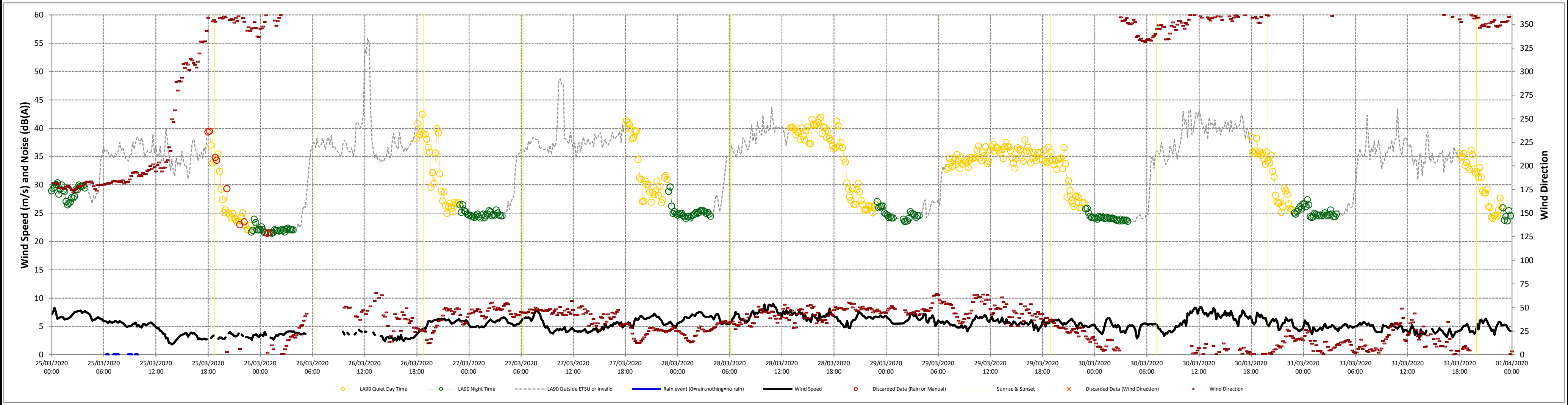
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML1 Page 2 of 4
Date	05/12/2023

tnei

18/03/2020 to 25/03/2020



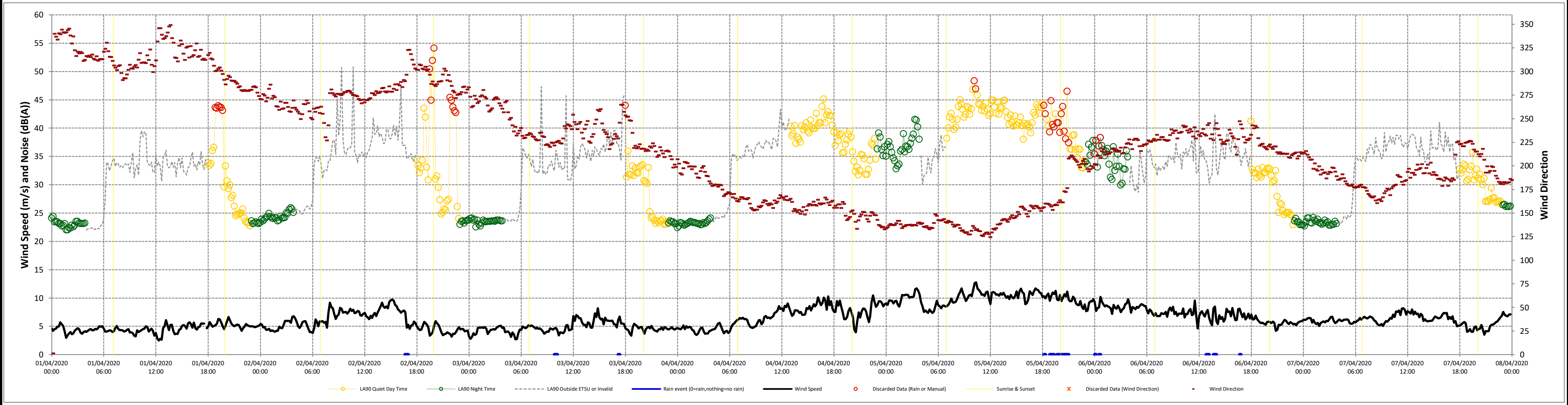
25/03/2020 to 01/04/2020



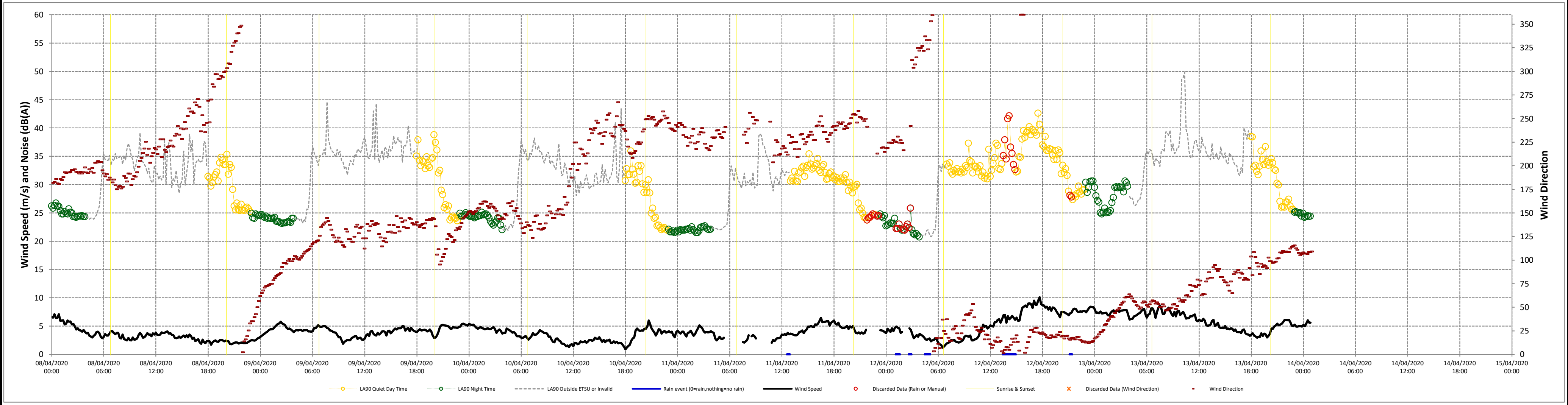
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML1 Page 3 of 4
Date	05/12/2023

tnei

01/04/2020 to 08/04/2020



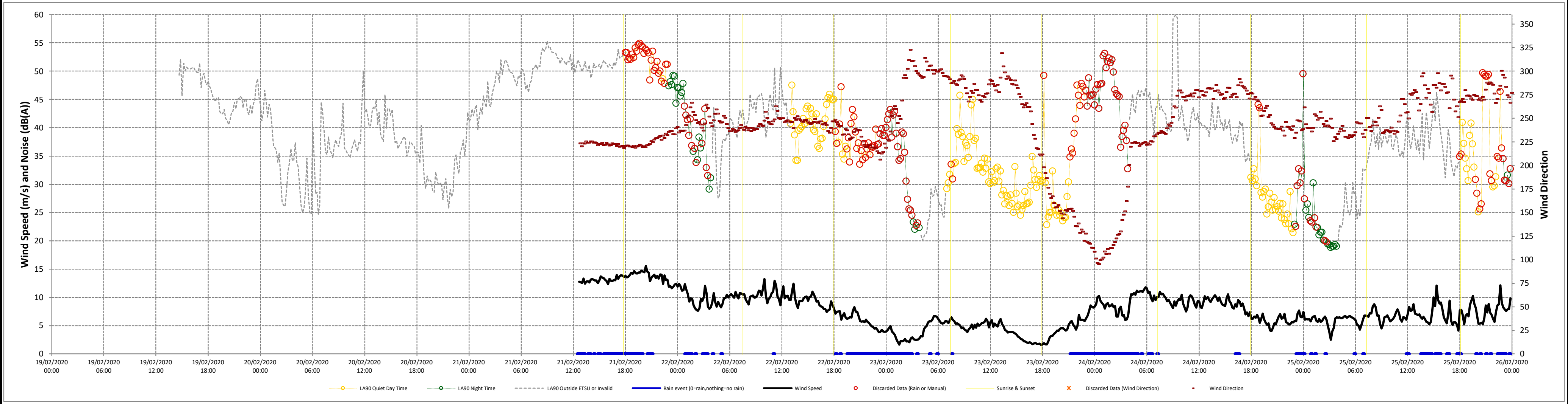
08/04/2020 to 15/04/2020



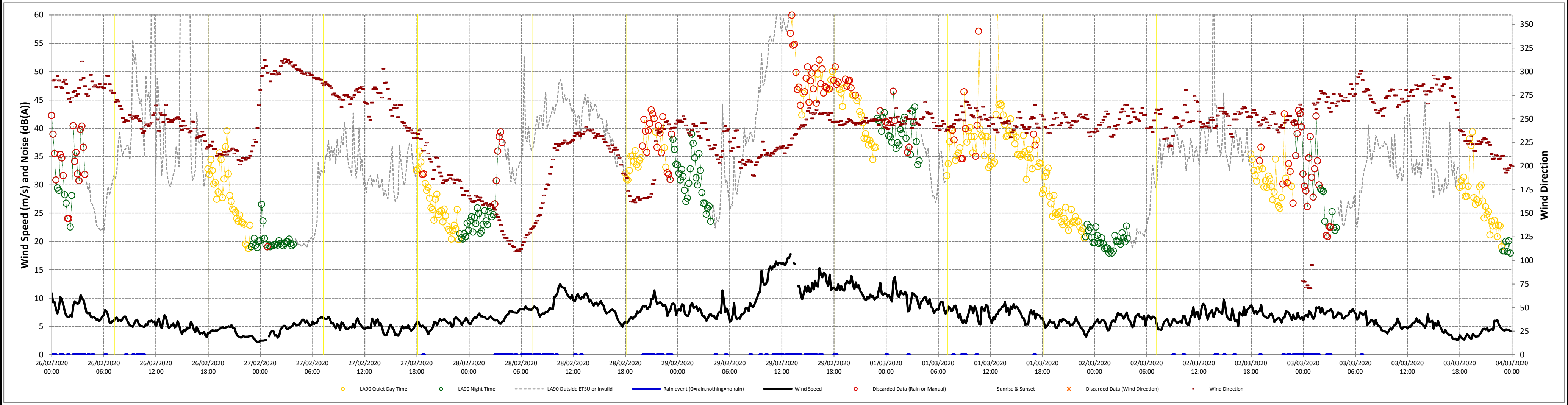
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML1 Page 4 of 4
Date	05/12/2023

tnei

19/02/2020 to 26/02/2020



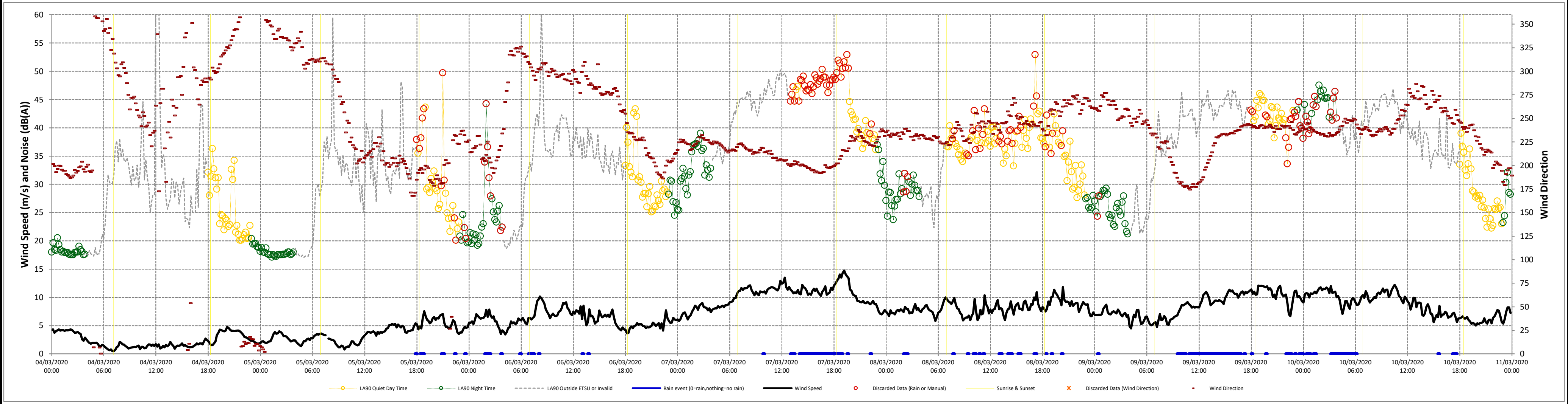
26/02/2020 to 04/03/2020



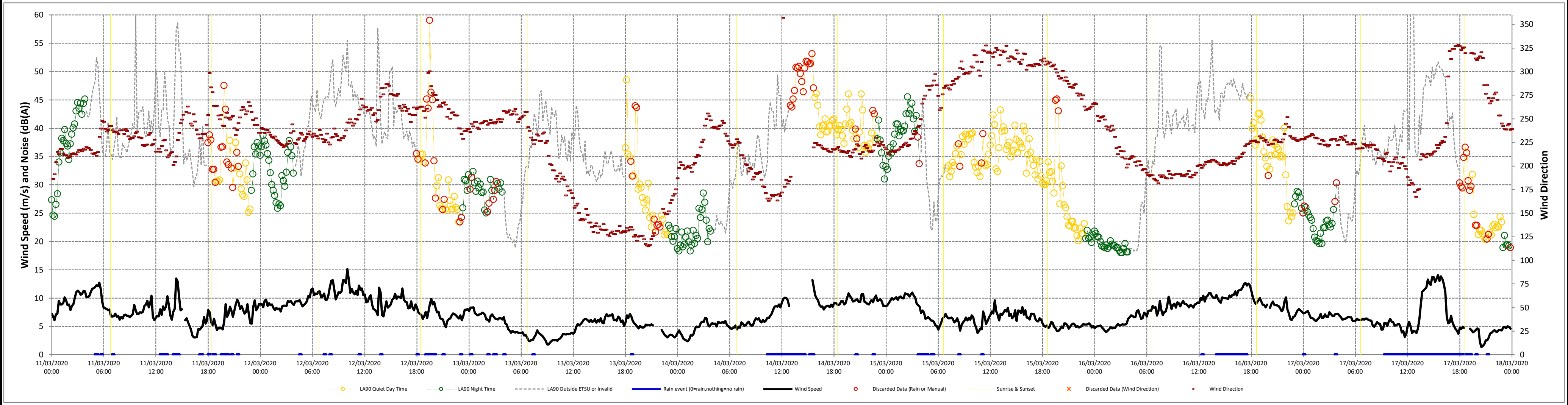
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML2 Page 1 of 4
Date	05/12/2023

tnei

04/03/2020 to 11/03/2020

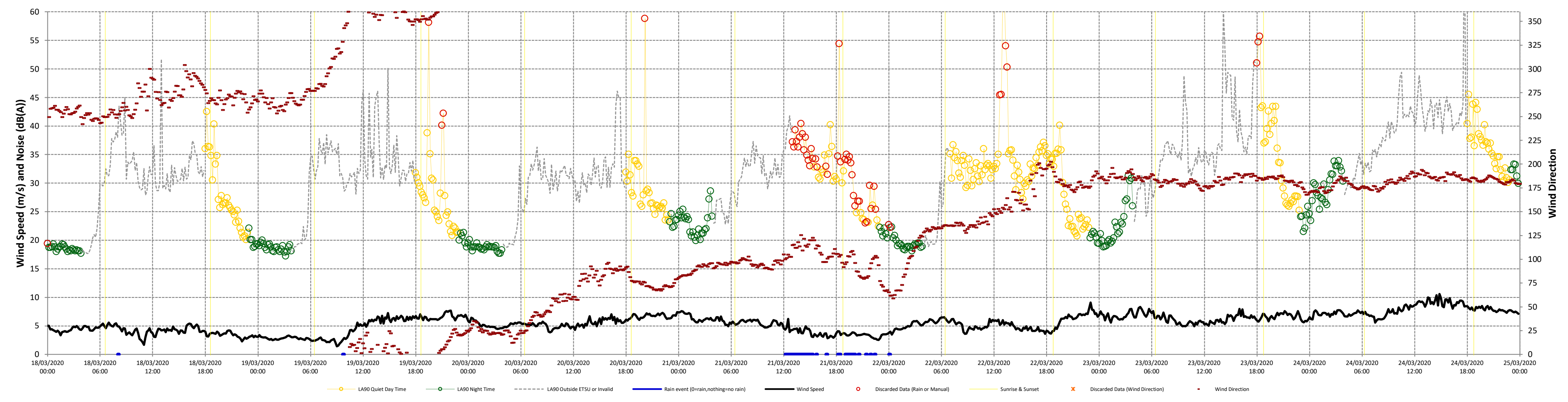


11/03/2020 to 18/03/2020

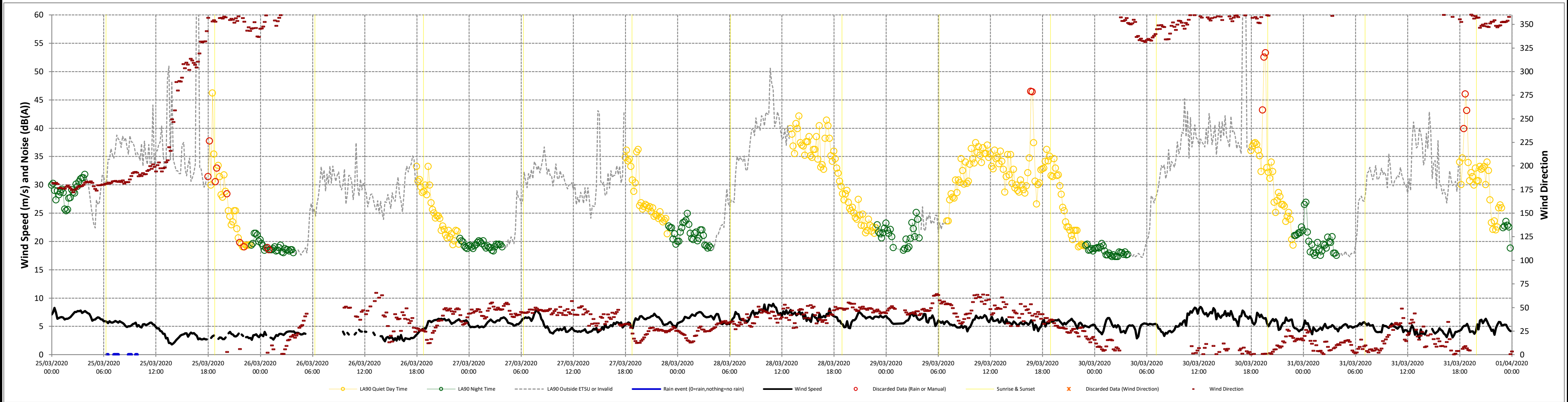


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML2 Page 2 of 4
Date	05/12/2023

18/03/2020 to 25/03/2020

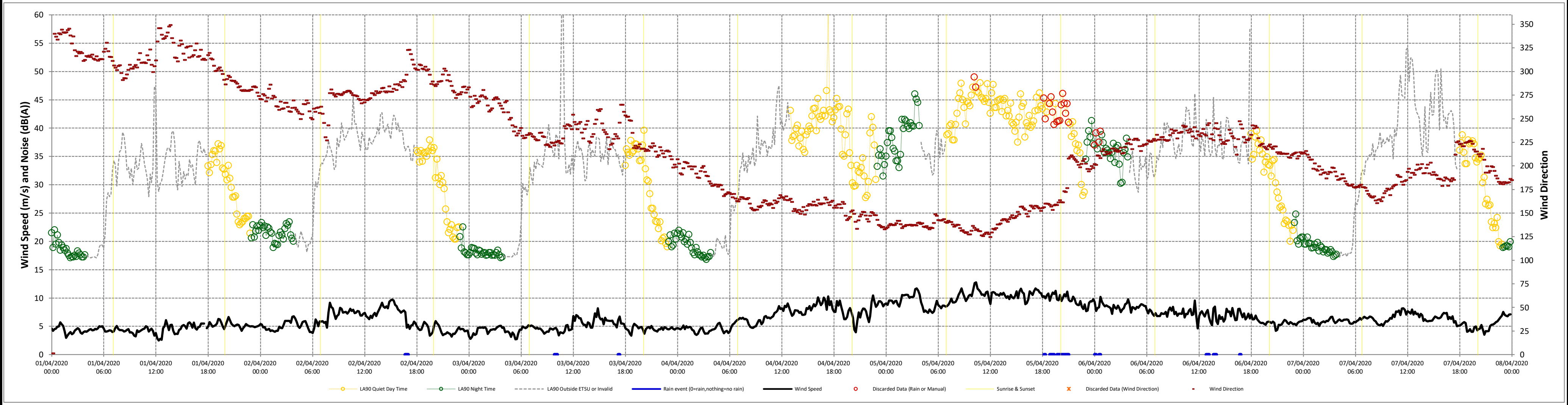


25/03/2020 to 01/04/2020

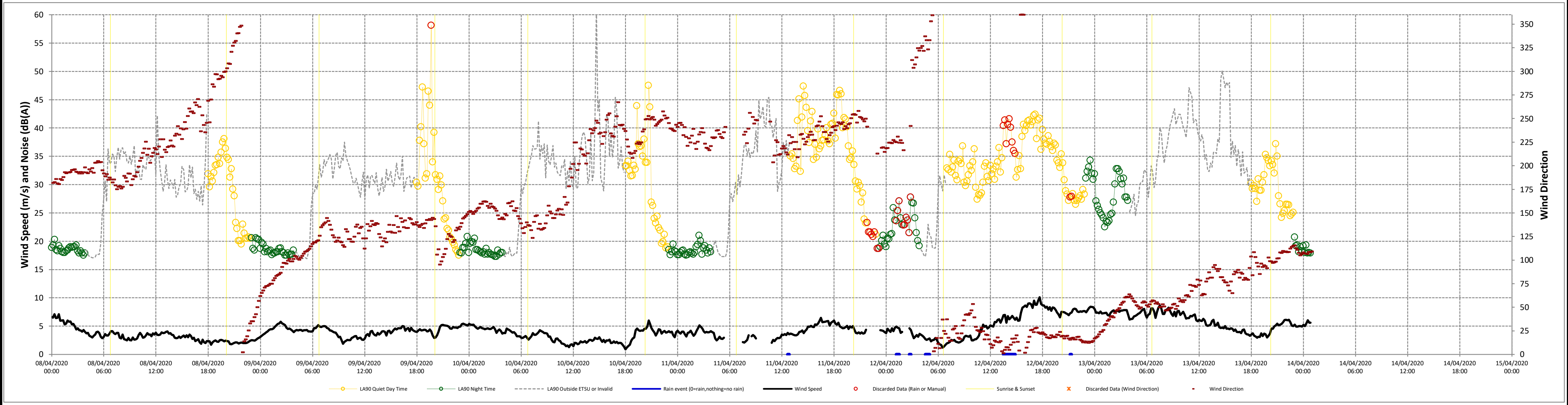


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML2 Page 3 of 4
Date	05/12/2023

01/04/2020 to 08/04/2020



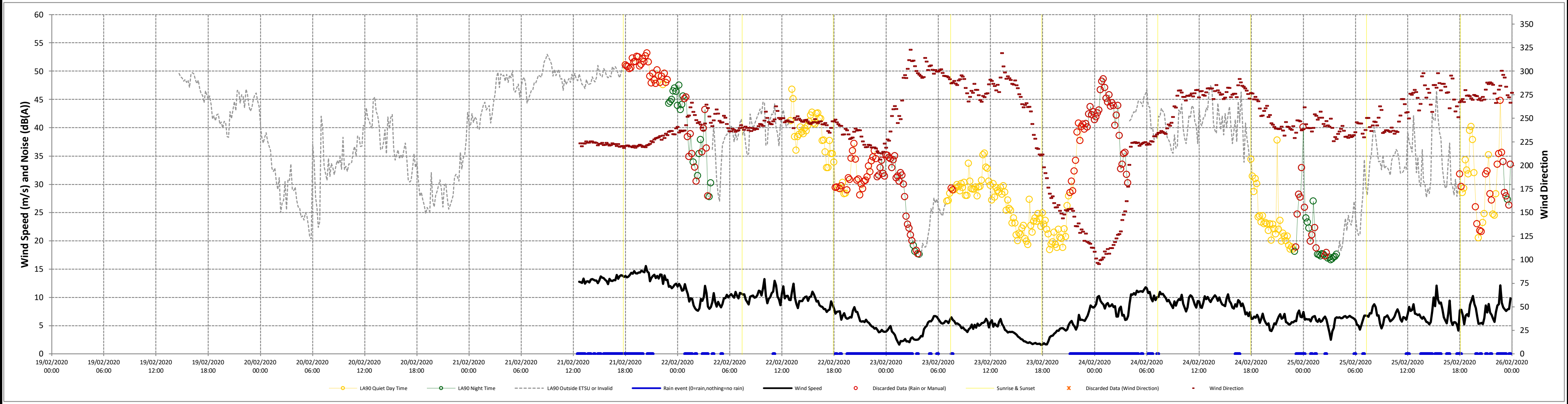
08/04/2020 to 15/04/2020



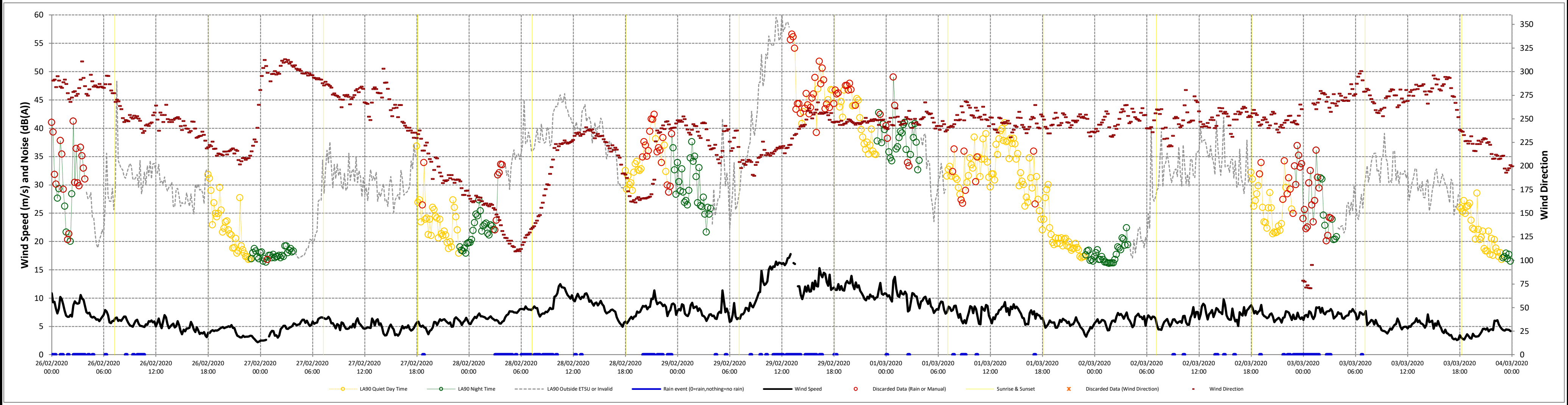
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML2 Page 4 of 4
Date	05/12/2023

tnei

19/02/2020 to 26/02/2020



26/02/2020 to 04/03/2020



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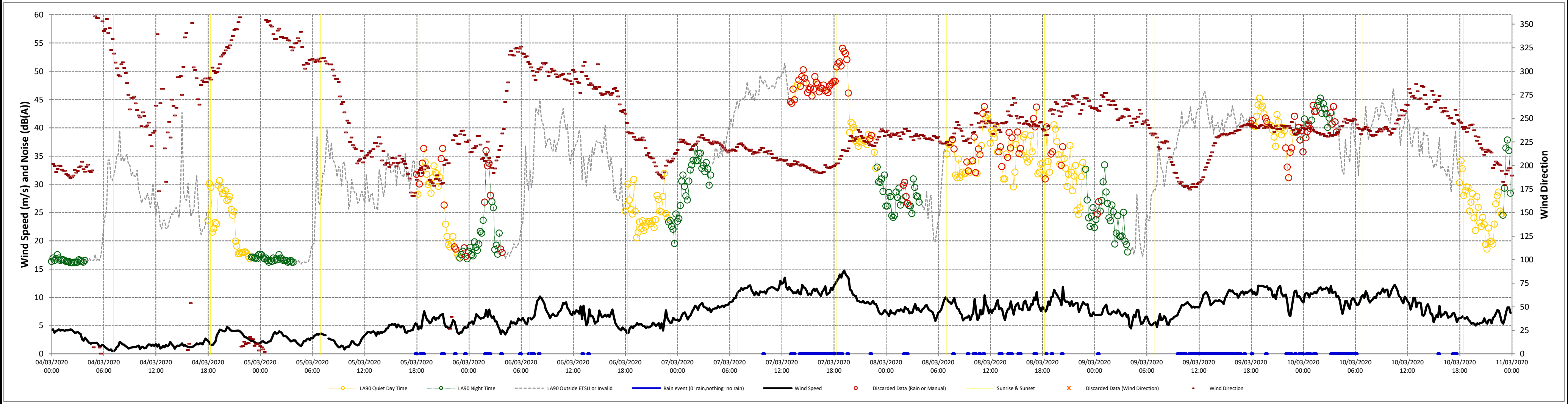
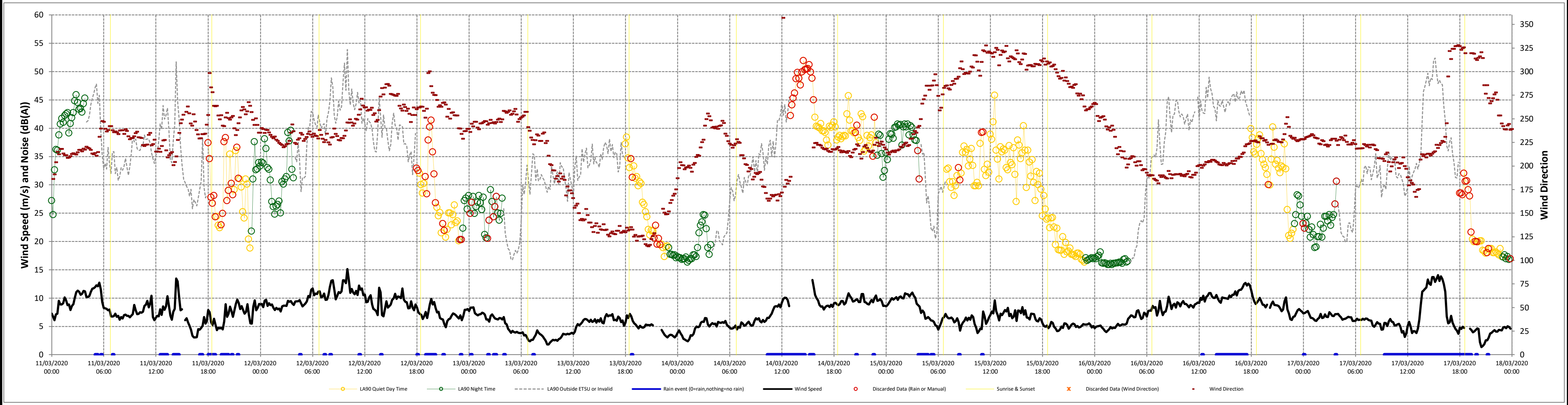
Client	MKO
Title	Time Series for NML3 Page 1 of 4
Date	05/12/2023

04/03/2020 to 11/03/2020



11/03/2020 to 18/03/2020



Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML3 Page 2 of 4
Date	05/12/2023

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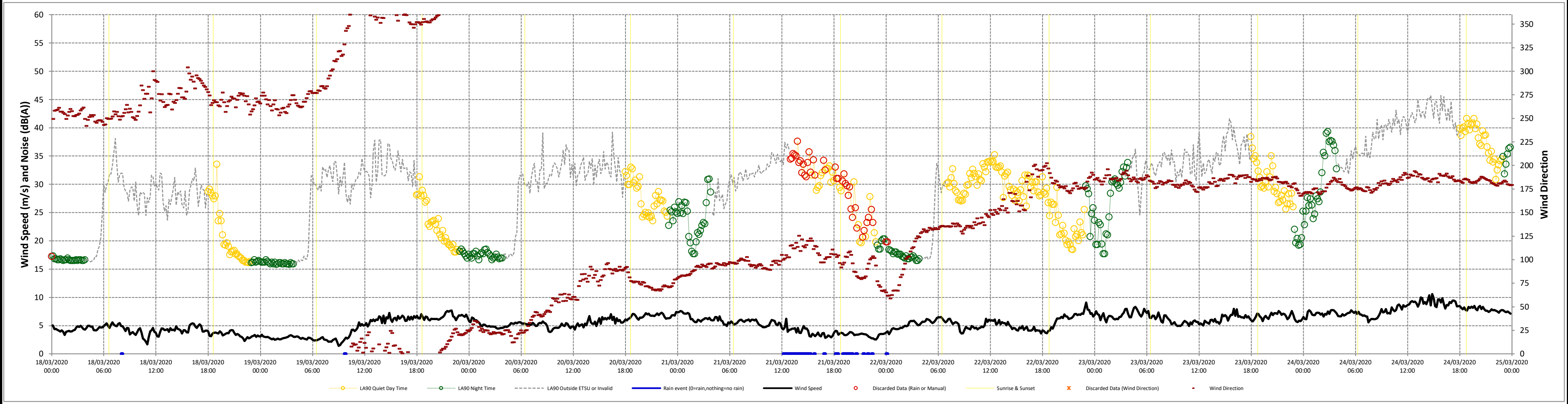
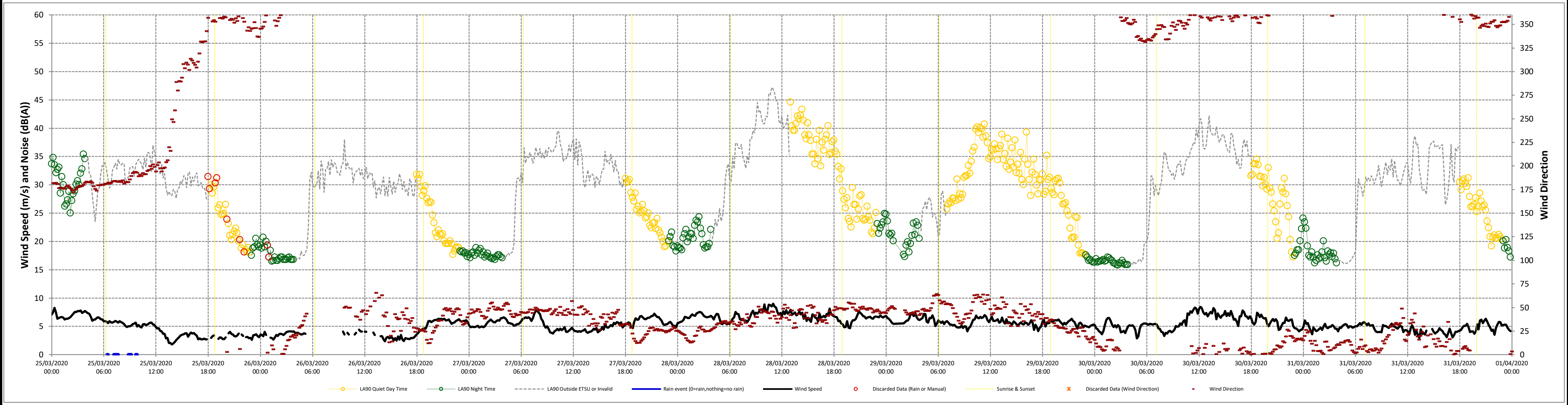
18/03/2020 to 25/03/2020



25/03/2020 to 01/04/2020



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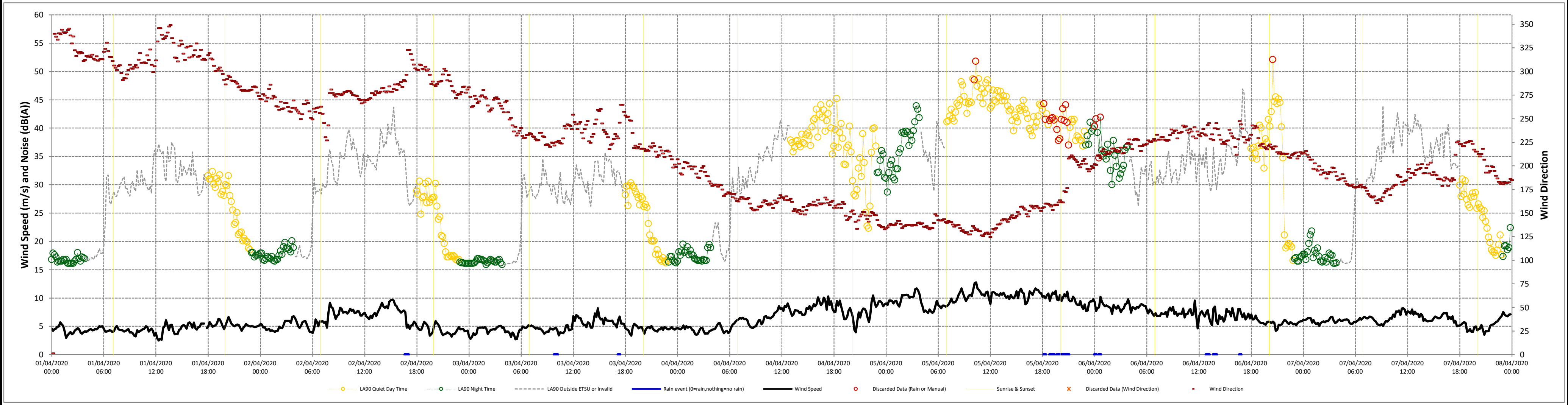
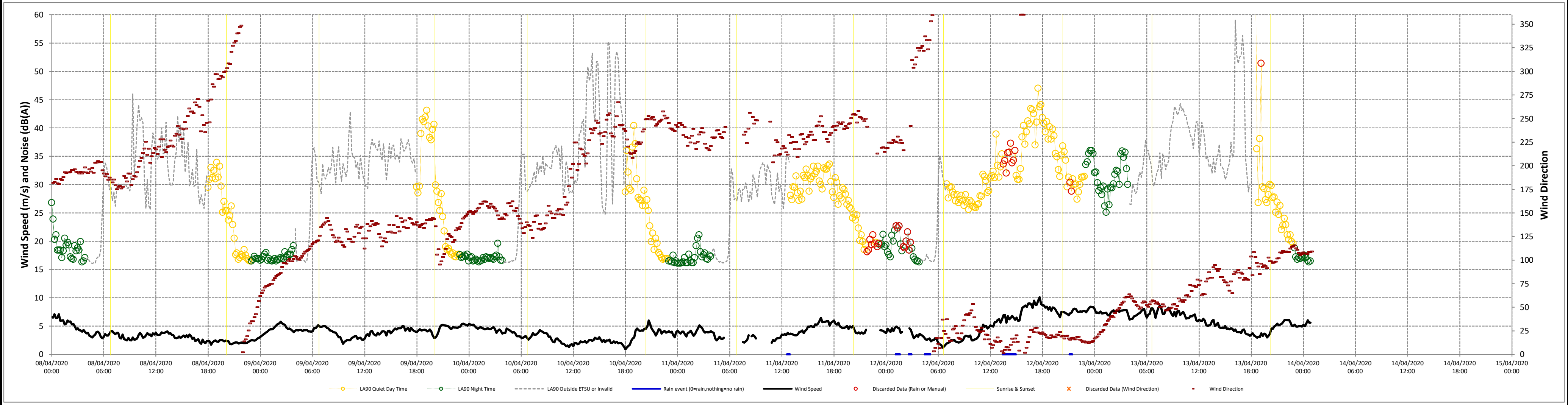
Client	MKO
Title	Time Series for NML3 Page 3 of 4
Date	05/12/2023

01/04/2020 to 08/04/2020

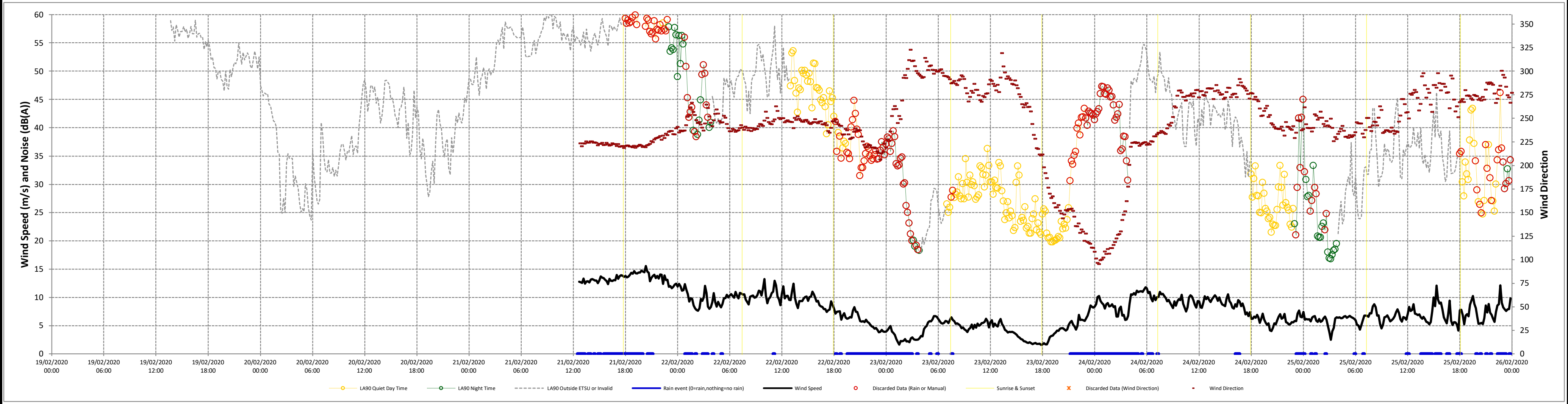


08/04/2020 to 15/04/2020

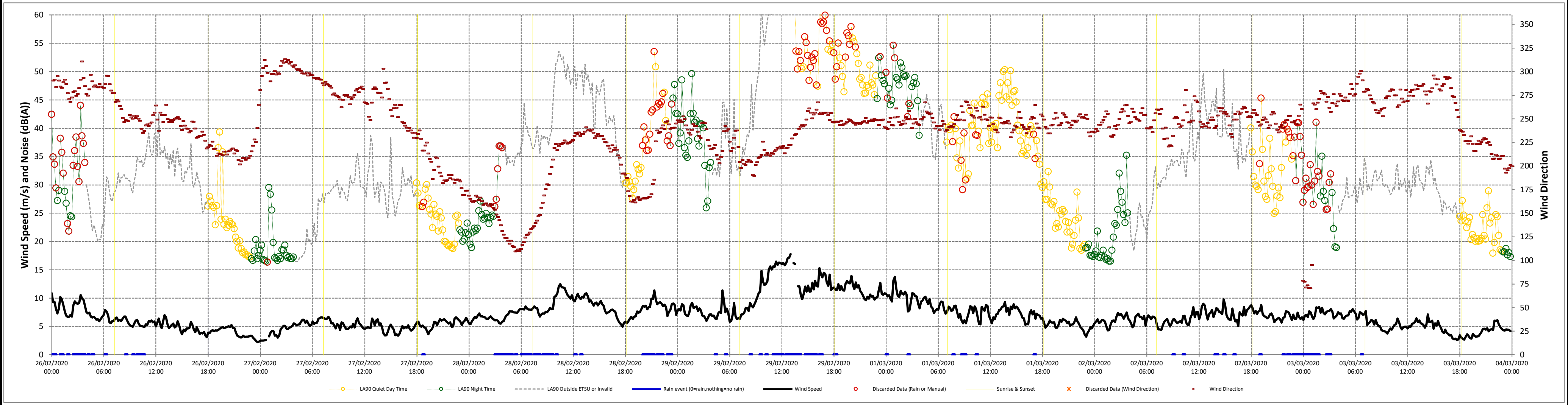


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML3 Page 4 of 4
Date	05/12/2023

19/02/2020 to 26/02/2020

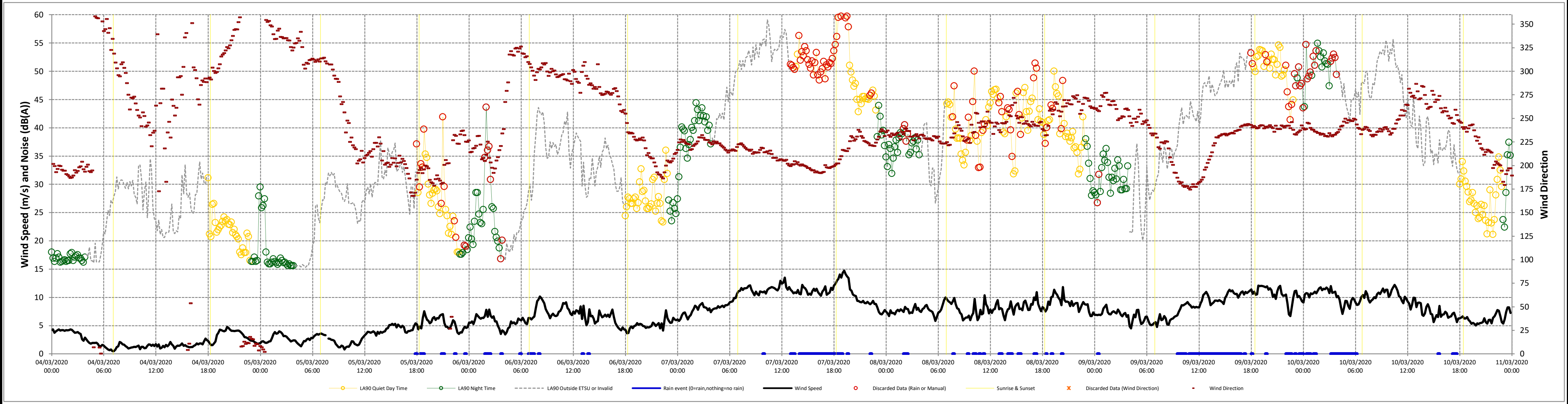


26/02/2020 to 04/03/2020

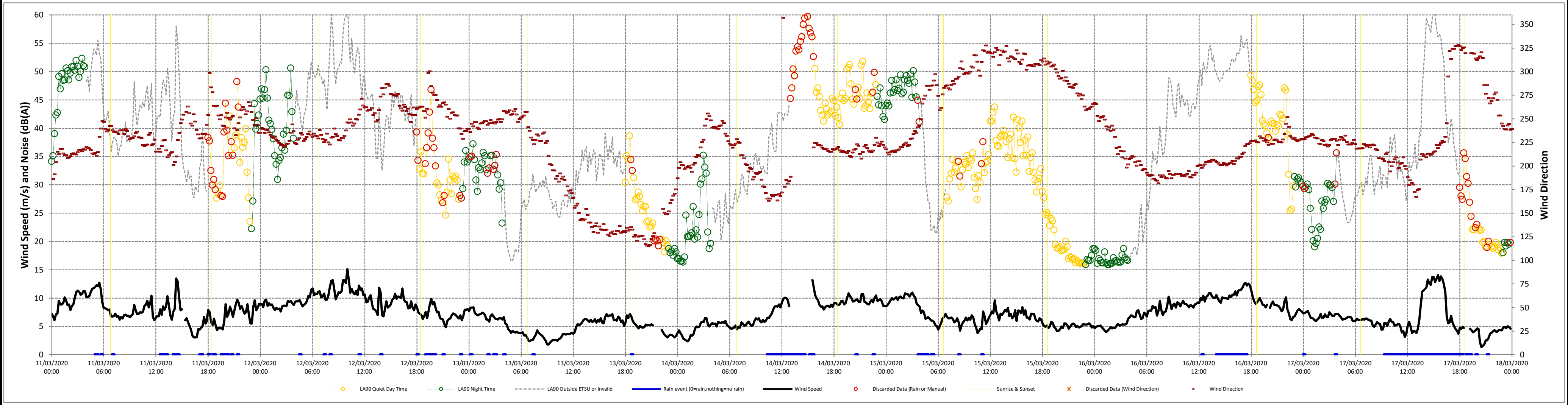


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML4 Page 1 of 4
Date	05/12/2023

04/03/2020 to 11/03/2020

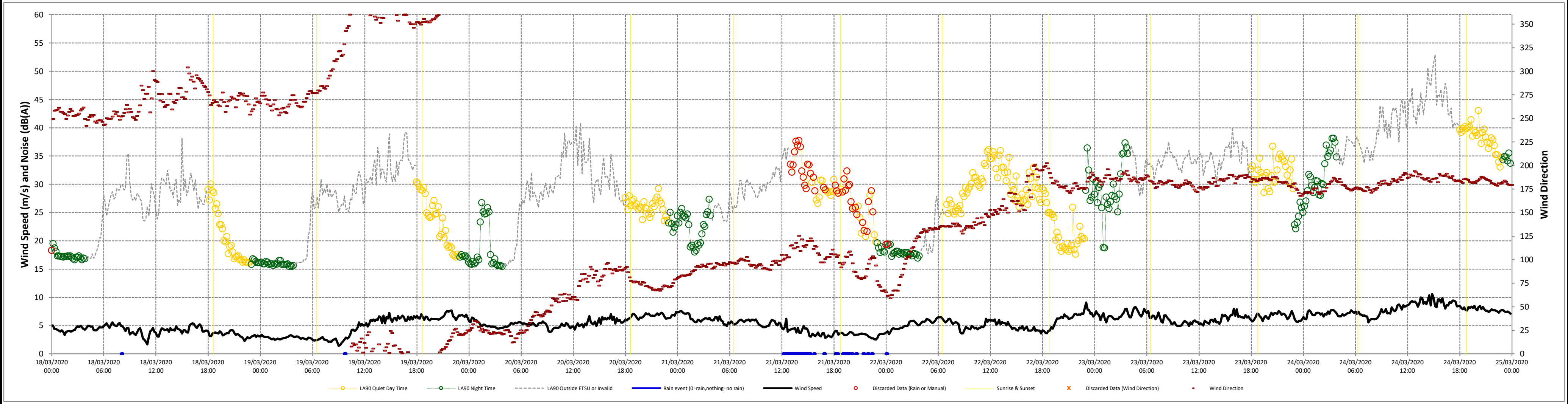


11/03/2020 to 18/03/2020

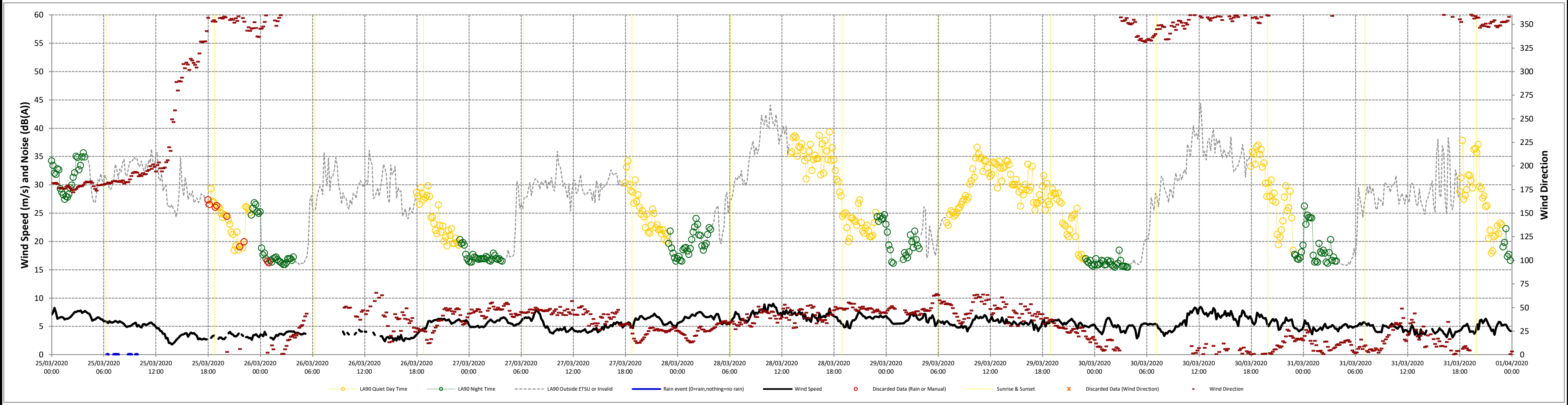


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML4 Page 2 of 4
Date	05/12/2023

18/03/2020 to 25/03/2020



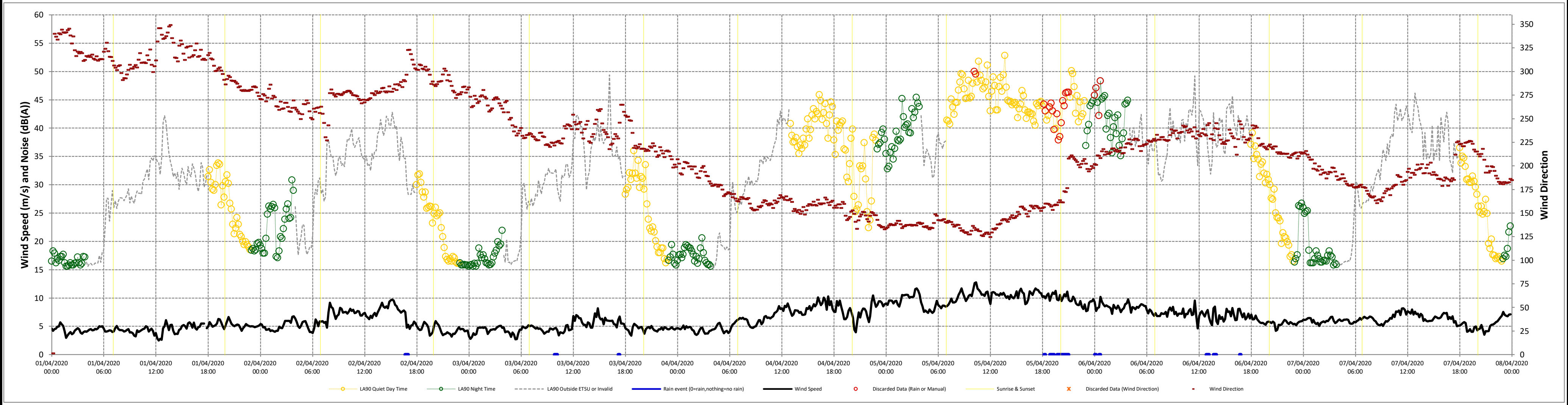
25/03/2020 to 01/04/2020



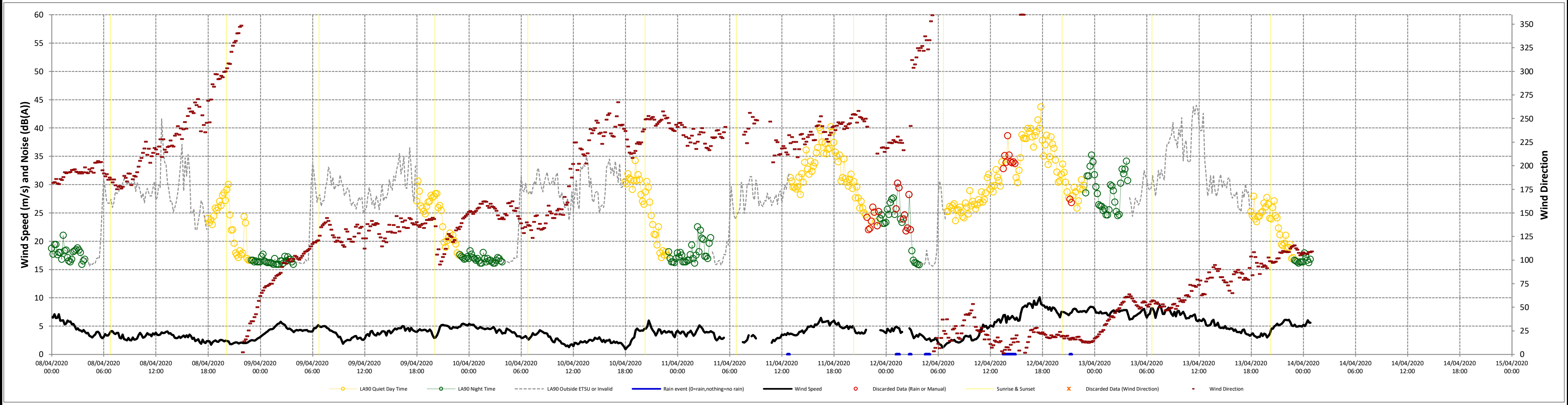
Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML4 Page 3 of 4
Date	05/12/2023

tnei

01/04/2020 to 08/04/2020

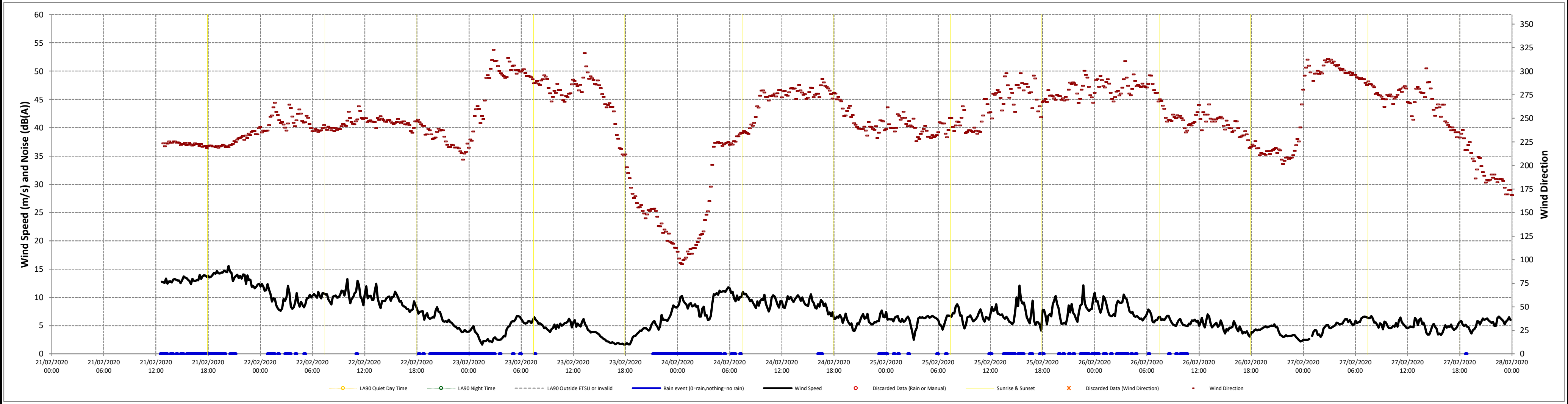


08/04/2020 to 15/04/2020

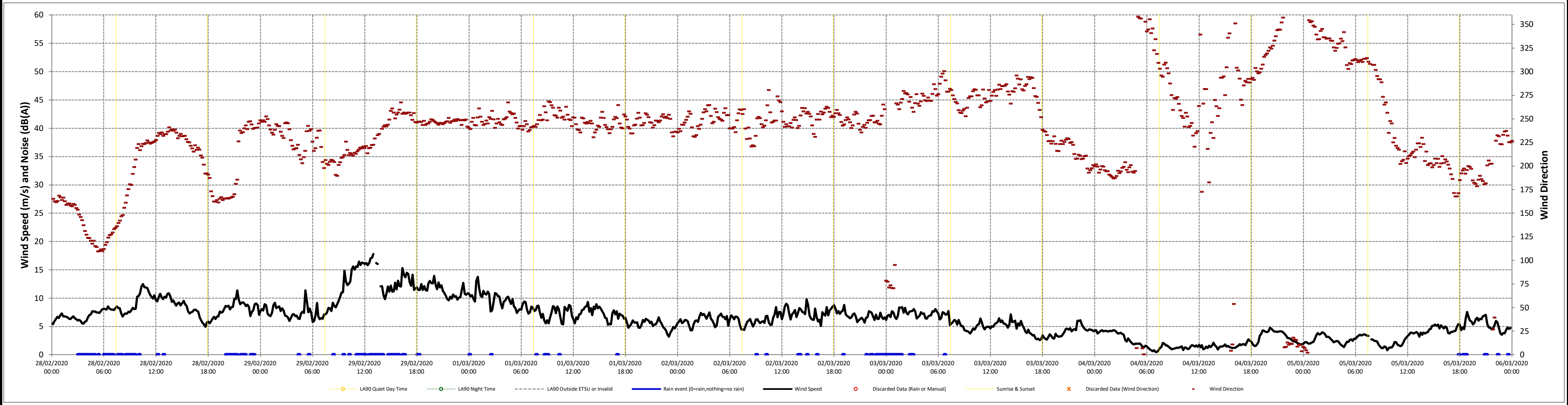


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML4 Page 4 of 4
Date	05/12/2023

21/02/2020 to 28/02/2020

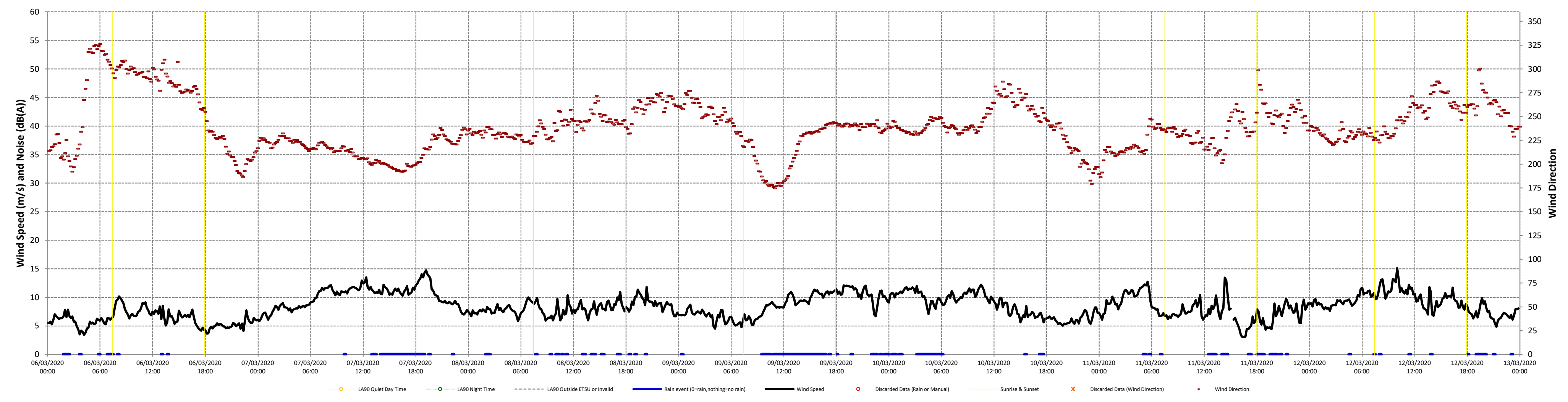


28/02/2020 to 06/03/2020

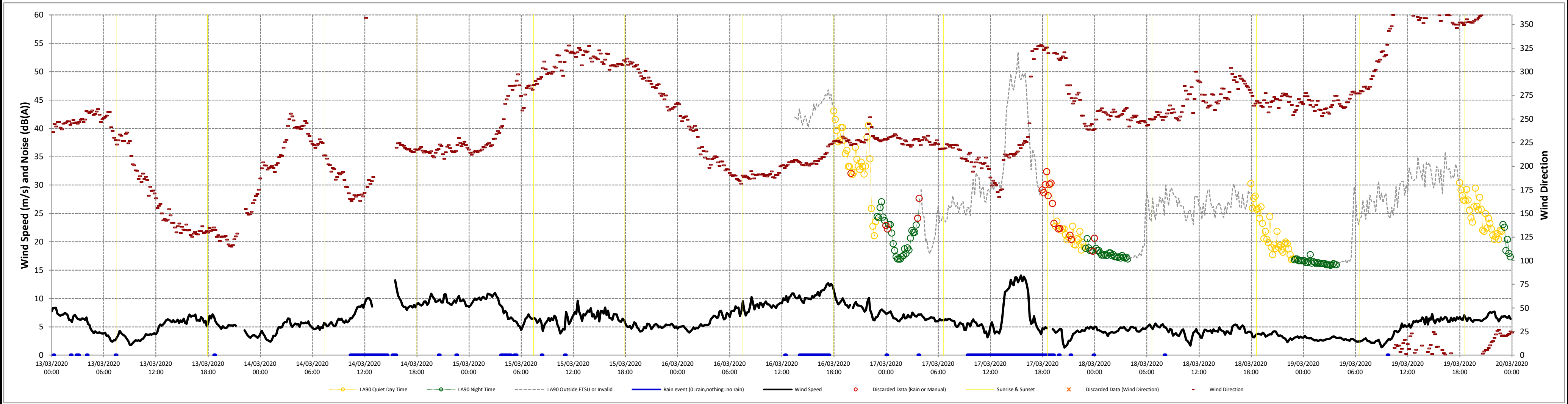


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML5 Page 1 of 4
Date	05/12/2023

06/03/2020 to 13/03/2020

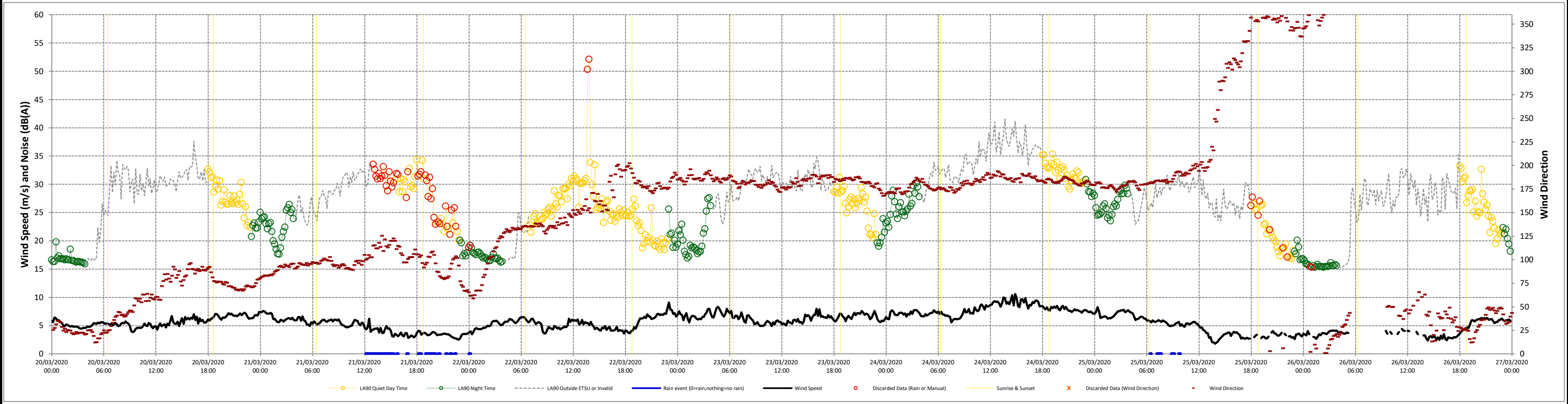


13/03/2020 to 20/03/2020

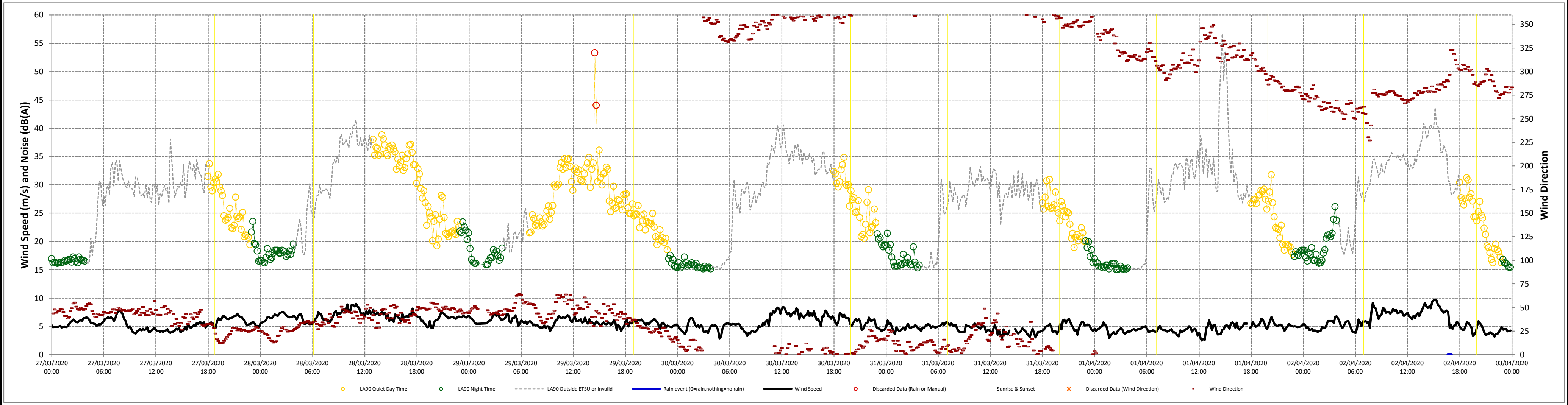


Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML5 Page 2 of 4
Date	05/12/2023

20/03/2020 to 27/03/2020



27/03/2020 to 03/04/2020



Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML5 Page 3 of 4
Date	05/12/2023

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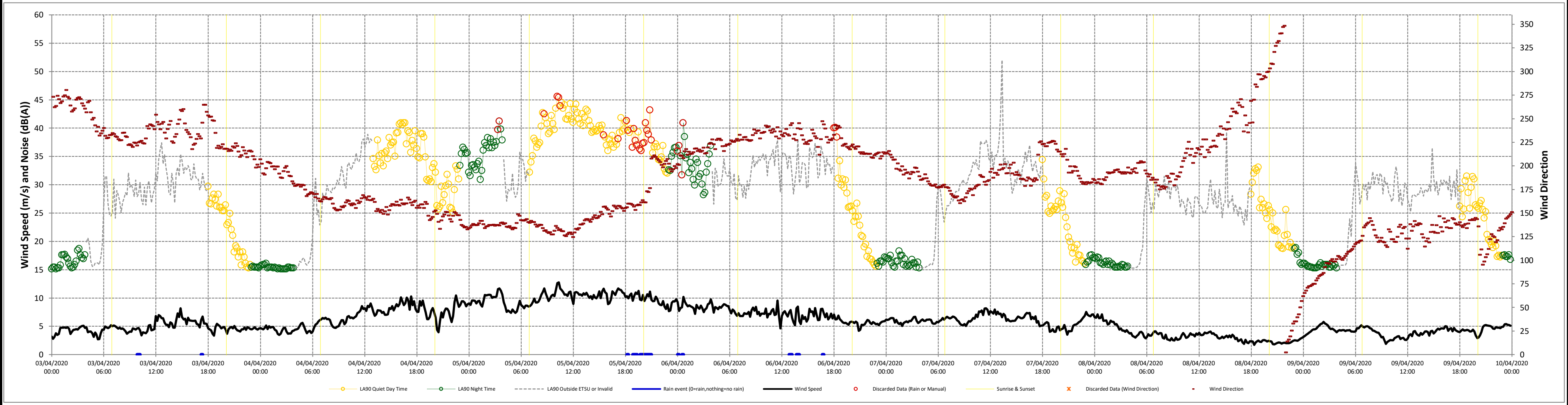
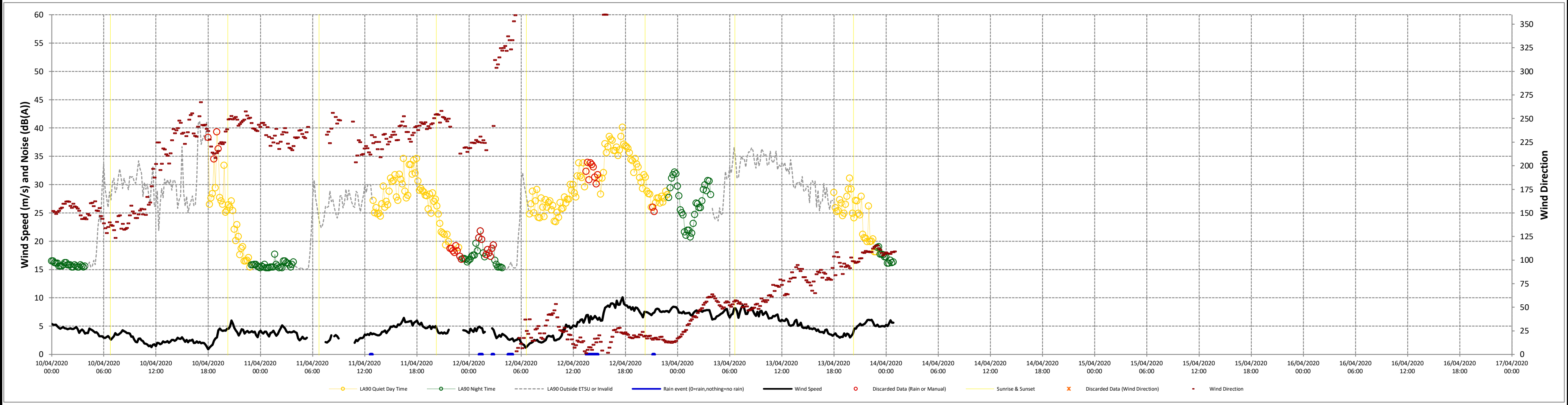
03/04/2020 to 10/04/2020



10/04/2020 to 17/04/2020



Project	Clonberne Wind Farm
Client	MKO
Title	Time Series for NML5 Page 4 of 4
Date	05/12/2023

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Annex 5 – NSR Coordinates & Prediction Modelling Results

Table A5.1: Noise Sensitive Receptors

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H01 (NAL1)	553264	756150	81	NML 3	Yes - NAL1*
H02 (NAL2)	554551	755067	72	NML 2	Yes - NAL2*
H03 (NAL3)	555425	755249	66	NML 2	Yes - NAL3*
H04 (NAL4)	553591	757438	79	NML 4	Yes - NAL4*
H05 (NAL5)	555610	758076	87	NML 5	Yes - NAL5*
H06	554119	755079	76	NML 2	No
H07	554115	755040	76	NML 2	No
H08 (NAL6)	553850	755166	73	NML 2	Yes - NAL6*
H09 (NAL7)	556377	756904	78	NML 1	Yes - NAL7*
H10	554985	754922	66	NML 2	No
H11	554498	754972	71	NML 2	No
H12	554682	754862	72	NML 2	No
H13	554464	754920	71	NML 2	No
H14	554078	754944	76	NML 2	No
H15	554217	754912	74	NML 2	No
H16	554241	754900	74	NML 2	No
H17	556558	757028	80	NML 1	No
H18	555047	754810	69	NML 2	No
H19	554833	754776	69	NML 2	No
H20	553806	754971	75	NML 2	No
H21	555696	755188	68	NML 2	No
H22	556354	758060	72	NML 5	No
H23	553968	758242	88	NML 4	No
H24	554727	754731	71	NML 2	No
H25	555689	755136	67	NML 2	No
H26	556649	756967	82	NML 1	No
H27	553557	755114	73	NML 2	No
H28	553699	754977	73	NML 2	No
H29	556324	758140	74	NML 5	No
H30	553641	758100	86	NML 4	No
H31	556319	758155	74	NML 5	No
H32	553965	758301	89	NML 4	No
H33	556388	758118	74	NML 5	No
H34	553721	758186	88	NML 4	No
H35	556686	756957	83	NML 1	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H36	556318	758211	77	NML 5	No
H37	556430	758119	74	NML 5	No
H38	555570	758511	79	NML 5	No
H39	556714	756950	83	NML 1	No
H40	556308	758233	77	NML 5	No
H41	553608	754938	76	NML 2	No
H42	553917	758357	89	NML 4	No
H43	553565	758139	85	NML 4	No
H44	556752	756936	82	NML 1	No
H45	553538	758139	84	NML 4	No
H46	556670	756419	76	NML 1	No
H47	553914	754730	77	NML 2	No
H48	556501	758130	75	NML 5	No
H49	556655	756356	75	NML 1	No
H50	555674	758514	81	NML 5	No
H51	553575	754909	77	NML 2	No
H52	553918	758417	87	NML 4	No
H53	556544	758129	75	NML 5	No
H54	556586	758083	74	NML 5	No
H55	555123	754572	70	NML 2	No
H56	553281	755184	73	NML 3	No
H57	556884	757260	86	NML 1	No
H58	556824	756923	82	NML 1	No
H59	553013	755398	73	NML 3	No
H60	555590	754733	67	NML 2	No
H61	553066	755316	73	NML 3	No
H62	556609	758134	75	NML 5	No
H63	552801	755730	72	NML 3	No
H64	553123	755242	71	NML 3	No
H65	555619	754720	68	NML 2	No
H66	556693	758078	73	NML 5	No
H67	552785	755704	73	NML 3	No
H68	552733	755852	76	NML 3	No
H69	554940	758884	73	NML 4	No
H70	552674	756051	80	NML 3	No
H71	553128	755167	75	NML 3	No
H72	556798	756324	74	NML 1	No
H73	553172	755129	77	NML 3	No
H74	556899	756855	82	NML 1	No
H75	552651	756077	81	NML 3	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H76	556983	757110	85	NML 1	No
H77	556994	757060	85	NML 1	No
H78	555208	754431	70	NML 2	No
H79	557021	757429	89	NML 1	No
H80	552792	755493	82	NML 3	No
H81	557037	757270	89	NML 1	No
H82	556954	756846	82	NML 1	No
H83	557036	757236	88	NML 1	No
H84	557047	757305	89	NML 1	No
H85	557042	757193	88	NML 1	No
H86	557042	757533	89	NML 1	No
H87	555919	758698	83	NML 5	No
H88	553997	758669	80	NML 4	No
H89	557034	756968	84	NML 1	No
H90	557081	757349	90	NML 1	No
H91	557002	756839	82	NML 1	No
H92	557070	757081	87	NML 1	No
H93	557085	757466	91	NML 1	No
H94	557086	757506	91	NML 1	No
H95	557042	756918	83	NML 1	No
H96	557095	757180	88	NML 1	No
H97	557024	756843	82	NML 1	No
H98	557085	757054	86	NML 1	No
H99	557051	756864	83	NML 1	No
H100	555310	754356	70	NML 2	No
H101	557088	756993	85	NML 1	No
H102	552424	757071	81	NML 3	No
H103	557114	757542	91	NML 1	No
H104	557094	757652	90	NML 1	No
H105	555357	754363	70	NML 2	No
H106	557076	757736	89	NML 1	No
H107	557118	757562	92	NML 1	No
H108	557073	756883	83	NML 1	No
H109	557054	756825	82	NML 1	No
H110	557070	757766	88	NML 1	No
H111	557100	757673	90	NML 1	No
H112	557094	756941	84	NML 1	No
H113	556867	758180	75	NML 5	No
H114	555941	758779	83	NML 5	No
H115	557130	757597	92	NML 1	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H116	557153	757497	92	NML 1	No
H117	556905	758175	76	NML 5	No
H118	557170	757421	92	NML 1	No
H119	557143	757622	92	NML 1	No
H120	557032	757964	82	NML 5	No
H121	557079	756634	78	NML 1	No
H122	557078	756612	78	NML 1	No
H123	553114	754905	84	NML 3	No
H124	557179	757484	92	NML 1	No
H125	557080	756600	78	NML 1	No
H126	557089	756642	79	NML 1	No
H127	557060	757947	84	NML 5	No
H128	557086	756591	78	NML 1	No
H129	552385	757195	77	NML 3	No
H130	557087	756575	78	NML 1	No
H131	557010	756252	70	NML 1	No
H132	557136	756863	83	NML 1	No
H133	555387	754296	73	NML 2	No
H134	557091	756557	77	NML 1	No
H135	555899	758842	84	NML 5	No
H136	557212	757386	93	NML 1	No
H137	557098	756554	77	NML 1	No
H138	555280	759099	79	NML 5	No
H139	555844	758863	84	NML 5	No
H140	553911	758793	80	NML 4	No
H141	555474	754313	74	NML 2	No
H142	557107	756554	78	NML 1	No
H143	552326	757084	84	NML 3	No
H144	555892	758864	84	NML 5	No
H145	554013	758830	78	NML 4	No
H146	552328	757156	81	NML 3	No
H147	557111	756465	76	NML 1	No
H148	555553	754321	74	NML 2	No
H149	557173	756820	82	NML 1	No
H150	557116	756421	75	NML 1	No
H151	555521	754284	74	NML 2	No
H152	555881	758907	84	NML 5	No
H153	557158	756571	79	NML 1	No
H154	557123	756382	75	NML 1	No
H155	557159	756558	78	NML 1	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H156	557268	757455	91	NML 1	No
H157	554352	759072	74	NML 4	No
H158	553154	754713	86	NML 3	No
H159	552380	755933	85	NML 3	No
H160	557282	757418	92	NML 1	No
H161	555841	758954	85	NML 5	No
H162	553169	754678	86	NML 3	No
H163	557260	756911	86	NML 1	No
H164	557110	756200	72	NML 1	No
H165	557177	756428	77	NML 1	No
H166	555814	758996	84	NML 5	No
H167	557320	757453	91	NML 1	No
H168	556376	758820	78	NML 5	No
H169	554180	759047	74	NML 4	No
H170	557013	758294	74	NML 5	No
H171	552708	755085	77	NML 3	No
H172	553168	754622	87	NML 3	No
H173	557297	756944	87	NML 1	No
H174	557155	758086	80	NML 5	No
H175	557312	756989	88	NML 1	No
H176	557307	756943	87	NML 1	No
H177	557317	756986	88	NML 1	No
H178	553247	754524	85	NML 3	No
H179	557325	756981	88	NML 1	No
H180	557318	756943	87	NML 1	No
H181	557331	756977	88	NML 1	No
H182	555694	754258	73	NML 2	No
H183	557329	756939	87	NML 1	No
H184	557339	756972	88	NML 1	No
H185	557338	756937	87	NML 1	No
H186	557347	756969	88	NML 1	No
H187	557353	756965	88	NML 1	No
H188	557350	756933	88	NML 1	No
H189	557361	756961	87	NML 1	No
H190	557390	757530	90	NML 1	No
H191	554011	759036	76	NML 4	No
H192	557357	756903	87	NML 1	No
H193	556636	758773	76	NML 5	No
H194	556704	758754	76	NML 5	No
H195	557060	758418	74	NML 5	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H196	553273	754382	82	NML 3	No
H197	556777	758742	76	NML 5	No
H198	557419	756879	86	NML 1	No
H199	557469	757470	90	NML 1	No
H200	556814	758738	77	NML 5	No
H201	555524	754032	66	NML 2	No
H202	556014	754313	66	NML 2	No
H203	556750	758815	78	NML 5	No
H204	553698	754077	72	NML 2	No
H205	557469	756887	85	NML 1	No
H206	552452	755107	78	NML 3	No
H207	557427	757937	83	NML 1	No
H208	553586	754079	72	NML 2	No
H209	553957	759194	77	NML 4	No
H210	556718	758903	79	NML 5	No
H211	556979	758698	78	NML 5	No
H212	553087	758740	85	NML 4	No
H213	557518	756834	84	NML 1	No
H214	556169	754342	71	NML 2	No
H215	556177	754308	70	NML 2	No
H216	553437	754082	74	NML 2	No
H217	556165	754288	70	NML 2	No
H218	551996	757356	88	NML 3	No
H219	557365	756007	78	NML 1	No
H220	556206	754308	72	NML 2	No
H221	557537	756657	82	NML 1	No
H222	553439	754050	73	NML 2	No
H223	557054	757699	88	NML 1	No
H224	556318	754366	75	NML 2	No
H225	557628	757597	86	NML 1	No
H226	553165	754325	82	NML 3	No
H227	557581	756919	86	NML 1	No
H228	557439	757618	89	NML 1	No
H229	557418	757590	89	NML 1	No
H230	553483	755176	72	NML 2	No
H231	555268	759094	78	NML 4	No
H234 (NAL8)	553992	758015	86	NML 4	Yes - NAL8*
H237	552743	756385	78	NML 3	No
H238	557057	757938	84	NML 5	No
H239	556463	756875	78	NML 1	No

Noise Sensitive Receptor (H)	Easting	Northing	Elevation (m AOD)	Background Noise Data Used	Is this NSR also an NAL?
H240	556610	757412	76	NML 1	No
H241	554042	758388	83	NML 4	No
H242	553819	758049	86	NML 4	No
H244	556678	756811	81	NML 1	No

Annex 6 – Topographical Corrections & Turbine Coordinates

Table A1: Topographical (concave ground/ barrier) Noise Prediction Adjustment Table

Wind Farm	Proposed Project (Clonberne Wind Farm)										
Turbine ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Hub Height (m)	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**	**99**
NAL1 (H1)	0	0	0	0	0	0	0	0	0	0	0
NAL2 (H2)	0	0	0	0	0	0	0	0	0	0	0
NAL3 (H3)	0	0	0	0	0	0	0	0	0	0	0
NAL4 (H4)	0	0	0	0	0	0	0	0	0	0	0
NAL5 (H5)	0	0	0	0	0	0	0	0	0	0	0
NAL6 (H8)	0	0	0	0	0	0	0	0	0	0	0
NAL7 (H9)	0	0	0	0	0	0	0	0	0	0	0
NAL8 (H234)	0	0	0	0	0	0	0	0	0	0	0

Notes/Comments

Requirement to include a concave ground profile correction of +3dB has been calculated in accordance with section 4.3.9 of the IOA GPG (July 2011).

A barrier correction of -2dB is included where the landform completely obscures a turbine at the noise assessment location.

Where analysis indicates that both are required the barrier correction take precedence and a correction of -2dB is applied.

Table A2: Wind Turbines Modelled

Wind Turbine	Easting	Northing	Height
T1	554967	757585	78
T2	555668	757319	70
T3	554635	757213	75
T4	555160	757117	73
T5	555568	756775	69
T6	554481	756822	67
T7	553833	756697	68
T8	553990	756165	67
T9	554333	755811	71
T10	554971	755827	71
T11	554831	756309	73