APPENDIX 12-3

Operational BESS and Substation Noise Assessment

A specialist energy consultancy

Appendix 12.3 – Battery Energy Storage System (BESS) & Substation Noise Report

Killoshulan Wind Farm

Atlantic Infrastructure Renewables Ltd

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1 Introduction

1.1 Overview

TNEI has been commissioned by MKO on behalf of Killoshulan Renewable Energy Ltd, subsidiary of Atlantic Infrastructure Renewables Ltd. (AIR) to undertake a Noise Impact Assessment (NIA) to support a planning application for the Proposed Battery Energy Storage System (BESS) and 110kV Substation (the Proposed BESS and 110kV Substation) elements of the Killoshulan Wind Farm (the Proposed Project).

The Proposed BESS and 110kV Substation is located approximately 8 km northeast of Urlingford, and approximately 6 km northwest of Freshford in County Kilkenny, at approximate Irish Transverse Mercator (ITM) coordinates 635027, 667350.

The local area around the site is mainly rural, predominantly consisting of agricultural pastural land, mixed forest/woodland, commercial forestry, and low-density residential land. There are a small number of residential properties located in the vicinity of the Proposed BESS and 110kV Substation, the nearest of which is located approximately 373 m to the north.

The method of assessing operational noise from a BESS development is very different from that which is used to assess operational wind turbine noise and, as such, the two assessment types cannot be combined. Accordingly, the assessment of operational noise attributable to the Proposed BESS is presented separately in this report, and the operational wind farm noise assessment is provided in Technical Appendix 12-2.

The aims of this NIA are to:

- Identify potential noise sensitive receptors in the vicinity of the Proposed BESS and 110kV Substation;
- Describe the existing noise environment around the noise sensitive receptors;
- Identify the dominant sound sources associated with the operation of the Proposed BESS and 110kV Substation;
- Calculate the likely levels of operational noise at the nearest noise sensitive receptors to determine the noise impacts associated with the development; and,
- Indicate any requirements for mitigation measures, if required, to provide sufficient levels of protection for nearby receptors.

All work undertaken to produce this report has been carried out by members of the TNEI Environment and Engineering Team, all of whom are affiliated with the Institute of Acoustics (IOA).

1.2 Nomenclature

Please note the following terms and definitions, which are used throughout this report;

- **Emission** refers to the noise level emitted from a noise source, expressed as either a sound power level or a sound pressure level;
- **Immission** refers to the sound pressure level received at a specific location from a noise source;
- **Rating Level** refers to the immission level after consideration of the character of the sound. The Rating Level is the Immission Level plus any required character corrections, if this is deemed necessary.
- **SWL** indicates the sound power level in decibels (dB);

- **SPL** indicates the sound pressure level in decibels (dB);
- **NML** (Noise Monitoring Location) refers to any location where noise levels have been measured;
- **NSRs** (Noise Sensitive Receptors) are all identified receptors that are sensitive to noise; and;
- **NAL** (Noise Assessment Location) refers to any location where the immission levels are calculated and assessed.

All figures referenced within the report can be found in Annex 4.

Unless otherwise stated, all noise levels refer to free field levels i.e. noise levels without influence from any nearby reflective surfaces.

All grid coordinates refer to the Irish Transverse Mercator (ITM) grid.

2 Project Description

A BESS principally consists of three main elements: batteries, inverters, and Medium Voltage (MV) transformers. Groups of batteries are connected into an inverter, which converts between Direct Current (DC) and Alternating Current (AC). The inverter is then connected to a Medium Voltage (MV) transformer.

A BESS development is made up of several battery, inverter and MV Transformer units. Sometimes the inverter and MV transformers can be combined into a single unit. Collectively the inverter and MV transformer is referred to as a Power Conversion System (PCS).

The MV transformers will ultimately be connected to the grid network, typically through one or two High Voltage (HV) transformers, although these are not always located within the BESS site itself, sometimes utilising existing HV transformers located within a nearby substation.

2.1 Proposed Layout

A high level, indicative layout for the Proposed BESS and 110kV Substation is included in Annex 1. The candidate plant for the layout consists of multiple externally located battery container units with integrated inverters, each of which will be connected to MV transformer stations. Two HV transformers are included as part of the adjacent Proposed 110kV Substation to the Proposed BESS. The Proposed BESS will have a capacity of up to 20 MW. The candidate plant modelled in this assessment has a total capacity of 25 MW which means that the prediction of the noise levels may be considered conservative.

Based on the high level layout and assumptions of candidate plant that could fit within, the primary sound sources considered within this assessment are:

- Battery Storage Containers, 10 of,
- MV Transformer Stations, 10 of, and,
- ABB HV Transformer Unit, 2 of.

The sound level output of any auxiliary infrastructure included as part of the Proposed BESS, for example, switch gear or auxiliary transformers, will be insignificant in comparison to the primary sound sources detailed above. Accordingly, no other items of plant have been considered within this assessment.

2.2 Study Area

Noise Sensitive Receptors (NSRs) are properties that are sensitive to noise and, therefore, require protection from nearby noise sources. The study area has been defined through the identification of the closest NSRs within approx. 2 km of the Site. The closest NSR to the BESS is located approximately 373 m north of the Proposed BESS and Substation site.

The assessment of noise attributable to the Proposed BESS and 110kV Substation considers the nearest and most sensitive NSRs only, on the assumption that if sound levels at these receptors are within the defined limits, then sound levels at NSRs at greater distances should also be within acceptable levels. The locations of the nearest identified residential NSRs in relation to the Proposed BESS and 110kV Substation can be seen on Figure A4.1 (Annex 4).

3 Methodology

3.1 Legislation, Policy Context and Guidelines

There is no specific Irish guidance that contains a detailed method for the assessment of environmental noise, however, to address this gap and try to bring consistency across Local Authorities, the Association of Acoustic Consultants of Ireland have published '*Environmental Noise Guidelines (ENG) for Local Authority Enforcement and Planning Sections'* (1), which states (in relation to Industrial developments):

"Useful guidance is additionally presented in British Standard BS 4142:2014 Methods for rating and assessing industrial and commercial sound (2014), which provides an assessment methodology based on existing background levels."

The ENG also refers to the Environmental Protection Agency Office of Environmental Enforcement's (OEE) *"Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4)",* stating:

"Industrial installations regulated by the EPA are typically subject to noise limits drawn from EPA document NG4 Guidance note for noise: Licence applications, surveys and assessments in relation to scheduled activities (2016). On this basis, NG4 is also arguably the most relevant guidance document with respect to industrial facilities regulated by Local Authorities."

It is acknowledged that the Proposed BESS and 110kV Substation is **not an EPA licensed site**, however some of the principles contained within NG4 could prove useful in the context of the assessment of operational noise from the Proposed BESS, so is included here for completeness.

3.2 Assessment Method

3.2.1 BS 4142 Assessment Method

The British Standard (BS) *4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound* BS 4142 (2) (hereafter referred to as BS 4142) form of assessment is based on the predicted or measured levels of an assessed sound source compared to the measured background sound levels without the specific sound source present and uses, *"outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident".*

In reference to the existing baseline conditions i.e. before any proposed development, BS 4142 uses the following terms:

- **Residual Sound Level:** The sound level of all noise sources in an area, except the sound source to be assessed, over a given time interval, t. Described using the metric $L_{Aeq(t)}$.
- **Background Sound Level:** This is also the sound level of all noise sources in an area except the sound source to be assessed, however, it is quantified by determining the sound level that is exceeded for 90% of the given time interval. Described using the metric $L_{A90(t)}$.

The next two noise metrics (below) represent noise attributable to a proposed development only:

- **Specific Sound Level:** The equivalent continuous A-weighted sound pressure level (SPL) produced by the specific sound source at the assessment location over a given reference time interval, i.e. the sound level of just the sound source to be assessed. Described using the metric $L_{Aeq(t)}$.

- **Rating Level:** The Specific Sound Level adjusted for the characteristics of the sound. The Rating Level is calculated by adding a character correction(s), if required, to the Specific Sound Level when the sound source contains audible characteristics at the receptor location, such as tonal, impulsive or intermittent components. Described using the metric, $L_{Aeq(t)}$.

The final noise metric represents the future noise level during the operational phase of a proposed development and can be thought of as the 'Total Sound' i.e. the existing baseline + the proposed development:

- **Ambient Sound Level:** Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, both near and far i.e. the sound level of all noise sources in an area, including the sound source to be assessed. Described using the metric, $L_{Aeq(t)}$.

BS 4142, Section 11, requires that the assessment considers the context in which the sound occurs, and as such there is no definitive pass/fail element to the standard. Rather, the assessment outcome is an indication as to the likelihood for adverse impact.

Additional guidance on the BS 4142 assessment methodology is provided in the Association of Noise Consultants' (ANC) BS 4142: Technical Note (3), which has been authored by the ANC Good Practice Working Group (ANC, 2020). The guide is "*designed to assist readers with a reasonable interpretation and application of BS 4142 as a whole*".

The BS 4142 assessment is a two-stage process. Initially, an estimate of the impact is made by subtracting the measured Background Sound Level from the calculated or measured Rating Level. The second part of the assessment is to then consider the context in which the sound occurs, which may modify the findings of the initial estimate.

The standard states:

"Obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level, and consider the following…

a) Typically, the greater this difference, the greater the magnitude of the impact.

b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.

c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

For the second stage of the assessment there are many elements of context that can be considered. The following list[1], which is not exhaustive, gives some examples that could be relevant to the assessment:

- the absolute level of sound;

[1] Examples of contextual issues to consider can be found in the BS 4142 standard, the ANC BS 4142 Technical Note and Method Implementation Document (MID) for BS 4142 [(7)]

- the character and level of the residual sound compared to the character and level of the specific sound;
- whether specific sound insulation and noise control measures have already been incorporated into a receptor (which would lower the sensitivity of the receptor);
- former uses, at or close to the site;
- the legitimacy of the industrial use, e.g. planning permissions or environmental permits;
- implementation of best practicable means for a given process or activity; and
- whether the Rating Level represents typical levels, realistic worst-case, unlikely worst-case etc.

3.2.2 NG4 Guideline Noise Level Limits

Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4) (4) provides a structured framework for the management of noise from licensed activities, as well proposing consistent methods for measuring, assessing, and reporting environmental noise at EPA-licensed and industrial use sites.

The guidance note details typical noise limits used for 'Licenced Sites' which range between 45 and 55 dB $LAeq_{(t),}$ depending on the time of day/night. In addition, recommendations are made for additional noise criteria to use in areas of low background noise levels, which initially requires the location to be assessed to determine whether it is classed as a "Quiet Area".

The site screening criteria, to determine whether it is a Quiet Area, is as follows:

- At least 3 km from urban areas with a population >1,000 people;
- At least 10 km from any urban areas with a population >5,000 people;
- At least 15 km from any urban areas with a population >10,000 people;
- At least 3 km from any local industry[2];
- At least 10 km from any major industry centre;
- At least 5 km from any National Primary Route, and;
- At least 7.5 km from any Motorway or Dual Carriageway.

The site is classed as a Quiet Area if ALL of the above criteria are met, in which case, NG4 suggests *"…very stringent noise criterion may be considered appropriate"*. Where the area is not classified as a *"Quiet Area,"* a survey is required in order to ascertain the existing baseline sound levels. In this regard the document states;

"For all areas not identified as Quiet Areas in Step 1, the existing background noise levels measured during the environmental noise survey should be examined to determine if they satisfy the following criteria:

- *Average Daytime Background Noise Level ≤40dB L_{AF90}, and;*
- *Average Evening Background Noise Level ≤35dB L_{AF90}, and;*
- *Average Night-time Background Noise Level ≤30dB L_{AF90}."*

Where the three bullet points above are satisfied, the area can be considered an *"Area of Low Background Noise"*.

Once the area has been classified, the noise criteria detailed in Table 3-1, can be applied.

[2] Local industry includes sources of noise that may be considered industrial in nature, for example: grain drying facilities, creameries and small factories.

Table 3-1: NG4 Recommended Noise Limit Criteria

Scenario	Daytime Noise Criterion, dB $L_{Ar,T}$ (07:00 to 19:00hrs	Evening Noise Criterion, dB $L_{Ar,T}$ (19:00 to 23:00hrs)	Night-time Noise Criterion, dB $L_{Aeq,t}$ (23:00 to 07:00hrs)
Quiet Area	Noise from the licensed site to be at least 10 dB below the average daytime background noise level measured during the baseline noise survey.	Noise from the licensed site to be at least 10 dB below the average evening background noise level measured during the baseline noise survey.	Noise from the licensed site to be at least 10 dB below the average night-time background noise level measured during the baseline noise survey.
Areas of Low Background Noise	45 dB	40 dB	35 dB
All Other Areas	55 dB	50 dB	45 dB

3.3 Assessment Criteria

Considering all of the above, the assessment is made as follows:

- The BS 4142 assessment is undertaken, in accordance with the guidance; and,

For the second stage of the BS 4142 assessment, the relevant noise criteria that would be set using NG4 is considered as a relevant contextual element.

3.4 Calculation Method

3.4.1 ISO 9613-2:2024

To predict the noise immission levels attributable to the Proposed BESS and 110kV Substation, a noise propagation model was created using the propriety noise modelling software, CadnaA. Within the software, complex models can be produced to simulate the propagation of noise according to a range of international calculation standards.

For this assessment noise propagation was calculated in accordance with ISO9613-2:2024 *Acoustics — Attenuation of sound during propagation outdoors: Engineering method for the prediction of sound pressure levels outdoors* (5), using the following input parameters;

- Temperature is assumed to be 10°C and relative humidity as 70%;
- A ground attenuation factor of 1 (soft ground) has been used except for specific areas of developed ground (including the Proposed BESS and 110kV Substation area) which is modelled with a ground attenuation factor of 0 (hard ground); and
- Receiver heights have been set to 4 m to represent the height of a first-floor bedroom window.

3.4.2 Uncertainties and Limitations

The noise propagation model is designed to give a good approximation of the specific sound level and the contribution of each individual sound source; however, it is expected that measured levels are unlikely to be matched exactly with modelled values. As such, the following limitations in the model should be considered:

- In accordance with ISO 9613, all assessment locations are modelled as downwind of all sound sources and propagation calculations are based on a moderate ground-based temperature inversion, such as commonly occurs at night. These conditions are favourable to noise propagation;
- The predicted barrier attenuation provided by local topography, embankments, walls, buildings and other structures in the intervening ground between source and receiver can only be approximated and not all barrier attenuation will have been accounted for;
- The model assumes all sound sources are operating continuously, simultaneously and at maximum anticipated operating capacity.

With due regard to the above, noise level predictions are likely to be higher than what will occur during normal operation.

Note that the modelled sound sources represent candidate plant and an associated site layout. The location, operating conditions, number of, and noise output of individual items of plant may vary from what is presented in this report after final plant specification, which cannot be undertaken without a tendering process that would occur after planning consent has been granted. As such, it is expected that an additional NIA will be undertaken upon final specification of plant.

4 Baseline Sound Level Survey

4.1 Monitoring Locations

TNEI undertook an operational wind turbine noise assessment for the Proposed Wind Farm. As part of the study, continuous background sound level monitoring was undertaken at six neighbouring properties over the period 7th December 2022 to the 31st of January 2023. Table 4-1 details the three Noise Monitoring Locations (NMLs), which are being used in this assessment. The NMLs are also shown in Figure A4.1 included within Annex 4.

Table 4-1: Noise Monitoring Locations (NMLs)

NML		Coordinates	
ID	**Approximate Distance and Bearing to BESS and Substation plant (m)**	**ITM X**	**ITM Y**
NML3	775, northwest	634614	668001
NML4	1,693, northeast	636812	667441
NML5	1,769, southeast	636332	666030

4.2 Survey Equipment

The noise monitoring equipment for the locations above consisted of three Rion NL-52 Sound Level Meters (SLMs) fitted with appropriate environmental wind shields. All noise monitoring equipment (calibrator, SLM and microphones) used for the study are categorised as Class 1, as specified in IEC 61672-1 *'Electroacoustics. Sound level meters. Specifications'* (6). The equipment was calibrated on-site at the beginning and end of each measurement period, with no significant deviations noted. All measurements were made with sound level meters (SLMs) mounted approximately 1.2 m above the ground and away from nearby reflective surfaces i.e., building façades, fences etc.

Wind speed and direction data was measured continuously during the noise survey using a LIDAR unit, which was temporarily installed within the Proposed Wind Farm site for the purposes of background noise collection. For wind farm operational noise assessments, the measured noise data is organised into wind speed 'bins' to determine wind-speed specific noise limits. In contrast, BS 4142 states:

"Exercise caution when making measurements in poor weather conditions, such as wind speeds greater than 5 m/s."

Accordingly, the noise data was filtered to remove any data points that were measured during periods of high wind speeds and rain. In this particular case, all noise data measured with wind speeds at or above 5 m/s has been removed. Time series charts are provided in Annex 2 for each of the NMLs, which present the measured 10-minute L_{Aeq} and L_{A90}, the wind speed (m/s) and any periods were data has been removed, including for precipitation events.

It should be noted that the wind speed data used in this assessment is based on measurements made at wind speeds at 10 m height (standardised). BS 4142 suggest that wind speed measurements should be undertaken at the NMLs, at comparable measurement heights to the SLMs. Therefore, the approach undertaken here in using wind speed measurements captured by a LiDAR unit on the site,

measuring at the turbine hub height and then standardising to 10 m, is a more cautious approach. This is due to the resulting higher wind speeds than if measurements were undertaken at each NML at a height of 1.5 m.

4.3 Existing Noise Environment

Subjective observations made during the installation and collection of equipment, and during two site visits for equipment maintenance, noted the following;

- At NML3 and NML4 birdsong, distant road traffic noise and wind through the vegetation were all noted during the survey.
- At NML5 agricultural noise, noise from dogs nearby, as well as birdsong were all noted during the survey.

Documentation relating to the survey (including calibration certificates), and full field data sheets which detail information and observations on each location are provided in the Annex 2 of Appendix 12-2.

Table 4-2 presents the derived representative Background Sound level and the Residual Sound Level for daytime and night-time at each NML.

The Background Sound Levels were determined with reference to the time-history charts, statistical analysis charts and distribution analysis charts included in Annex 2, following the guidance presented within the ANC technical note and BS 4142, which states:

"A representative level should account for the range of background sound levels and should not automatically be assumed to be either the minimum or modal value."

The Residual Sound Levels were determined through consideration of the range, mean and modal values of the daytime and night-time measured LAeq values, which are detailed in Annex 2.

Table 4-2: Measured Sound levels

NML	Background Sound Level, dB LA90(10mins)		Residual Sound Level, dB LAeq(10mins)	
	Day	Night	Day	Night
NML3	30	27	35	30
NML4	29	24	34	26
NML5	31	26	38	30

4.4 NG4 Baseline Characterisation

TNEI can confirm that the study area cannot be classed as a Quiet Area, as it does not comply with all of the requirements presented in Section 3.2.2:

- The nearest motorway is within 5 km; and,
- Tirlán Ballyragget is a large food processing plant within 10 km.

Consideration of the BS 4142 derived background sound levels, however, does indicate that the area can be classified as an *"Area of Low Background Noise"*.

5 Operational Noise Impacts

5.1 Modelling of Noise Sources

The noise model considers all of the primary sound sources detailed within Section 2 of the report. The following section describes how each sound source has been incorporated into the noise model.

All sound sources and are assumed to be operating concurrently, continually and with a constant sound level output. Noise modelling is based on candidate plant typical for the size and class of the Proposed BESS and 110kV Substation. It should be noted that final plant specifications may vary during the final tendering process.

Where possible, noise modelling data is shown within Annex 3, however, where data cannot be published due to confidentiality reasons, TNEI would be happy to discuss this data in more detail with the Local Authority (or any other relevant stakeholders), if required.

5.1.1 Battery Storage Containers

The Battery Storage Containers within the noise propagation model have been represented using the specifications and noise source data for a suitable candidate item of plant; the Sungrow PowerTitan 2.0. TNEI hold both 1/3 Octave Band Sound Pressure Level (SPL) and Sound Power Level (SWL) data for this candidate. For the purposes of this model, we have assumed that the unit is operating at 100% fan speed and at an ambient temperature of 25°C. In reality, the plant may not operate at 100% fan speed at ambient temperature of 25°C and such temperatures would be occasional across a calendar year, thus the data represent a conservative prediction of noise. The detailed 1/3 Octave noise data has been provided to TNEI from Sungrow through work on another BESS development and cannot be provided in this report. However, we can report that the equivalent broadband SWL used to model each façade, shown in Table 5-1**Error! Reference source not found.** below.

Table 5-1: SWL Data used to model the Sungrow PowerTitan 2.0 Battery Storage Container

Sungrow PowerTitan 2.0 with Noise Attenuation Kit (100% Power, 25°C)	SWL, dBA
Top Façade	76
Right Façade	69
Left Façade	69
Front Façade	74
Rear Façade	70

5.1.2 MV Transformer Stations

The Battery Storage Containers will be connected to multiple MV Transformer Stations. These have been represented within the noise model using the specifications and noise source data for a suitable

candidate item of plant; the Sungrow MVS5140-LS. Again, TNEI hold both 1/3 Octave Band Sound Pressure Level (SPL) and Sound Power Level (SWL) data for this candidate and for the purposes of this model we have assumed the use of the SPL data (operating at full power) as it is specific to each façade of the unit. As with the Battery Storage Container data, the MV Transformer Station detailed 1/3 Octave noise data cannot be provided in this report. However, we can report the equivalent broadband SWL used to model each façade of the unit, as shown in Table 5-2 below.

Table 5-2: SWL Data Used to Model the Sungrow MVS5140-LS

Sungrow MVS5140-LS	SWL, dBA
Top Façade	71
Right Façade	63
Left Façade	70
Front Façade	68
Rear Façade	79

5.1.3 High Voltage (HV) Grid Transformer

The MV Transformer Stations will be connected to a single HV Grid Transformer. In the absence of specific information on which model may be used, TNEI have assumed noise data for a candidate GE unit with a broadband SPL value of 68 dBA @ 2 m (inclusive of cooler noise), which is approximately equivalent to 82 dBA SWL.

As no spectral data is available for this candidate, typical transformer One-Third Octave Band spectra have been input into the noise model and transposed to equal a broadband SWL of 82 dBA. Table 5-3 details the resulting SWL used within the noise model and the relevant data sheets are included within Annex 3.

Table 5-3: One-Third Octave Band SWL Data Used to Model the GE HV Grid Transformer

Frequency (Hz)									
HV Transformer GE Candidate	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**
	-	-	-	58	42	49	66	62	72
	200	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**
	68	70	74	71	71	73	72	71	68
	1600	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
	66	64	62	61	61	59	56	54	52

5.2 Incorporation of Additional Mitigation Measures

The model assumes that no additional mitigation measures, for example, noise-attenuating fencing or bunds, will be included as part of the Proposed BESS and 110kV Substation.

5.3 Calculated Immission Levels

Noise immission levels have been calculated at four BESS Noise Assessment Locations (BNALs), which have been selected to represent the closest NSRs to the Proposed BESS and 110kV Substation. Each NAL has been set on the side of the property facing the Proposed BESS and 110kV Substation. The BNALs are detailed in Table 5-4 alongside its associated representative NML. BNALs are also shown on Figure A4.2 in Annex 4.

The immission levels (Specific Sound Level) have been calculated assuming all plant is operating continuously and concurrently. The model assumes, as a worst case, that noise levels do not fluctuate and remain the same throughout the daytime and night-time assessment periods. The noise immission levels are detailed in Table 5-4.

Table 5-4: Noise Assessment Locations (BNALs) and Specific Sound Levels

BESS Noise Assessment Location	ITM Coordinates		Representative NML	Specific Sound Level (dB $L_{Aeq(t)}$)
NAL ID	X	Y		
BNAL1	635105	667754	NML3	26
BNAL2	634346	667821	NML3	19
BNAL3	636618	667431	NML4	12
BNAL4	636320	666088	NML5	11

6 Noise Impact Assessment (BS 4142)

6.1 BS 4142 Rating Level

To assess the immission levels in accordance with BS 4142, the Specific Sound Level must be converted into a Rating Level. The Rating Level allows for character corrections to be added to account for particular characteristics of the sound that may be perceived as more annoying. In particular, the Rating Level considers tonality, impulsivity and intermittency of the sound, as well other sound characteristics that are neither tonal, impulsive, or intermittent, but are otherwise readily distinctive against the residual acoustic environment.

Note: Character corrections consider the noise at the receiver location, not the source location.

6.1.1 Tonality

With regards to tonality, BS 4142 states:

'For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible and 6 dB where it is highly perceptible.'

Consideration of both the SWL data of candidate plant, and the predicted one-third octave levels at the BNALs, indicates that tonality will not be present at any BNAL and as such, no tonal character correction is required. It should be noted that consideration of one-third octave levels is generally insufficient to determine if tonality will be present when plant is fully installed. Tonal assessments require a series of audio recordings of the installed plant from the receptor location such that fine resolution spectra of the plant can be obtained, i.e. of a finer resolution than one-third octave bands. However, given that this is not possible at the planning stage, consideration of the one-third octave band levels represents the most suitable method to determine the likelihood of tonality being present with the data that are available.

6.1.2 Impulsivity

With regards to impulsivity, BS 4142 states:

'A correction of up to +9dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible.'

Impulsivity is not considered to be a relevant sound characteristic of a BESS as when operational, the noise level will be predictable and consistent.

6.1.3 Intermittency

The intermittency of the sound source needs to be considered when it has identifiable on/off conditions with regards to intermittency, BS 4142 states:

'If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.'

As with impulsivity, intermittency is not considered to be a relevant sound characteristic in this case. Once operational, noise levels may fluctuate by a small amount over long periods of time, but no step changes in noise level are anticipated.

6.1.4 Other Sound Characteristics

With regards to other sound characteristics, BS 4142 states:

'Where the specific sound features characteristics that are neither tonal nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.'

Based on TNEI's understanding and experience of this type of plant, we do not anticipate any additional sound characteristics that would be considered readily distinctive against the residual acoustic environment.

6.1.5 Calculation of the Rating Level

With due regard to the above, no character corrections are required. Therefore, the BS 4142 Rating Levels are equal to the Specific Sound Levels, as presented in Table 5-4.

6.2 BS 4142 Stage 1 Assessment – Initial Estimate of Impact

Stage 1 of the assessment compares the Rating Levels against the Background Sound Level, as detailed in Table 6-1.

Table 6-1: BS 4142 Initial Estimate of Impact

BNAL	Rating Level		Background Sound Level		Difference (+/-)	
	Day	Night	Day	Night	Day	Night
BNAL1	26	26	30	27	-4	-1
BNAL2	19	19	30	27	-11	-8
BNAL3	12	12	29	24	-18	-13
BNAL4	11	11	31	26	-21	-16

During the daytime and night-time, the Rating Levels are below the Representative Background Sound Level at all BNALs. This is an *"indication of the specific sound source having a low impact, depending on the context*."

6.3 BS 4142 Stage 2 Assessment – Consideration of Context

Although there are other elements of context that may be relevant to the assessment, BS 4142 requires the following three contextual elements to be considered:

- the absolute level of the sound;
- the character and level of the residual sound compared to the character and the level of the specific sound; and
- the sensitivity of the receptor.

Each of these is considered in turn below, alongside other contextual elements that are relevant for the Proposed BESS and Substation.

6.3.1 Context: Absolute Level of Sound

BS 4142 suggests that in instances where the existing sound environment is considered either particularly low or particularly high then absolute levels may be more relevant than the initial estimate of impact. The standard states:

"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

The ANC BS 4142 Technical Note provides additional guidance on this, providing indicative values that could be used to describe 'low' background sound levels and 'low' rating levels. Specifically, the Technical Note states:

"BS 4142 does not define 'low' in the context of background sound levels nor rating levels. The note to the Scope of the 1997 version of BS 4142 defined very low background sound levels as being less than about 30 dB LA90, and low rating levels as being less than about 35 dB LAr,Tr".

In this case the background sound levels are in the low-30's (dB LA90(10mins)) during the daytime, however, during the night-time, background sound levels are below 30 dB, which could be described as 'very low'.

The Rating Levels are similarly 'low', being no more than 25 dB LAeq(10mins). In this case, due to the low rating and low background sound levels, the ANC Technical Note suggests that the initial estimate of impact may be modified, and notes that what may otherwise constitute a significant adverse impact may be considered acceptable due to this modifying factor. As such, **consideration of the absolute level of sound suggests that the initial estimate of impact could be reduced.**

6.3.2 Context: Character and Level of Residual Sound

The Residual Sound Level at all locations, as reported in Table 4-2 are greater than the Rating Levels, ranging from 26 – 38 dB $L_{Aeq(10\ mins)}$. Table 6-2 compares the Specific Sound Levels with the Residual Sound Level and also indicates the estimated level of change.

Table 6-2: Residual (Existing) and Ambient (Future) Sound Levels, dB LAeq(10mins)

NAL	a) Specific Sound Level		b) Residual Sound Level		c) Ambient Sound Level (a + b)*		Change (+/-)	
ID	Day	Night	Day	Night	Day	Night	Day	Night
BNAL1	26	26	35	30	36	31	1	1
BNAL2	19	19	35	30	35	30	0	0
BNAL3	12	12	34	26	34	26	0	0
BNAL4	11	11	38	30	38	30	0	0

**Note that this column is the logarithmic sum of the Specific Sound Level and the Residual Sound Level*

No noticeable change in noise level is anticipated during the daytime or night-time (with a maximum increase of 1 dB indicated) and the Specific Sound Levels are well below the Residual Sound Levels.

The character of the residual sound is consistent at all NMLs, influenced mostly by wind induced noise, with a small contribution from intermittent sound sources, such as distant road traffic, farming activity and birdsong. The Proposed BESS and Substation would operate with a continuous and relatively low

sound level, which is not expected to be readily distinctive against the residual acoustic environment. As such, **consideration of the character and level of residual sound suggests that the initial estimate of impact could be reduced.**

6.3.3 Context: Sensitivity of Receptor

BS 4142 suggests that the sensitivity of the receptor may be lessened if design measures that secure good internal and/or outdoor acoustic conditions are already implemented within the receptor. An example of this could be where a residential building has been fitted with non-openable windows in an already high noise environment. This is not relevant to this assessment, where it is assumed that all nearby NSRs do not incorporate any specific noise control measures. As such**, the sensitivity of the receptor remains high and this contextual element does not materially affect the initial estimate of impacts.**

6.3.4 Context: Operational Scenarios and Calculation of the Rating Level

The calculated Rating Level assumes that all plant will be operating continually and concurrently and with cooling plant running at maximum anticipated fan duties. In reality, not all cooling plant will be required to running in this mode and overall noise level output of the site will be reduced. Consideration of the conservative nature in the way the plant is assumed to be running in the noise model **suggests that contextually the impact would be reduced.**

6.3.5 Context: Consideration of NG4 Guideline Levels

NG4 has defined the area as an *"Area of Low Background Noise"*. Accordingly, noise limit criteria recommended in NG4 (see Table 3-1) is 35 dBA for night-time, 40 dBA for evening and 45 dBA for daytime.

The predicted noise levels are well below 35 dBA at all receptors and for all time periods, which is another indication that the absolute level of sound from the Proposed BESS and Substation is within acceptable levels. Therefore, **consideration of this contextual element would further reduce the initial estimate of impact.**

6.4 BS 4142 Assessment Conclusion

The Stage 1 – Initial Estimate of Impact indicated that, depending on the context, there would be a low impact at all receptors for both the daytime and night-time periods. Detailed considerations of the context clearly indicates that the impacts associated with the operation of the Proposed BESS and 110kV Substation could be less than that found in the initial estimate particularly with regards to the combination of very low background levels and low Rating Levels, as well as the comparison against the NG4 guideline noise level limits. As a low impact is the lowest possible initial estimate, it cannot be reduced further.

Accordingly, the **BS4142 assessment concludes that there would be a low impact when considering the context, at all residential receptors during both the daytime and night-time from the operation of the Proposed BESS and 110kV Substation.**

7 Summary

In order to assess the impact of noise emissions from the Proposed BESS and 110kV Substation elements of the Killoshulan Wind Farm, TNEI has produced a noise propagation model in accordance with ISO 9613-2:2024 that predicts the noise immission levels at the nearest identified residential receptors. Predictions are based on an indicative layout and candidate plant that is typical for this type and class of BESS and 110kV Substation development.

The nearest four residential properties surrounding the Proposed BESS and 110kV Substation compound were assessed as part of the main assessment presented within this report.

As part of the BS 4142 assessment, an initial estimate predicted that, depending on the context, there would be a low impact at all BESS Noise Assessment Locations (BNALs) during the daytime and night-time

Detailed consideration of the context indicates that the impacts associated with the operation of the Proposed BESS and 110kV Substation could be less than that found in the initial estimate. As a low impact is the lowest possible initial estimate, the full BS 4142 assessment process concludes that there would be a low impact when considering the context, at all residential receptors.

8 References

1. **Association of Acoustic Consultants of Ireland.** *Environmental Noise Guidelines for Local Authority Enforcement and Planning Sections.* AACI. Dublin : AACI, 2021.

2. **British Standards Institution (BSI).** *Methods for rating and assessing industrial and commercial sound.* London : BSI, 2019. BS 4142:2014+A1:2019.

3. **Association of Noise Consultants (ANC).** *BS 4142:2014+A1:2019 Technical Note. Version 1.0.* London : ANC, 2020.

4. **Environmental Protection Agency.** *Guidance Note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities (NG4).* Wexford : Environmental Protection Agency (EPA), 2016.

5. **International Organization for Standardization (ISO).** *Acoustics — Attenuation of sound during propagation outdoors — Part 2: Engineering method for the prediction of sound pressure levels outdoors.* Geneva : ISO, 2024. ISO 9613-2:2024.

6. **International Electrotechnical Commission (IEC).** *Electroacoustics – Sound level meters – Part 1: Specifications.* Geneva : IEC, 2013. IEC 61672-1:2013.

7. **British Standards Institution (BSI).** *Guidance on sound insulation and noise reduction for buildings.* London : BSI, 2014. BS 8233:2014.

8. **Environment Agency, Natural Resources Wales and Northern Ireland Environment Agency,.** *Method Implementation Document (MID) for BS 4142.* London : Environment Agency, 2023.

Annex 1 – Proposed BESS and 110kV Substation Details

- Indicative Substation (left) and BESS (right) site layout drawing

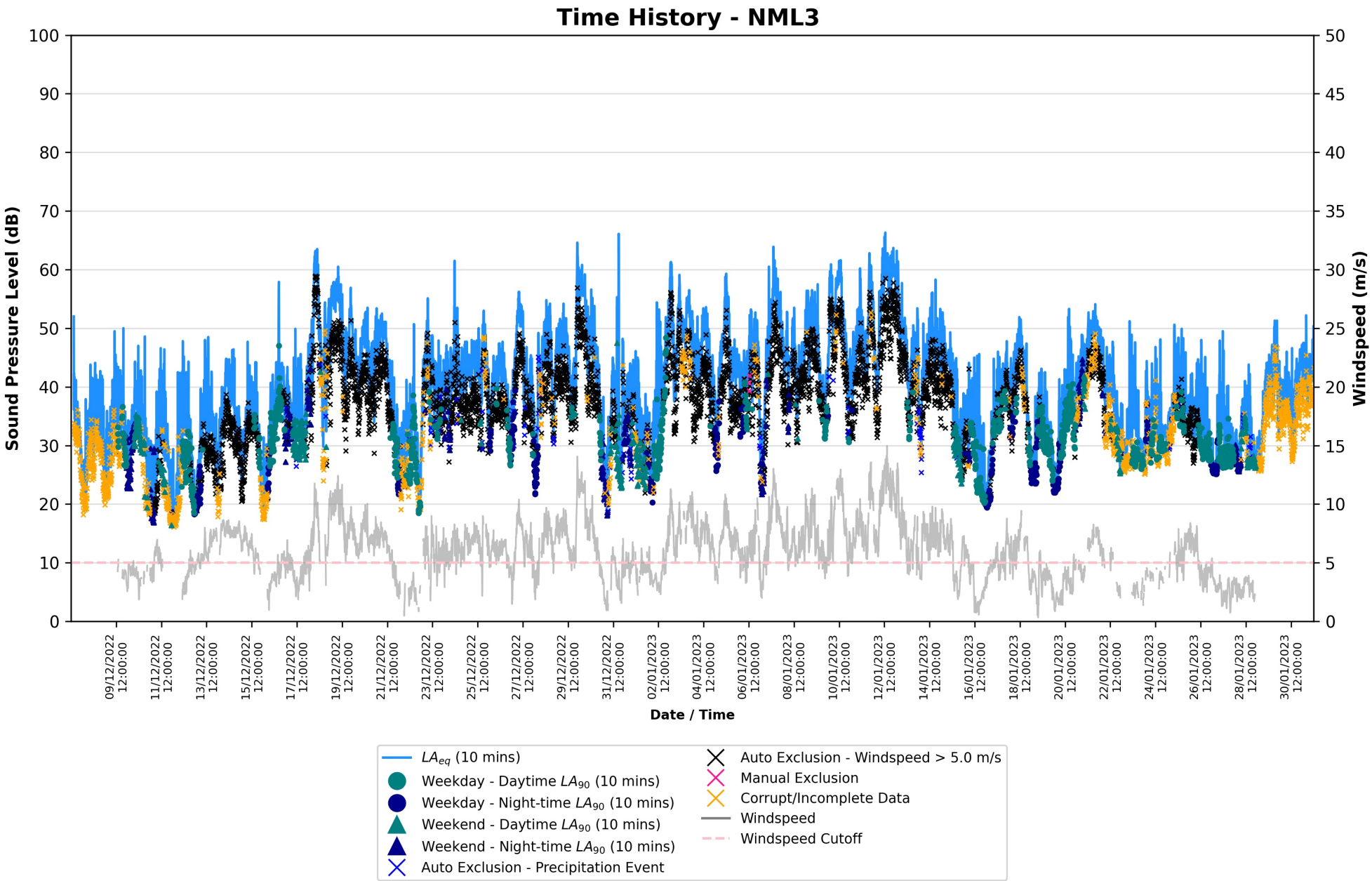


Annex 2 – Baseline Survey Data

- BS 4142 baseline analysis charts

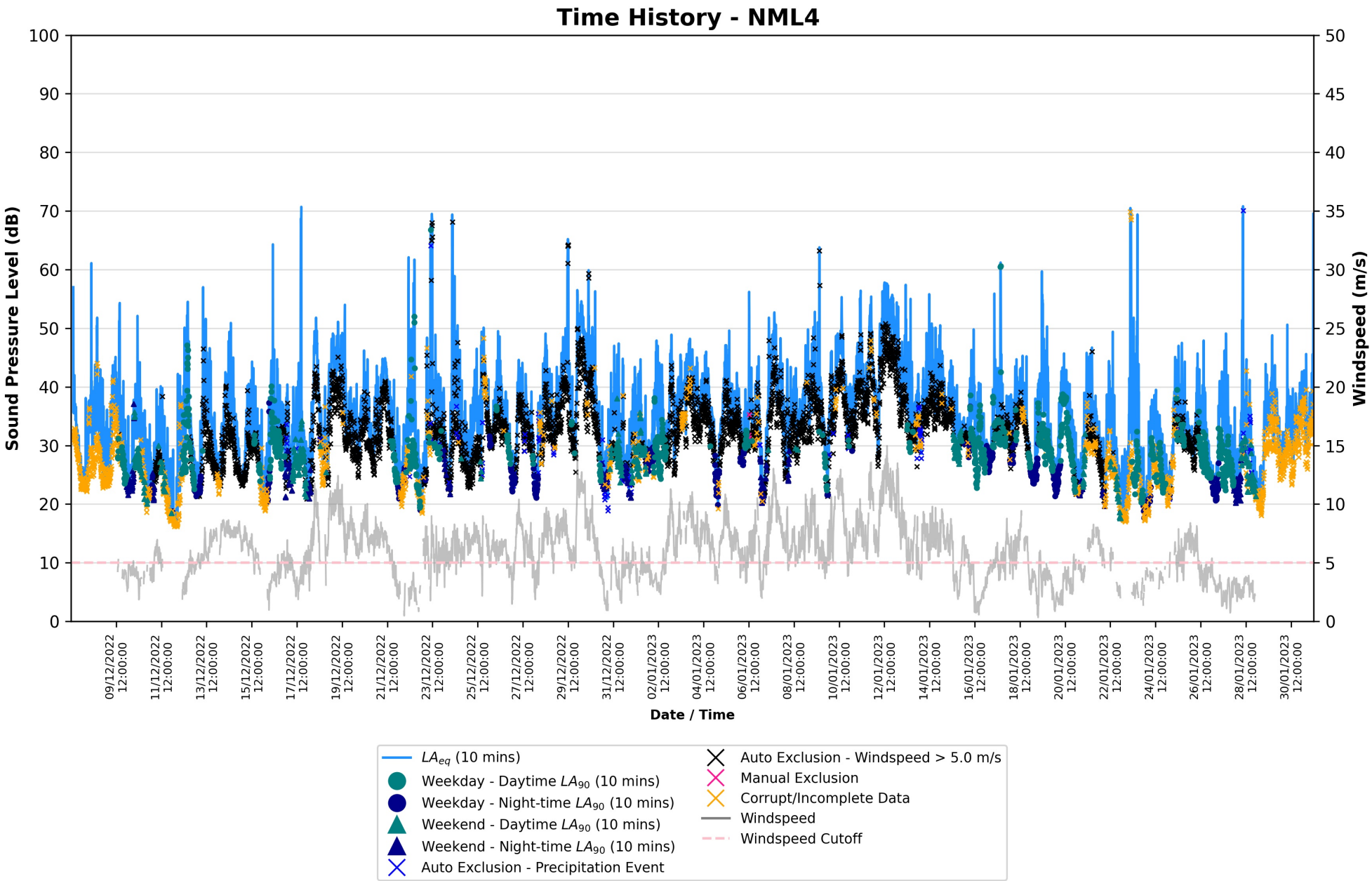
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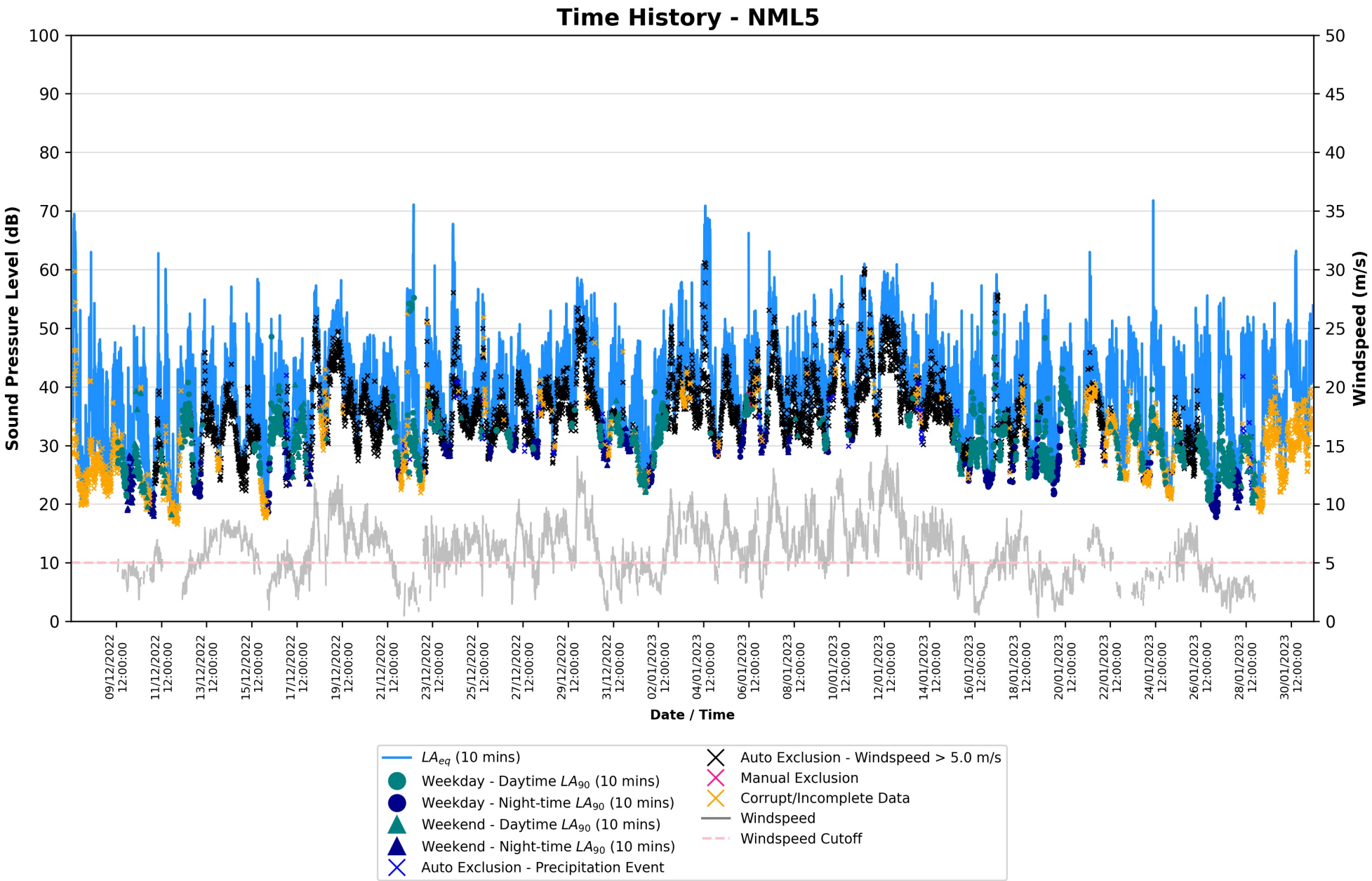


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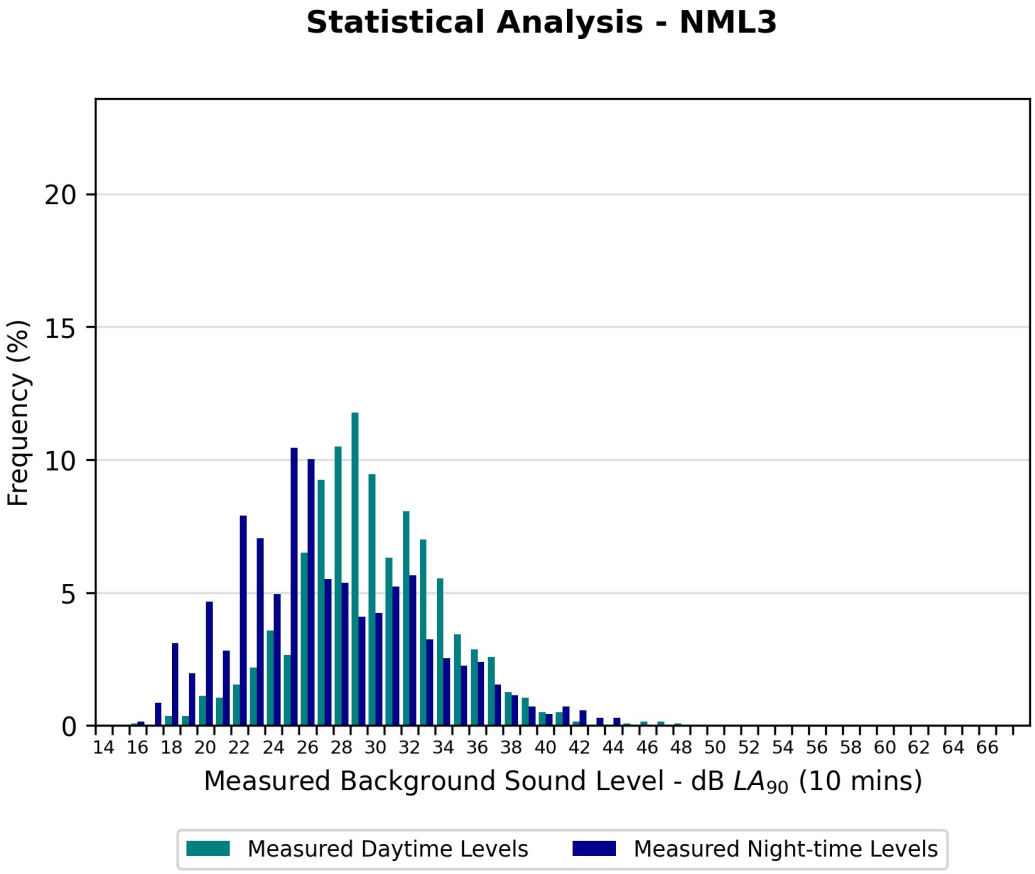
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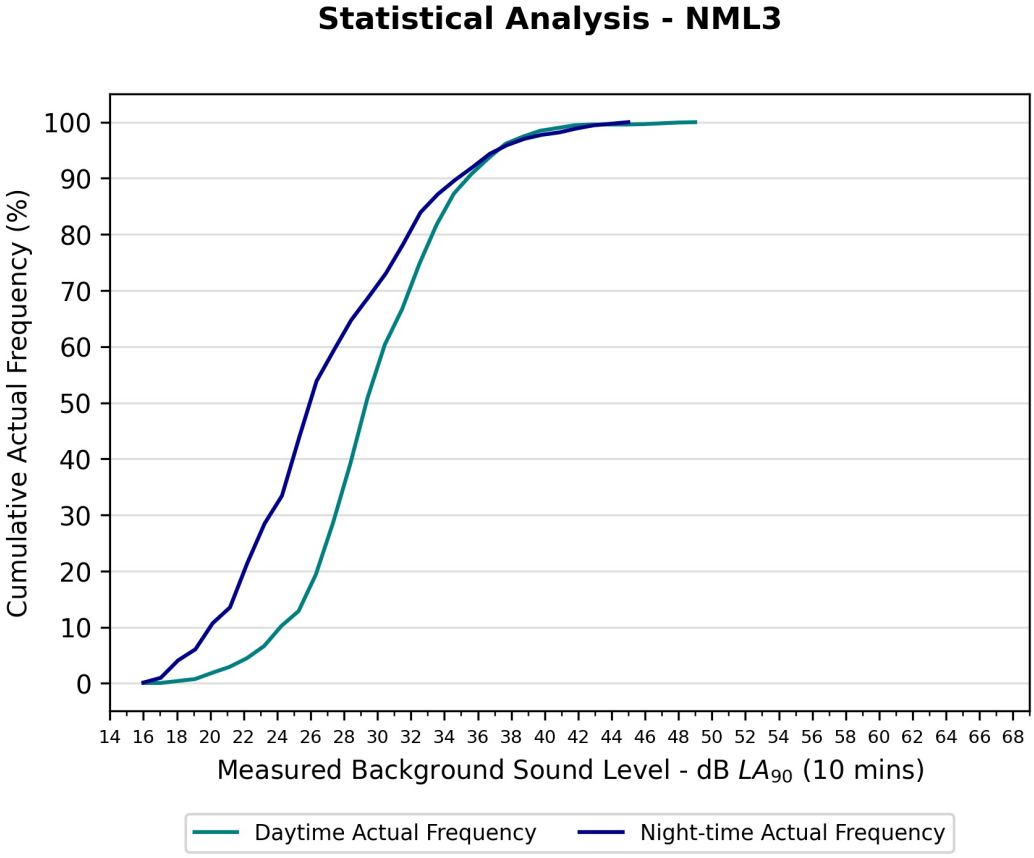


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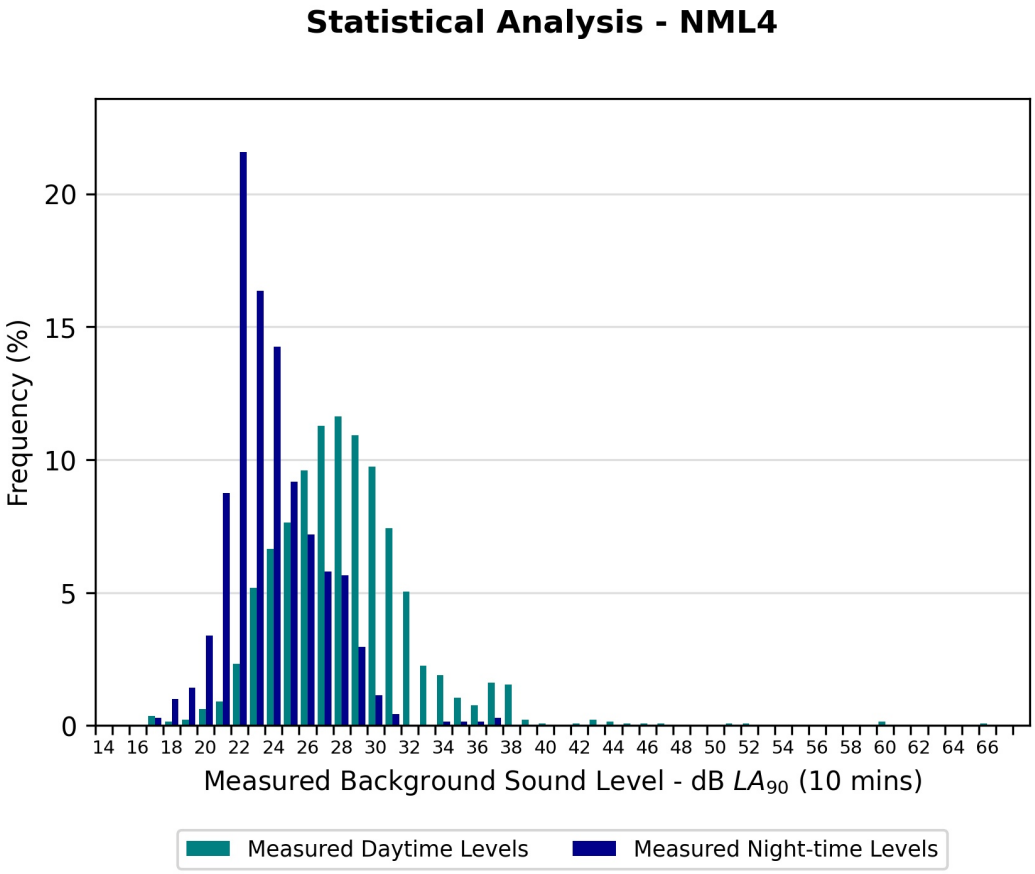


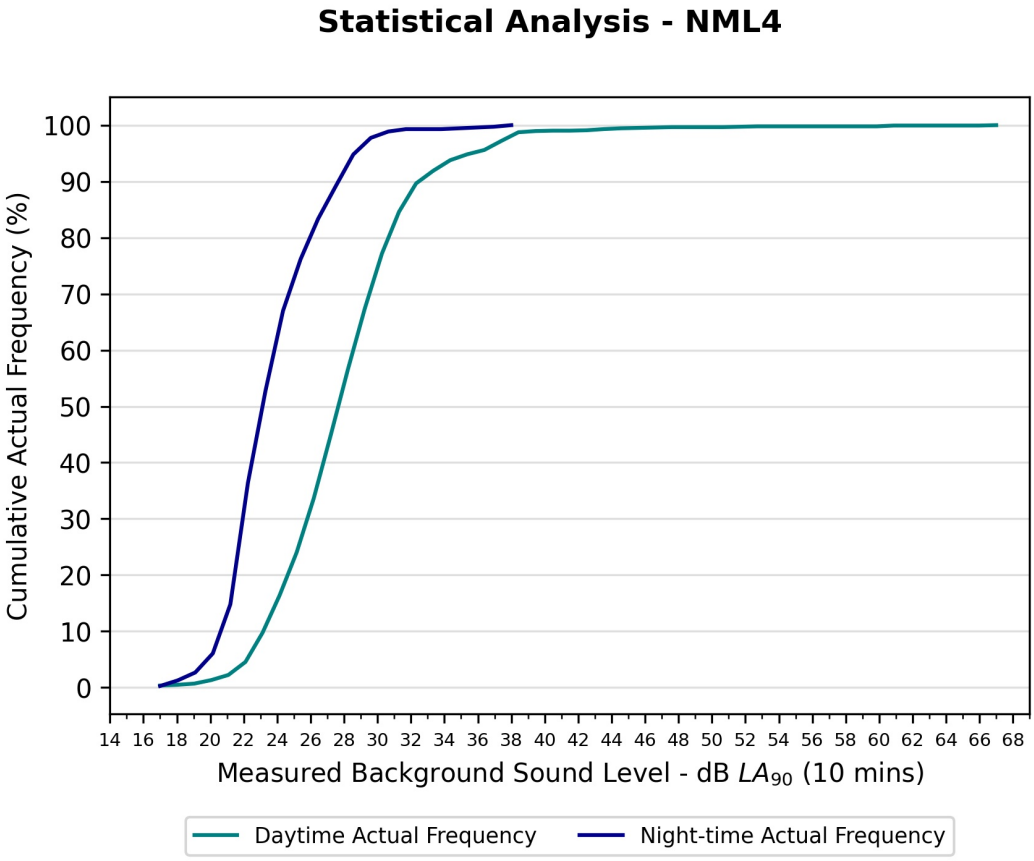
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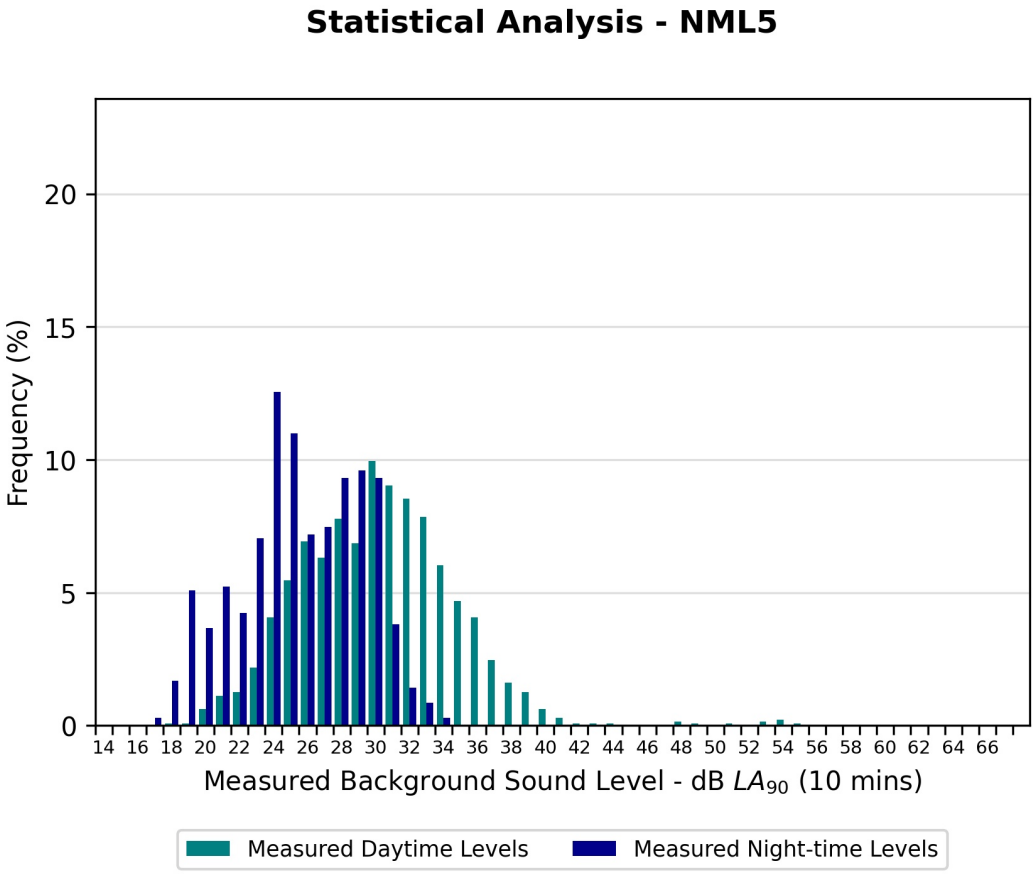


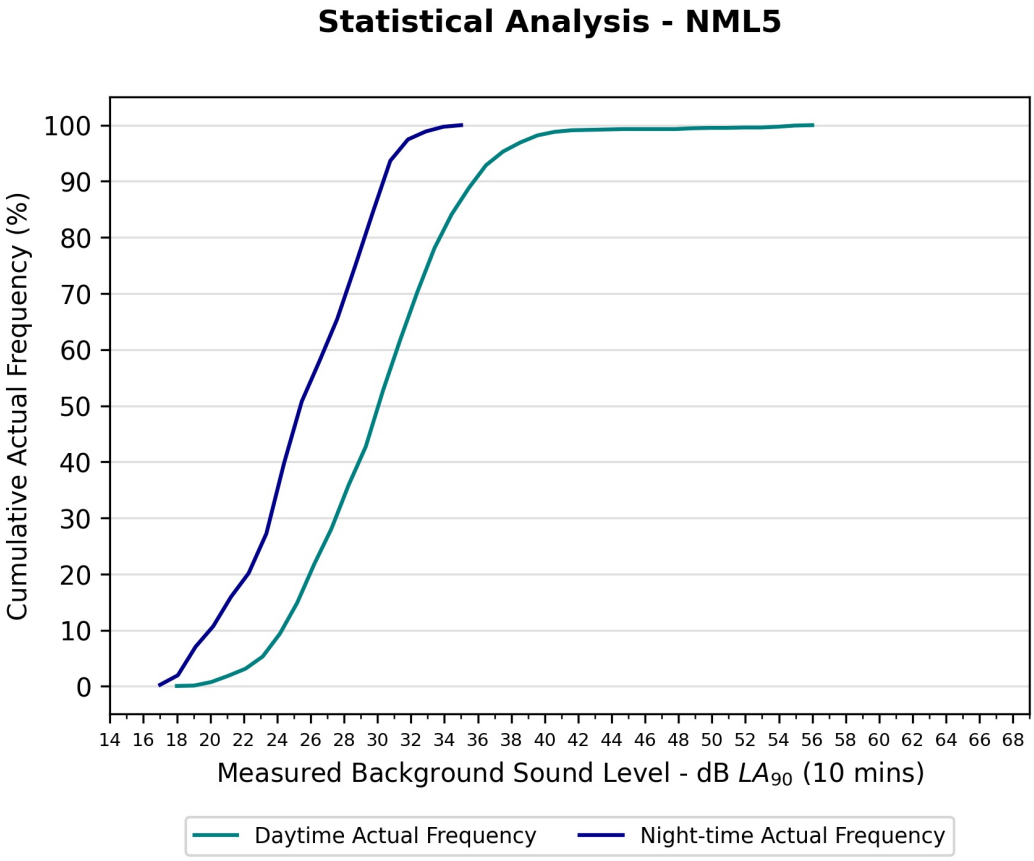
IE00061 - Killoshulan Wind Farm - Measured Sound Levels:





IE00061 - Killoshulan Wind Farm - Measured Sound Levels:





IE00061 - Killoshulan Wind Farm - Measured Sound Levels:

Relevant Statistics

NML3

		COUNT	MEAN	MEDIAN	RANGE
DAYTIME	LA90 (10 MINS)	1428	30	30	16 - 48
	LAEQ (10 MINS)	1428	36	35	17 - 66
NIGHT-TIME	LA90 (10 MINS)	709	27	27	17 - 45
	LAEQ (10 MINS)	709	31	30	18 - 49

NML4

		COUNT	MEAN	MEDIAN	RANGE
DAYTIME	LA90 (10 MINS)	1428	29	28	18 - 67
	LAEQ (10 MINS)	1428	34	34	19 - 71
NIGHT-TIME	LA90 (10 MINS)	709	24	24	18 - 37
	LAEQ (10 MINS)	709	27	26	19 - 40

IE00061 - Killoshulan Wind Farm - Measured Sound Levels:

Relevant Statistics

NML5

		COUNT	MEAN	MEDIAN	RANGE
DAYTIME	LA90 (10 MINS)	1428	31	31	18 - 55
	LAEQ (10 MINS)	1428	38	38	20 - 71
NIGHT-TIME	LA90 (10 MINS)	709	26	26	18 - 34
	LAEQ (10 MINS)	709	29	30	19 - 48

NML6

		COUNT	MEAN	MEDIAN	RANGE
DAYTIME	LA90 (10 MINS)	1426	31	31	19 - 58
	LAEQ (10 MINS)	1426	37	36	22 - 74
NIGHT-TIME	LA90 (10 MINS)	709	24	23	18 - 35
	LAEQ (10 MINS)	709	29	30	19 - 49

Annex 3 – Noise Modelling Data

- HV Transformer Sound Power Level Data

Transformer Data Sheet 275/13.8/13.8 kV, 140/70/70 MVA, ONAN/ONAF, 3 phase

Transformer Details

Continuous Maximum Rating		
HV – LV1 and HV – LV2	MVA	47/70 – 47/70
HV – (LV1 + LV2)	MVA	94/140
HV Voltage	(kV)	275
LV1 – LV2 Voltage	(kV)	13.8 – 13.8
Tapping Range (OLTC)		275 kV -19.5% to +25.5% 31 positions, 30 x 1.5% steps Principal tap shall be position 18
Impedance at principal tap – position 18 (%)		
HV – LV1 and HV – LV2 @ 70 MVA		14.0%
HV – (LV1 + LV2) @ 140 MVA		15.6%
LV1 – LV2 @ 70 MVA		25.0%
Vector Group		YNd11-d11
Cooling		ONAN/ONAF
Maximum Top Oil Rise	(°C)	60
Maximum Average Winding Rise	(°C)	65
Frequency	(Hz)	50
Connections:		
HV		Oil/air bushings
HVN		Oil/air bushing
LV		Oil/air bushing
Finish Shade		BS 381C – 632 Dark Admiralty Grey
Maximum Sound Pressure Level		
Transformer only	dB(a)	65
Transformer plus coolers	dB(a)	68
BIL HV/LV	kVp	1050/125
BIL HVN	kVp	125
SIL HV (kVp)	kVp	850
IVPD enhanced level		1.8
IVPD one-hour level		1.58
Applied Voltage		
HV to LV and earth	kV_{rms}	395
LV to HV and earth	kV_{rms}	38

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Guaranteed Losses		Transformer losses shall be such as to comply with EU 548/2014, Tier 2 July 2021.
Minimum efficiency		99.770%.

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Technical Schedules

Item	Units	Specified by Company	Guaranteed by GE
Continuous Maximum Rating			
HV – LV1 and HV – LV2	MVA	47/70 – 47/70	47/70 – 47/70
HV – (LV1 + LV2)	MVA	94/140	94/140
HV Voltage	(kV)	275	275
LV1 – LV2 Voltage	(kV)	13.8 – 13.8	13.8 – 13.8
Tapping Range (OLTC)		275 kV -19.5% to +25.5% 31 positions, 30 x 1.5% steps Principal tap position 18	275 kV -19.5% to +25.5% 31 positions, 30 x 1.5% steps Principal tap position 18.
Impedance at principal tap – position 18			
HV – LV1 and HV – LV2 @ 70 MVA		14.0%	14% (IEC tolerance +/- 7.5%)
HV – (LV1 + LV2) @ 140 MVA		15.6%	15.6% (IEC tolerance +/10%)
LV1 – LV2 @ 70 MVA		25.0%	25% (IEC tolerance +/-10%)
Impedance at maximum tap position 1			
HV – LV1 and HV – LV2 @ 70 MVA		-	16.4% (IEC tolerance +/10%)
HV – (LV1 + LV2) @ 140 MVA		-	17% (IEC tolerance +/10%)
LV1 – LV2 @ 70 MVA		-	TBA
Impedance at minimum tap position 31			
HV – LV1 and HV – LV2 @ 70 MVA		-	15.2% (IEC tolerance +/10%)
HV – (LV1 + LV2) @ 140 MVA		-	15.9% (IEC tolerance +/10%)
LV1 – LV2 @ 70 MVA		-	TBA
Vector Group		YNd11-d11	YNd11-d11
Cooling		ONAN/ONAF	ONAN/ONAF
Maximum Top Oil Rise	(°C)	60	60k
Maximum Average Winding Rise	(°C)	65	65k
Frequency	(Hz)	50	50
Connections:			
HV		Oil/air bushings	Oil/air bushings
HVN		Oil/air bushing	Oil/air bushings
LV		Oil/air bushing	Oil/air bushings
Finish Shade		BS 381C – 632 Dark Admiralty Grey	BS 381C – 632 Dark Admiralty Grey
Maximum Sound Pressure Level			
Transformer only	dB(a)	65	65 @1m. Sound Intensity method
Transformer plus coolers	dB(a)	68	68 @2m. Sound Intensity method
BIL HV/LV	kVp	1050/125	1050/125
BIL HVN	kVp	125	125
SIL HV (kVp)	kVp	850	850 (IEC60076-3 – Table 2)
IVPD enhanced level		1.8	1.8

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IVPD one-hour level		1.58	1.58
Applied Voltage			
HV to LV and earth	kV_{rms}	395	395
LV to HV and earth	kV_{rms}	38	38
Guaranteed Losses			
No load	kW	EU 548/2014, Tier 2 July 2021	54 @1pu rated Voltage.
Full load	kW	EU 548/2014, Tier 2 July 2021	440 @ 140MVA, both LV's loaded on Nom Tap Pos 18
Minimum efficiency		99.770%.	99.78%

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Core Detail	GE Transformer
Core construction, step-lap etc.	Core type, step lap.
Type of core - 3 limb, 5 limb, etc.	3 Limb.
Core plate material type	M105-30P5.
Core plate material thickness (mm)	0.3
Core diameter (mm)	773
Core area (mm^2)	432400
Flux density at 100% volts & 50 Hz (Tesla)	1.65
Core weight excluding clamps (kg)	51000
Core weight including clamps (kg)	Approximately 55850.
Clamping type, tie-rod, flitch plate	Flitch Plate.
Tie rod diameter, flitch plate thickness (mm)	10
Top/Bottom clamp thickness (mm)	70 / 50
Method of securing (bands, belts etc.)	Bands.

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Winding Detail	GE Transformer			
Winding disposition core/__/__/__	LV1 Bottom - LV2 Top / HV / Taps			
Winding name	LV1 Bottom	LV2 Top	HV	Taps
Winding type - spiral/disc etc.	Layer	Layer	Shielded Disc	Disc
Total turns	87	87	1031	240
Total no. of discs/sections	2 layers	2 layers	2 x 70	2 x 32
Turns/disc or section	43.5 T/layer	43.5 T/layer	15	7.5
Min cooling gap between discs/sects (mm)	3	3	4	4
Copper hardness	80MPA	80MPA	80MPA	140MPA
Conductor type	Netted/mylar CTC	Netted/mylar CTC	CTC	Strip
For CTC - No. strips in llel	37	37	9	N/A
Bare conductor size (mm)	4.35 x 1.7	4.35 x 1.7	4.8 x 1.3	9 x 2.6
No. conductors in llel	2	2	1/half stack	2/half stack
Epoxy bonded Y/N	Y	Y	Y	N
Conductor ins - radial enamel/paper (mm)	0.04/0.075 mylar	0.04/0.75 mylar	0.04/0.55	N/A / 0.55
Conductor area (mm^2)	520.4	520.4	108.5	91.4
Max current density @ CMR (A/mm^2)	3.25	3.25	2.71	3.22
Wdg ID/OD (mm)	807 / 977	807 / 977	1109 / 1377	1507 / 1625
Wdg pressed height (mm)	2130 over LV1 + LV2	2130 over LV1 + LV2	2090	1518
Final clamping pressure (kN/mm^2). Based on worst case end force.	3.7	3.7	3.7	3.7
Shield wire used Y/N	N	N	Y	N
Dimensions and ins of shield wire	N/A	N/A	9.7x1 with 0.55 rad PC	N/A
Winding gradient to oil (°C) (ONAF)	13k calc	13k calc	15k calc	17k calc
Max winding hotspot temperature (°C) (ONAF)	69k rise	69k rise	72k rise	74k rise
Position of max wdg hotspot	Top 2 turns	Top 2 turns	Top 2 discs	Top 2 discs

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Annex 4 – Figures

- Figure A4.1: Noise Assessment Study Area
- Figure A4.2: BESS Noise Assessment Locations

N

NML 01

NML 02

NML 03

NML 04

NML 05

NML 06

0 1 2 3 Kilometre

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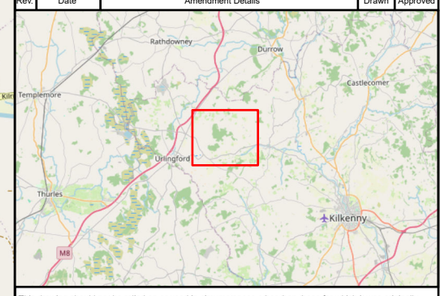
LEGEND

- EIAR Site Boundary
- Proposed On-Site Substation & BESS Compound
- Noise Monitoring Locations (NMLs)

Noise Sensitive Receptors (NSRs) Represented By:

- NML1
- NML2
- NML3
- NML4
- NML5
- NML6

Rev.	Date	Amendment Details	Drawn	Approved
0	15/09/2026	FIRST ISSUE	FL	MC



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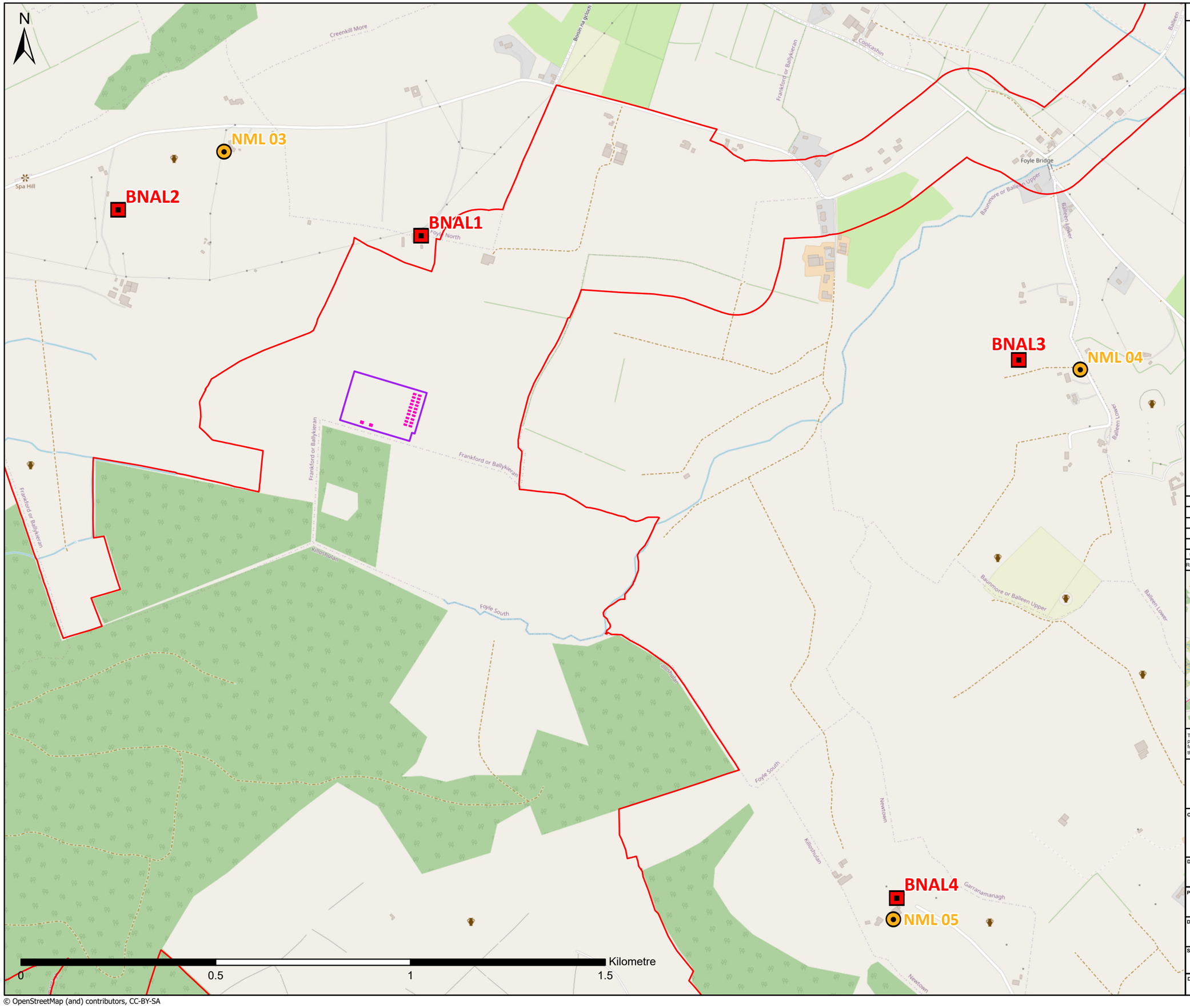
Drawing Status: FOR INFORMATION

Project Title: KILLOSHULAN WIND FARM

Drawing Title: FIGURE A4.1 - BESS STUDY AREA

Scale:	Size:	Spatial Reference:
1:25,000	A3	IRENET95 Irish Transverse Mercator

Drawing Number: IE00061-015



LEGEND

- Noise Monitoring Locations (NMLs)
- BESS Noise Assessment Locations (BNALs)
- Modelled Noise Sources
- EIAR Site Boundary
- Proposed On-Site Substation & BESS Compound

Rev.	Date	Amendment Details	Drawn	Approved
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Client: MKO

Drawing Status: FOR INFORMATION

Project Title: KILLOSHULAN WIND FARM

Drawing Title: FIGURE A4.2 - BESS NOISE ASSESSMENT LOCATIONS

Scale:	Size:	Spatial Reference:
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Drawing Number: IE00061-016

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