Technical Appendix 10.3: Solar and BESS Noise Report

Appendix 10.3

Battery Energy Storage System (BESS), Substation and Solar Farm Operational Noise Report

M74 West Renewable Energy Park

M74 West Limited

15990-021-R0
02 August 2024

COMMERCIAL IN CONFIDENCE

Quality Assurance

TNEI Services Ltd, TNEI Africa (PTY) Ltd and TNEI Ireland Ltd operate an Integrated Management System and is registered with The British Assessment Bureau as being compliant with ISO 9001 (Quality), ISO 14001 (Environmental) and ISO 45001 (Health and Safety).

Disclaimer

Document Control

Revision	Status	Prepared by	Checked by	Approved by	Date
R0	DRAFT	TS	EW	EW	02/08/2024

TNEI Services Ltd
Company Registration Number: 03891836 **VAT Registration Number: 239 0146 20**

Registered Address		
Bainbridge House	7th Floor West One	6th and 7th Floor
86-90 London Road	Forth Banks	80 St. Vincent Street
Manchester	Newcastle upon Tyne	Glasgow
M1 2PW	NE1 3PA	G2 5UB
Tel: +44 (0)161 233 4800	Tel: +44 (0)191 211 1400	Tel: +44 (0)141 428 3180

TNEI Ireland Ltd
Registered: 104 Lower Baggot Street, Dublin 2, DO2 Y940
Company Registration Number: 662195 **VAT Registration Number: 3662952IH**

Unit S12, Synergy Centre
TU Dublin Tallaght Campus
Tallaght
D24 A386
Tel: +353 (0)190 36445

TNEI Africa (Pty) Ltd
Registered: Mazars House, Rialto Rd, Grand Moorings Precinct,7441 Century City, South Africa
Company Number: 2016/088929/07

Unit 514 Tyger Lake
Niagara Rd & Tyger Falls Blvd
Bellville, Cape Town
South Africa, 7530

TNEI Inc.
Registered Address: 9319 Robert D/ Snyder Rd. PORTAL Building Mecklenburg County
Charlotte, NC 228223-0001 USA
Certification Number: C202305805696-1

Unit 216 PORTAL Building,
9319 Robert D. Snyder Road
Charlotte, Mecklenburg County,
North Carolina 28223
Tel: +1 (980) 245-4024

Contents

TABLES

APPENDICES

1 Introduction

TNEI Services Ltd was commissioned by Ramboll on behalf of M74 West Limited ('the Applicant') to undertake a Noise Impact Assessment (NIA) for the operation of a 50 MW Battery Energy Storage System (BESS), substation and solar farm, which form part of the Proposed M74 West Renewable Energy Park (hereinafter referred to as 'the Proposed Development').

The method of assessment when considering operational noise from developments such as a BESS, a substation or a solar farm is different to that used for the assessment of operational noise attributable to a wind turbine and as such the two assessment types cannot be combined. Accordingly, the assessment of operational noise attributable to the BESS, substation and solar farm element of the Proposed Development is presented separately within this report. The operational wind farm noise assessment is provided within a separate document, entitled Technical Appendix 10.2.

The Proposed Development is to be located immediately northwest of Abington in South Lanarkshire, Scotland, with the centre of the site located at approximate OS Grid Reference 289227, 626397. The area immediately surrounding the site is rural in nature, comprising of open moorland, improved and semi-improved grassland and is intersected by the M74 motorway and the B7078 and B740 local roads. The BESS and Substation elements of the Proposed Development are located on the western side of the site, adjacent to the proposed construction compound and just north of the B7078. The Solar farm element of the Proposed Development is located on the eastern side of the site, with infrastructure located immediately adjacent to the west and east of the M74. The location of the various elements of the Proposed Development are displayed within Figure 01, included within Annex 5 of this report.

The aims of this NIA were to:

- Identify the nearest noise sensitive receptors in the vicinity of the proposed BESS, substation and solar farm;
- Identify the primary sound sources associated with the operation of the BESS, substation and solar farm;
- Calculate the likely levels of operational noise at the identified receptors to determine the noise impacts; and
- Indicate any requirements for mitigation measures, if required, to provide sufficient levels of protection for all noise sensitive 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). Specifically, the following members of staff have been involved in the project:

- Tom Suddaby, AffIOA, BA (Hons): Baseline Noise Survey, Noise Propagation Modelling, Assessment and Reporting; and,
- Ewan Watson, AMIOA, BEng (Hons), IOA Postgraduate Diploma in Acoustics and Noise Control: Quality Assurance.

1.1 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;

- **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 baseline noise levels have been measured;
- **NSRs** (Noise Sensitive Receptors) are all identified receptors which are sensitive to noise; and
- **BNAL** (BESS Noise Assessment Location) refers to any location where the noise immission levels from the BESS are calculated and assessed.

A Glossary of Terms is also provided as Annex 1 of this report.

All figures referenced within the report can be found in Annex 5.

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

All grid coordinates refer to the Ordnance Survey grid using Eastings and Northings.

2 Project Description

The BESS, substation and solar farm elements of the Proposed Development would introduce new sound sources to the local area. For the BESS, this will likely consist of externally located fixed plant in the form of multiple Liquid-Cooled Battery Storage units (or 'Cubes') and Power Conversion System (PCS) units combining both Medium Voltage (MV) Transformers and Inverters. It is assumed that the substation will consist of a single High Voltage (HV) Grid Transformer, as well as some additional ancillary plant, such as switch gear, customer substation/welfare cabins and auxiliary transformers. The solar farm is to consist of multiple rows of PV panels, serviced by a number of centralised Solar Inverter/Transformer units.

With due consideration of the above, the dominant sound sources considered within this assessment are assumed as follows:

- Liquid Cooled Battery Cubes (88 of);
- MV Transformer/Inverter Units (11 of);
- HV Grid Transformer Unit (1 of); and,
- Centralised Solar Inverter/Transformer Units (12 of).

Any ancillary infrastructure associated with the BESS, substation and solar farm (such as auxiliary transformers etc.) is expected to have a negligible noise output in comparison to the main sources of noise associated with the respective elements as detailed above. Accordingly, no other items of plant have been considered within the assessment.

A plan of the Proposed Development included within Annex 2 provides an overview of the solar farm layout and an indicative BESS and Substation location. A detailed layout plan of the BESS and substation has not at this stage been detailed by the Applicant and as such TNEI has designed a layout that incorporates specific candidate plant to equate to a BESS capacity of 50 MW, as well as the inclusion of a typical HV Grid Transformer to form the substation. Selection of a candidate plant supplier is required for the purposes of the NIA in order to accurately quantify the likely operational noise emissions of the BESS, substation and solar farm. Whilst the exact specifications are subject to detailed design, the principal components described form the basis of the assessment to allow the impact to be appropriately estimated and potential mitigation measures to be considered.

2.1 Study Area

Noise Sensitive Receptors (NSRs) are properties that are sensitive to noise and, therefore, require protection from nearby noise sources. The study area for the assessment of environmental noise is usually defined through the identification of the closest NSRs to the development.

The assessment of noise attributable to the BESS, substation and solar farm considers the nearest NSRs only, on the assumption that if sound levels at the closest receptors are deemed acceptable, then sound levels at NSRs at greater distances from the BESS, substation and solar farm should also be within acceptable levels.

The nearest identified NSRs are existing residential properties at varying distances to the north, south and east of the BESS, substation and solar farm. The closest NSR specific to the BESS and substation is located approximately 900 m to the south, whilst the closest NSR to the solar farm is located approximately 300 m to the north of the nearest noise emitting infrastructure.

Figure 1 within Annex 5 details the study area and the closest NSRs to the Proposed Development.

3 Assessment Methodology

3.1 Legislation and Policy Context

3.1.1 3.1.1 PAN 1/2011

At a national level, the relevant policy is PAN 1/2011 (PAN) *'Planning and Noise'* (1) and the associated Technical Advice Note (TAN) – 'Assessment of Noise' (2).With regards to the assessment of environmental noise, Appendix 1 of the TAN describes a number of standards and guidelines that may be referred to and details BS 4142:2014 *'Methods for Rating and Assessing Industrial and Commercial Sound'* (3) and BS 8233 '*Guidance on sound insulation and noise reduction for buildings*' (4) as appropriate standards to refer to for the assessment of industrial noise.

3.2 Assessment Methods

A number of standards and guidelines are available for the assessment of environmental noise from proposed new developments or activities. Typically, assessments are based on a comparison of likely noise levels against either 'context' based limits or a set of fixed limits.

Context based limits are set relative to the existing noise environment and may also consider the characteristics of the noise source(s), whilst fixed limits are usually set regardless of the existing noise environment or type of noise source(s).

3.2.1 'Context' Based Limits (BS 4142:2014 +A1:2019)

BS 4142:2014+A1:2019 (Henceforth referred to as 'BS 4142') is commonly used to assess the potential impacts of new industrial sound sources on nearby receptors. The 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"*.

Specifically, the assessment is made by subtracting the measured background sound level from a calculated or measured 'Rating Level'.

BS 4142 uses the following definitions;

- **Ambient Sound**: Totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, both near and far. Described using the metric, LAeq (t).
- Specific Sound Level: Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, Tr. Described using the metric LAeq (t). Also referred to in this Appendix as the Immission Level.
- Residual Sound Level: Equivalent continuous A-weighted sound pressure level of the residual sound without the specific sound source(s) present at the assessment location over a given time interval, T. Described using the metric LAeq (t).
- Background Sound Level: A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels. Described using the metric LA90 (t).
- Rating Level: The Specific Sound Level adjusted for the characteristics of the sound. The Rating Level is calculated by adding a penalty or penalties (if required) to the Specific Sound Level when the sound source contains audible characteristics such as tonal, impulsive or intermittent components. Described using the metric, $L_{Aeq\ (t)}$.

BS 4142 is a qualitative assessment, not a quantitative assessment i.e. it does not simply provide a pass or fail result by comparing a predicted noise level to a noise limit. Rather, it considers predicted levels in context with the wider setting to estimate whether adverse impacts may occur.

Supplementary information regarding the application of BS 4142 is provided within the Association of Noise Consultants' (ANC) BS 4142 Technical Note (March 2020) (5). The technical note provides guidance on the appropriate interpretation and application of the standard, including clarifying the methodology for the derivation of representative background sound levels. Critically, the technical note states the following with regards to the application of the standard in the event measured background sound levels and predicted Rating Levels are low:

'*… the absolute level of sound can be of significance, where the residual values are low and where they are high, and should be taken into account when determining the overall impact of a particular specific sound source. The second paragraph* [of BS 4142] *notes that absolute levels may be as, or more, important than relative outcomes where background and rating levels are low. It is important to note that both background and rating levels would need to be low for this particular caveat to apply. BS 4142 does not indicate how the initial estimate of impact should be adjusted when background and rating levels are low, only that the absolute levels may be more important than the difference between the two values. It is likely that where the background and rating levels are low, the absolute levels might suggest a more acceptable outcome than would otherwise be suggested by the difference between the values. For example, a situation might be considered acceptable where a rating level of 30dB is 10dB above a background sound level of 20dB, i.e. an initial estimate of a significant adverse impact is modified by the low rating and background sound levels.'*

With regards to what constitutes 'low', the technical note goes on to state:

'*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 L_{A90}, and low rating levels as being less than about 35 dB $L_{Ar,Tr}$. The WG suggest that similar values would not be unreasonable in the context of BS 4142, but that the assessor should make a judgement and justify it where appropriate.'*

Extracts underlined by TNEI for emphasis.

3.2.2 Fixed Guideline Levels (BS 8233:2014)

BS 8233:2014 '*Guidance on sound insulation and noise reduction for buildings*' presents guideline noise levels for daytime and night-time periods for a number of different building types. For residential developments, these are based on guidelines issued by the World Health Organisation (WHO). Specifically, the standard states: *'In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values in Table 4.'* Table 4 is reproduced here as Table 3.1:

Table 3.1: Indoor Ambient Noise Levels for Dwellings (*BS 8233:2014 Table 4*)

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq\ (16hour)}$	-
Dining	Dining room/area	40 dB $L_{Aeq\ (16hour)}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq\ (16hour)}$	30 dB $L_{Aeq\ (8hour)}$

The *Acoustics, Ventilation and Overheating Guide (AVO)* (January 2020), jointly published by the UK's ANC and the Institute of Acoustics (6), suggests that a value of 13 dB is an appropriate to convert between internal and external sound levels for a partially open window. Therefore, an assessment of external noise levels can assume an external noise level limit of 13 dB above those values detailed within Table 3.1 (i.e. to achieve an internal night-time level of 30 dB $L_{Aeq\ (8hour)}$ with windows open, the external sound level must not exceed 43 dB $L_{Aeq\ (8hour)}$.

3.3 Assessment Criteria

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

- A quantitative assessment is made against the fixed noise guideline levels defined in BS 8233:2014, and;
- A qualitative assessment is undertaken at the nearest residential receptors in accordance with BS 4142, taking into consideration the context of the Proposed Development.

3.4 Calculation Method

3.4.1 Noise Propagation Model (ISO 9613-2:2024)

In order to predict the noise immission levels attributable to the Proposed Development, a noise propagation model was created using the propriety noise modelling software, CadnaA (7). 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 ISO 9613 '*Acoustics – Attenuation of sound during propagation outdoors* (8) using the following input parameters:

- Temperature was assumed to be 10 °C and relative humidity as 70%;
- A ground attenuation factor of 1 (soft ground) has been used across most of the site, except for hardstanding areas such as the BESS, substation, turbine foundations, roads and waterbodies which use 0 (hard ground) and the solar farm area which uses an attenuation factor of 0.5 (mixed ground); and
- Receiver heights were set to 4 m.

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 and simultaneously; and,
- Modelled sound sources represent candidate plant only and a proposed site layout. The noise output of individual items of plant may vary from what is presented in this report after final plant specification.

4 Baseline Sound Level Monitoring

TNEI undertook an operational noise assessment for the associated wind farm that is included as part of the Proposed Development. As part of the study, TNEI undertook a baseline sound level survey where continuous background sound level monitoring was undertaken for the period between 18th January and 26th of March 2024 at five neighbouring residential properties. Noise data measured until 7th February has not been used due to insufficient met data available during this period, as such, the dataset collected between the period 7th February – 26th of March has been used for the purpose of this assessment.

Table 4.1 details all seven Noise Monitoring Locations (NMLs), which are being used to inform the assessment. The NMLs are also shown in Figure 1 included within Annex 5. For completeness, although already included within the Annex of Technical Appendix 10.2, Annex 3 of this report also includes the Field Data Sheets (FDS) and Installation Report completed for the baseline noise survey, as well as the calibration certificates for the Sound Level Meters (SLMs) used.

Table 4.1: Baseline Noise Monitoring Locations

NML	Approximate Distance and Bearing to Proposed Development (m)	Coordinates	
		Eastings	Northings
NML01	2,000 m southwest of BESS and Substation, 3,000 m west of Solar Farm	288047	624648
NML02	1,800 m east/southeast of BESS and Substation, 400 m east and west of Solar Farm	291629	624561
NML03	1,750 m southwest of BESS and Substation, 820 m North of Solar Farm	290936	625425
NML04	3,400 m east of BESS and Substation, 380 m north of Solar Farm	292798	626245
NML05	2,000 m southeast of BESS and Substation, 1,400 m west of Solar Farm	289688	624128

The noise monitoring equipment consisted of Rion NL-52 Sound Level Meters (SLM), 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'* (9). The equipment was calibrated onsite at the beginning and end of each measurement period with no significant deviations noted.

Wind speed and direction data was measured continuously during the baseline noise survey using a LIDAR unit, which was temporarily installed within the wind farm area of the Proposed Development 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, for the purposes of this assessment the measured 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 3 for each of the NMLs, which present the measured 10-minute L_{Aeq} and L_{A90} values, the measured wind speed (m/s) and any data points that have been removed from the analysis, including for precipitation events.

It should be noted that the wind speed data used in this assessment is based on measurements obtained by a LIDAR unit located on the site, measuring at the proposed turbine hub height and then being standardised to a height of 10 m. This process is dictated by the relevant wind turbine noise assessment methodology. In contrast, BS 4142 suggests that wind speed measurements should be undertaken at (or as near as practicable to) the NMLs, at comparable measurement heights to the SLMs (approximately 1.5 m). In practice, the data filtering undertaken has been based upon wind speeds of 5 m/s or more but measured at a height of 10 m (standardised). If wind speeds had been measured at a height of 1.5 m for the same given time period, the values would likely have been lower due to the effects of wind shear. As such, the filtering has likely removed more noise data than is necessary from the dataset, which will provide a conservative approach (i.e. filtering out higher noise level data).

Table 4.2 presents an overview of the measured baseline sound levels:

Table 4.2: Overview of the Measured Baseline Sound Levels

NML	Average $L_{Aeq\ (10\ mins)}$		Mean $L_{A90\ (10\ mins)}$		Mode $L_{A90\ (10\ mins)}$		Range $L_{A90\ (10\ mins)}$	
	Day	Night	Day	Night	Day	Night	Day	Night
NML01	41	32	33	28	30	23	44	37
NML02	46	37	36	32	34	30	36	30
NML03	48	43	43	39	40	36	40	41
NML04	54	48	48	44	54	45	32	33
NML05	39	33	32	30	28	30	27	25

Subjective observations during site visits (for installation and collection of equipment and period calibrations), noted the following:

- At NML01, the M74 motorway to the east was audible as well as farm animal calls. In addition, birdsong and wind induced noise from the vegetation was audible;
- At NML02, noise from the M74 motorway was audible and dominant. Birdsong and wind induced noise from vegetation was audible during installation and collection. A distant watercourse was faintly audible during the collection of the noise kit;
- At NML03, the M74 motorway, B7078 minor road, wind induced noise from the vegetation and birdsong were the main noise sources observed;
- At NML04, the M74 motorway was the dominant noise source audible. Wind induced noise from the surrounding vegetation, birdsong and farm animal calls were also audible, and;
- At NML05, birdsong, wind induced noise from vegetation and activities from nearby residential gardens were the main noise sources observed.

Table 4.3 details the representative background sound levels, $L_{A90\ (10mins)}$, which have been determined after considering the distribution of data for each measurement period. Typically, baseline sound level measurements made in accordance with BS 4142 are undertaken in 15-minute periods. However, as the baseline data was measured as part of the operational wind turbine noise assessment, a 10-minute measurement period was adopted for use as part of this assessment. Annex 3 contains the statistical and distribution analysis charts used to ascertain the representative background sound levels.

Table 4.3: Representative Background Sound level, dB $L_{A90\ (10\ mins)}$

NML ID	Daytime $L_{A90(10mins)}$	Night-time $L_{A90(10mins)}$
NML01	33	27
NML02	35	30
NML03	43	38
NML04	50	45
NML05	31	30

The daytime and night-time representative background sound level at all NMLs is 30 dB $L_{A90\ (10mins)}$ or higher, except at NML01 which is below 30 dB $L_{A90\ (10\ mins)}$ during the night-time which can be classified as ‘very low’ in accordance with the ANC BS 4142 Technical Note (see Section 3.2.1).

5 Operational Noise Impacts

5.1 Modelling of Individual Sound Sources

The noise model considers all of the 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 items of plant associated with the BESS and substation have been modelled as area sources i.e. each side and top of each unit are modelled as individual sound sources. The centralised solar farm inverter/transformer units have been modelled as point sources. All sources 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 Development. It should be noted that final plant specifications may vary during the tendering process. In particular, the BESS and Substation configuration provides an indication of the type of infrastructure that can be accommodated on the site to equate to a storage capacity of 50 MW, but technical design considerations (e.g. inter-module spacing, access, ventilation and fire risk) will need to be sufficiently addressed at a later stage.

5.1.1 Liquid-Cooled Battery Cube Units

In the absence of a confirmed battery supplier from the Applicant, TNEI have used in-house noise data provided for the Wartsila Gridsolv Quantum unit to model the liquid-cooled battery cubes. Each Gridsolv Quantum battery unit includes two Envicool Chiller units which are fixed to two outward-facing sides of each cube. Each Gridsolv Quantum has been modelled as a box with the outer façades being modelled as an area source.

Octave-band Sound Power Level (SWL) data has been provided for the chiller unit. Table 5.1 details the octave-band data used in the noise model, which equates to an overall SWL of 74 dBA for each BESS chiller unit:

Table 5.1: Octave Band SWL (dBA) values used to model the Liquid-cooled Battery Cube Units

Battery Chiller Unit	Frequency (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Wartsila Gridsolv Quantum Envicool Chiller	40	56	70	70	68	63	60	51	47

5.1.2 Inverter/Transformer Units

The noise model considers an SMA SC4600-UP inverter. TNEI hold data for multiple variants of this unit but for the purpose of this assessment, noise level data has been used for a J-Schneider coil unit working at 100% load without a silencer fitted. This represents the loudest of the models available, however, the actual unit that is installed may have a lower noise output.

The MV inverter/transformer units have been modelled as boxes consisting of five area sources (four facades and the roof). Each area source has been modelled with 7 dB of attenuation such that the logarithmic sum of the five area sources per piece of plant equates to the overall sound power of their respective plant.

The noise data has been provided to TNEI from SMA under a Non-Disclosure Agreement and as such the spectral data cannot be provided within this report. However, we can report that the broadband

SWL is modelled at 93 dBA. TNEI would be happy to discuss this data in more detail with the Local Planning Authority, if required.

5.1.3 High Voltage (HV) Grid Transformer

In the absence of provided data, the HV Grid Transformer has been modelled using TNEI's in-house data for a candidate ABB HV transformer with a broadband sound power level (SWL) value of 88 dBA. The transformer has been modelled as a box consisting of five area sources (four facades and the roof). Each area source has been modelled with 7 dB of attenuation such that the logarithmic sum of the five sources equates to the overall sound power level of 88 dBA. Table 5.2 details the resulting SWL used within the noise model and the relevant data sheets are included within Annex 4:

Table 5.2: 1/3 Octave Band SWL, dBA used to model the HV Grid Transformer

HV Grid Transformer	Frequency (Hz)								
	Hz	**50**	**63**	**80**	**100**	**125**	**160**	**200**	**250**
ABB HV Grid Transformer	**dBA**	64	48	55	72	69	78	74	77
	Hz	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**
	dBA	80	77	77	79	79	77	75	72
	Hz	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**
	dBA	70	69	68	67	65	62	60	58

5.1.4 Centralised Solar Inverters

Again, in the absence of provided data, the Solar Farm Inverters have been modelled using TNEI's in-house data for a candidate Sungrow 3150U Inverter Unit with a broadband sound power level (SWL) value of 85.8 dBA. Each inverter has been modelled as a single point source. Table 5.3 details the resulting SWL used within the noise model and the relevant data sheets are included within Annex 4:

Table 5.3: Octave Band SWL (dBA) values used to model the Centralised Solar Inverters

Centralised Solar Inverter Unit	Frequency (Hz)								
	31.5	63	125	250	500	1000	2000	4000	8000
Sungrow 3150U	35	52	72	77	79	79	78	80	69

5.2 Additional Mitigation Measures

The model assumes that no additional mitigation measures (in terms of noise-attenuating fencing or bunds) will be included as part of the BESS, Substation or Solar Farm element of the Proposed Development.

5.3 Calculated Immission Levels

Noise immission levels have been calculated at nine locations termed BESS Noise Assessment Locations (BNALs), which have been selected to represent the closest NSRs. The BNALs have been set on the side of the property facing the proposed BESS/Substation compound or solar farm, representing the closest point of the property's amenity area to the nearest noise sources. At NSRs where the proposed development is situated both sides of the property, noise immission levels have been calculated within property's amenity area on either side of the building.

The BNALs are detailed in Table 5.4 and shown on Figure 2 within Annex 5.

Table 5.4: BESS Noise Assessment Locations (BNALs)

BNAL ID	Eastings	Northings
BNAL01	289013	625359
BNAL02a	290783	625537
BNAL02b	290916	625441
BNAL03	289704	624153
BNAL04	291395	623691
BNAL05a	291582	624577
BNAL05b	291629	624579
BNAL06	292829	626161
BNAL07	293972	626085
BNAL08	293562	624701
BNAL09	293119	624359

The immission levels (Specific Sound Level) are calculated assuming all plant is operating continuously and concurrently. The levels are detailed in Table 5.5 as dB $L_{Aeq(t)}$. No time period is specified as the model assumes that noise levels will not fluctuate and will remain the same for all time periods.

Table 5.5: Predicted Immission Levels, dB $L_{Aeq(t)}$

Noise Assessment Location, BNAL ID	Immission Level, dB $L_{Aeq(t)}$
BNAL01	26
BNAL02a	18
BNAL02b	14
BNAL03	14
BNAL04	13
BNAL05a	22
BNAL05b	19
BNAL06	26
BNAL07	17
BNAL08	18
BNAL09	18

6 Noise Impact Assessment

6.1 Quantitative Assessment

An assessment is detailed below in Table 6.1 against the most stringent of the guideline levels presented in BS 8233:2014 (as detailed in Table 3.1).

Table 6.1: Derived BS 8233 Fixed Level Limits

Assessment Parameter	BS 8233 Guideline Level	Allowance for Open Window Attenuation	Equivalent External Level
Daytime 07:00-23:00	35	13	48 dB L_{Aeq} (16-hour)
Night-time 23:00-07:00	30	13	43 dB L_{Aeq} (8-hour)

Table 6.2 below compares the predicted immission levels with the derived noise limits.

Table 6.2: Quantitative Assessment

Noise Assessment Location	Daytime		Night-time	
BNAL ID	Immission Level, dB $L_{Aeq(t)}$	Margin above/below Noise Level Limit, dB	Immission Level, dB $L_{Aeq(t)}$	Margin above/below Noise Level Limit, dB
BNAL01	26	-22	26	-17
BNAL02a	18	-30	18	-25
BNAL02b	14	-34	14	-29
BNAL03	14	-34	14	-29
BNAL04	13	-35	13	-30
BNAL05a	22	-26	22	-21
BNAL05b	19	-29	19	-24
BNAL06	26	-22	26	-17
BNAL07	17	-31	17	-26
BNAL08	18	-30	18	-25
BNAL09	18	-30	18	-25

The predicted immission levels are considerably below the fixed guideline levels for both daytime and night-time assessment periods at all BNALs.

6.2 Qualitative Assessment

The qualitative assessment, which is undertaken following the guidance presented in BS 4142, considers the predicted immission levels, the character of the sound, the existing sound environment and the context of the development.

6.2.1 Rating Level

In order 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.

6.2.2 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.'

Electrical plant, such as power transformers, are often tonal at source, typically in the 100 Hz frequency band. BS 4142 corrections, however, are only applied if the noise characteristics are present at the receptor location, not at the source location.

Comparison of the predicted one-third octave band levels at the NALs against the assessment criteria presented in BS 4142's *'One-Third Octave Band Objective Method of Assessment'* indicates that no tonality is likely to be present at any of the NSRs. As such, no tonal character correction needs to be applied. Additionally, consideration of the absolute levels in the 100 Hz frequency band shows that the highest predicted level at all of the NSRs (15.7 dB $L_{Aeq\ (t)}$ at BNAL01) is still considerably below the lowest representative background sound level during the night-time at all NMLs of 27 dB L_{A90}.

6.2.3 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, substation or solar farm as when operational, the noise level will be predictable and consistent.

6.2.4 Intermittency

The intermittency of the sound source needs to be considered when it has identifiable on/off conditions with regards to intermittency, BS4142 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 regular step changes in noise level are anticipated.

6.2.5 Other Sound Characteristics

With regards to other sound characteristics, BS4142 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, it is not anticipated that any additional sound characteristics that would be considered readily distinctive against the residual acoustic environment.

6.2.6 Calculation of the Rating Level

With due regard to the above, no character corrections are required. Therefore, the BS4142 Rating Levels are equal to the Specific Sound Levels.

6.2.7 Assessment of the Impacts

BS4142, 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. However, as a starting point 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."

Table 6.3 presents a comparison of the Rating Levels to the daytime and night-time background sound levels:

Table 6.3: Margin Above / Below (+/-) Background Sound Level, dB

Noise Assessment Location	Daytime			Night-time		
BNAL ID	Rating Level, dBA	Representative Background Sound Level, dBA	Margin, dB	Rating Level, dBA	Representative Background Sound Level, dBA	Margin, dB
BNAL01	26	33	-7	26	27	-1
BNAL02a	18	43	-25	18	38	-20
BNAL02b	14	43	-29	14	38	-24
BNAL03	14	31	-17	14	30	-16
BNAL04	13	35	-23	13	30	-18
BNAL05a	22	35	-13	22	30	-8
BNAL05b	19	35	-16	19	30	-11

Noise Assessment Location	Daytime			Night-time		
BNAL ID	Rating Level, dBA	Representative Background Sound Level, dBA	Margin, dB	Rating Level, dBA	Representative Background Sound Level, dBA	Margin, dB
BNAL06	26	50	-24	26	45	-19
BNAL07	17	50	-33	17	45	-28
BNAL08	18	50	-32	18	45	-27
BNAL09	18	50	-33	18	45	-28

For all receptors the Rating Levels remain below the background sound levels during both the daytime and night-time assessment periods. This is "*an indication of the specific sound source having a low impact, depending on the context.*"

The context in which the assessment is made is as follows:

- The primary noise generation mechanism for all plant associated with this development is related to cooling. The noise model assumes all cooling plant for the batteries, inverters and transformers is operating at maximum noise level output. However, for much of the time it is anticipated that cooling equipment will be operating at lower capacities and as such the overall sound output will be reduced.
- Similarly, the noise model assumes all plant is operating concurrently, however not all units will necessarily be required to operate at the same time and as such, overall noise levels are likely to be lower than predicted.
- The Rating Levels at all NALs have been classed as 'low' i.e. below 35 dB LAeq(t).
- At one BNAL, the background sound level at night is classed as 'very low' (below 30 dB L_{A90}) in accordance with the ANC BS 4142 Technical Note. In this situation, the guidance states that the "*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 absolute levels will remain well below the fixed guideline values as detailed in BS 8233 for all receptors and for all time periods.
- An analysis of the measured $L_{Aeq\ (t)}$ values at NML01 (where the highest levels are predicted – BNAL01) shows the average daytime and night-time levels to be 41 dBA and 32 dBA respectively. The overall sound level increase during the night-time (i.e. the resulting increase when logarithmically adding the existing value (32 dBA) and the predicted operational value (26 dBA)) is less than 1 dB. For context, a change of 3 dB(A) is generally considered to be the smallest change in environmental noise that is perceptible to the human ear and is considered 'just perceptible'. As such, an increase of 1 dB is not anticipated to result in an adverse impact.

With due regards to the context of the development, **the outcome of the BS 4142 assessment is that the Proposed Development is not expected to have an adverse impact in terms of the operational noise from the BESS, substation and solar farm elements.**

7 Summary

In order to assess the impact of noise emissions from the proposed BESS, substation and solar farm that form part of the Proposed Development, 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. The model is based on a layout and candidate plant that is typical for this type of BESS development. A number of residential properties were identified and assessed, the nearest of which is approximately 300 m to the north of the proposed solar farm.

No additional mitigation measures were included within the noise propagation model.

Two assessments considering the nearest residential NSRs have been carried out:

- A quantitative assessment has concluded that levels would remain considerably below the fixed guideline levels detailed in BS 8233 for the daytime and night-time assessment periods, and;
- A quantitative assessment was undertaken in accordance with BS 4142 which concluded that for all BNALs during the daytime and night-time periods the rating level does not exceed the background sound level which is *'an indication of the specific sound source having a low impact, depending on the context.'*

Accordingly, the Noise Impact Assessment concludes that the BESS, Substation and Solar Farm elements of the Proposed Development will not have an adverse noise impact on the NSRs identified within the local area.

8 References

1. **The Scottish Government.** *PAN 1/2011 Planning and Noise.* Scotland : The Crown, 2011.

2. —. *Technical Advice Note (TAN) 'Assessment of Noise'.* Scotland : The Crown, 2011.

3. **British Standards Institute.** *Methods for Rating and Assessing Industrial and Commercial Sound.* UK : BSI, 2014. BS4142:2014 + A1:2019.

4. —. *Guidance on Sound Insulation and Noise Reduction for Buildings.* UK : BSI, 2014. BS8233:2014.

5. **The Association of Noise Consultants (ANC).** *BS 4142:2014+A1:2019 - Technical Note.* s.l. : The Association of Noise Consultants (ANC), 2020.

6. **Association of Noise Consultants.** *Acoustics Ventilation and Overheating (AVO) Residential Design Guide.* 2020.

7. **Datakustik GmbH.** CadnaA. 2024.

8. **(ISO), International Organization for Standardization.** *Acoustics – Attenuation of Sound During Propagation Outdoors: Part 2 – General Method of Calculation.* Geneva : (ISO), International Organization for Standardization, 2024. ISO 9613-2:2024.

9. **Commission Electrotechnique Internationale (IEC).** *Electroacoustics - Sound level meters - Part 1: Specifications.* Geneva : IEC, 2013. IEC 61672-1:2013.

Annex 1 – Glossary of Terms

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 Sound Level: the sound level rarely fallen below in any given location over any given time period, often classed according to daytime, evening or night-time periods. The LA90 indices (see below) are typically used to represent the background sound level.

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 sound 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 sound in the same way as the ear, and to counter this weakness the sound 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) weighting is internationally accepted and has been found to correspond well with people's subjective reaction to sound levels and noise. Some typical subjective changes in sound levels are:

- a change of 3 dB(A) is just perceptible;
- a change of 5 dB(A) is clearly perceptible; and
- 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.

Emission: the sound energy emitted by a sound source (e.g. a wind turbine).

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 waves with the ground along its propagation path from source to receiver. Described using the term 'G', and ranges between 0 (hard ground), 0.5 (mixed ground) and 1 (soft ground).

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)).

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

Isopleth: a line on a map connecting points of equal value, for example air pressure, noise level etc.

Noise: unwanted sound.

L_w: is the sound power level. It is a measure of the total sound energy radiated by a sound source and is used to calculate sound 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 $L_{Aeq,\,T}$ is the A - weighted equivalent continuous sound level over a given time period (T).

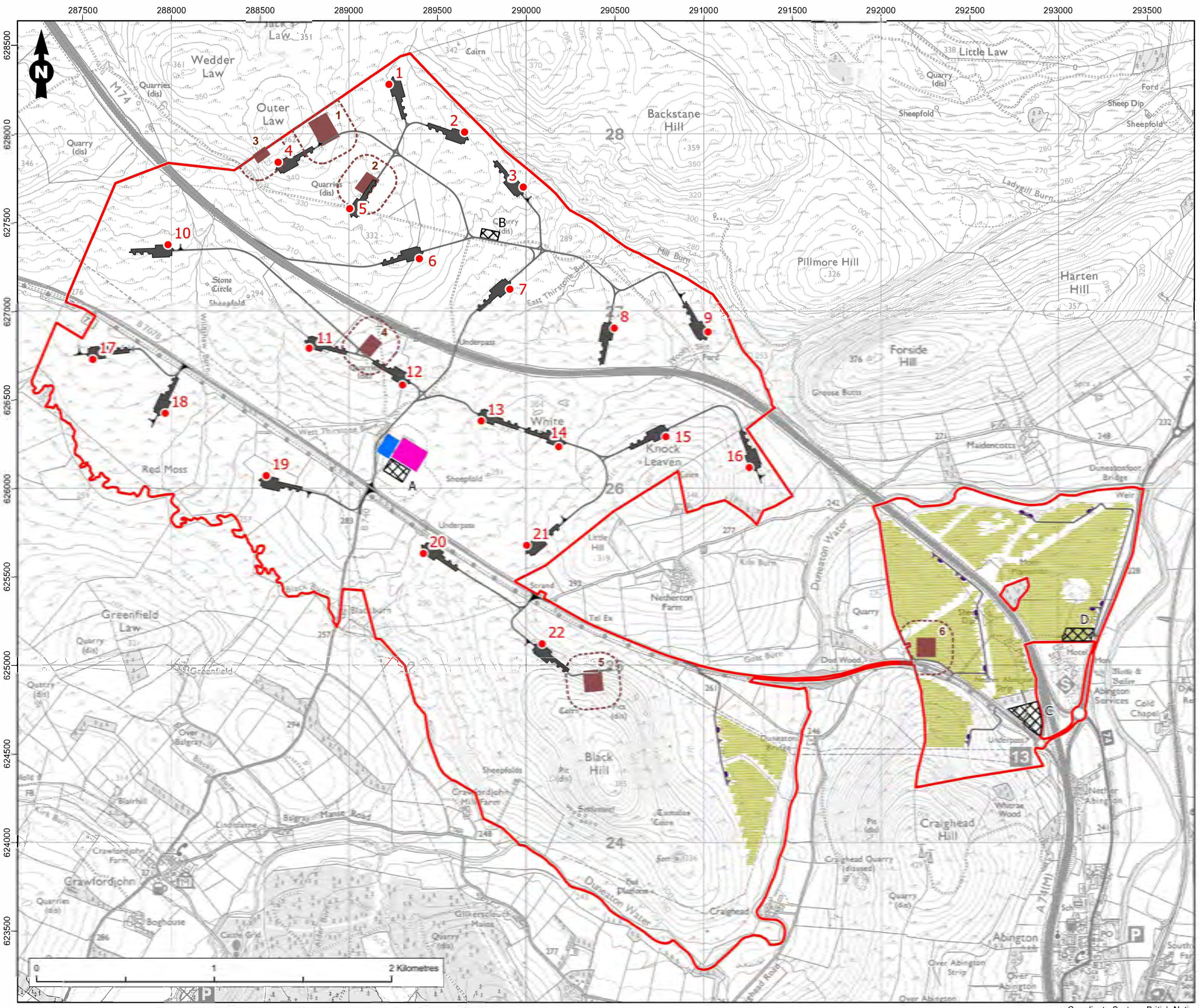
L_{90}: index represents the sound level exceeded for 90 percent of the measurement period and is used to indicate quieter times during the measurement period. It is often used to measure the background sound level. The $L_{A90,10min}$ is the A - weighted background sound level over a ten-minute measurement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

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

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

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

Annex 2– Development Information



Legend

- Site Boundary
- Turbines
- Solar PV Modules
- Inverter
- Substation
- Construction Compound
- Battery Site
- Borrow Pit Location
- Borrow Pit Micrositing Allowance
- Turbine Hardstanding Concrete
- Access Track, Junction & Turning Heads

Figure Title	Site Layout
Project Name	M74 West Renewable Energy Park
Project Number	1620015684
Figure No.	2.1
Date	August 2024
Prepared By	BE
Scale	1:20,000 @A3
Issue	1
Client	M74 West Ltd

RAMBOLL

Coordinate System: British National Grid. Projection: Transverse Mercator. Datum: OSGB 1936.
1620015684-RAM-MA-IA-0000X_Fig2.1SiteLayout_03.pagx

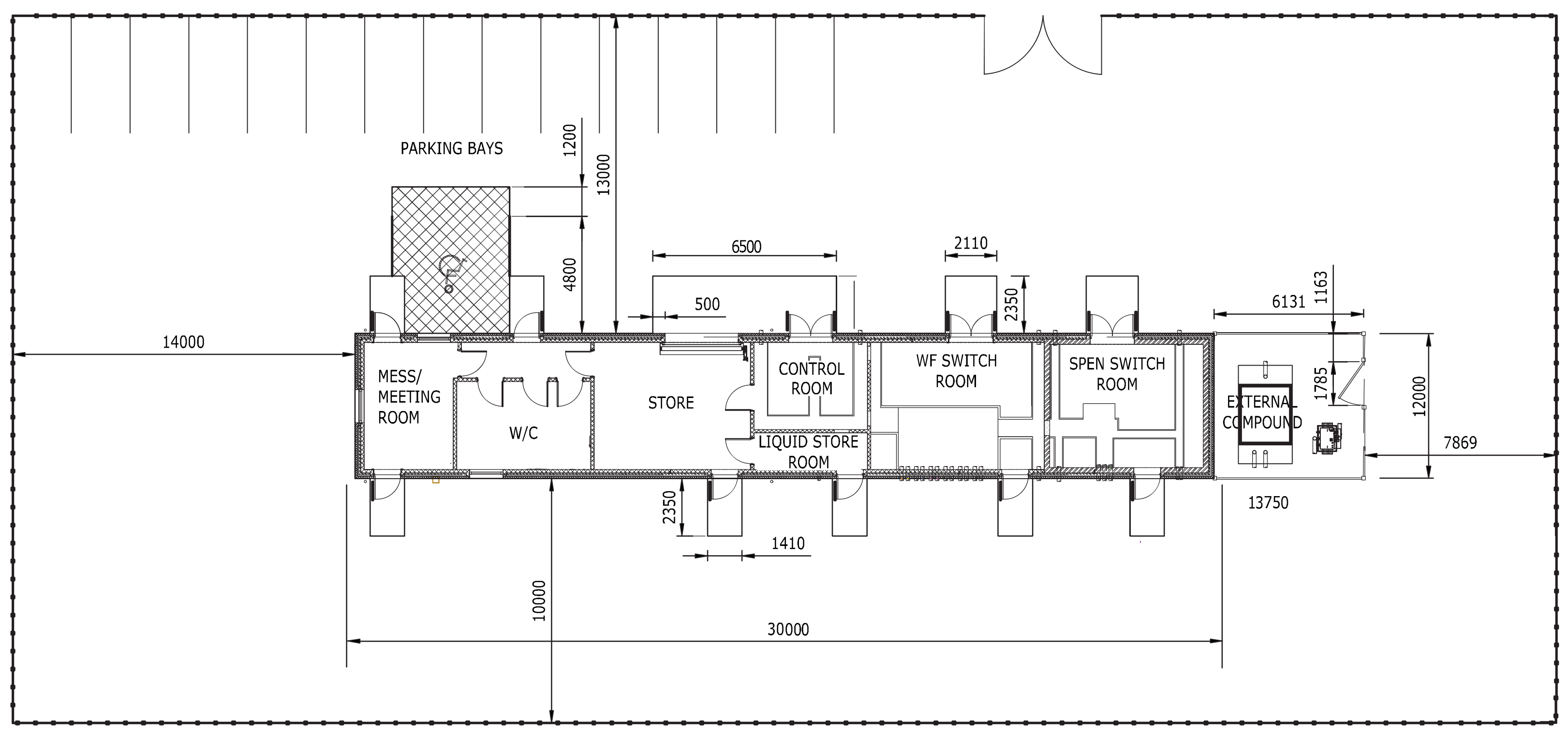


Figure Title
Figure 2.5: Typical Substation & Compound Layout

Project Name
M74 West Renewable Energy Park

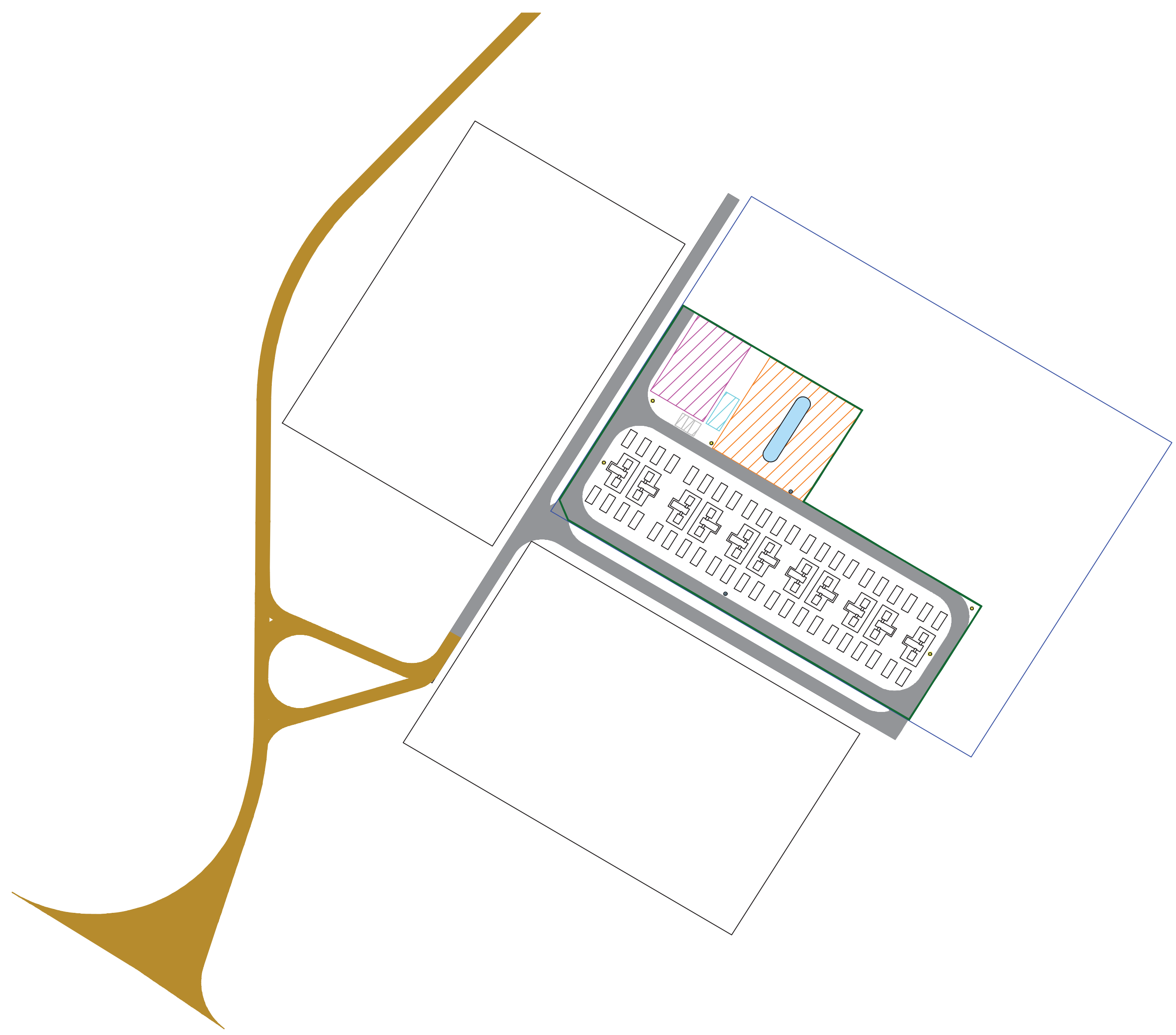
Project No./Filery ID
1620015684 / REH2023N01765

Date	Figure No.	Version
May 2024	2.5	01

Scale	Prepared by
NOT TO SCALE	SR

Client
M74 West Ltd

RAMBOLL



Legend

- Site Boundary
- Security Fence
- Substation Area
- Fire Management Area
- Spares Container
- Fire Hydrant
- Parking
- BESS Area
- CCTV & Lighting
- Buried Firewater Storage Tank
- PCS Unit
- BESS Container
- Infrastructure Road
- Site Track

Notes

BESS
50MWac
44no. of BESS Containers

PCS
11 PCS Units
PCS consists of 2no. of Inverters and 1no. of Transformers

Figure Title
Figure 2.8a: Battery Storage Layout

Project Name
M74 West Renewable Energy Park

Project No./Filery ID
1620015684 / REH2023N01765

Date	Figure No.	Version
May 2024	2.8a	01

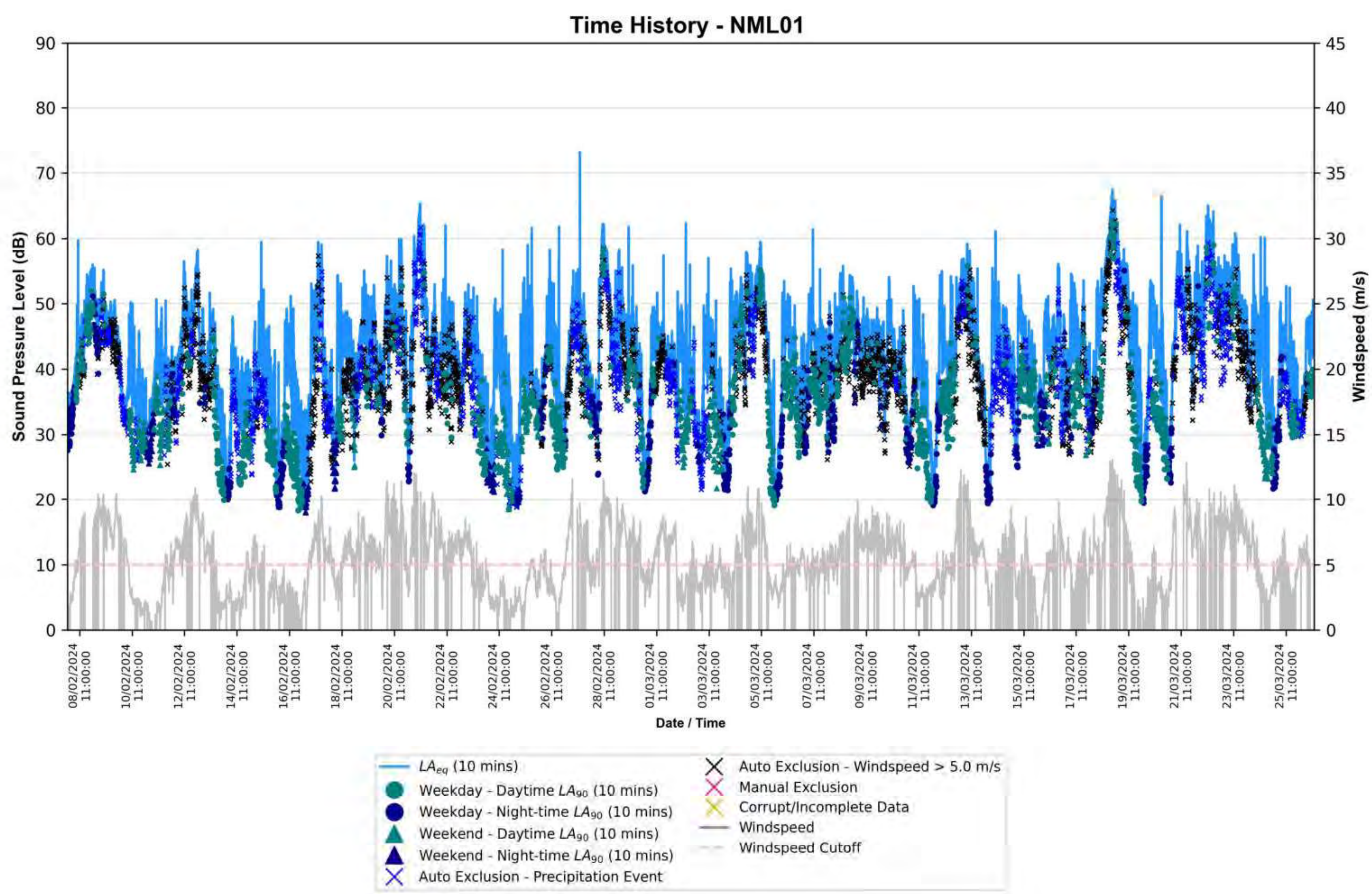
Scale	Prepared by
NOT TO SCALE	SR

Client
M74 West Ltd

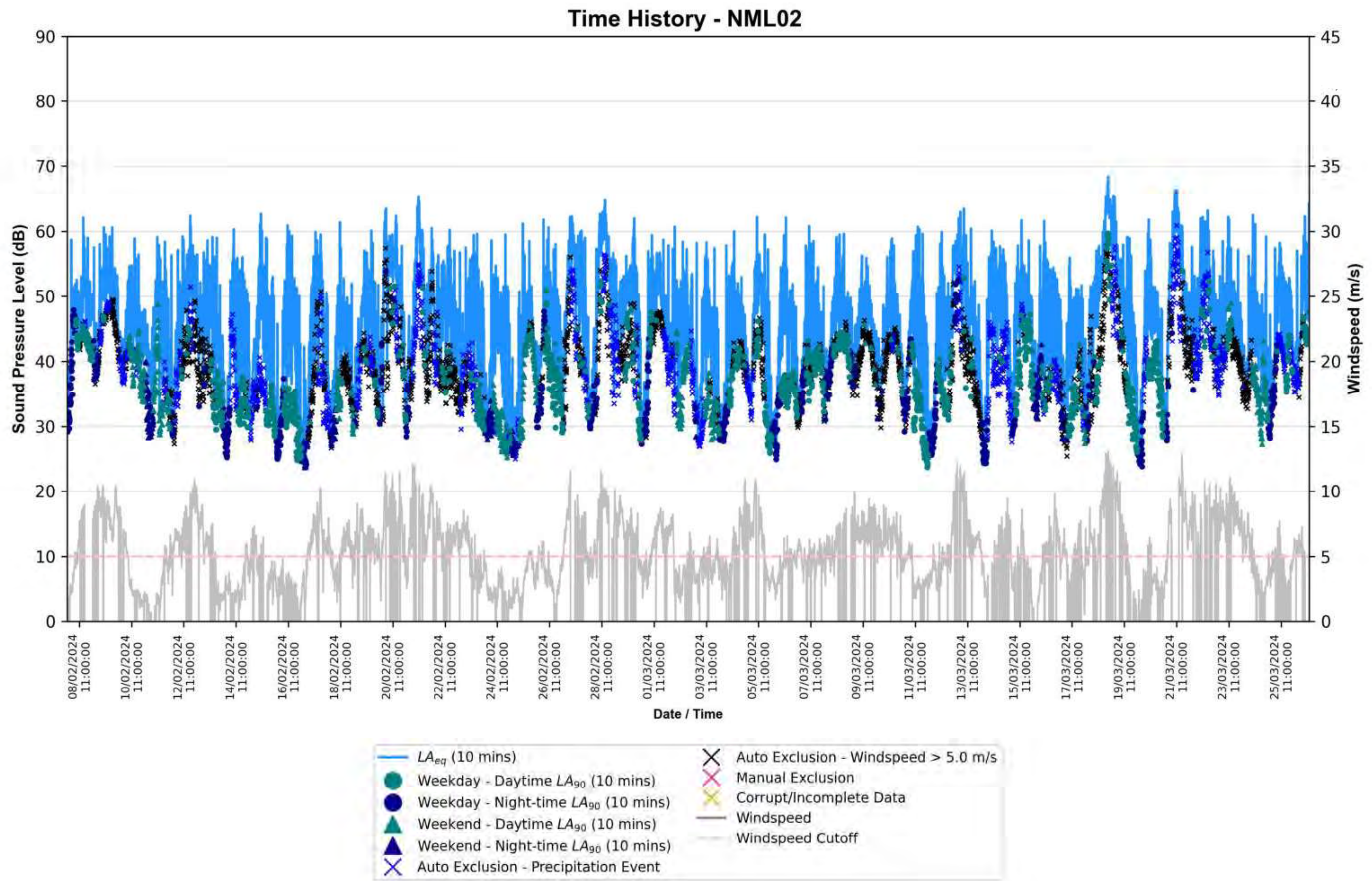
RAMBOLL

Annex 3 - Baseline Survey Data

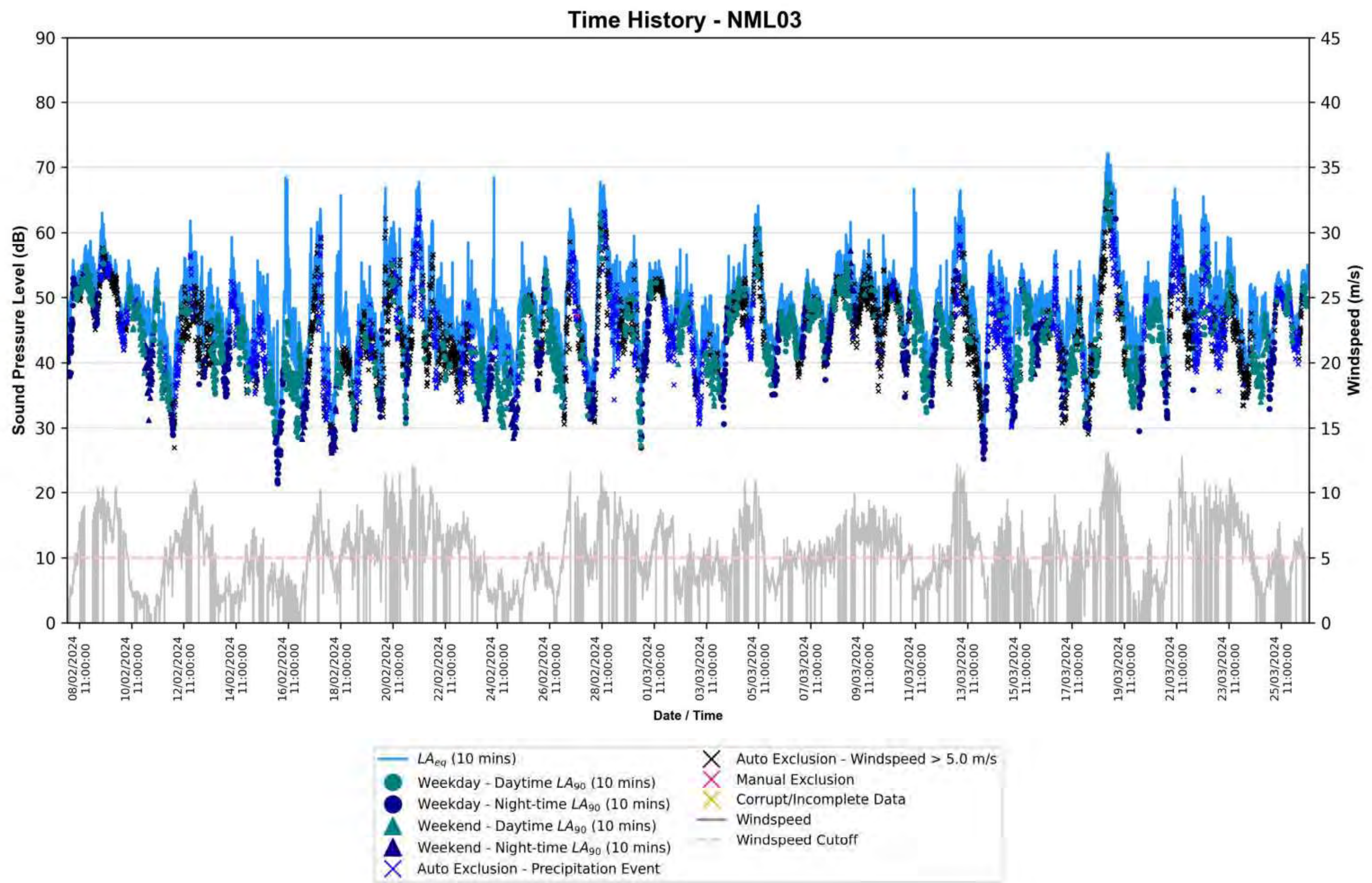
15990 - M74 West Renewable Energy Park - Measured Sound Levels:



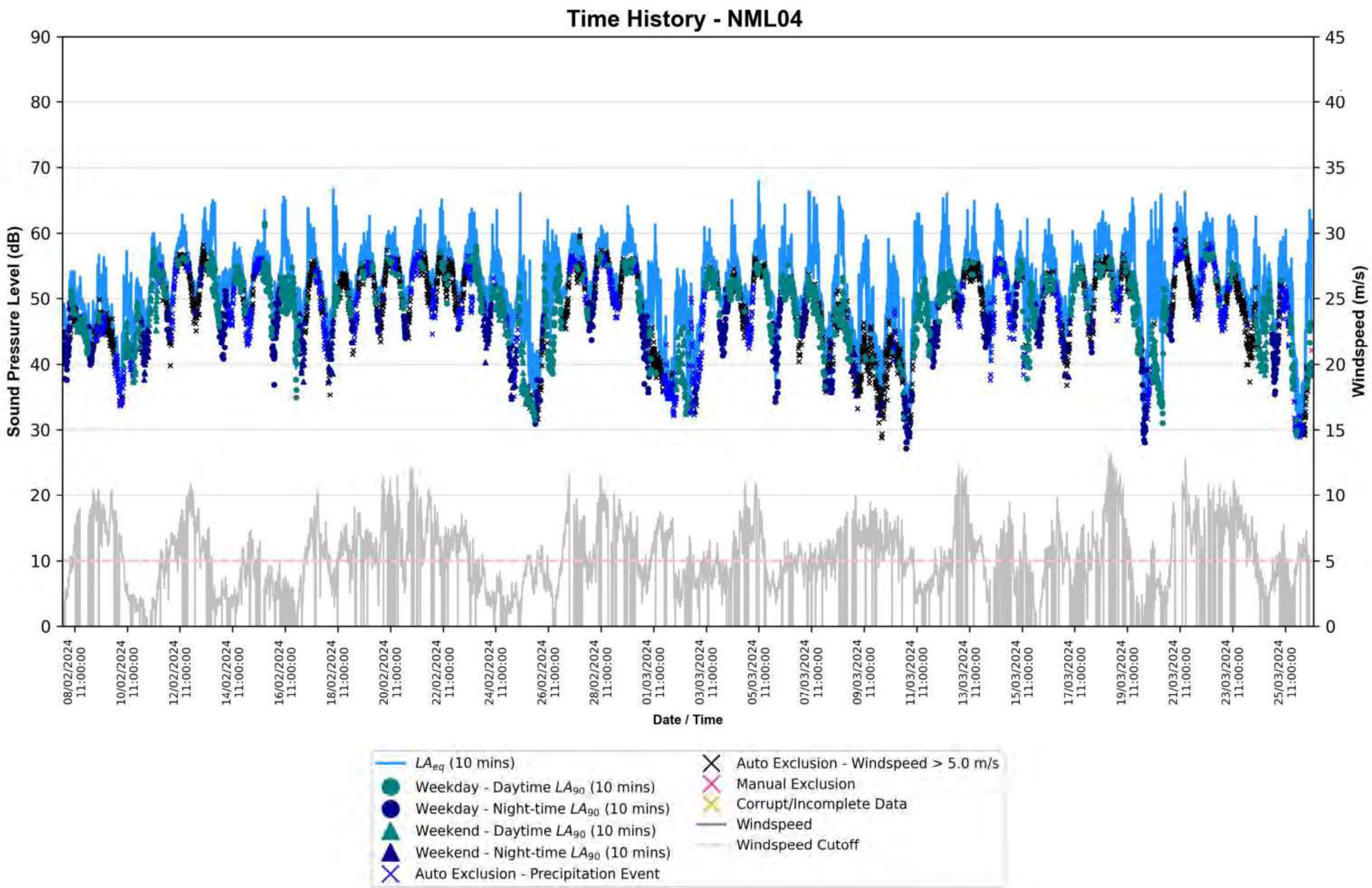
15990 - M74 West Renewable Energy Park - Measured Sound Levels:



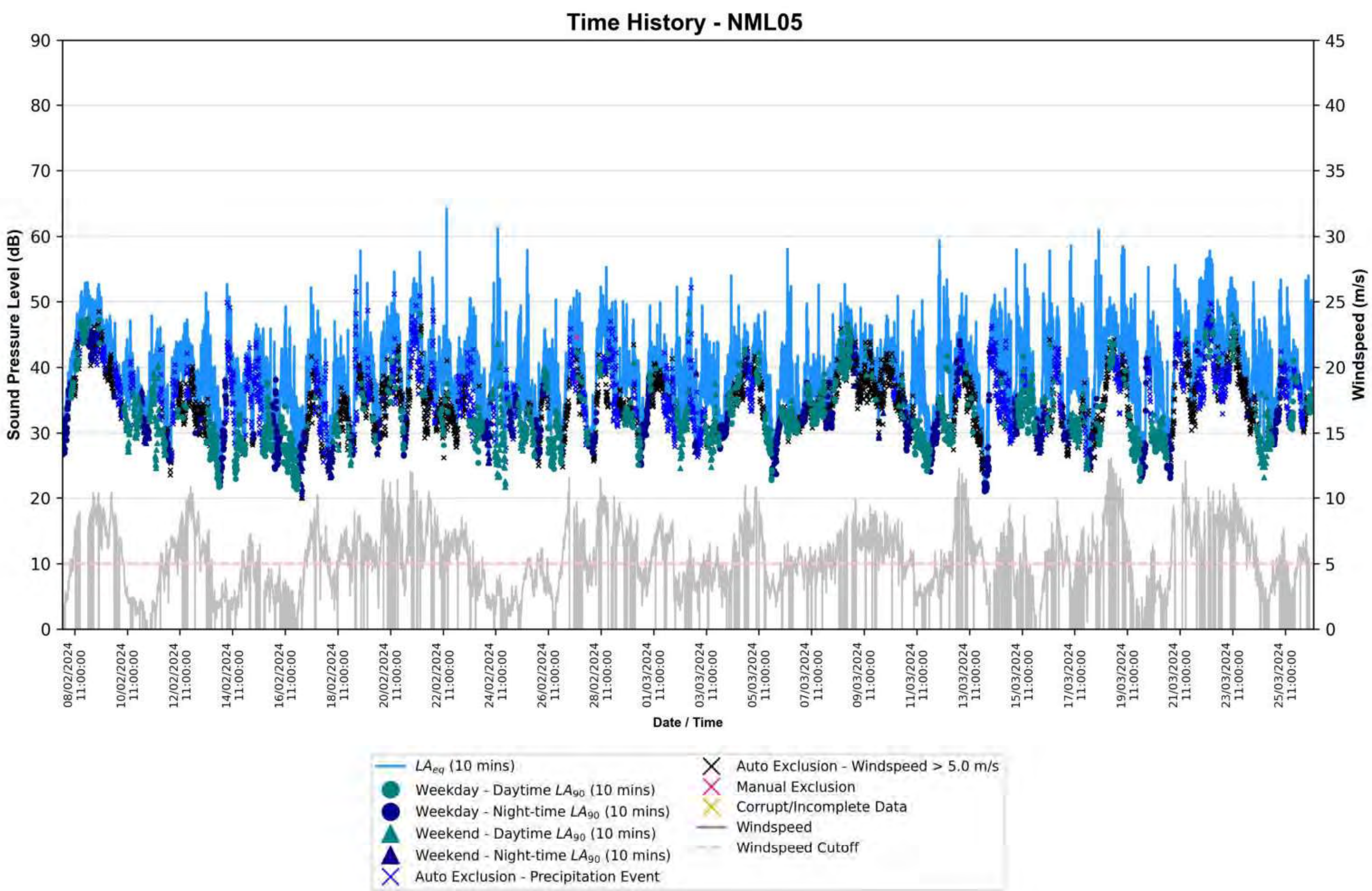
15990 - M74 West Renewable Energy Park - Measured Sound Levels:



15990 - M74 West Renewable Energy Park - Measured Sound Levels:

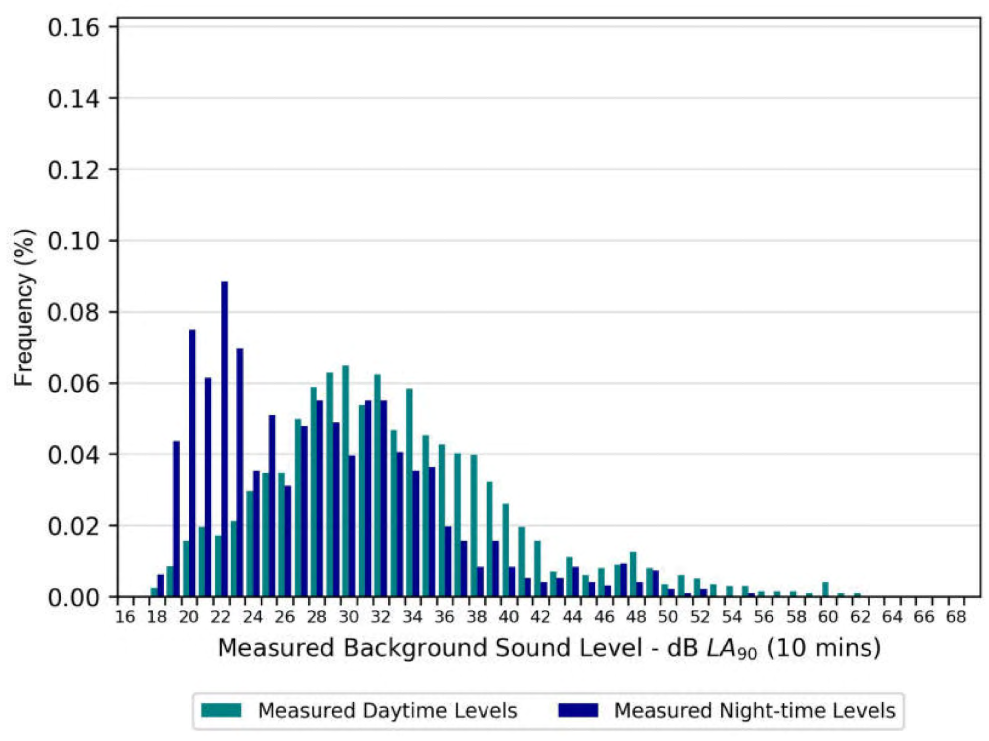


15990 - M74 West Renewable Energy Park - Measured Sound Levels:

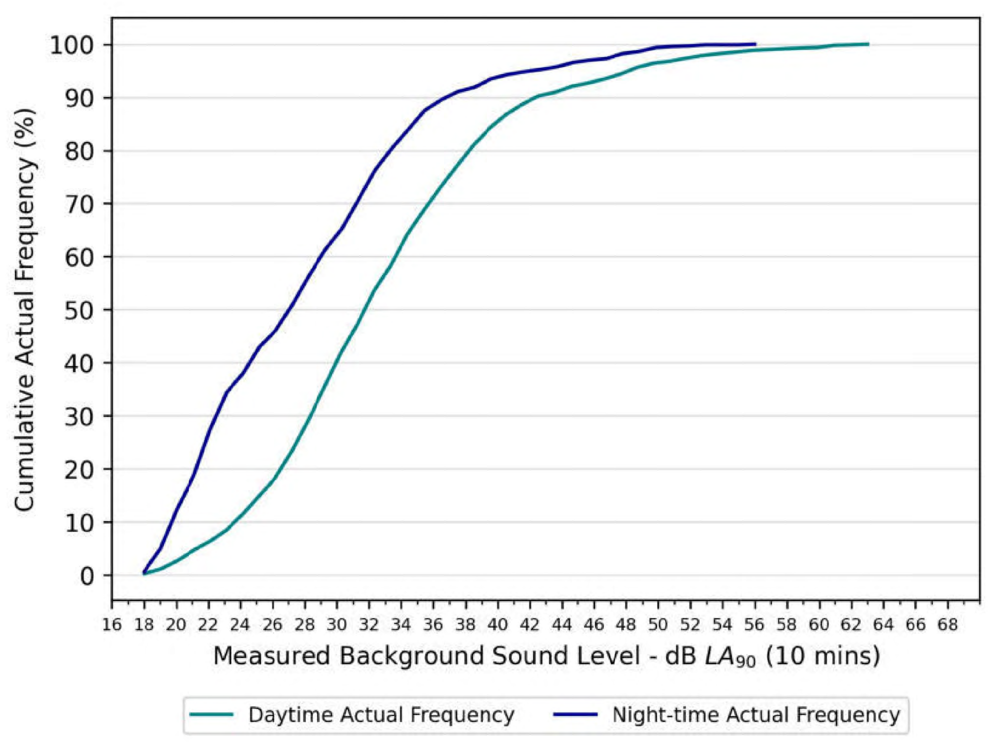


15990 - M74 West Renewable Energy Park - Measured Sound Levels:

Statistical Analysis - NML01

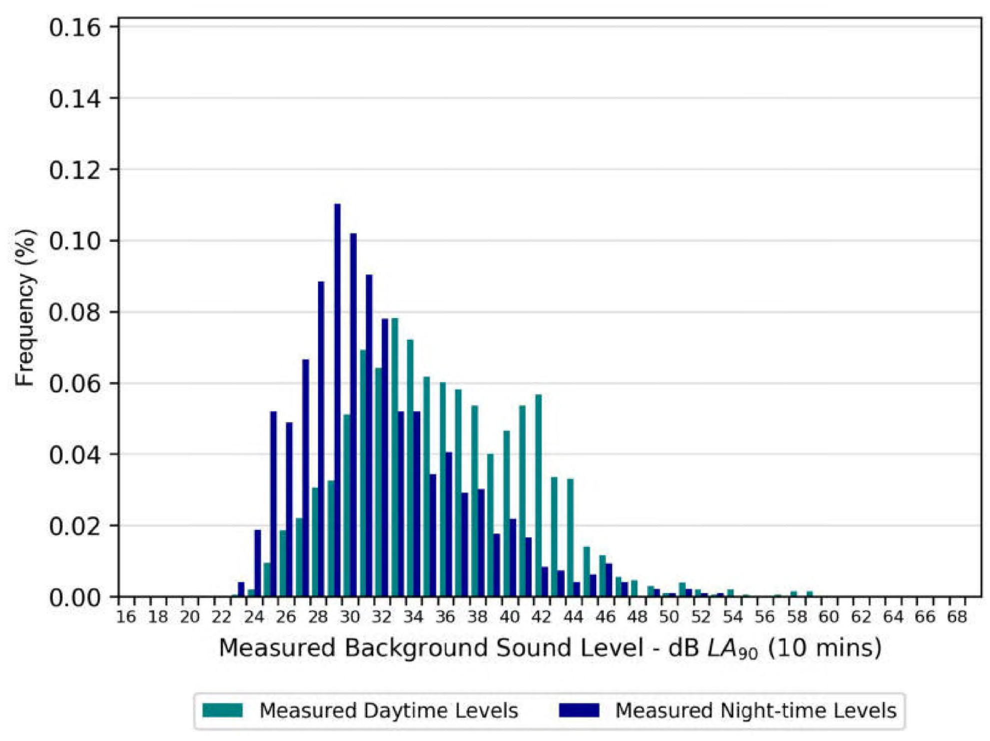


Statistical Analysis - NML01

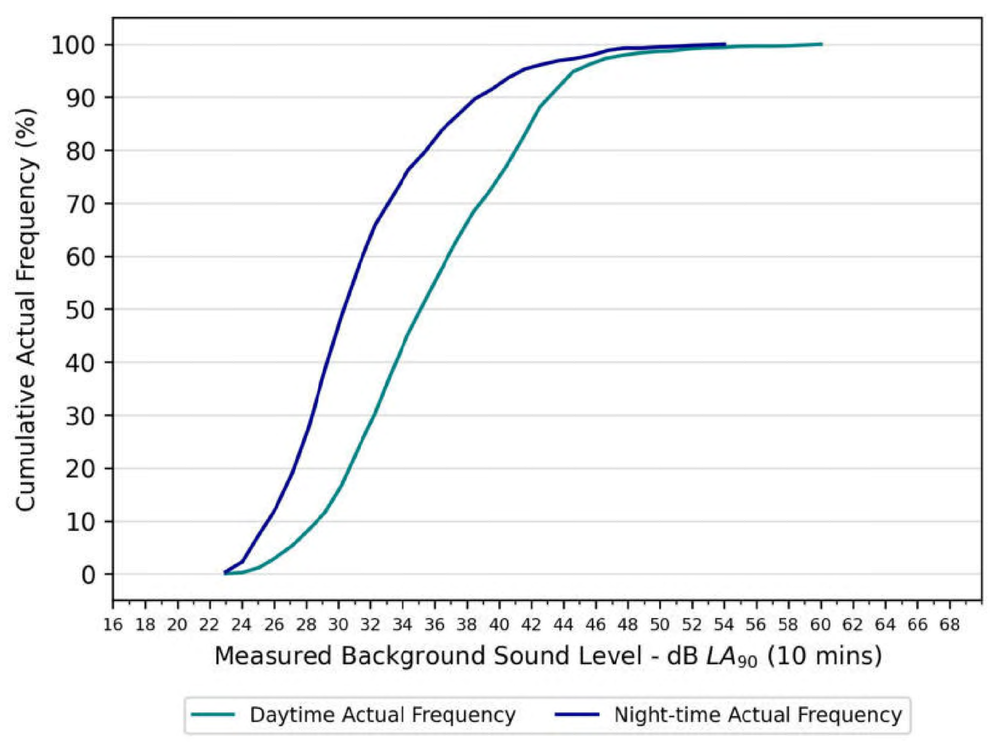


15990 - M74 West Renewable Energy Park - Measured Sound Levels:

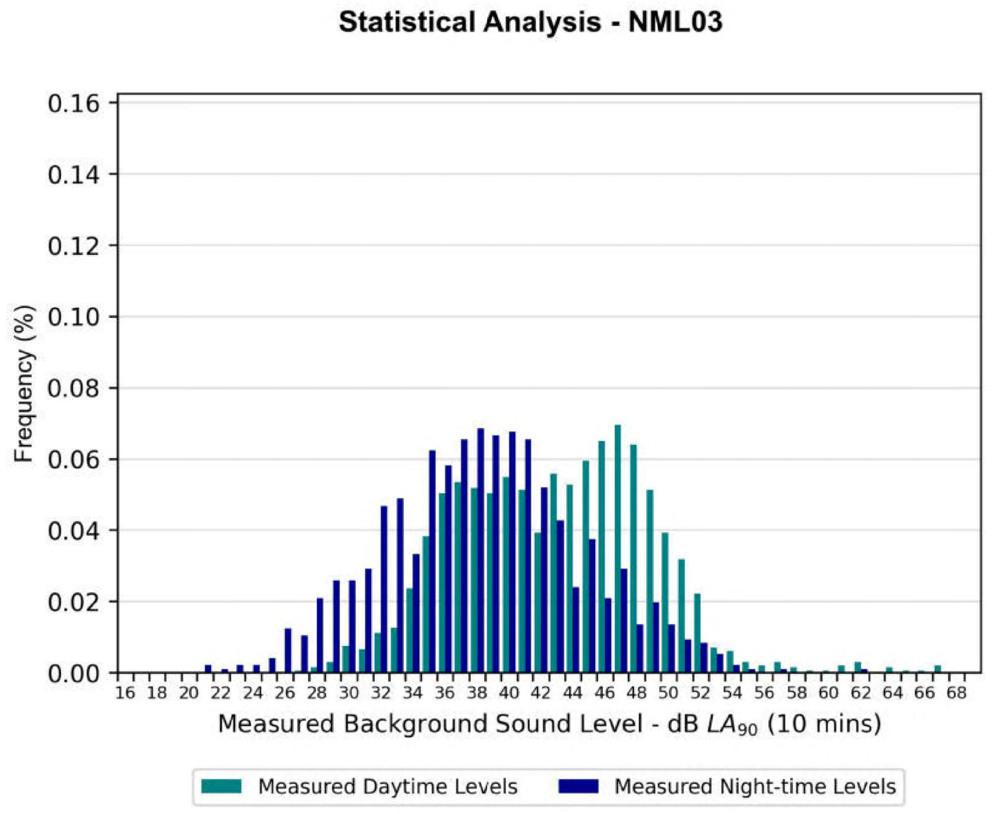
Statistical Analysis - NML02

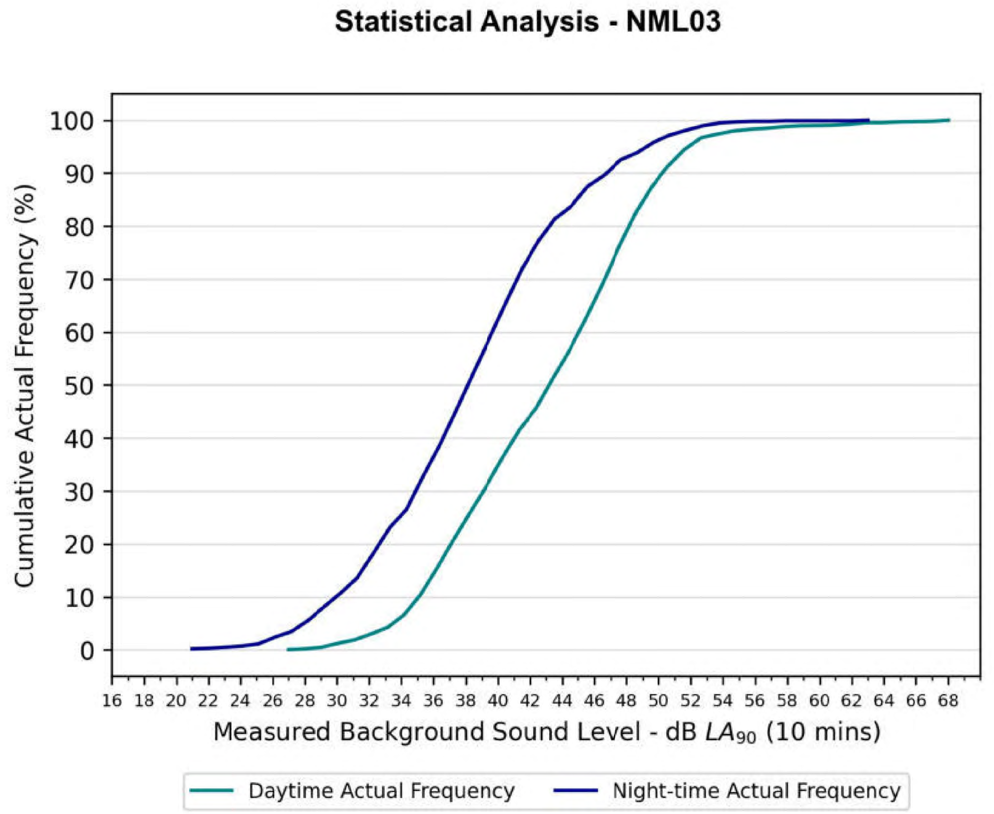


Statistical Analysis - NML02

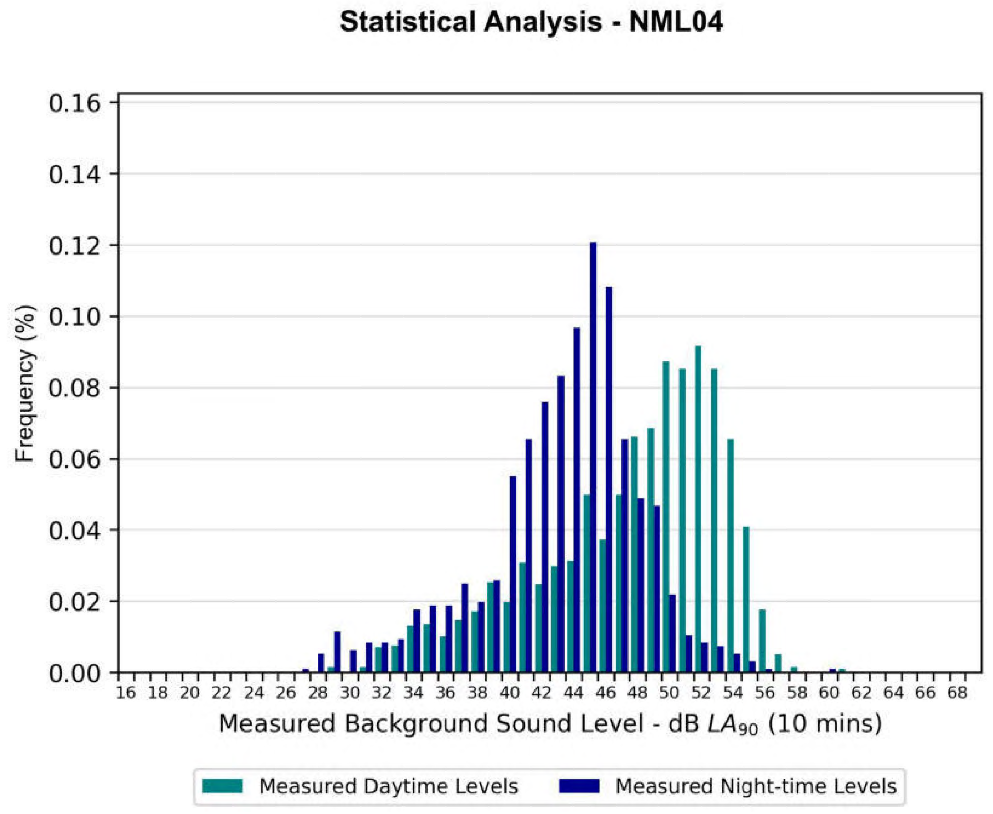


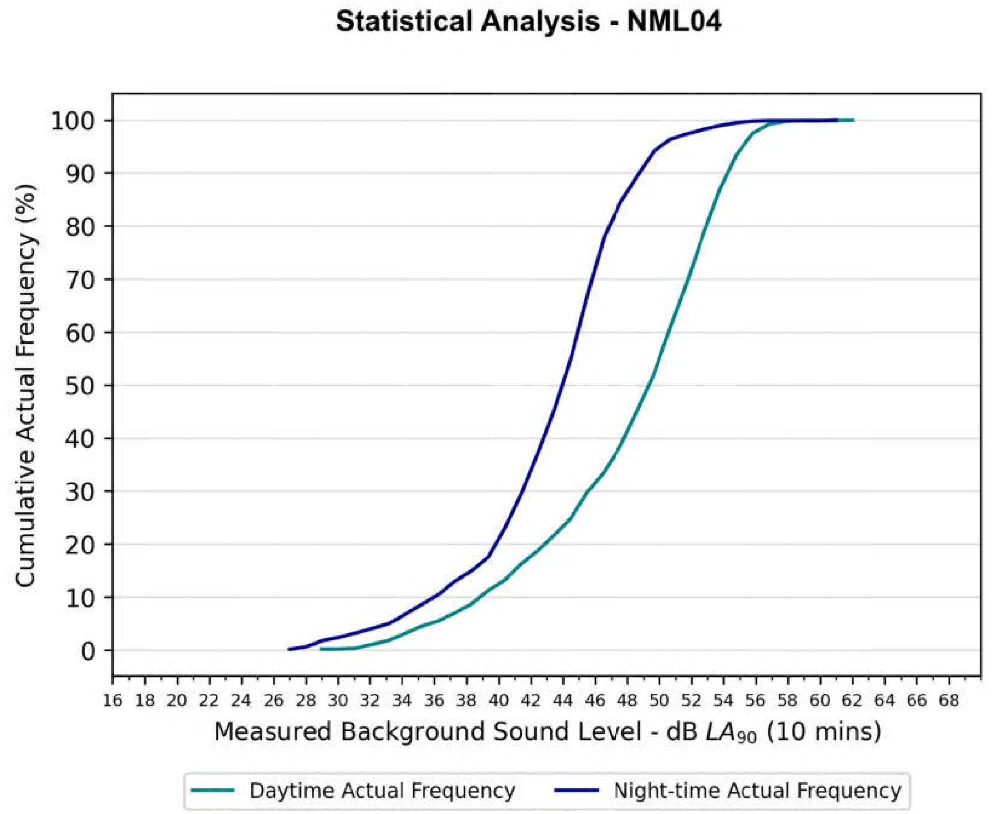
15990 - M74 West Renewable Energy Park - Measured Sound Levels:





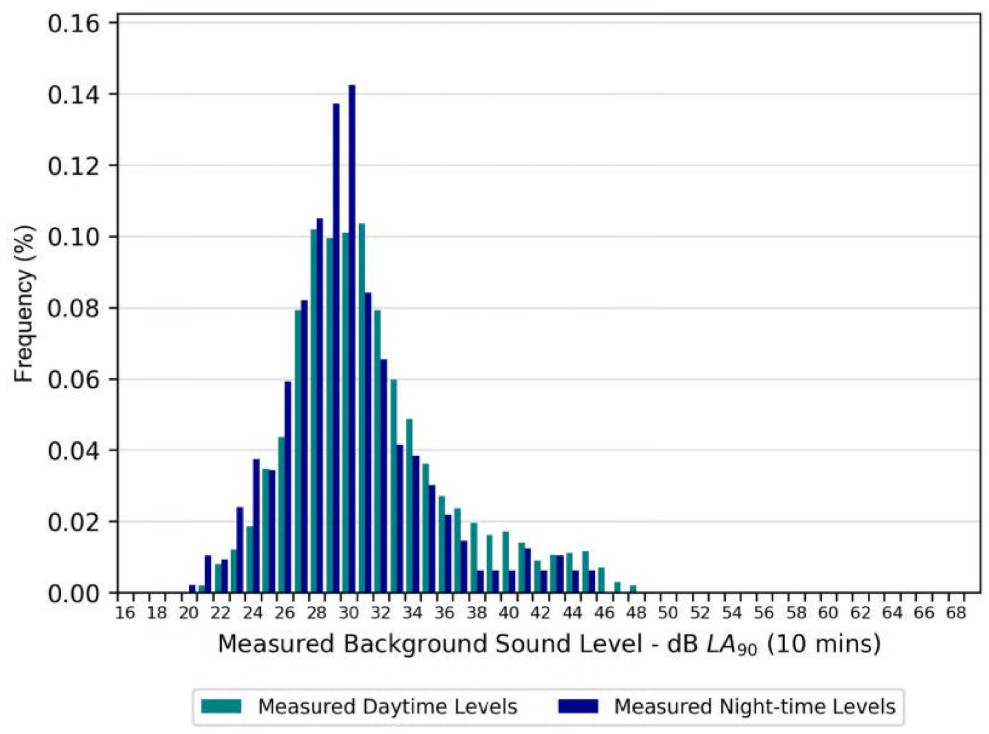
15990 - M74 West Renewable Energy Park - Measured Sound Levels:



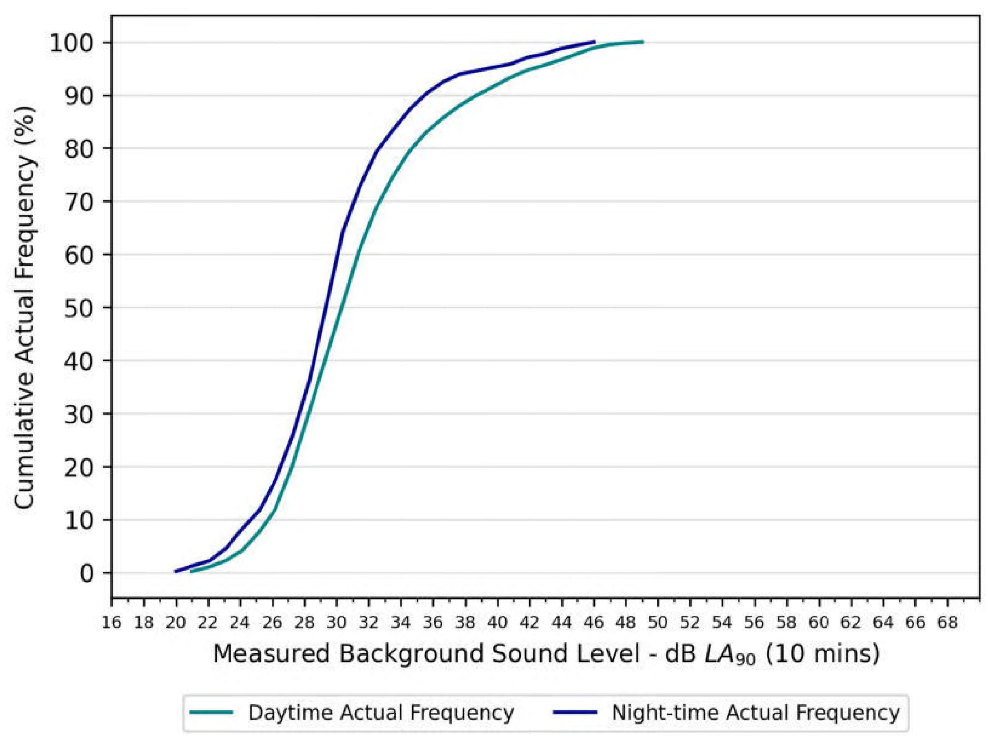


15990 - M74 West Renewable Energy Park - Measured Sound Levels:

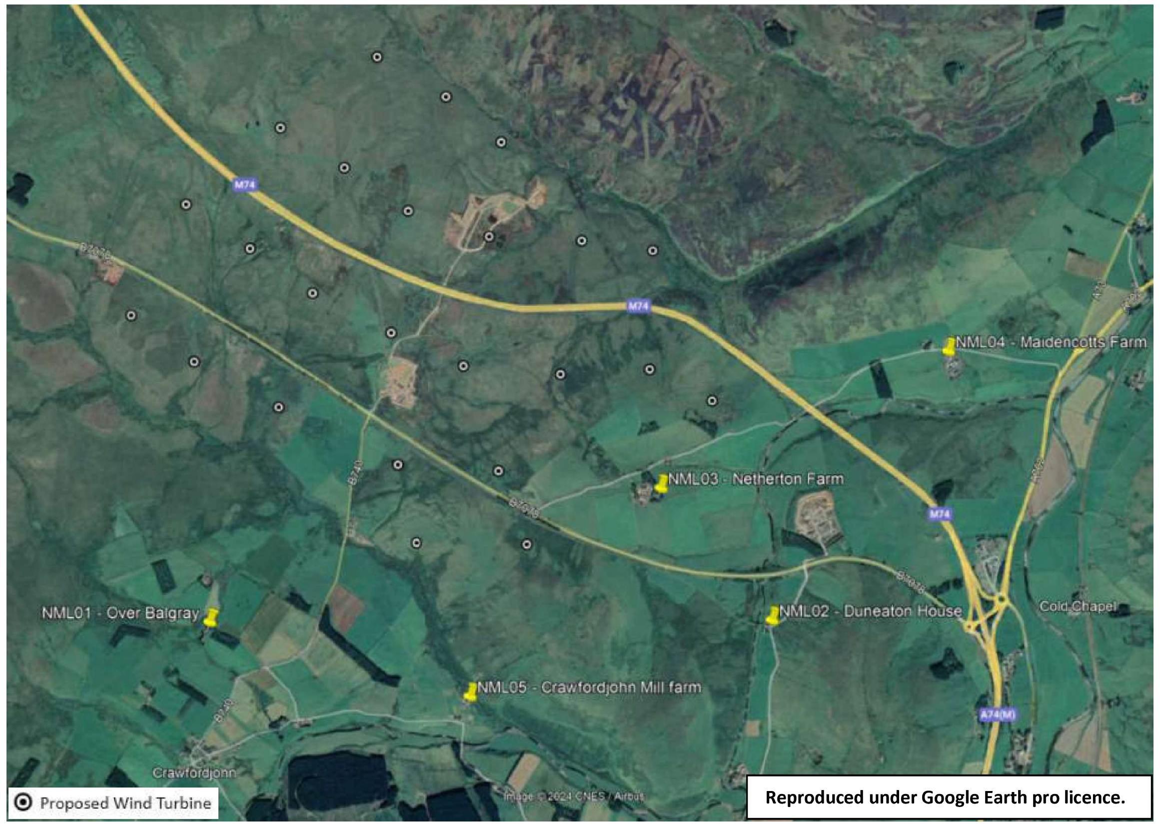
Statistical Analysis - NML05



Statistical Analysis - NML05



M74 West Baseline Noise Survey – Installed Noise Monitoring Locations



Reproduced under Google Earth pro licence.

Present during the installation:

- Tom Suddaby, Technical Consultant, TNEI Services Ltd (all Noise Monitoring Locations (NMLs)); and
- Mark Tideswell, Senior Consultant, TNEI Services Ltd (NML02 and NML03 only).

Unless specified, all noise kits 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. The EHO was made aware of all installation locations before staff attended site.

Detailed information and pictures for each of the installed locations are provided below. The original full-size pictures are available on request. Noise monitoring equipment was installed at two locations (NML02 and NML03) on 18th of January and the remaining three on the 30th of January 2024.

Noise Monitoring Locations (NMLs)

NML	Installation Location (BNG)
NML01 – Over Balgray	288047, 624648
NML02 – Duneaton House	291629, 624561
NML03 – Netherton Farm	290936, 625425
NML04 – Maidencotts Farm	292798, 626245
NML05 – Crawfordjohn Mill Farm	289688, 624128

NML01 – Over Balgray

North West	North East
	

South West	South east
	

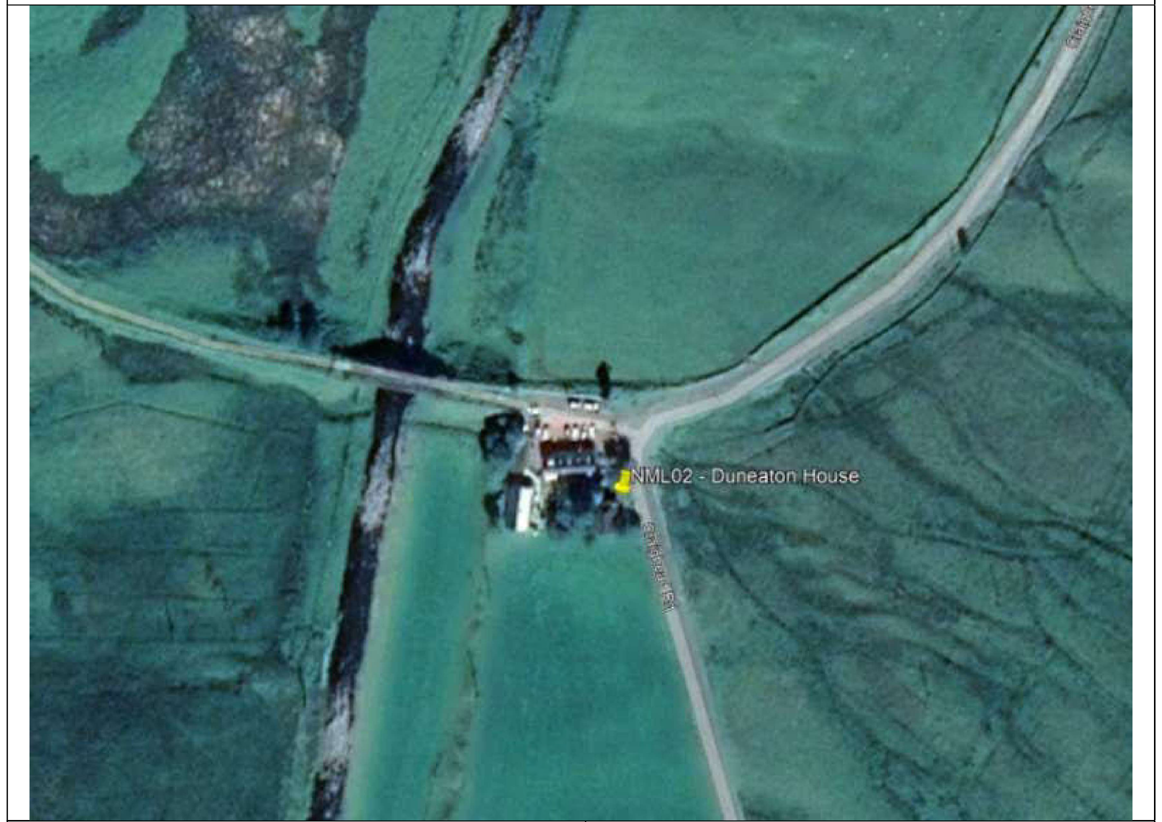
Description

Installed at NML01, located to the southwest of the proposed M74 development.

The resident requested the kit not be located in their garden, so the noise monitoring equipment was installed in the field to the south east of the property. This location is close to the driveway and amenity area of the property and less than 20m from the house, therefore is representative of the typical soundscape at the property.

The soundscape at this location consisted of distant road traffic noise from the M74 motorway and birdsong. Middle Muir Wind Farm to the west was not audible at the time of installation.

NML02 – Duneaton House



North	East